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A Custom Bibliography From the
NASA Scientific and Technical Information Program

October 2004

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This custom bibliography from the NASA Scientific and Technical Information Program lists a sampling of records found in the NASA Aeronautics and Space Database. The scope of this topic includes technologies for next-generation astronomical telescopes and detectors. This area of focus is one of the enabling technologies as defined by NASA's *Report of the President's Commission on Implementation of United States Space Exploration Policy*, published in June 2004.

OCTOBER 2004

20040121082 Ball Aerospace and Technologies Corp., Boulder, CO, USA
Final Results of the Ball AMSD Beryllium Mirror
Chaney, David M.; [2004]; In English, 17-19 Aug. 2004, Huntsville, AL, USA; No Copyright; Avail: Other Sources; Abstract Only

The 1.4-meter semi-rigid, beryllium Advanced Mirror System Demonstrator (AMSD) mirror completed initial cryogenic testing at Marshall's X-ray Calibration Facility (XRCF) in August of 2003. Results of this testing show the mirror to have very low cryogenic surface deformation and possess exceptional figure stability. Subsequent to this cryogenic testing beryllium was selected as the material of choice for the James Webb Space Telescope (JWST) multi-segment primary mirror. Therefore, the AMSD mirror was sent back to SSG-Tinsley for additional ambient polishing to JWST requirements. The mirror was successfully polished to less than 22nm rms of low frequency error. Those additional results are presented with comparisons to the JWST requirements.
Author
Beryllium; Cryogenics; Segmented Mirrors; James Webb Space Telescope

20040110276 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Integrated Modeling for the James Webb Space Telescope (JWST) Project: Structural Analysis Activities
Johnston, John; Mosier, Mark; Howard, Joe; Hyde, Tupper; Parrish, Keith; Ha, Kong; Liu, Frank; McGinnis, Mark; [2004]; In English; NASA/GSFC FEMCI Workshop, 6 May 2004, Greenbelt, MD, USA; Copyright; Avail: CASI; A02, Hardcopy

This paper presents viewgraphs about structural analysis activities and integrated modeling for the James Webb Space Telescope (JWST). The topics include: 1) JWST Overview; 2) Observatory Structural Models; 3) Integrated Performance Analysis; and 4) Future Work and Challenges.
CASI
James Webb Space Telescope; Structural Analysis; Mathematical Models; Space Missions; Systems Integration

20040110275 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Wavefront Sensing Using a Multi-Object Spectrograph (NIRSpec)
Dean, Bruce H.; Boucarut, Rene; Hadjimichael, Theo; Smith, Scott; [2004]; In English, 19-25 Jun. 2004, Glasgow, Scotland, UK; No Copyright; Avail: CASI; A03, Hardcopy

An analysis is presented that illustrates how the James Webb Space Telescope (JWST) fine-phasing process can be carried out using the Near-Infrared Spectrograph (NIRSpec) data collected at the science focal plane. The analysis considers a multi-plane diffraction model which properly accounts for the microshutter diffractive element placed at the first relay position of the spectrograph. Wavefront sensing results are presented based on data collected from the NASA Goddard Microshutter Testbed.
Author
Spectrographs; Wave Fronts; James Webb Space Telescope; Mirrors; Image Processing; Microelectromechanical Systems

20040110247 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Mission Concept for the Single Aperture Far-Infrared (SAFIR) Observatory
Benford, Dominic J.; Amato, Michael J.; Mather, John C.; Moseley, S. Harvey, Jr.; [2004]; In English; Copyright; Avail: Other Sources

We have developed a preliminary but comprehensive mission concept for SAFIR, as a 10 m-class far-infrared and submillimeter observatory that would begin development later in this decade to meet the needs outlined above. Its operating

temperature (\h or = 4K) and instrument complement would be optimized to reach the natural sky confusion limit in the far-infrared with diffraction-limited performance down to at least the atmospheric cutoff, lambda \g or approx. 40 microns. This would provide a point source sensitivity improvement of several orders of magnitude over that of the Spitzer Space Telescope (previously SIRTF) or the Herschel Space Observatory. Additionally, it would have an angular resolution 12 times finer than that of Spitzer and three times finer than Herschel. This sensitivity and angular resolution are necessary to perform imaging and spectroscopic studies of individual galaxies in the early universe. We have considered many aspects of the SAFIR mission, including the telescope technology (optical design, materials, and packaging), detector needs and technologies, cooling method and required technology developments, attitude and pointing, power systems, launch vehicle, and mission operations. The most challenging requirements for this mission are operating temperature and aperture size of the telescope, and the development of detector arrays. SAFIR can take advantage of much of the technology under development for JWST, but with much less stringent requirements on optical accuracy.
Author
Infrared Astronomy; Infrared Telescopes; Spaceborne Telescopes; Mission Planning

20040095901 Science Systems and Applications, Inc., Lanham, MD, USA, NASA Goddard Space Flight Center, Greenbelt, MD, USA
Wavefront Control Testbed (WCT) Experiment Results
Burns, Laura A.; Basinger, Scott A.; Campion, Scott D.; Faust, Jessica A.; Feinberg, Lee D.; Hayden, William L.; Lowman, Andrew E.; Ohara, Catherine M.; Petrone, Peter P., III, et al.; May 2004; In English, 21-25 Jun. 2004, Glasgow, Scotland, UK; Copyright; Avail: CASI; A03, Hardcopy

The Wavefront Control Testbed (WCT) was created to develop and test wavefront sensing and control algorithms and software for the segmented James Webb Space Telescope (JWST). Last year, we changed the system configuration from three sparse aperture segments to a filled aperture with three pie shaped segments. With this upgrade we have performed experiments on fine phasing with line-of-sight and segment-to-segment jitter, dispersed fringe visibility and grism angle;. high dynamic range tilt sensing; coarse phasing with large aberrations, and sampled sub-aperture testing. This paper reviews the results of these experiments.
Author
James Webb Space Telescope; Wave Fronts; Spaceborne Telescopes; Dynamic Range; Visual Perception

20040095307 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Optical Modeling Activities for the James Webb Space Telescope (JWST) Project, II, Determining Image Motion and Wavefront Error Over an Extended Field of View with a Segmented Optical System
Howard, Joseph M.; Ha, Kong Q.; [2004]; In English; No Copyright; Avail: Other Sources; Abstract Only

This is part two of a series on the optical modeling activities for JWST. Starting with the linear optical model discussed in part one, we develop centroid and wavefront error sensitivities for the special case of a segmented optical system such as JWST, where the primary mirror consists of 18 individual segments. Our approach extends standard sensitivity matrix methods used for systems consisting of monolithic optics, where the image motion is approximated by averaging ray coordinates at the image and residual wavefront error is determined with global tip/tilt removed. We develop an exact formulation using the linear optical model, and extend it to cover multiple field points for performance prediction at each instrument aboard JWST. This optical model is then driven by thermal and dynamic structural perturbations in an integrated modeling environment. Results are presented.
Author
James Webb Space Telescope; Models; Optical Activity; Image Motion Compensation; Wave Fronts; Errors

20040084295 Northrop Grumman Space Technology, Redondo Beach, CA, USA
Design and Development of the Primary and Secondary Mirror Deployment Systems for the Cryogenic JWST
Reynolds, Paul; Atkinson, Charlie; Gliman, Larry; 37th Aerospace Mechanisms Symposium; May 2004, 29-44; In English; No Copyright; Avail: CASI; A03, Hardcopy

With a 7-meter primary mirror (PM) aperture, the James Webb Space Telescope will require structures that remain stable to levels on the order of 10 nanometers out of plane under dynamic and thermal loading while operating at cryogenic temperatures. Moreover, the JWST will be the first telescope in space to deploy primary and secondary mirrors. The resulting primary mirror (PM) aperture will not only be segmented, but will have hinge-lines and associated latches. The secondary mirror will be deployed with folding booms that latch to support it approximately 7 m away from the PM. This paper describes

the design of the JWST Optical Telescope Element (OTE) structures and mechanisms, focusing primarily on the primary and secondary mirror deployment systems. It discusses the driving design requirements, how the resulting designs satisfy those requirements, and how the risk associated with these very large, stable, deployed structures was reduced through development and testing of the Development Optical Telescope Assembly (DOTA).
Author
James Webb Space Telescope; Mirrors; Cryogenic Temperature; Deployment

20040084061 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Integrated Modeling Activities for the James Webb Space Telescope (JWST): Structural-Thermal-Optical Analysis
Johnston, John D.; Parrish, Keith; Howard, Joseph M.; Mosier, Gary E.; McGinnis, Mark; Bluth, Marcel; Kim, Kevin; Ha, Hong Q.; January 2004; In English; SPIE Astronomical Telescopes Meeting, 21-25 Jun. 2004, Glasgow, Scotland, UK
Report No.(s): SPIE Paper 5487-123; Copyright; Avail: Other Sources; Abstract Only

This is a continuation of a series of papers on modeling activities for JWST. The structural-thermal- optical, often referred to as 'STOP', analysis process is used to predict the effect of thermal distortion on optical performance. The benchmark STOP analysis for JWST assesses the effect of an observatory slew on wavefront error. The paper begins an overview of multi-disciplinary engineering analysis, or integrated modeling, which is a critical element of the JWST mission. The STOP analysis process is then described. This process consists of the following steps: thermal analysis, structural analysis, and optical analysis. Temperatures predicted using geometric and thermal math models are mapped to the structural finite element model in order to predict thermally-induced deformations. Motions and deformations at optical surfaces are input to optical models and optical performance is predicted using either an optical ray trace or WFE estimation techniques based on prior ray traces or first order optics. Following the discussion of the analysis process, results based on models representing the design at the time of the System Requirements Review. In addition to baseline performance predictions, sensitivity studies are performed to assess modeling uncertainties. Of particular interest is the sensitivity of optical performance to uncertainties in temperature predictions and variations in metal properties. The paper concludes with a discussion of modeling uncertainty as it pertains to STOP analysis.
Author
James Webb Space Telescope; Structural Analysis; Thermal Analysis; Optical Properties; Temperature Distribution; Performance Prediction

20040082331 NASA Marshall Space Flight Center, Huntsville, AL, USA
AS04-AS02-133 Electroformed-Nickel Hard-X-Ray Optic Development at NASA/MSFC
Ramsey, Brian; Eisner, Ron; Engelhaupt, Darell; Gubarev, Mikhail; Kolodziejczak, Jeffrey; ODell, Stephen; Speegle, Chet; Weisskopf, Martin; [2004]; In English; Space Telescope Systems (UV-Gamma) Symposium: AS04 Astronomical Telescopes and Instrumentation, 21-25 Jun. 2004, Glasgow, Scotland, UK; Copyright; Avail: Other Sources; Abstract Only

We are developing the nickel electroforming process to fabricate high-quality mirrors for the region. Two applications for these optics are a balloon-borne payload, termed HERO, and a hard-X-ray telescope module for consideration for the Constellation-X mission. In the formation on shells, of 15 arcsec angular resolution, will provide over 200 sq cm of effective collecting area unprecedented sensitivity in the 20-75 keV region. A first flight of a partial payload, feature approximately 1/4 of the total collecting area, is scheduled for the Spring of 2004. In the Co-application, two mirror shells, of diameters 150 and 230 mm, are being fabricated. This is particularly challenging as high angular resolution must be maintained with shells of only 1 mm thickness (driven by the tight weight budget for the mission). Further, the shells must be low (less than 5 A on sub-micron spatial scales) to permit efficient use of planned multilayer coatings which must release cleanly from their forming mandrels without any surface degradation.
Author
X Ray Optics; Nickel; Electroforming; Fabrication

20040082314 NASA Marshall Space Flight Center, Huntsville, AL, USA
Mirror Requirements for SAFIR
Stahl, H. Philip; Leisawitz, David T.; Benford, Dominic J.; [2004]; In English, 21-25 Jun. 2004, Glasgow, Scotland, UK; No Copyright; Avail: Other Sources; Abstract Only

Large-aperture lightweight low-cost cryogenic mirrors are an enabling technology for planned NASA far-infrared and sub-millimeter missions such as CMB-Pol, SAFIR and SPECS. This paper examines d e mirror requirements necessary to design, build and characterize mirror segments for large space telescopes operating at temperatures of less than 1OK. Such

mirrors should be diffraction limited in the far-IR with an areal density of less than 10 kg/sq m, aperture of 1 to 2 meters and cost of less than $500,000 per square meter.
Author
Cryogenics; Mirrors; Far Infrared Radiation; Diffraction; Low Cost

20040082304 NASA Marshall Space Flight Center, Huntsville, AL, USA
James Webb Space Telescope (JWST) Primary Mirror Material Selection
Stahl, H. Philip; Feinberg, Lee D.; Russell, Kevin; Texter, Scott; [2004]; In English, 21-25 Jun. 2004, Glasgow, Scotland, UK; No Copyright; Avail: Other Sources; Abstract Only

The James Webb Space Telescope (JWST) conducted a phase down select process via the Advanced Mirror System Demonstrator (AMSD) project to assess the Technology Readiness Level of various candidate mirror materials. This process culminated in the selection of Beryllium as the JWST primary mirror material. This paper outlines the mirror evaluation process, defines the selection criteria and summarizes the candidate mirror's performances.
Derived from text
Mirrors; Optical Materials; James Webb Space Telescope; Evaluation; Optical Data Storage Materials

20040082113 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Navigation Concepts for the James Webb Space Telescope
Long, Anne; Leung, Dominic; Kelbel, David; Beckman, Mark; Grambling, Cheryl; [2003]; In English, 29-30 Oct. 2003, Greenbelt, MD, USA; No Copyright; Avail: CASI; A03, Hardcopy

This paper evaluates the performance that can be achieved using candidate ground and onboard navigation approaches for operation of the James Webb Space Telescope, which will be in an orbit about the Sun-Earth L2 libration point. The ground navigation approach processes standard range and Doppler measurements from the Deep Space Network The onboard navigation approach processes celestial object measurements and/or ground-to- spacecraft Doppler measurements to autonomously estimate the spacecraft s position and velocity and Doppler reference frequency. Particular attention is given to assessing the absolute position and velocity accuracy that can be achieved in the presence of the frequent spacecraft reorientations and momentum unloads planned for this mission. The ground navigation approach provides stable navigation solutions using a tracking schedule of one 30-minute contact per day. The onboard navigation approach that uses only optical quality celestial object measurements provides stable autonomous navigation solutions. This study indicates that unmodeled changes in the solar radiation pressure cross-sectional area and modeled momentum unload velocity changes are the major error sources. These errors can be mitigated by modeling these changes, by estimating corrections to compensate for the changes, or by including acceleration measurements.
Author
James Webb Space Telescope; Autonomous Navigation; Onboard Equipment; Optical Measurement; Space Navigation; Solar Radiation

20040081206 NASA Goddard Space Flight Center, Greenbelt, MD, USA
NASA's Far-Infrared/Submillimeter Roadmap Missions
Leisawitz, David; [2003]; In English, 30-31 Jan. 2003, Noordwijk, Netherlands; No Copyright; Avail: Other Sources; Abstract Only

Information vital to the attainment of the major scientific objectives of NASA's Origins and Structure and Evolution of the Universe themes is uniquely available in the far-IR and submillimeter (FIR/SMM). NASA is studying concepts and investing in technologies for FIR/SMM telescopes that could fly in the decade 2010 - 2020 and provide enormous increases in measurement capabilities to extend the legacy of the next-generation missions SIRTF and Herschel. Future FIR/SMM space observatories will have the sensitivity needed to reach back in time to the formation epoch of the first luminous objects, the angular resolution needed to image proto-planetary systems and distinguish the emissions of individual galaxies, and the spectral resolution needed to probe the physical conditions and measure the flows of interstellar gas in young galaxies, nascent stars, and the dust-enshrouded nuclei of galaxies that harbor massive black holes. NASA's infrared roadmap includes the JWST-class Single Aperture Far-IR (SAFIR) telescope and FIR/SMM interferometers. The talk will give the scientific motivation for these missions, describe mission concepts and telescope measurement capabilities, and compare these capabilities with those of the next-generation IR telescopes and with the complementary JWST and ALMA.
Author
Far Infrared Radiation; Submillimeter Waves; Spectral Resolution; Telescopes; Mission Planning

20040081165 NASA Goddard Space Flight Center, Greenbelt, MD, USA

Cryogenic Characterization and Testing of Magnetically-Actuated Microshutter Arrays for the James Webb Space Telescope

King, T. T.; Kletetschka, G.; Jah, M. A.; Li, M. J.; Jhabvala, M. D.; Wang, L. L.; Beamesderfer, M. A.; Kutyrev, A. S.; Silverberg, R. F.; Rapchun, D.; Schwinger, D. S., et al.; [2004]; In English, 6-10 Jun. 2004, Hilton Head, SC, USA; Original contains color and black and white illustrations; Copyright; Avail: CASI; A01, Hardcopy

Two-dimensional MEMS microshutter arrays (MSA) have been fabricated at the NASA Goddard Space Flight Center (GSFC) for the James Webb Space Telescope (JWST) to enable cryogenic (approximately 35 K) spectrographic astronomy measurements in the near-infrared region. Functioning as a focal plane object selection device, the MSA is a 2-D programmable aperture mask with fine resolution, high efficiency and high contrast. The MSA are close- packed silicon nitride shutters (cell size of 100 x 200 microns) patterned with a torsion flexure to allow opening to 90 degrees. A layer of magnetic material is deposited onto each shutter to permit magnetic actuation. Two electrodes are deposited, one onto each shutter and another onto the support structure side-wall, permitting electrostatic latching and 2-D addressing. New techniques were developed to test MSA under mission-similar conditions (8 K less than or equal to T less than 300K). The magnetic rotisserie has proven to be an excellent tool for rapid characterization of MSA. Tests conducted with the magnetic rotisserie method include accelerated cryogenic lifetesting of unpackaged 128 x 64 MSA and parallel measurement of the magneto-mechanical stiffness of shutters in pathfinder test samples containing multiple MSA designs. Lifetest results indicate a logarithmic failure rate out to approximately 10(exp 6) shutter actuations. These results have increased our understanding of failure mechanisms and provide a means to predict the overall reliability of MSA devices.

Author

Actuation; Cryogenics; James Webb Space Telescope; Microelectromechanical Systems; Fabrication; Magnetic Materials; Focal Plane Devices

20040079802 NASA Goddard Space Flight Center, Greenbelt, MD, USA

James Webb Space Telescope: Supporting Multiple Ground System Transitions in One Year

Detter, Ryan; Fatig, Curtis; Steck, Jane; [2004]; In English, 19-26 Jun. 2004, Glasgow, Scotland, UK; No Copyright; Avail: CASI; A02, Hardcopy

Ideas, requirements, and concepts developed during the very early phases of the mission design often conflict with the reality of a situation once the prime contractors are awarded. This happened for the James Webb Space Telescope (JWST) as well. The high level requirement of a common real-time ground system for both the Integration and Test (I&T), as well as the Operation phase of the mission is meant to reduce the cost and time needed later in the mission development for re-certification of databases, command and control systems, scripts, display pages, etc. In the case of JWST, the early Phase A flight software development needed a real-time ground system and database prior to the spacecraft prime contractor being selected. To compound the situation, the very low level requirements for the real-time ground system were not well defined. These two situations caused the initial real-time ground system to be switched out for a system that was previously used by the Bight software development team. To meet the high-!evel requirement, a third ground system was selected based on the prime spacecraft contractor needs and JWST Project decisions. The JWST ground system team has responded to each of these changes successfully. The lessons learned from each transition have not only made each transition smoother, but have also resolved issues earlier in the mission development than what would normally occur.

Author

James Webb Space Telescope; Software Engineering; Applications Programs (Computers); Certification; Command and Control; Computer Programming; Real Time Operation

20040079749 NASA Goddard Space Flight Center, Greenbelt, MD, USA

Large Format Arrays for Far Infrared and Millimeter Astronomy

Moseley, Harvey; 2004; In English, 5-8 Jan. 2004, Boulder, CO, USA; No Copyright; Avail: Other Sources; Abstract Only

Some of the most compelling questions in modem astronomy are best addressed with submillimeter and millimeter observations. The question of the role of inflation in the early evolution of the universe is best addressed with large sensitive arrays of millimeter polarimeters. The study of the first generations of galaxies requires sensitive submillimeter imaging, which can help us to understand the history of energy release and nucleosynthesis in the universe. Our ability to address these questions is dramatically increasing, driven by dramatic steps in the sensitivity and size of available detector arrays. While the MIPS instrument on the SIRTF mission will revolutionize far infrared astronomy with its 1024 element array of photoconductors, thermal detectors remain the dominant technology for submillimeter and millimeter imaging and polarimetry. The last decade has seen the deployment of increasingly large arrays of bolometers, ranging from the 48 element

arrays deployed on the KAO in the late 198Os, to the SHARC and SCUBA arrays in the 1990s. The past years have seen the deployment of a new generation of larger detector arrays in SHARC II (384 channels) and Bolocam (144 channels). These detectors are in operation and are beginning to make significant impacts on the field. Arrays of sensitive submillimeter bolometers on the SPIRE instrument on Herschel will allow the first large areas surveys of the sky, providing important insight into the evolution of galaxies. The next generation of detectors, led by SCUBA II, will increase the focal scale of these instruments by an order of magnitude. Two major missions are being planned by NASA for which further development of long wavelength detectors is essential, The SAFlR mission, a 10-m class telescope with large arrays of background limited detectors, will extend our reach into the epoch of initial galaxy formation. A major goal of modem cosmology is to test the inflationary paradigm in the early evolution of the universe. To this end, a mission is planned to detect the imprint of inflation on the CMB by precision measurement of its polarization. This work requires very large arrays of sensitive detectors which can provide unprecedented control of a wide range of systematic errors, given the small amplitude of the signal of interest. We will describe the current state of large format detector arrays, the performance requirements set by the new missions, and the different approaches being developed in the community to meet these requirements. We are confident that within a decade, these developments will lead to dramatic advances in our understanding of the evolution of the universe.
Author
Arrays; Far Infrared Radiation; Millimeter Waves; Infrared Astronomy

20040079371 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Fabrication of Microshutter Arrays for James Webb Space Telescope
Li, Mary J.; Zheng, Yun; Hess, Larry; Hu, Ron; Kelly, Dan; Lynch, Barney; Oh, Lance; Ray, Chris; Smith, Wayne; Babu, Sachi, et al.; [2004]; In English; No Copyright; Avail: Other Sources; Abstract Only

Two-dimensional MEMS microshutter arrays are being developed at NASA Goddard Space Flight Center for use in the near-infrared region on the Next Generation Space Telescope (NGST). The microshutter arrays are designed for the selective transmission of light with high efficiency and high contrast. The NGST environment requires cryogenic operation at 45K. Microshutter arrays are fabricated out of silicon-oxide-insulated (SOI) silicon wafers. Arrays are close-packed silicon nitride membranes with a pixel size of 100x100 microns. Individual shutters are patterned with a torsion flexure permitting shutters to open 90 degrees with a minimized mechanical stress concentration. The mechanical shutter arrays are fabricated using MEMS technologies. The processing includes a multi-layer metal deposition and patterning of shutter electrodes and magnetic pads, reactive ion etching (RE) of the front side to form shutters out of the nitride membrane, an anisotropic back-etch for wafer thinning, followed by a deep RIE (DRIE) back-etch down to the nitride shutter membrane to form frames and relieve shutters from the silicon substrate. An additional metal deposition and patterning is used to form back electrodes. Shutters are actuated using a magnetic force and latched using an electrostatic force.
Author
Microelectromechanical Systems; Etching; James Webb Space Telescope; Spaceborne Telescopes; Silicon Nitrides; Membranes; Electrostatics

20040077275 NASA Goddard Space Flight Center, Greenbelt, MD, USA
The James Webb Space Telscope
Mather, John C.; 2003; In English, 5-7 Nov. 2003, Cambridge, MA, USA; No Copyright; Avail: Other Sources; Abstract Only

The James Webb Space Telescope (JWST) will extend the discoveries of the Hubble Space Telescope by deploying a large cooled infrared telescope at the Sun-Earth Lagrange point L2. With a 6 m aperture and three instruments covering the wavelength range from 0.6 to 28 microns, it will provide sensitivities orders of magnitude better than any other facilities. It is intended to observe the light from the first galaxies and the first supernovae, the assembly of galaxies, and the formation and evolution of stars and planetary systems. In this talk I will review the scientific objectives, the hardware concepts and technology, and the predicted system performance.
Author
James Webb Space Telescope; Infrared Telescopes; Star Formation; Stellar Evolution; Supernovae

20040077273 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Detectors for the JWST Near-Infrared Spectrometer
Rauscher, B. J.; Strada, P.; Regan, M. W.; Figer, D. F.; Jakobsen, P.; Moseley, H. S.; Boeker, T.; 2004; In English, 3-9 Jan. 2004, Atlanta, GA, USA; Copyright; Avail: Other Sources; Abstract Only

The Near-Infrared Spectrometer (NIRSpec) places the most stringent demands upon its detectors of all James Webb Space

Telescope (JWST) instruments. We present the scientific rationale for challenging requirements including noise \hor=6 e- rms per exposure. In concert, we discuss laboratory test results that are informing the design of NIRSpec's detector system and operational concept.
Author
James Webb Space Telescope; Infrared Spectroscopy; Spectrometers

20040076587
Continuous cooling from 10 to 4 K using a toroidal ADR
DiPirro, Michael; Canavan, Edgar; Shirron, Peter; Tuttle, James; Cryogenics. 2003 Space Cryogenics Workshop; June/August 2004; ISSN 0011-2275; Volume 44, Issue no. 6-8, p. 559-564; In English; Copyright; Avail: Other Sources

Future large infrared space telescopes will require cooling to 4 K to achieve background limited performance for submillimeter wavelengths. These observatories will require lifetimes of many years and will have relatively large cooling requirements making stored helium dewars impractical. We have designed and are building an adiabatic demagnetization refrigerator (ADR) for use in cooling relatively large loads (10-100 mW) at 4 K and rejecting that heat to a cryocooler operating at 10 K. The ADR magnet consists of eight short coils wired in series and arranged in a toroid to provide self shielding of its magnetic field. We will use gas gap heat switches to alternately connect the toroid to the cold load and the warm heat sink. A small continuous stage will maintain the cold end at 4 K while the main toroid is recycled. (copyright) 2004 Published by Elsevier Ltd.
EI
Cooling; Cryogenic Cooling; Demagnetization; Electric Coils; Magnetic Fields; Solenoids; Submillimeter Waves

20040074321 TRW Space and Electronics Group, USA
An Infrared Telescope for Planet Detection and General Astrophysics
Lillie, C. F.; Atkinson, C. B.; Casement, L. S.; Flannery, M. R.; Kroening, K. V.; Moses, S. L.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 214-223; In English
Contract(s)/Grant(s): JPL-1217284; No Copyright; Avail: CASI; A02, Hardcopy

NASA plans to launch a Terrestrial Planet Finder (TPF) mission in 2014 to detect and characterize Earth-like planets around nearby stars, perform comparative planetology studies, and obtain general astrophysics observations. During our recently completed a TPF Mission Architecture study for NASA/JPL we developed the conceptual design for a 28-meter telescope with an IR Coronagraph that meets these mission objectives. This telescope and the technology it embodies are directly applicable to future Far-IR and Submillimeter space missions. The detection of a 30th magnitude planet located within 50 milli-arc-seconds of a 5th (Visual) magnitude star is an exceptionally challenging objective. Observations in the thermal infrared (7-17 microns) are somewhat easier since the planet is 'only' 15(sup m) fainter than the star at these wavelengths, but many severe challenges must still be overcome. These challenges include: 1. Designing a coronagraph for star:planet separations less than or equal to lambda/D. 2. Developing the deployment scheme for a 28m space telescope that can fit in an existing launch vehicle payload fairing. 3. Generating configuration layouts for the IR telescope, coronagraph, spacecraft bus, sunshade, solar array, and high-gain antenna. 4. Providing: Structural stability to within 10 microns to support the optics. Thermal control to achieve the necessary structural stability, as well as providing a stable (approx. 30K) thermal environment for the optics. Dynamics isolation from potential jitter sources. 5. Minimizing launch mass to provide the maximum payload for the science mission Interfacing to an EELV Heavy launch vehicle, including acoustic and stress loads for the launch environment. 6. Identifying the key technologies (which can be developed by 2009) that will enable TPF mission to be performed. 7. Generating a manufacturing plan that will permit TPF to be developed at a reasonable cost and schedule. Many of these design challenges result in inherently conflicting requirements on the design of TPF. Drawing on our experience with large space telescopes such as the Chandra X-ray Observatory and the Next Generation Space Telescope, we have created a conceptual design for TPF that successfully meets these challenging requirements. This paper describes our solution to these challenges.
Author
Infrared Telescopes; Planet Detection; Astrophysics; Far Infrared Radiation; Temperature Control

20040074320 California Inst. of Tech., Pasadena, CA, USA
Future Developments in Far-IR and Submm Space Observations
Blain, Andrew W.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 86-89; In English; No Copyright; Avail: CASI; A01, Hardcopy

Recent observations have highlighted the importance of mid-and far-infrared surveys for studying galaxy evolution. A crucial step forward will be provided by moving to resolve galaxies at these wavelengths, and providing resolution better than 10 arcsec in order to reduce the effects of source confusion.
Author
Far Infrared Radiation; Submillimeter Waves; Galactic Evolution; Spaceborne Astronomy

20040074319 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Cryogenic Delay Line for Long-Baseline Interferometry in the Far-Infrared
Lawson, P. R.; Swain, M. R.; Dumont, P. J.; Moore, J. D.; Smythe, R. F.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 408-414; In English; No Copyright; Avail: CASI; A02, Hardcopy

We discuss the design, current status, and ongoing development of a cryogenic delay line for long-baseline direct-detection interferometry in the far-infrared.
Author
Cryogenics; Delay Lines

20040074318 California Univ., Berkeley, CA, USA
Future Far Infrared/Submillimeter Direct Detectors
Richards, P. L.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 325-328; In English; No Copyright; Avail: CASI; A01, Hardcopy

The new mission concepts developed at this workshop will require large format arrays (1024 or more) of direct detectors at far infrared and millimeter wavelengths. The present status of such detectors will be reviewed and new technologies will be described which promise to meet anticipated mission requirements.
Author
Far Infrared Radiation; Submillimeter Waves; Infrared Detectors

20040074317 UK Astronomy Technology Centre, UK
Detector Technology for SCUBA-2: The New Generation Submillimeter Imager for the JCMT
Duncan, W. D.; Holland, W. S.; Audley, M. D.; Kelly, B. D.; Gostick, D.; Peacocke, P. T.; MacIntosh, M. J.; Hodson, T.; Irwin, K. D.; Hilton, G., et al.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 295-300; In English; No Copyright; Avail: CASI; A02, Hardcopy

The contents include the following: 1. New Detector Technologies. Transition Edge sensors. Pixel modelling. Monolithic arrays. 2. Thermal conductance of the pixel. Multiplexed SQUID Readout. 3. Dark SQUID experiment. 4. SCUBA 2 instrument - 4K and 1K optics and array modules.
CASI
Detectors; Technology Assessment; Submillimeter Waves

20040074316 Universities Space Research Association, Moffett field, CA, USA
SOFIA: Current Performance and Future Instrument Upgrades
Sandell, Goeran; Wolf, Juergen; Davidson, Jacqueline; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 269-270; In English; No Copyright; Avail: CASI; A01, Hardcopy

The joint U.S. and German SOFIA project to develop and operate a 2.5-meter infrared airborne telescope in a Boeing 747-SP is now well into development. First science flights will begin in late 2004. Once fully operational the observatory will do 960 observing hours/year, with an expected lifetime of over 20 years. The advantages and drawbacks of an airborne observatory relative to space missions are briefly discussed, and the sensitivity, characteristics and science instrument complement are presented. SOFIA will take advantage of new technology development, which allows the observatory to upgrade or replace instruments when new technology, for example more sensitive detectors or larger arrays become available. Some examples of possible future instruments are discussed.
Author
SOFIA (Airborne Observatory); Infrared Telescopes; Space Missions; Spacecraft Instruments

20040074310 Composite Optics, Inc., San Diego, CA, USA

The Status of Composite Telescope Technology for Space Astronomy

Connell, Steve; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 438-444; In English; No Copyright; Avail: CASI; A02, Hardcopy

Carbon Fiber Reinforced Composites (CFRP) are promising material for segmented mirrors on spaceborne telescopes. A 2-meter Herschel telescope demonstrator is profiled in this viewgraph presentation, which shows the surface figure of the primary mirror through thermal cycling at Herschel temperatures.

CASI

Carbon Fibers; Fiber Composites; Spaceborne Telescopes

20040074309 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

BLAST: The Balloon-Borne Large Aperture Submillimeter Telescope

Devlin, Mark; Ade, Peter; Bock, Jamie; Dicker, Simon; Griffin, Matt; Gunderson, Josh; Halpern, Mark; Hargrave, Peter; Hughes, David; Klein, Jeff, et al.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 317-322; In English

Contract(s)/Grant(s): NRA-99-01-SPA-015; No Copyright; Avail: CASI; A02, Hardcopy

BLAST is the Balloon-borne Large-Aperture Sub-millimeter Telescope. It will fly from a Long Duration Balloon (LDB) platform from Antarctica. The telescope design incorporates a 2 m primary mirror with large-format bolometer arrays operating at 250, 350 and 500 microns. By providing the first sensitive large-area (10 sq. deg.) sub-mm surveys at these wavelengths, BLAST will address some of the most important galactic and cosmological questions regarding the formation and evolution of stars, galaxies and clusters. Galactic and extragalactic BLAST surveys will: (1) identify large numbers of high-redshift galaxies; (2) measure photometric redshifts, rest-frame FIR luminosities and star formation rates thereby constraining the evolutionary history of the galaxies that produce the FIR and sub-mm background; (3) measure cold pre-stellar sources associated with the earliest stages of star and planet formation; (4) make high-resolution maps of diffuse galactic emission over a wide range of galactic latitudes. In addition to achieving the above scientific goals, the exciting legacy of the BLAST LDB experiment will be a catalogue of 3000-5000 extragalactic sub-mm sources and a 100 sq. deg. sub-mm galactic plane survey. Multi-frequency follow-up observations from SIRTF, ASTRO-F, and Herschel, together with spectroscopic observations and sub-arcsecond imaging from ALMA are essential to understand the physical nature of the BLAST sources.

Author

Balloon-Borne Instruments; Bolometers; Galactic Evolution; Imaging Techniques; Telescopes

20040074308 New South Wales Univ., Sydney, Australia

Antarctica as a Stepping Stone to Space

Storey, J. W. V.; Burton, M. G.; Ashley, M. C. B.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 264-268; In English; No Copyright; Avail: CASI; A01, Hardcopy

The high Antarctic plateau offers a unique observing environment that is in many ways intermediate between earth and space. In the infrared, for example, the sky brightness is typically 10 to 100 times darker than at 'temperate' observatories. The sub-mm transmission is superior to that measured anywhere else on earth. However, perhaps the most important feature of Antarctica is the extraordinary stability of the upper atmosphere, which dramatically reduces scintillation and offers large gains in astrometric precision. In this presentation we will discuss the site-testing results to date, the science that can be best be done, and the technology demonstrators that can best be tested in Antarctica.

Author

Antarctic Regions; Astrometry; Aerospace Environments; Spaceborne Astronomy

20040074307 NASA Goddard Space Flight Center, Greenbelt, MD, USA

Complementarity of NGST, ALMA, and Far IR Space Observatories

Mather, John C.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 178-187; In English; No Copyright; Avail: CASI; A02, Hardcopy

The Next Generation Space Telescope (NGST) and the Atacama Large Millimeter Array (ALMA) will both start operations long before a new far IR observatory to follow SIRTF into space can be launched. What will be unknown even after they are operational, and what will a far IR space observatory be able to add? I will compare the telescope design concepts

and capabilities and the advertised scientific programs for the projects and attempt to forecast the research topics that will be at the forefront in 2010.
Author
Spaceborne Telescopes; Infrared Space Observatory (ISO)

20040074306 Smithsonian Astrophysical Observatory, Cambridge, MA, USA
SAFIR and Interstellar Medium Studies
Melnick, Gary; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 149-154; In English; No Copyright; Avail: CASI; A02, Hardcopy

The questions of greatest scientific interest addressable at far-infrared and submillimeter wavelengths at the time SAFIR would fly will have been shaped by the results from the Space Infrared Telescope Facility (SIRTF) and the Herschel Space Observatory (HSO) as well as ongoing studies using the Stratospheric Observatory for Infrared Astronomy (SOFIA) and the Atacama Large Millimeter Array (ALMA). In light of these other efforts, SAFIR must offer unique and compelling capabilities.
Author
Spatial Resolution; Astronomical Observatories

20040074304 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Community Plan for Far-Infrared/Submillimeter Space Astronomy
Ade, Peter; Akeson, Rachel; Ali, Shafinaz; Amato, Michael; Arendt, Richard; Baker, Charles; Benford, Dominic; Blain, Andrew; Bock, James; Borne, Kirk, et al.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, XV-XXVI; In English; No Copyright; Avail: CASI; A03, Hardcopy

This paper represents the consensus view of the 124 participants in the Second Workshop on New Concepts for Far-Infrared/Submillimeter Space Astronomy.We recommend that NASA pursue the vision for far-IR astronomy outlined in the NAS Decadal Survey, which said: A rational coordinated program for space optical and infrared astronomy would build on the experience gained with NGST1 to construct [a JWST-scale filled-aperture far-IR telescope SAFIR, and then ultimately, in the decade 2010 to 2020, build on the SAFIR, TPF, and SIM experience to assemble a space-based, far-infrared interferometer. SAFIR will study star formation in the young universe, the buildup of elements heavier than hydrogen over cosmic history, the process of galaxy formation, and the early phases of star formation, which occur behind a veil of dust that precludes detection at mid IR and shorter wavelengths. The far-infrared interferometer will resolve distant galaxies to study protogalaxy interactions and mergers and the processes that led to enhanced star formation activity and the formation of Active Galactic Nuclei, and will resolve protostars and debris disks in our Galaxy to study how stars and planetary systems form.
Derived from text
Spaceborne Astronomy; Infrared Interferometers; Infrared Astronomy

20040074303 Cologne Univ., Germany
Heterodyne Array Receiver Development at KOSMA
Heyminck, S.; Graf, U. U.; Michael, E. A.; Stanko, S.; Rabanus, D.; Honingh, C. E.; Jacobs, K.; Schieder, R.; Stutzki, J.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 359-369; In English
Contract(s)/Grant(s): DFG-SFB-494; BMBF-05-AH9PK1; No Copyright; Avail: CASI; A03, Hardcopy

We present an overview of the array receiver development in the KOSMA receiver group. The central topic of the presentation is the 16 element 40/810 GHz array SMART (SubMillimeter Array Receiver for Two frequencies), which has been installed at the KOSMA telescope on Gornergrat near Zermatt/Switzerland in September of 2001. The opto-mechanical design of this receiver makes intensive use of our CNC machining capabilities, both to produce special optical components like imaging phase gratings for LO multiplexing, and also to manufacture relatively large receiver sub-assemblies as monolithic integrated optics blocks. We use our standard waveguide SIS mixers as detectors and the KOSMA Array-AOS as backends. We give a short presentation of the receiver design and show results obtained with the instrument during its first astronomical observing season. Based on the good experience with SMART, we are using a similar approach for the design of STAR (SOFIA Terahertz Array Receiver), a 16 element 1.9 THz hot electron bolometer array, which we are currently developing.
Author
Heterodyning; Arrays; Receivers

20040074301 NASA Goddard Space Flight Center, Greenbelt, MD, USA

Technology Needs for Far-Infrared, Submillimeter, and Millimeter Missions

Moseley, S. Harvey; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 37-58; In English; No Copyright; Avail: CASI; A03, Hardcopy

SAFIR will: Study the important and relatively unexplored region of the spectrum between 30 and 300 m; Enable the study of galaxy formation and the earliest stage of star formation by revealing regions too enshrouded by dust to be studied by NGST; Be more than 100 times as sensitive as SIRTF or the European [Herschel] mission.SAFIR is projected to cost around $600M total. The decadal review committee recommends that $100M be allocated in this decade to start the SAFIR project, and that additional technology developments be funded separately: Far-Infrared Array Development ($10M) Refrigerators ($50M) Large, Lightweight Optics ($80M). Current developments are also described.

Derived from text

Infrared Telescopes; Resource Allocation; Design Optimization

20040074300 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

An Overview of the StarLight Mission

Lay, Oliver; Blackwood, Gary; Dubovitsky, Serge; Duren, Riley; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 224-234; In English; No Copyright; Avail: CASI; A03, Hardcopy

An overview of the Starlight Mission is presented. Mission summary: June 2006 launch to heliocentric orbit; Nominal 6 month mission with option of additional 6 month extension; Validate autonomous formation flying system: range control to 10 cm bearing, control to 4 arcmin; Demonstrate formation flying optical interferometry.The original 3 spacecraft design did not fit the budget. 2 spacecraft concept demonstrates all key areas of formation flying interferometry. Collector flown on the surface of a virtual paraboloid, with combiner at the focus. It Gives a baseline of 125 m with a fixed delay of only 14 m.

Derived from text

Spacecraft Design; Trajectory Control; Astronomical Interferometry

20040074298 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

The Millimeter-Wave Bolometric Interferometer

Ali, S.; Ade, P. A. R.; Bock, J. J.; Novak, G.; Piccirillo, L.; Timbie, P.; Tucker, G. S.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 309-316; In English; No Copyright; Avail: CASI; A02, Hardcopy

The Millimeter-wave Bolometric Interferometer (MBI) is a proposed ground-based instrument designed for a wide range of cosmological and astrophysical observations including studies of the polarization of the cosmic microwave background (CMB). MBI combines the advantages of two well-developed technologies - interferometers and bolometric detectors. Interferometers have many advantages over .filled-aperture telescopes and are particularly suitable for high resolution imaging. Cooled bolometers are the highest sensitivity detectors at millimeter and sub-millimeter wavelengths. The combination of these two technologies results in an instrument with both high sensitivity and high angular resolution.

Author

Millimeter Waves; Bolometers; Interferometers

20040074297 NASA Goddard Space Flight Center, Greenbelt, MD, USA

Ideal Integrating Bolometer

Kogut, A.; DiPirro, M.; Moseley, S. H.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 342-348; In English; No Copyright; Avail: CASI; A02, Hardcopy

We describe a new 'ideal integrator' bolometer as a prototype for a new generation of sensitive, flexible far-IR detectors suitable for use in large arrays. The combination of a non-dissipative sensor coupled with a fast heat switch provides breakthrough capabilities in both sensitivity and operation. The bolometer temperature varies linearly with the integrated infrared power incident on the detector, and may be sampled intermittently without loss of information between samples. The sample speed and consequent dynamic range depend only on the heat switch reset cycle and can be selected in software. Between samples, the device acts as an ideal integrator with noise significantly lower than resistive bolometers. Since there is no loss of information between samples, the device is well-suited for large arrays. A single SQUID readout could process an entire column of detectors, greatly reducing the complexity, power requirements, and cost of readout electronics for large pixel arrays.

Author

Bolometers; Far Infrared Radiation; Sensitivity; Prototypes

20040074296 California Inst. of Tech., Pasadena, CA, USA

The Role of Coherent Detection

Zmuidzinas, J.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 329-341; In English; No Copyright; Avail: CASI; A03, Hardcopy

Many interesting astronomical objects, such as galaxies, molecular clouds, PDRs, star - forming regions, protostars, evolved stars, planets, and comets, have rich submillimeter spectra. In order to avoid line blending, and to be able to resolve the line shape, it is often necessary to measure these spectra at high resolution. This paper discusses the relative advantages and limitations of coherent and direct detection for high resolution spectroscopy in the submillimeter and far - infrared. In principle, direct detection has a fundamental sensitivity advantage. In practice, it is di.cult to realize this advantage given the sensitivities of existing detectors and reasonable constraints on the instrument volume. Thus, coherent detection can be expected to play an important role in submillimeter and far - infrared astrophysics well into the future.

Author

Comets; Detection; Far Infrared Radiation; High Resolution; Line Shape; Spectroscopy; Submillimeter Waves

20040074295 NASA, Washington, DC, USA

The Lunar L1 Gateway Concept: Supporting Future Major Space Science Facilities

Thronson, H.; Geffre, J.; Prusha, S.; Caroff, L.; Weisbin, C., et al.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 259-263; In English; No Copyright; Avail: CASI; A01, Hardcopy

We report here on a series of ongoing studies to evaluate alternative architectures for future space science facilities and how robots, humans, and autonomous systems might be optimally used to support them. This presentation outlines one scenario -- a 'Gateway' at the Earth-Moon L1 point for supporting multiple options beyond Low Earth Orbit -- plus our process for evaluating human/robotic activities to construct telescopes.

Derived from text

Evaluation; Architecture (Computers); Support Systems

20040074294 NASA Goddard Space Flight Center, Greenbelt, MD, USA

Charting the Winds that Change the Universe, II: The Single Aperture Far Infrared Observatory (SAFIR)

Rieke, G. H.; Benford, D. J.; Harvey, P. M.; Lawrence, C. R.; Leisawitz, D. T.; Lester, D. F.; Mather, J. C.; Stacey, G. J.; Werner, M. W.; Yorke, H. W.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 157-166; In English; No Copyright; Avail: CASI; A02, Hardcopy

SAFIR will study the birth and evolution of stars and planetary systems so young that they are invisible to optical and near-infrared telescopes such as NGST. Not only does the far-infrared radiation penetrate the obscuring dust clouds that surround these systems, but the protoplanetary disks also emit much of their radiation in the far infrared. Furthermore, the dust reprocesses much of the optical emission from the newly forming stars into this wavelength band. Similarly, the obscured central regions of galaxies, which harbor massive black holes and huge bursts of star formation, can be seen and analyzed in the far infrared. SAFIR will have the sensitivity to see the first dusty galaxies in the universe. For studies of both star-forming regions in our galaxy and dusty galaxies at high redshifts, SAFIR will be essential in tying together information that NGST will obtain on these systems at shorter wavelengths and that ALMA will obtain at longer wavelengths.

Author

Black Holes (Astronomy); Astronomical Observatories; Infrared Astronomy

20040074291 NASA Goddard Space Flight Center, Greenbelt, MD, USA

Progress Towards High-Sensitivity Arrays of Detectors of Sub-mm Radiation Using Superconducting Tunnel Junctions with Integrated Radio Frequency Single-Electron Transistors

Stevenson, T. R.; Hsieh, W.-T.; Li, M. J.; Prober, D. E.; Rhee, K. W.; Schoelkopf, R. J.; Stahle, C. M.; Teufel, J.; Wollack, E. J.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 349-358; In English

Contract(s)/Grant(s): NSG5-8589; No Copyright; Avail: CASI; A02, Hardcopy

For high resolution imaging and spectroscopy in the FIR and submillimeter, space observatories will demand sensitive, fast, compact, low-power detector arrays with 104 pixels and sensitivity less than 10(exp -20) W/Hz(sup 0.5). Antenna-coupled superconducting tunnel junctions with integrated rf single-electron transistor readout amplifiers have the potential for achieving this high level of sensitivity, and can take advantage of an rf multiplexing technique. The device consists of an antenna to couple radiation into a small superconducting volume and cause quasiparticle excitations, and a single-electron transistor to measure current through junctions contacting the absorber. We describe optimization of device parameters, and

results on fabrication techniques for producing devices with high yield for detector arrays. We also present modeling of expected saturation power levels, antenna coupling, and rf multiplexing schemes.
Author
Antenna Couplers; High Resolution; Imaging Techniques; Submillimeter Waves

20040074290 Max-Planck-Inst. fuer Extraterrestrische Physik, Garching, Germany
Integral Field Spectroscopy in the Far Infrared
Poglitsch, Albrecht; Geis, Norbert; Looney, Leslie; Raab, Walfried; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 301-308; In English; No Copyright; Avail: CASI; A02, Hardcopy

We are presently building far-infrared integral field spectrometers for Herschel (PACS) and SOFIA (FIFI LS). These have become possible by: (1) the development of relatively large, low noise photoconductor arrays and their associated cryogenic readout electronics and (2) a novel design for a reflective image slicer which - compared to equivalent designs in the visible or near-infrared - leads to a very compact unit capable of handling the large etendue (A(Omega)) required in a diffraction limited FIR system. In conjunction with a moderate size (30 cm x 8 cm) grating this concept allows for moderate resolution (R approx. 2000), imaging spectroscopy perfectly suited for extragalactic astronomy. If we project the recent progress in detector development (photoconductors and bolometers) in terms of number of pixels and sensitivity into the near future then this instrument concept could be readily extended in two ways which could contribute significantly to the scientific success of SAFIR: A line spectrometer with an instantaneous spectral coverage of a modest number of resolutions elements but a large field of view would ideally complement the photometric imaging capabilities of the mission for objects that can be spatially resolved. Applications could be spectral line maps of galaxies which would allow detailed diagnostics of phenomena like sequential star formation, galaxy interaction, and nuclear activity. Complementary to this, a small field of view in combination with very broad spectral coverage would be ideally suited for pointing-uncertainty tolerant spectroscopy, including spectroscopic redshift determination, of galaxies in the early universe, with the goal to study their formation and evolution (star formation and AGN formation).
Author
Spectroscopy; Far Infrared Radiation; Imaging Techniques

20040074285 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Least-Squares Self-Calibration of Imaging Array Data
Arendt, R. G.; Moseley, S. H.; Fixsen, D. J.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 382-390; In English; No Copyright; Avail: CASI; A02, Hardcopy

When arrays are used to collect multiple appropriately-dithered images of the same region of sky, the resulting data set can be calibrated using a least-squares minimization procedure that determines the optimal fit between the data and a model of that data. The model parameters include the desired sky intensities as well as instrument parameters such as pixel-to-pixel gains and offsets. The least-squares solution simultaneously provides the formal error estimates for the model parameters. With a suitable observing strategy, the need for separate calibration observations is reduced or eliminated. We show examples of this calibration technique applied to HST NICMOS observations of the Hubble Deep Fields and simulated SIRTF IRAC observations.
Author
Calibrating; Imaging Techniques; Least Squares Method

20040074284 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
WaFIRS, a Waveguide Far-IR Spectrometer: Enabling Space-Borne Spectroscopy of High-z Galaxies in the Far-IR and Submm
Bradford, C. M.; Bock, J. J.; Dragovan, M.; Earle, L.; Glenn, J.; Naylor, B.; Nguyen, H.; Zmuidzinas, J.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 285-294; In English; No Copyright; Avail: CASI; A02, Hardcopy

The discovery of galaxies beyond z approximately equal to 1 which emit the bulk of their luminosity at long wavelengths has demonstrated the need for high sensitivity, broadband spectroscopy in the far-IR/submm/mm bands. Because many of these sources are not detectable in the optical, long wavelength spectroscopy is key to measuring their redshifts and ISM conditions. The continuum source list will increase in the next decade with new ground-based instruments (SCUBA2, Bolocam, MAMBO) and the surveys of HSO and SIRTF. Yet the planned spectroscopic capabilities lag behind, primarily due to the difficulty in scaling existing IR spectrograph designs to longer wavelengths. To overcome these limitations, we are

developing WaFIRS, a novel concept for long-wavelength spectroscopy which utilizes a parallel-plate waveguide and a curved diffraction grating. WaFIRS provides the large (approximately 60%) instantaneous bandwidth and high throughput of a conventional grating system, but offers a dramatic reduction in volume and mass. WaFIRS requires no space overheads for extra optical elements beyond the diffraction grating itself, and is two-dimensional because the propagation is confined between two parallel plates. Thus several modules could be stacked to multiplex either spatially or in different frequency bands. The size and mass savings provide opportunities for spectroscopy from space-borne observatories which would be impractical with conventional spectrographs. With background-limited detectors and a cooled 3.5 telescope, the line sensitivity would be better than that of ALMA, with instantaneous broad-band coverage. We have built and tested a WaFIRS prototype for 1-1.6 mm, and are currently constructing Z-Spec, a 100 mK model to be used as a ground-based lambda/DELTAlambda approximately equal to 350 submillimeter galaxy redshift machine.
Author
Galaxies; Spectroscopy; Submillimeter Waves; Far Infrared Radiation; Waveguides; Spaceborne Astronomy; Spectrometers

20040074283 NASA Goddard Space Flight Center, Greenbelt, MD, USA
TES Detector Noise Limited Readout Using SQUID Multiplexers
Staguhn, J. G.; Benford, D. J.; Chervenak, J. A.; Khan, S. A.; Moseley, S. H.; Shafer, R. A.; Deiker, S.; Grossman, E. N.; Hilton, G. C.; Irwin, K. D., et al.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 370-373; In English; No Copyright; Avail: CASI; A01, Hardcopy

The availability of superconducting Transition Edge Sensors (TES) with large numbers of individual detector pixels requires multiplexers for efficient readout. The use of multiplexers reduces the number of wires needed between the cryogenic electronics and the room temperature electronics and cuts the number of required cryogenic amplifiers. We are using an 8 channel SQUID multiplexer to read out one-dimensional TES arrays which are used for submillimeter astronomical observations. We present results from test measurements which show that the low noise level of the SQUID multiplexers allows accurate measurements of the TES Johnson noise, and that in operation, the readout noise is dominated by the detector noise. Multiplexers for large number of channels require a large bandwidth for the multiplexed readout signal. We discuss the resulting implications for the noise performance of these multiplexers which will be used for the readout of two dimensional TES arrays in next generation instruments.
Author
Sensors; Superconductivity; Submillimeter Waves; Readout; Noise Intensity

20040074282 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Dual Transition Edge Sensor Bolometer for Enhanced Dynamic Range
Chervenak, J. A.; Benford, D. J.; Moseley, S. H.; Irwin, K. D.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 378-381; In English; No Copyright; Avail: CASI; A01, Hardcopy

Broadband surveys at the millimeter and submillimeter wavelengths will require bolometers that can reach new limits of sensitivity and also operate under high background conditions. To address this need, we present results on a dual transition edge sensor (TES) device with two operating modes: one for low background, ultrasensitive detection and one for high background, enhanced dynamic range detection. The device consists of a detector element with two transition temperatures (T(sub c)) of 0.25 and 0.51 K located on the same micromachined, thermally isolated membrane structure. It can be biased on either transition, and features phonon-limited noise performance at the lower T(sub c). We measure noise performance on the lower transition 7 x 10(exp -18) W/rt(Hz) and the bias power on the upper transition of 12.5 pW, giving a factor of 10 enhancement of the dynamic range for the device. We discuss the biasable range of this type of device and present a design concept to optimize utility of the device.
Author
Bolometers; Dynamic Range; Bias; Superconducting Devices

20040074281 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Maximizing Science Capability for Far-Infrared Space Missions
Benford, Dominic; Leisawitz, Dave; Moseley, Harvey; Staguhn, Johannes; Voellmer, George; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 278-282; In English; No Copyright; Avail: CASI; A01, Hardcopy

The far-infrared and submillimeter region (20 microns-800 microns) has perhaps the greatest potential of all wavelengths for advancement in astronomy. When viewed in terms of the cosmic backgrounds, the far-IR is extremely important: half of the total luminosity in the Universe is emitted at rest wavelengths approximately 80-100 microns. At the highest known galaxy

redshifts (z approximately equal to 6) this energy is redshifted to approximately 600 microns. Existing and planned missions have a broad range of capabilities, defined in terms of their spectral coverage, spectral resolution, angular resolution, mapping speed, and sensitivity. In this 5-dimensional parameter space, the far-IR is substantially be-hind most other wavelength bands. The opportunity for future missions with great discovery potential is evident. Such missions will be well-suited to answering fundamental questions about the history of energy release in the Universe, the formation and evolution of galaxies, and formation of stellar and protoplanetary systems. We discuss the parameter space that can be filled by a few well-chosen space missions, specifically a submillimeter all-sky survey and a far-IR to submillimeter observatory. Ultimately, a long baseline submillimeter interferometer is necessary to provide sensitivity and angular resolution.
Author
Far Infrared Radiation; Space Missions; Submillimeter Waves; Sky Surveys (Astronomy); Spaceborne Astronomy

20040074279 NASA Goddard Space Flight Center, Greenbelt, MD, USA
First Astronomical Use of Multiplexed Transition Edge Sensor Bolometers
Staguhn, J. G.; Ames, T. A.; Benford, D. J.; Chervenak, J. A.; Grossman, E. N.; Irwin, K. D.; Khan, S. A.; Maffei, B.; Moseley, S. H.; Pajot, F., et al.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 374-377; In English; No Copyright; Avail: CASI; A01, Hardcopy

We present performance results based on the first astronomical use of multiplexed superconducting bolometers. The Fabry-Perot Interferometer Bolometer Research Experiment (FIBRE) is a broadband submillimeter spectrometer that achieved first light in June 2001 at the Caltech Submillimeter Observatory (CSO). FIBRE's detectors are superconducting transition edge sensor (TES) bolometers read out by a SQUID multiplexer. The Fabry-Perot uses a low resolution grating to order sort the incoming light. A linear bolometer array consisting of 16 elements detects this dispersed light, capturing 5 orders simultaneously from one position on the sky. With tuning of the Fabry-Perot over one free spectral range, a spectrum covering Delta lambda/lambda = 1/7 at a resolution of delta lambda/lambda approx. 1/1200 can be acquired. This spectral resolution is sufficient to resolve Doppler-broadened line emission from external galaxies. FIBRE operates in the 350 m and 450 m bands. These bands cover line emission from the important star formation tracers neutral carbon (CI) and carbon monoxide (CO). We have verified that the multiplexed bolometers are photon noise limited even with the low power present in moderate resolution spectrometry.
Author
Bolometers; Multiplexing; Fabry-Perot Interferometers; Spectrometers

20040074278 European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands
The Herschel Mission
Pilbratt, Goeran; deGraauw, Thijs; Griffin, Matt; Poglitsch, Albrecht; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 256-258; In English; No Copyright; Avail: CASI; A01, Hardcopy

The Herschel Space Observatory (formerly known as FIRST) is the fourth cornerstone mission in the European Space Agency (ESA) science programme. It will perform imaging photometry and spectroscopy in the far infrared and submillimetre part of the spectrum, covering approximately the 60-670 micron range. The key science objectives emphasize current questions connected to the formation of galaxies and stars, however, having unique capabilities in several ways, Herschel will be a facility available to the entire astronomical community. The three Herschel payload instruments and their capabilities are briefly described.
Author
Space Missions; Astronomical Observatories; Spectrometers; Spaceborne Telescopes; European Space Agency

20040074277 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Science Questions for the Post-SIRTF and Herschel Era
Werner, Michael; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 23-36; In English; No Copyright; Avail: CASI; A03, Hardcopy

The contents include the following: 1. SIRTF. Long wavelength surveys planned for SIRTF. Galaxy Discovery Rates for Future Missions. Impact of SIRTF s Improved Resolution at 160um: Resolving the Background. 2. Polarimetry. Submillimeter Polarimetry - The State of Play. Magnetic Vectors Across the Orion Molecular Cloud Core. Neutral and Ionized Molecular Spectral Lines. Variation of Polarization With Wavelength. The Polarization Spectrum. Submillimeter Polarimetry - Looking Ahead. 3.Confusion. Confusion at 500, 600 micron. 4. Extragalactic Science. Do Massive Black Holes and Galaxy Bulges form Together? 5. Galactic Science. Can We See the First Generations of Stars and Metal Formation? The Birth of Planets

and the Origins of Life. Spatial Resolution at 100 microns. Far-ir/Sub-mm Transitions of Linear Carbon Clusters. Predicted Spectra of Glycine.
Derived from text
Biological Evolution; Black Holes (Astronomy); Line Spectra; Molecular Clouds; Spatial Resolution

20040074276 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Cryo-Infrared Optical Characterization at NASA GSFC
Boucarut, Ray; Quijada, Manuel A.; Henry, Ross M.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 428-437; In English; No Copyright; Avail: CASI; A02, Hardcopy

The development of large space infrared optical systems, such as the Next Generation Space Telescope (NGST), has increased requirements for measurement accuracy in the optical properties of materials. Many materials used as optical components in infrared optical systems, have strong temperature dependence in their optical properties. Unfortunately, data on the temperature dependence of most of these materials is sparse. In this paper, we provide a description of the capabilities existing in the Optics Branch at the Goddard Space Flight Center that enable the characterization of the refractive index and absorption coefficient changes and other optical properties in infrared materials at cryogenic temperatures. Details of the experimental apparatus, which include continuous flow liquid helium optical cryostat, and a Fourier Transform Infrared (FTIR) spectrometer are discussed.
Author
Cryogenics; Optical Equipment; Optical Properties; Infrared Spectrometers

20040074275 NASA Goddard Space Flight Center, Greenbelt, MD, USA
The Wide-Field Imaging Interferometry Testbed: Progress and Plans
Rinehart, S. A.; Leisawitz, D.; Leviton, D.; Martino, A.; Maynard, W.; Mundy, L. G.; Zhang, X.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 421-427; In English; No Copyright; Avail: CASI; A02, Hardcopy

We describe the technique of wide field mosaic imaging for optical/IR interferometers and present early experimental results from a laboratory instrument designed to validate, experiment with, and refine the technique. A conventional single-detector stellar interferometer operating with narrow bandwidth at center wavelength lambda is limited in its field of view to the primary beam of the individual telescope apertures, or approx. lambda/D(sub tel) radians, where is the telescope diameter. Such a field is too small for many applications; often one wishes to image extended sources. We are developing and testing a technique analogous to the mosaic method employed in millimeter and radio astronomy, but applicable to optical/IR Michelson interferometers, in which beam combination is done in the pupil plane. An N(sub pix) x N(sub pix) detector array placed in the image plane of the interferometer is used to record simultaneously the fringe patterns from many contiguous telescope fields, effectively multiplying the field size by N(sub pix)/2, where the factor 2 allows for Nyquist sampling. This mosaic imaging technique will be especially valuable for far IR and submillimeter interferometric space observatories such as the Space Infrared Interferometric Telescope (SPIRIT) and the Submillimeter Probe of the Evolution of Cosmic Structure (SPECS). SPIRIT and SPECS will be designed to provide sensitive, high angular resolution observations of fields several arcminutes in diameter, and views of the universe complementary to those provided by HST, NGST, and ALMA.
Author
Interferometers; Image Analysis; Mosaics; Optical Equipment; Imaging Techniques

20040074274 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
The DART System for Far-IR/Submillimeter Space Missions
Dragovan, Mark, et al.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 415-420; In English; No Copyright; Avail: CASI; A02, Hardcopy

The DART is a system of two cylindrical-parabolic reflectors. One reflector will produce a line focus; two reflectors properly oriented will produce a point focus. For far-infrared/submillimeter missions, the DART presents a compelling new telescope architecture that is scalable to alrge apertures, and with it's large membrane area is well suited to passive cooling.
Author
Reflecting Telescopes; Parabolic Reflectors

20040074273 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Wavefront Sensing and Control Technology for Submillimeter and Far-Infrared Space Telescopes
Redding, Dave; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 393-407; In English; No Copyright; Avail: CASI; A03, Hardcopy

The NGST wavefront sensing and control system will be developed to TRL6 over the next few years, including testing in a cryogenic vacuum environment with traceable hardware. Doing this in the far-infrared and submillimeter is probably easier, as some aspects of the problem scale with wavelength, and the telescope is likely to have a more stable environment; however, detectors may present small complications. Since this is a new system approach, it warrants a new look. For instance, a large space telescope based on the DART membrane mirror design requires a new actuation approach. Other mirror and actuation technologies may prove useful as well.
Author
Membranes; Mirrors; Submillimeter Waves

20040074272 National Radio Astronomy Observatory, Charlottesville, VA, USA
The Atacama Millimeter Array (ALMA): Imaging Cosmic Dawn at Near-THz Frequencies
Wootten, Alwyn; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 247-255; In English; No Copyright; Avail: CASI; A02, Hardcopy

The Atacama Large Millimeter Array, or ALMA, is an international telescope project which will be built over the coming decade in Northern Chile. With over 7000 square meters of collecting area comprised of 64 12m antennas arrayed over baselines up to 14 kilometers in extent, ALMA will provide images of unprecedented clarity and detail. One revolutionary feature of ALMA will be its ability to combine interferometric and single telescope data, providing complete flux recovery. ALMA will cover a spectral wavelength range from 7 mm to 0.3 mm or shorter wavelengths, providing astronomy with its first detailed look at the structures which emit Terahertz and subTerahertz photons, the most abundant photons in the Universe.
Author
Imaging Techniques; Telescopes; Cosmology; Spaceborne Astronomy; Frequency Ranges; Antenna Arrays

20040074271 Institute of Space and Astronautical Science, Sagamihara, Japan
Future Far-IR and Submm Missions: Japanese Perspective
Nakagawa, Takao; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 237-240; In English; No Copyright; Avail: CASI; A01, Hardcopy

We present the concept of the SPICA (Space Infrared Telescope for Cosmology and Astrophysics) mission, which incorporates a 3.5 m telescope cooled to 4.5 K. SPICA will focus on high-resolution mid-to far-infrared observations with unprecedented sensitivity. It will make great contributions to our understanding of important astronomical questions, such as the history of star-formation in the universe, the birth and evolution of AGN, the formation of planets in extrasolar systems, and the history of our solar system. In order to reduce the total weight dramatically, we propose a 'warm launch' cooled telescope concept; the telescope is to be launched at ambient temperature and is to be cooled in orbit to 4.5 K by a modest mechanical cooler system with the assistance of effective radiative cooling. SPICA is proposed to be launched into a halo orbit around S-E L2 in 2010.
Author
Far Infrared Radiation; Submillimeter Waves; Space Missions; Spaceborne Telescopes; Cosmology; Japan; Astrophysics

20040074270 Wales Univ. Inst. of Science and Technology, Cardiff, UK
Future Far-IR Mission and Submillimeter Space Missions: The European Perspective
Griffin, Matt; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 241-246; In English; No Copyright; Avail: CASI; A02, Hardcopy

The European astronomy and instrumentation community has a long history of participation in far-IR space astronomy satellites including IRAS, ISO, Herschel and Planck. While there are no specific far-IR/submillimetre missions in ESA's current long-term plan after Herschel and Planck, technology and design studies are currently underway, in connection with the IRSI-DARWIN infrared interferometer mission, which are relevant to any future FIR space observatory. In addition, following work on the Herschel, Planck, and NGST satellites, as well as many ground-based, balloon-borne and air-borne instruments, the European instrumentation community will have much to contribute at an international level to the next generation of far-IR/submillimetre missions. This includes the design and construction of large cryogenic focal plane units, optical design and stray light control, filter and quasi-optical component technology, cryogenic mechanisms, and large-format

detector arrays for imaging and spectroscopy. Instrumentation heritage and expertise will be complemented by a strong scientific enthusiasm amongst European astronomers to exploit the great astronomical potential of the far-IR and submillimetre range.
Author
Far Infrared Radiation; Submillimeter Waves; Space Missions; Europe; Spaceborne Astronomy; Observatories

20040074268 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Surveying Galaxy Evolution in the Far-Infrared: A Far-Infrared All-Sky Survey Concept
Benford, D. J.; Amato, M. J.; Dwek, E.; Freund, M. M.; Gardner, J. P.; Kashlinsky, A.; Leisawitz, D. T.; Mather, J. C.; Moseley, S. H.; Shafer, R. A., et al.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 188-193; In English; No Copyright; Avail: CASI; A02, Hardcopy

Half of the total luminosity in the Universe is emitted at rest wavelengths approximately 80-100 microns. At the highest known galaxy redshifts (z greater than or equal to 6) this energy is redshifted to approximately 600 microns. Quantifying the evolution of galaxies at these wavelengths is crucial to our understanding of the formation of structure in the Universe following the big bang. Surveying the whole sky will find the rare and unique objects, enabling follow-up observations. SIRCE, the Survey of Infrared Cosmic Evolution, is such a mission concept under study at NASA's Goddard Space Flight Center. A helium-cooled telescope with ultrasensitive detectors can image the whole sky to the confusion limit in 6 months. Multiple wavelength bands permit the extraction of photometric redshifts, while a large telescope yields a low confusion limit. We discuss the implications of such a survey for galaxy formation and evolution, large-scale structure, star formation, and the structure of interstellar dust.
Author
Galactic Evolution; Far Infrared Radiation; Sky Surveys (Astronomy); Spaceborne Astronomy

20040074266 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Formations of Tethered Spacecraft as Stable Platforms for Far IR and Sub-mm Astronomy
Quadrelli, Marco B.; Hadaegh, Fred Y.; Shao, Michael; Lorenzini, Enrico C.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 472-482; In English
Contract(s)/Grant(s): JPL-1215076; No Copyright; Avail: CASI; A03, Hardcopy

In this paper we describe current research in tethered formations for interferometry, and a roadmap to demonstrating the required key technologies via on-ground and in-orbit testing. We propose an integrated kilometer-size tethered spacecraft formation flying concept which enables Far IR and Sub-mm astronomy observations from space. A rather general model is used to predict the dynamics, control, and estimation performance of formations of spacecraft connected by tethers in LEO and deep space. These models include the orbital and tethered formation dynamics, environmental models, and models of the formation estimator/controller/commander. Both centralized and decentralized control/sensing/estimation schemes are possible, and dynamic ranges of interest for sensing/control are described. Key component/subsystem technologies are described which need both ground-based and in-orbit demonstration prior to their utilization in precision space interferometry missions using tethered formations. Defining an orbiting formation as an ensemble of orbiting spacecraft performing a cooperative task, recent work has demonstrated the validity of the tethering the spacecraft to provide both the required formation rigidity and satisfy the formation reconfiguration needs such as interferometer baseline control. In our concept, several vehicles are connected and move along the tether, so that to reposition them the connecting tether links must vary in length. This feature enables variable and precise baseline control while the system spins around the boresight. The control architecture features an interferometer configuration composed of one central combiner spacecraft and two aligned collector spacecraft. The combiner spacecraft acts as the formation leader and is also where the centralized sensing and estimation functions reside. Some of the issues analyzed with the model are: dynamic modes of deformation of the distributed structure, architecture of the formation sensor, and sources of dynamical perturbation that need to be mitigated for precision operation in space. Examples from numerical simulation of an envisioned scenario in heliocentric orbit demonstrate the potential of the concept for space interferometry.
Author
Tethered Satellites; Formation Flying; Astronomical Satellites; Infrared Astronomy; Radio Astronomy

20040074265 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Tethered Formation Configurations: Meeting the Scientific Objectives of Large Aperture and Interferometric Science
Farley, Rodger E.; Quinn, David A.; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 463-471; In English; No Copyright; Avail: CASI; A02, Hardcopy

With the success of the Hubble Space Telescope, it has become apparent that new frontiers of science and discovery are made every time an improvement in imaging resolution is made. For the HST working primarily in the visible and near-visible spectrum, this meant designing, building and launching a primary mirror approximately three meters in diameter. Conventional thinking tells us that accomplishing a comparable improvement in resolution at longer wavelengths for Earth and Space Science applications requires a corresponding increase in the size of the primary mirror. For wavelengths in the sub-millimeter range, a very large telescope with an effective aperture in excess of one kilometer in diameter would be needed to obtain high quality angular resolution. Realistically a single aperture this large is practically impossible. Fortunately such large apertures can be constructed synthetically. Possibly as few as three 3 - 4 meter diameter mirrors flying in precision formation could be used to collect light at these longer wavelengths permitting not only very large virtual aperture science to be carried out, but high-resolution interferometry as well. To ensure the longest possible mission duration, a system of tethered spacecraft will be needed to mitigate the need for a great deal of propellant. A spin-stabilized, tethered formation will likely meet these requirements. Several configurations have been proposed which possibly meet the needs of the Space Science community. This paper discusses two of them, weighing the relative pros and cons of each concept. The ultimate goal being to settle on a configuration which combines the best features of structure, tethers and formation flying to meet the ambitious requirements necessary to make future large synthetic aperture and interferometric science missions successful.
Author
Tethered Satellites; Astronomical Satellites; Formation Flying; Astronomical Interferometry; Synthetic Apertures

20040074264 NASA Goddard Space Flight Center, Greenbelt, MD, USA
A Continuous Adiabatic Demagnetization Refrigerator for Far-IR/Sub-mm Astronomy
Shirron, Peter; Canavan, Edgar; DiPirro, Michael; Jackson, Michael; King, Todd; Tuttle, James; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 454-460; In English; No Copyright; Avail: CASI; A02, Hardcopy

We report on recent progress in the development of a continuous adiabatic demagnetization refrigerator (CADR). Continuous operation avoids the constraints of long hold times and short recycle times that lead to the generally large mass of single-shot ADRs, allowing us to achieve an order of magnitude larger cooling power per unit mass. Our current design goal is 10 microW of cooling at 50 mK using a 6-10 K heat sink. The estimated mass is less than 10 kg, including magnetic shielding of each stage. The relatively high heat rejection capability allows it to operate with a mechanical cryocooler as part of a cryogen-free, low temperature cooling system. This has the advantages of long mission life and reduced complexity and cost. We have assembled a three-stage CADR and have demonstrated continuous cooling using a superfluid helium bath as the heat sink. The temperature stability is 8 microK rms or better over the entire cycle, and the cooling power is 2.5 microW at 60 mK rising to 10 microW at 100 mK.
Author
Adiabatic Conditions; Demagnetization; Refrigerators; Cryogenic Cooling; Infrared Astronomy

20040074263 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Cryogenic Technology: Ongoing Developments for the Next Decade
DiPirro, Michael; New Concepts for Far-Infrared and Submillimeter Space Astronomy; April 2004, 447-453; In English; No Copyright; Avail: CASI; A02, Hardcopy

To obtain optimum sensitivity a submillimeter space observatory will require low temperature mirrors (approx. 3K) and very low temperature detectors (\h or approx. 0.1 K). Both of these temperatures have been achieved by space cryogenic systems, but neither for a 10 year duration. Past systems used superfluid helium to provide direct cooling in the 1 to 2 K range (IRAS, COBE, IRTS, ISO) or as an upper stage for an adiabatic demagnetization refrigerator to achieve temperatures down to 0.06 K (Astro-E/XRS). Boiloff vapor may be used to cool an otherwise warm telescope as in the Space InfraRed Telescope Facility (SIRTF). In SIRTF a 0.85 m telescope is cooled to 5.5 K by absorbing about 6 mW in the cold vapor. This residual heat is due to both radiation from a helium vapor cooled outer shield at about 20 K and from conduction through a structure mounting the cold telescope and instruments to the warm spacecraft. The boil off rate required to cool the telescope results in a 2.6 to 5 year lifetime, depending on whether other parasitic heat sources such as thermoacoustic oscillations are also present. A helium dewar results in a very heavy system to achieve 2 to 5 year lifetimes. For example it takes roughly 400 kg for XRS to achieve 0.06 K for two year life with a 250 K boundary temperature, and approx. 300 kg (including thermal shielding) for SIRTF to achieve 1.3 K for 5 year life with a 35 K boundary temperature. To go to longer duration and to lower the weight, active cooling methods are required combined with more aggressive passive cooling techniques. It is possible, with some development, to provide cooling for detectors to 0.05 K and telescopes and instruments to \h 4 K for a 10 year mission

with a 100 kg system including power sources, structural support, and vacuum enclosures for critical portions of the instruments.
Author
Cryogenic Equipment; Cryogenic Cooling; Astronomical Satellites

20040071149 Smithsonian Astrophysical Observatory, Cambridge, MA, USA
Constellation X-Ray Mission and Support
Grady, Jean, Technical Monitor; Tananbaum, H.; April 2004; In English
Contract(s)/Grant(s): NCC5-368; No Copyright; Avail: CASI; A03, Hardcopy

This Fifth Annual Report summarizes work performed by the Smithsonian Astrophysical Observatory (SAO) for NASA Goddard Space Flight Center (GSFC) under Cooperative Agreement NCC5-368. The Agreement is entitled 'Constellation X-ray Mission Study and Support.' This report covers the period from October 1, 2002 through September 30,2003. The report summarizes the main areas of SAO activity. Most of the work has been done jointly with personnel from GSFC and Marshall Space Flight Center (MSFC). We describe SAO participation in these efforts. In spite of the work being mainly a level of effort, a significant amount of work was accomplished. Under the Agreement, SAO performed work in eight major areas of activity. These areas related to: 1) Constellation X-ray Mission Facility Definition Team and Study Management; 2) Science Support; 3) Spectroscopy X-ray Telescope (SXT); 4) Systems Engineering; 5) Travel in Support of the Work Effort; 6) In-house Management and Coordination; 7) Technical Readiness and Implementation Plan (TRIP) Report and Follow-up; 8) Industry Liaison and Study Preparation.
Author
X Ray Telescopes; Astronomical Observatories; Spaceborne Telescopes; Contract Management

20040068215 NASA Goddard Space Flight Center, Greenbelt, MD, USA
SQUID Multiplexers for Cryogenic Detector Arrays
Irwin, Kent; Beall, James; Deiker, Steve; Doriese, Randy; Duncan, William; Hilton, Gene; Moseley, S. Harvey; Reintsema, Carl; Stahle, Caroline; Ullom, Joel; Vale, Leila; International Thermal Detectors Workshop (TDW 2003); February 2004, 4-5; In English; No Copyright; Abstract Only; Available from CASI only as part of the entire parent document

SQUID multiplexers make it possible to build arrays of thousands of cryogenic detectors with a manageable number of readout channels. We are developing time-division SQUID multiplexers based on Nb trilayer SQUIDs to read arrays of superconducting transition-edge sensors. Our first-generation, 8-channel SQUID multiplexer was used in FIBRE, a one-dimensional TES array for submillimeter astronomy. Our second-generation 32-pixel multiplexer, based on an improved architecture, has been developed for instruments including Constellation-X, SCUBA-2, and solar x-ray astronomy missions. SCUBA-2, which is being developed for the James Clerk Maxwell Telescope, will have more than 10,000 pixels. We are now developing a third-generation architecture based on superconducting hot-electron switches. The use of SQUID multiplexers in instruments operating at above 2 K will also be discussed.
Author
Cryogenics; Multiplexing; SQUID (Detectors); Arrays

20040068204 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Programmable 2-D Addressable Cryogenic Aperture Masks
Kutyrev, A. S.; Moseley, S. H.; Jhabvala, M.; Li, M.; Schwinger, D. S.; Silverberg, R. F.; Wesenberg, R. P.; International Thermal Detectors Workshop (TDW 2003); February 2004, P4; In English; No Copyright; Abstract Only; Available from CASI only as part of the entire parent document

We are developing a two-dimensional array of square microshutters (programmable aperture mask) for a multi-object spectrometer for the James Webb Space Telescope (JWST). This device will provide random access selection of the areas in the field to be studied. The device is in essence a close packed array of square slits, each of which can be opened independently to select areas of the sky for detailed study.The device is produced using a 100-micron thick silicon wafer as a substrate with 0.5-micron thick silicon nitride shutters on top of it. Silicon nitride has been selected as the blade and flexure material because its stiffness allows thinner and lighter structures than single crystal Si, the chief alternative, and because of its ease of manufacture. The 100 micron silicon wafer is backetched in a high aspect ratio Deep Reactive Ion Etching (Deep RIE) to leave only a support grid for the shutters and the address electronics. The shutter actuation is done magnetically whereas addressing is electrostatic. 128x128 format microshutter arrays have been produced. Their operation has been demostarted on 32x32 subarrays. Good reliability of the fabrication process and good quality of the microshutters has been achieved. The mechanical

behavior and optical performance of the fabricated arrays at cryogenic temperature are being studied.
Author
James Webb Space Telescope; Spectrometers; Shutters; Microelectromechanical Systems

20040062013 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Planetary Remote Sensing Science Enabled by MIDAS (Multiple Instrument Distributed Aperture Sensor)
Pitman, Joe; Duncan, Alan; Stubbs, David; Sigler, Robert; Kendrick, Rick; Chilese, John; Lipps, Jere; Manga, Mike; Graham, James; dePater, Imke, et al.; Lunar and Planetary Science XXXV: Outer Solar System; 2004; In English; Original contains color and black and white illustrations; Copyright; Avail: CASI; A01, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The science capabilities and features of an innovative and revolutionary approach to remote sensing imaging systems, aimed at increasing the return on future space science missions many fold, are described. Our concept, called Multiple Instrument Distributed Aperture Sensor (MIDAS), provides a large-aperture, wide-field, diffraction-limited telescope at a fraction of the cost, mass and volume of conventional telescopes, by integrating optical interferometry technologies into a mature multiple aperture array concept that addresses one of the highest needs for advancing future planetary science remote sensing.
Derived from text
Apertures; Imaging Techniques; Remote Sensing; Space Missions; Spectroscopic Telescopes; Measuring Instruments

20040062000 California Univ., Berkeley, CA, USA
Geosciences at Jupiter's Icy Moons: The Midas Touch
Lipps, J. H.; Delory, G. T.; Manga, M.; DePater, I.; Graham, J.; Reiboldt, S.; Pitman, J.; Duncan, A.; Lunar and Planetary Science XXXV: Outer Solar System; 2004; In English; Original contains color illustrations; Copyright; Avail: CASI; A01, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The Galileo mission revealed that the Jovian Icy Moons (JIM) and Io are dynamic worlds possessing possible subsurface oceans, magnetism, spectacular volcanic activity, and potentially life. While Galileo's images and spectroscopic measurements have greatly increased our understanding of these bodies, higher spectral and spatial resolution measurements are clearly needed in order to begin to address the myriad of new questions and uncertainties regarding these moons. Here we describe the potential science objectives on the Jupiter Icy Moons Orbiter (JIMO) mission enabled by the Multiple Instrument Distributed Aperture System (MIDAS), a low-volume, 1.5m aperture imaging spectrometer capable of ~nm spectral resolution at spatial resolutions of approximately 2cm-1m/pixel from orbit.
Derived from text
Galileo Spacecraft; Geophysics; Imaging Spectrometers; Jupiter (Planet); Icy Satellites; Planetary Geology

20040056809
Hot pixel behavior in WFC3 CCD detectors irradiated under operational conditions
Polidan, Elizabeth J.; Waczynski, Augustyn; Marshall, Paul; Johnson, Scott D.; Marshall, Cheryl; Reed, Robert; Kimble, Randy A.; Delo, Gregory; Schlossberg, David; Russell, Anne Marie; Beck, Terry; Wen, Yiting; Yagelowich, John; Hill, Robert J.; Wassell, Edward; Proceedings of SPIE - The International Society for Optical Engineering; 2004; ISSN 0277-786X; Volume 5167, p. 258-269; In English; Focal Plane Arrays for Space Telescopes, Aug. 4-6, 2003, San Diego, CA, USA; Copyright; Avail: Other Sources

A Hubble Space Telescope Wide Field Camera 3 (WFC3) CCD detector was tested for radiation effects while operating at -83 C. The detector has a format of 2048 x 4096 pixels with a 15 micron square pixel size, a supplemental buried channel, an MPP implant and is back side illuminated. Detector response was tested for total radiation fluences ranging from 1 x 10(sup 3) to 2.5 x 10(sup 9) of 63.3 MeV protons/cm(sup 2) and for a range of beam intensities. Radiation damage was investigated and the annealing of damage was tested by warming up to +30 C. The introduction rate of hot pixels and their statistics, hot pixel annealing as a function of temperature and time, and radiation changes to the mean value of dark current were investigated. Results are compared with the experiences of other HST instruments.
EI
Charge Coupled Devices; Radiation Damage; Radiation Detectors; Space Flight; Telescopes

20040056808

Radiation Effects in WFC3 IR Detectors

Johnson, Scott D.; Waczynski, Augustyn; Marshall, Paul; Polidan, Elizabeth; Marshall, Cheryl; Reed, Robert; Kimble, Randy; Delo, Gregory; Schlossberg, David; Russell, Anne Marie; Beck, Terry; Wen, Yiting; Yagelowich, John; Hill, Robert J.; Wassell, Edward; Cheng, Edward; Proceedings of SPIE - The International Society for Optical Engineering; 2004; ISSN 0277-786X; Volume 5167, p. 243-257; In English; Focal Plane Arrays for Space Telescopes, Aug. 4-6, 2003, San Diego, CA, USA; Copyright; Avail: Other Sources

A Hubble Space Telescope (HST) Wide Field Camera 3 (WFC3) flight-like IR detector was tested for radiation hardness by exposing it to high energy protons while operating at the nominal flight temperature of 150 K. The detector is a 1.7 mu m cutoff HgCdTe detector with a CdZnTe substrate. The device is hybridized to a silicon multiplexer. The detector response was tested for gradually increasing fluence from less than 1 x 10(sup 3) to a total of 5 x 10(sup 9) 63 MeV protons/cm(sup 2). Dark current changes were evaluated after each step. An increase in dark current and new hot pixels were observed after large steps of irradiation. The increased dark current was observed to partially anneal at 190K and fully anneal at room temperature. Radiation effects, hot pixel distribution, and results of annealing at different temperatures are presented here.
EI

Infrared Radiation; Mercury Cadmium Tellurides; Radiation Detectors; Radiation Effects; Space Flight; Telescopes

20040056807

Radiation environment performance of JWST prototype FPAs

McKelvey, M. E.; Ennico, K. A.; Johnson, R. R.; Marshall, P. W.; McMurray, Jr. , R. E.; McCreight, C. R.; Pickel, J. C.; Reed, R. A.; Proceedings of SPIE - The International Society for Optical Engineering; 2004; ISSN 0277-786X; Volume 5167, p. 223-234; In English; Focal Plane Arrays for Space Telescopes, Aug. 4-6, 2003, San Diego, CA, USA; Copyright; Avail: Other Sources

As the logical extension of the 20-year mission of the Hubble Space Telescope, NASA plans to launch the James Webb Space Telescope (JWST, formerly NGST) near the end of this decade. As Hubble's scientific and technological successor, equipped with a 6-meter-class deployable mirror, JWST will allow observations of the very early universe and initial formation of galaxies at levels not achievable today. JWST's unprecedented sensitivity cannot be utilized without a new class of IR focal plane arrays whose performance matches that of the telescope. In particular, JWST focal planes must be able to withstand the ionizing-particle radiation environment expected for its Lagrange-point (L2) orbit and ten-year mission lifetime goal. To help determine their suitability for JWST, NASA is evaluating prototype megapixel-class readouts and hybrid detector arrays under proton bombardment to simulate the anticipated JWST lifetime radiation dose. This report describes the results of early tests on devices from two manufacturers using photovoltaic (HgCdTe or InSb) candidate near-infrared detector structures. Results to date have shown encouraging performance, along with some areas of continuing concern.
EI

Environmental Surveys; Galaxies; Mirrors

20040056806

Carrier Plus: A sensor payload for Living With a Star Space Environment Testbed (LWS/SET)

Marshall, Cheryl J.; Moss, Steven; Howard, Regan; LaBel, Kenneth A.; Grycewicz, Tom; Barth, Janet L.; Brewer, Dana; Proceedings of SPIE - The International Society for Optical Engineering; 2004; ISSN 0277-786X; Volume 5167, p. 216-222; In English; Focal Plane Arrays for Space Telescopes, Aug. 4-6, 2003, San Diego, CA, USA; Copyright; Avail: Other Sources

The Defense Threat Reduction Agency (DTRA) and National Aeronautics and Space Administration (NASA) Goddard Space Flight Center are collaborating to develop the Carrier Plus sensor experiment platform as a capability of the Space Environment Testbed (SET). The Space Environment Testbed (SET) provides flight opportunities for technology experiments as part of NASA's Living With a Star (LWS) program. The Carrier Plus will provide new capability to characterize sensor technologies such as state-of-the-art visible focal plane arrays (FPAs) in a natural space radiation environment. The technical objectives include on-orbit validation of recently developed FPA technologies and sensor performance prediction methodologies, as well as characterization of the FPA radiation response to total ionizing dose damage, displacement damage and transients. It is expected that the sensor experiment will carry 46 FPAs and associated radiation correlative environment monitors (CEMs) for a 2008 launch. Sensor technology candidates may include n- and p-charge coupled devices (CCDs), active pixel sensors (APS), and hybrid CMOS arrays. This paper will describe the Carrier Plus goals and objectives, as well as provide details about the architecture and design. More information on the LWS program can be found at http://

lws.gsfc.nasa.gov/. Business announcements for LWS/SET and program briefings are posted at http://lws-set.gsfc.nasa.gov.
EI
Charge Coupled Devices; CMOS; Environmental Surveys; Integrated Circuits; Sensors

20040056802
Development of a 1K x 1K GaAs QWIP Far IR Imaging Array
Jhabvala, M.; Choi, K.; Goldberg, A.; La, A.; Gunapala, S.; Proceedings of SPIE - The International Society for Optical Engineering; 2004; ISSN 0277-786X; Volume 5167, p. 175-185; In English; Focal Plane Arrays for Space Telescopes, Aug. 4-6, 2003, San Diego, CA, USA; Copyright; Avail: Other Sources

In the on-going evolution of GaAs Quantum Well Infrared Photodetectors (QWIPs) we have developed a 1,024 x 1, 024 (1K x 1K), 8.4-9 micron infrared focal plane array (FPA). This 1 megapixel detector array is a hybrid using the Rockwell TCM 8050 silicon readout integrated circuit (ROIC) bump bonded to a GaAs QWIP array fabricated jointly by engineers at the Goddard Space Flight Center (GSFC) and the Army Research Laboratory (ARL). The finished hybrid is thinned at the Jet Propulsion Lab. Prior to this development the largest format array was a 512 x 640 FPA. We have integrated the 1K x 1K array into an imaging camera system and performed tests over the 40K-90K temperature range achieving BLIP performance at an operating temperature of 76K (f/2 camera system). The GaAs array is relatively easy to fabricate once the superlattice structure of the quantum wells has been defined and grown. The overall arrays costs are currently dominated by the costs associated with the silicon readout since the GaAs array fabrication is based on high yield, well-established GaAs processing capabilities. In this paper we will present the first results of our 1K x 1K QWIP array development including fabrication methodology, test data and our imaging results.
EI
Gallium Arsenides; Imaging Techniques; Infrared Radiation; Photometers; Quantum Wells; Semiconductors (Materials); Silicon

20040056795
Noise Sources and Noise Suppression in CMOS Imagers
Pain, Bedabrata; Cunningham, Thomas J.; Hancock, Bruce; Proceedings of SPIE - The International Society for Optical Engineering; 2004; ISSN 0277-786X; Volume 5167, p. 111-120; In English; Focal Plane Arrays for Space Telescopes, Aug. 4-6, 2003, San Diego, CA, USA; Copyright; Avail: Other Sources

Mechanisms for noise coupling in CMOS imagers are complex, since unlike a CCD, a CMOS imager has to be considered as a full digital-system-on-a-chip, with a highly sensitive front-end. In this paper, we analyze the noise sources in a photodiode CMOS imager, and model their propagation through the signal chain to determine the nature and magnitude of noise coupling. We present methods for reduction of noise, and present measured data to show their viability. For temporal read noise reduction, we present pixel signal chain design techniques to achieve near 2 electrons read noise. We model the front-end reset noise both for conventional photodiode and CTIA type of pixels. For the suppression of reset noise, we present a column feedback-reset method to reduce reset noise below 6 electrons. For spatial noise reduction, we present the design of column signal chain that suppresses both spatial noise and power supply coupling noise. We conclude by identifying problems in low-noise design caused by dark current spatial distribution.
EI
Charge Coupled Devices; CMOS; Imagery; Integrated Circuits; Measuring Instruments; Photodiodes; Random Signals

20040056794
Hardening CMOS Imagers: Radhard-by-design or Radhard-by-foundry
Pain, Bedabrata; Hancock, Bruce; Cunningham, Thomas J.; Seshadri, Suresh; Sun, Chao; Peddada, Pavani; Wrigley, Chris; Stirbl, Robert C.; Proceedings of SPIE - The International Society for Optical Engineering; 2004; ISSN 0277-786X; Volume 5167, p. 101-110; In English; Focal Plane Arrays for Space Telescopes, Aug. 4-6, 2003, San Diego, CA, USA; Copyright; Avail: Other Sources

A comparative study between radhard-by-design and radhard-by-foundry approaches for radiation hardening of CMOS imagers is presented. Main mechanisms for performance degradation in CMOS imagers in a radiation environment are identified, and key differences between the radiation effects in CMOS imagers and that in digital logic circuits are explained. Design methodologies for implementation of CMOS imagers operating in a radiation environment are presented. By summarizing the performance results obtained from imagers implemented in both radhard-by-design and radhard-by-foundry approaches, the advantages and shortcomings of both approaches are identified. It is shown that neither approach presents an

optimum solution. The paper concludes by discussing an alternate pathway to overcome these limitations and enable the next-generation high-performance radiation-hard CMOS imagers.
EI
CMOS; Digital Electronics; Imagery; Integrated Circuits; Logic Circuits; Measuring Instruments; Radiation Hardening

20040056786
NASA's Structure and Evolution of the Universe focal plane directions
Schwartz, P. Christopher; Proceedings of SPIE - The International Society for Optical Engineering; 2004; ISSN 0277-786X; Volume 5167, p. 24-30; In English; Focal Plane Arrays for Space Telescopes, Aug. 4-6, 2003, San Diego, CA, USA; Copyright; Avail: Other Sources

The SEU theme encompasses an extremely diverse area of space science. Recent roadmapping efforts have been devoted to prioritizing science challenges rather than defining all that is contained in the SEU theme. The highest priorities are the Big Bang and a look at Black Holes and the regions near them. To support these challenges the following technologies are of high priority: Cryogenic Systems, Formation Flying, High Performance Optics: Mid- and Far-IR Optics, X-Ray/UV optics, Advanced Detectors: X-ray and Submm/Far IR, Energy resolving detectors and Large Format Arrays. The initiative, Beyond Einstein, includes baseline missions that utilize technologies that are generally at a laboratory proof of concept level. Technology development plans are established for the flagship missions: Con-X and LISA. Conceptual development is still progressing for some Einstein Probe missions. Vision missions are still in conceptual development.
EI
Aerospace Sciences; Astrophysics; Galaxies; Optics; X Rays

20040056785
Future Focal Plane Technology Challenges for Nasa's Origins Missions
Breckinridge, James B.; Proceedings of SPIE - The International Society for Optical Engineering; 2004; ISSN 0277-786X; Volume 5167, p. 19-23; In English; Focal Plane Arrays for Space Telescopes, Aug. 4-6, 2003, San Diego, CA, USA; Copyright; Avail: Other Sources

Recent advances in astronomical research have led to a much-improved understanding of the evolution of the physical Universe. Recent advances in biology and genetics have led to a much-improved understanding of our biological Universe. Scientists now believe that we have the research tools to begin to answer one of man's two most compelling research questions: 'are we alone?' and 'how did we get here?' This paper reviews the requirements and challenges we face to engineer and build the large area and very sensitive focal planes for interferometers and innovative single aperture telescopes to detect and characterize Earth-type planets around stars other than our sun.
EI
Aerospace Sciences; Astrophysics; Galaxies; Planets

20040053928
Application of a Large Space-Based Diffractive Optical Element Telescope to the Terrestrial Planet-Finder Mission: Design and Tolerance Issues
Hoppe, Daniel J.; Baron, Richard L.; Cwik, Thomas A.; Proceedings of SPIE - The International Society for Optical Engineering; 2004; ISSN 0277-786X; Volume 5166, p. 281-295; In English; UV/Optical/IR Space Telescopes: Innovative Technologies and Concepts, Aug. 3-5, 2003, San Diego, CA, USA; Copyright; Avail: Other Sources

An analytical description of the scattered light from a 10 meter diameter Diffractive Optical Element lens-based telescope operating at 1 micron wavelength has been formulated. The specifics of the grating and blaze as well as physical manufacturing constraints were made a part of the problem to be solved. A major simplifying approximation made is that a 1 dimensional lens was assumed for the calculations. This simplified model still serves to illustrate the important effects and limitations of a high performance lens used as a telescope. Focal plane light scattering has been rigorously determined for simplified cases.
EI
Focusing; Interplanetary Spacecraft; Light Scattering; Telescopes; Wave Diffraction

20040053900
Options for Post-JWST space telescopes
Thronson, Jr. , Harley A.; Proceedings of SPIE - The International Society for Optical Engineering; 2004; ISSN 0277-786X; Volume 5166, p. 13-18; In English; UV/Optical/IR Space Telescopes: Innovative Technologies and Concepts, Aug. 3-5, 2003, San Diego, CA, USA; Copyright; Avail: Other Sources

With the selection completed of the industrial partners for the James Webb Space Telescope (JWST) and subsequent replanning concluded, several groups and NASA have begun to consider options for subsequent major space astronomy missions. Active interest includes scientific justification for even larger space observatories, the technologies necessary to enable such missions, supporting infrastructure and facilities, system designs, and the political environment that would be receptive to the sustained funding necessary for such major missions. This paper discusses each of these issues in turn and concludes similarly to the recommendations of the NASA Exploration Team (NEXT) that a human-occupied gateway at the Earth-Moon LI point offers several attractive opportunities for NASA and the scientific community, including primarily the capability to support very large aperture science facilities, as well as a publicly appealing option for human exploration beyond low-Earth orbit.
EI
Astronomy; Planets; Systems Analysis

20040053899
Astronomical Search for Origins: Are We Alone?
Breckinridge, James B.; Proceedings of SPIE - The International Society for Optical Engineering; 2004; ISSN 0277-786X; Volume 5166, p. 8-12; In English; UV/Optical/IR Space Telescopes: Innovative Technologies and Concepts, Aug. 3-5, 2003, San Diego, CA, USA; Copyright; Avail: Other Sources

Recent advances in astronomical research have led to a much-improved understanding of the evolution of the physical Universe. Recent advances in biology and genetics have led to a much-improved understanding of our biological Universe. Scientists now believe that we have the research tools to begin to answer one of man's two most compelling research questions: Are we alone? and How did we get here? This paper reviews the requirements and challenges we face to engineer and build the large space-based systems of interferometers and innovative single-aperture telescopes to detect and characterize in detail earth type planets around stars other than our sun.
EI
Astronomy; Geology; Glaciers; Infrared Radiation; Planets

20040052528
Optic needs for future space telescopes
Stahl, H. Philip; Proceedings of SPIE - The International Society for Optical Engineering; 2003; ISSN 0277-786X; Volume 5180, p. 1-5; In English; Optical Manufacturing and Testing V, Aug. 3-5, 2003, San Diego, CA, USA; Copyright; Avail: Other Sources

Large-aperture lightweight space mirrors are critical for NASA space science missions. But, a technology gap exists between the current state-of-art and the optics required to enable planned missions (SAFIR, SUVO, MTRAP, TPF). Building on the highly successful JWST technology development program, a new unified sustained effort is required for these future missions. This effort's objectives are to develop enabling mirror technology and to reduce cost & schedule. The ultimate goal is to return $10 of savings for each dollar invested. This paper summarizes the optic needs for several planned NASA missions and describes a technology development roadmap.
EI
Aerospace Sciences; Mirrors; Optics; Technology Utilization

20040046944 NASA Goddard Space Flight Center, Greenbelt, MD, USA
A Proposed Robotic Astronomy Mission to the Lunar South Polar Regions
Lowman, Paul D., Jr.; October 15, 2003; In English, 16-22 Nov. 2003, Waikoloa, HI, USA; No Copyright; Avail: CASI; A03, Hardcopy

This paper outlines a possible mission to emplace a robotic infrared / submillimeter wave interferometer array near the lunar south pole. This region has now been investigated by the Clementine and Lunar Prospector missions, and by Earth-based radar, and its topography and thermal environment are fairly well-known. The area would be exceptionally suitable for infrared / submillimeter astronomy because of the continually low temperatures, approaching that of liquid nitrogen (77K) in some places. A submillimeter spaceborne interferometer mission, Submillimeter Probe of the Evolution of the Cosmic Structure (SPECS) has been proposed by John Mather and others, covering the 40 - 500 micron region with 3 formation flying telescopes. The present paper proposes a lunar adaptation of the SPECS concept, LSPECS. This adaptation would involve landing 4 telescopes on the area north of Shackleton crater at zero degrees longitude. This is in nearly year round darkness but is continually radar visible from Earth. The landed payload of LSPECS would include a telerobotic rover, 4 three meter

submm telescopes, a solar power array to be emplaced on the continually sunlit north rim of Shackleton crater, and an S-band antenna for data relay to Earth. Passive cooling without the use of expendable cryogenics. might be possible, trading long exposure time for instrument temperatures above that of liquid helium. The LSPECS would permit long-term study of an extremely wide range of cosmic and solar system phenomena in the southern celestial hemisphere. For complete sky coverage, a similar installation near the north pole would be required. The LSPECS site would also be suitable other types of observation, such as optical interferometry or centimeter wavelength radio astronomy. The lunar south pole is also of great interest because of its extensive ice deposits, which may represent cometary infall with pre-biotic compounds.
Author
Astronomy; Space Missions; Lunar Prospector; Polar Regions; Telerobotics; Southern Hemisphere

20040037727 NASA Goddard Space Flight Center, Greenbelt, MD, USA
The James Webb Space Telescope
Gardner, Jonathan P.; [2003]; In English, July 2003, Sydney,, Australia; No Copyright; Avail: Other Sources; Abstract Only

The James Webb Space Telescope (JWST) will be a large (6m) cold (50K) telescope launched to the second Earth-Sun Lagrange point. It is the successor to the Hubble Space Telescope, and is a partnership of NASA, ESA and CSA. It's science goals are to detect and identify the first galaxies to form in the universe, to trace their assembly into the Hubble Sequence, and to study stellar and planetary system formation. JWST will have three instruments: The Near InfiaRed Camera (NIRCam) and the Near InfraRed multiobject Spectrometer (NIRSpec) will cover the wavelength range 0.6 to 5 microns, and the Mid InfraRed Instrument (MIRI) will do both imaging and spectroscopy from 5 to 28 microns.
Author
James Webb Space Telescope; Imaging Techniques; Galaxies; Lagrangian Equilibrium Points

20040035831 Lawrence Livermore National Lab., Livermore, CA
Eyeglass: A Very Large Aperture Diffractive Space Telescope
Hyde, R.; Dixt, S.; Weisberg, A.; Rushford, M.; Jul. 29, 2002; In English
Report No.(s): DE2003-15005362; UCRL-JC-149397; No Copyright; Avail: Department of Energy Information Bridge

Eyeglass is a very large aperture (25-100 meter) space telescope consisting of two distinct spacecraft, separated in space by several kilometers. A diffractive lens provides the telescope's large aperture, and a separate, much smaller, space telescope serves as its mobile eyepiece. Use of a transmissive diffractive lens solves two basic problems associated with very large aperture space telescopes; it is inherently fieldable (lightweight and flat, hence packagable and deployable) and virtually eliminates the traditional, very tight, surface shape tolerances faced by reflecting apertures. The potential drawback to use of a diffractive primary (very narrow spectral bandwidth) is eliminated by corrective optics in the telescope's eyepiece. The Eyeglass can provide diffraction-limited imaging with either single-band, multiband, or continuous spectral coverage.
NTIS
Apertures; Eyepieces; Diffraction; Spaceborne Telescopes

20040035670 NASA Goddard Space Flight Center, Greenbelt, MD, USA
James Webb Space Telescope Ka-Band Trade
Gal-Edd, Jonathan; Luers, Ed; [2004]; In English, 6-13 Mar. 2004, Big Sky, MT, USA
Report No.(s): IEEE Paper 1129; No Copyright; Avail: CASI; A02, Hardcopy

In August 2003 James Webb Space Telescope (JWST) had its Initial Review Confirmation Assessment Briefing with NASA HQ management. This is a major milestone as the project was approved to proceed from Phase A to B, and NASA will commit funds for the project towards meeting its science goals from the Earth-Sun s Lagrange 2 (L2) environment. At this briefing, the Project was asked, 'to take another look' into using, the JPL s Deep Space Network (DSN) as the provider of ground stations and evaluate other ground station options. The current operations concept assumes S-band and X-band communications with a daily &hour contact using the DSN with the goal of transmitting over 250 Gigabit (Gb) of data to the ground. The Project has initiated a trade study to look at this activity, and we would like to share the result of the trade in the conference. Early concept trades tends to focus on the 'normal' operation mode of supporting telemetry (science and engineering), command and radio metrics. Entering the design phase, we find that we have the unique ranging requirement for our L2 orbit using alternating ground stations located in different hemispheres. The trade must also address emergency operations (which are covered when using the DSN). This paper describes the issues confronting this Project and how the DSN and the JWST Project are working together to find an optimized approach for meeting these issues. We believe this trade is

of major interest for future Code S and other L2 missions in that JWST will set the standard.
Author
James Webb Space Telescope; Extremely High Frequencies; Radio Communication; Ground Stations; Ultrahigh Frequencies

20040035613 NASA Goddard Space Flight Center, Greenbelt, MD, USA
James Webb Space Telescope (JWST) Optical Telescope Element (OTE) Architecture and Technology
Feinberg, Lee D.; [2004]; In English, 6-13 Mar. 2004, USA; No Copyright; Avail: CASI; A01, Hardcopy

The James Webb Space Telescope (JWST) Optical Telescope Element (OTE) is the first NASA segmented space telescope and is planned for launch in 2011. The telescope architecture was recently finalized with the selection of the primary mirror material. This presentation reviews the telescope architecture and discusses the remaining key technological challenges of this element.
Author
James Webb Space Telescope; Spaceborne Telescopes; Technology Utilization; Design Analysis; Systems Engineering

20040031494 NASA Goddard Space Flight Center, Greenbelt, MD, USA
NASA's Far-IR/Submillimeter Roadmap Missions SAFIR and SPECS
Leisawitz, David; [2003]; In English, 13-26 Jul. 2003, Sydney, Australia; No Copyright; Avail: Other Sources; Abstract Only

The far-IR is rich with information about star, disk and planet formation because protostars emit predominantly in this spectral range, and the radiation can escape from the inherently dusty stellar birth sites. Spectral lines contain particularly valuable information about the cooling, collapse, and chemistry of molecular cloud cores and protostars. However, the interpretation of line intensities and profiles is model-dependent; ultimately, high angular resolution is needed to break model degeneracy and definitively characterize the source. Processes occurring on scales smaller than 10,000 AU (72 arcsec at 140 pc, where the nearest protostellar objects are found) likely affect the stellar initial mass function and determine the product of cloud collapse (Binary star or planetary system? How many planets, and what kind will they be?) The next-generation far-IR observatories SIRTF, SOFIA, and Herschel will revolutionize star formation studies and leave the community yearning for telescopes that operate in this spectral region but provide many orders of magnitude better angular resolution. NASA's space science roadmap includes the JWST-scale Single Aperture Far-IR (SAFIR) telescope and the 1 km maximum baseline far-IR interferometer, SPECS (the Submillimeter Probe of the Evolution of Cosmic Structure). I will give the scientific motivation for these missions, describe mission concepts and telescope measurement capabilities, and compare these capabilities with those of the next-generation IR telescopes and with the complementary JWST and ALMA. I will also describe the Space Infrared Interferometric Telescope (SPIRIT), a science and technology pathfinder for SPECS, which could be ready to launch in about a decade. At 100 microns, SAFIR will provide 2.5 arcsec resolution (10 times better than SIRTF), SPIRIT will provide 0.25 arcsec resolution, and SPECS will provide 10 milli-arcsec resolution, which is comparable to that of the Hubble Space Telescope.
Author
Far Infrared Radiation; Star Formation; Disk Galaxies; Molecular Clouds; Protostars; Spaceborne Telescopes

20040016419 Lawrence Livermore National Lab., Livermore, CA
Twenty Meter Space Telescope Based on Diffractive Fresnel Lens
Early, J.; Hyde, R.; Baron, R.; Jun. 26, 2003; In English
Report No.(s): DE2003-15004856; UCRL-JC-154093; No Copyright; Avail: Department of Energy Information Bridge

Diffractive lenses offer two potential advantages for very large aperture space telescopes; very loose surface-figure tolerances and physical implementation as thin, flat optical elements. In order to actually realize these advantages one must be able to build large diffractive lenses with adequate optical precision and also to compactly stow the lens for launch and then fully deploy it in space. We will discuss the recent fabrication and assembly demonstration of a 5m glass diffractive Fresnel lens at LLNL. Optical performance data from smaller full telescopes with diffractive lens and corrective optics show diffraction limited performance with broad bandwidths. A systems design for a 20m space telescope will be presented.
NTIS
Diffractive Optics; Spaceborne Telescopes; Fresnel Lenses

20040016313 NASA Goddard Space Flight Center, Greenbelt, MD, USA
The James Webb Telescope Instrument Suite Layout: Optical System Engineering Considerations for a Large, Deployable Space Telescope
Bos, Brent; Davila, Pam; Jurotich, Matthew; Hobbs, Gurnie; Lightsey, Paul; Contreras, Jim; Whitman, Tony; [2003]; In

English; SPIE Meeting on Astronomical Telescopes and Instrumentation, 21-24 Jun. 2004, Glasgow, Scotland, UK; No Copyright; Avail: Other Sources; Abstract Only

The James Webb Space Telescope (JWST) is a space-based, infrared observatory designed to study the early stages of galaxy formation in the Universe. The telescope will be launched into an elliptical orbit about the second Lagrange point and passively cooled to 30-50 K to enable astronomical observations from 0.6 to 28 microns. A group from the NASA Goddard Space Flight Center and the Northrop Grumman Space Technology prime contractor team has developed an optical and mechanical layout for the science instruments within the JWST field of view that satisfies the telescope s high-level performance requirements. Four instruments required accommodation within the telescope's field of view: a Near-Infrared Camera (NIRCam) provided by the University of Arizona; a Near-Mared Spectrometer (NIRSpec) provided by the European Space Agency; a Mid-Infrared Instrument (MIRI) provided by the Jet Propulsion Laboratory and a European consortium; and a Fine Guidance Sensor (FGS) with a tunable filter module provided by the Canadian Space Agency. The size and position of each instrument's field of view allocation were developed through an iterative, concurrent engineering process involving the key observatory stakeholders. While some of the system design considerations were those typically encountered during the development of an infrared observatory, others were unique to the deployable and controllable nature of JWST. This paper describes the optical and mechanical issues considered during the field of view layout development, as well as the supporting modeling and analysis activities.

Author

Cameras; Field of View; James Webb Space Telescope; Layouts; Systems Engineering; Optical Equipment; Mechanical Engineering

20040015299 NASA Goddard Space Flight Center, Greenbelt, MD, USA

The James Webb Space Telescope

Mather, John C.; [2003]; In English, 7-8 Apr. 2003, TX, USA; No Copyright; Avail: Other Sources; Abstract Only

The James Webb Space Telescope (JWST) will extend the discoveries of the Hubble Space Telescope by deploying a large cooled infrared telescope at the Sun-Earth Lagrange point L2. With a 6 m aperture and three instruments covering the wavelength range from 0.6 to 28 pm, it will provide sensitivities orders of magnitude better than any other facilities. It is intended to observe the light from the first galaxies and the first supernovae, the assembly of galaxies, and the formation and evolution of stars and planetary systems. In this talk I will review the scientific objectives, the hardware concepts and technology, and the predicted system performance.

Author

James Webb Space Telescope; Stellar Evolution; Planetary Systems; Infrared Telescopes

20040010331 Smithsonian Astrophysical Observatory, Cambridge, MA, USA

High Resolution Imaging of Circumstellar Disks at Millimeter Wavelengths

Wilner, David J.; December 2003; In English

Contract(s)/Grant(s): NAG5-11777; No Copyright; Avail: CASI; A01, Hardcopy

We update progress on our research program to use high angular resolution imaging of thermal dust continuum emission at millimeter and submillimeter wavelengths to probe the structure of protoplanetary disks and debris disks around nearby stars. Observations at these wavelengths are advantageous because the dust emission is generally optically thin and directly proportional to mass, contrast with stellar photospheres is not problematic, and the wavelength dependence provides information on an important regime of grain sizes. We employ several facilities for state-of-the-art high resolution observations, including the Very Large Array (VLA), the Australia Telescope Compact Array (ATCA), the Plateau de Bure Interferometer (PdBI) of the Institut de RadioAstronomie Millimetrique, the Submillimeter Array (SMA) of the Smithsonian Astrophysical Observatory, and the Caltech Submillimeter Observatory (CSO). Many recent highlights of our program were presented in an invited review on High Angular Resolution Studies of Disks- the Millimetre at IAU Symposium 221, Star Formation at High Angular Resolution, in July 2003.

Derived from text

Debris; Protoplanetary Disks; Stellar Envelopes

20040006275

Prototype system for superconducting quantum interference device multiplexing of large-format transition-edge sensor arrays

Reintsema, Carl D.; Beyer, Jorn; Nam, Sae Woo; Deiker, Steve; Hilton, Gene C.; Irwin, Kent; Martinis, John; Ullom, Joel; Vale, Leila R.; MacIntosh, Mike; Review of Scientific Instruments; October 2003; ISSN 0034-6748; Volume 74, Issue no. 10, 4500-4508; In English

Contract(s)/Grant(s): S-03970-G; S-94800-Y; Copyright

We discuss the implementation of a time-division superconducting quantum interference device (SQUID) multiplexing system for the instrumentation of large-format transition-edge sensor arrays. We cover the design and integration of cryogenic SQUID multiplexers and amplifiers, signal management and wiring, analog interface electronics, a digital feedback system, serial-data streaming and management, and system configuration and control. We present data verifying performance of the digital-feedback system. System noise and bandwidth measurements demonstrate the feasibility of adapting this technology for a broad base of applications, including x-ray materials analysis and imaging arrays for future astronomy missions such as Constellation-X (x-ray) and the SCUBA-2 instrument (submillimeter) for the James Clerk Maxwell Telescope. [copyright] 2003 American Institute of Physics.

Author (AIP)

Amplifiers; Arrays; Astronomy; Multiplexing; Noise; Signal Processing; SQUID (Detectors); Submillimeter Waves; Superconducting Devices; Superconductivity; Time Division Multiplexing; X Ray Astronomy

20030112446 NASA Goddard Space Flight Center, Greenbelt, MD, USA

Community Plan for Far-Infared/Submillimeter Space Astronomy

Leisawitz, David; Oegerle, William, Technical Monitor; [2003]; In English; Workshop on New Concepts for Far-Infrared/ Submillimeter Space Astronomy, 7-8 Mar. 2002, College Park, MD, USA; Original contains color illustrations; No Copyright; Avail: CASI; A03, Hardcopy

The consensus of attendees at the Second Workshop on New Concepts for Far-Infrared/Submillimeter Space Astronomy is that the Single Aperture Far-IR telescope (SAFIR), a cooled spaceborne observatory, is important for the future of far-infrared astronomy. This paper describes the specifications and capabilities of SAFIR, possible designs for SAFIR, and suggests a development strategy for the technology necessary for the telescope.

CASI

Far Infrared Radiation; Infrared Astronomy; Astronomical Observatories; Spaceborne Telescopes; Development; Project Planning

20030089784

A novel process to fabricate mirrors with very long radius and ultra smooth surfaces

Chen, Peter C.; Carpenter, Kenneth G.; Romeo, Robert C.; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4854, p. 21-28; In English; Future EUV/UV and Visible Space Astrophysics Missions and Instrumentation, Aug. 22-23, 2002, Waikoloa, HI, USA; Copyright; Avail: Other Sources

During the course of performing space flight qualification testing of composite mirrors at NASA GSFC, a serendipitous event was observed which, in retrospect, should have been obvious. Investigation of this phenomenon leads to a promising avenue towards the fabrication of large aperture precision spherical mirrors with very long radius of curvature (greater than f/100). Such mirrors are required for future missions such as the Stellar Imager. We report on the observation and analysis of the event, optical measurements, and the development of associated active figure control systems.

EI

Composite Materials; Mirrors; Space Flight; Surface Roughness; Technology Utilization

20030088976

Phase retrieval camera for testing NGST optics

Lowman, Andrew E.; Redding, David C.; Basinger, Scott A.; Cohen, David; Faust, Jessica A.; Green, Joseph J.; Ohara, Catherine M.; Shi, Fang; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4850, Issue no. 1, p. 329-335; In English; IR Space Telescopes and Instruments, Aug. 24-28, 2002, Waikoloa, HI, USA; Copyright; Avail: Other Sources

The NGST Phase Retrieval Camera (PRC) is a portable wavefront sensor useful for optical testing in high-vibration environments. The PRC uses focus-diverse phase retrieval to measure the wavefront propagating from the optical component or system under test. Phase retrieval from focal plane images is less sensitive to jitter than standard pupil plane interferometric measurements; the PRC's performance is further enhanced by using a high-speed shutter to freeze out seeing and jitter along with a reference camera to maintain the correct boresight in defocused images. The PRC hardware was developed using components similar to those in NGST's Wavefront Control Testbed (WCT), while the PRC software was derived from WCT's extensive software infrastructure. Primary applications of the PRC are testing and experimenting with NGST technology

demonstrator mirrors, along with exploring other wavefront sensing and control problems not easily studied using WCT. An overview of the hardware and testing results will be presented.
EI
Cameras; Image Analysis; Optical Equipment; Sensors

20030088191
The astrobiology explorer (ABE) MIDEX mission concept - Identifying organic molecules in space
Ennico, K.; Sandford, S.; Allamandola, L.; Bregman, J.; Cohen, M.; Cruikshank, D.; Greene, T.; Hudgins, D.; Kwok, S.; Lord, S.; Madden, S.; McCreight, C.; Roellig, T.; Strecker, D.; Tielens, A.; Werner, M.; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4850, Issue no. 2, p. 1149-1160; In English; IR Space Telescopes and Instruments, Aug. 24-28, 2002, waikoloa, HI, USA; Copyright; Avail: Other Sources

The Astrobiology Explorer (ABE) is a MIDEX mission concept, currently under Concept Phase A study at NASA's Ames Research Center in collaboration with Ball Aerospace & Technologies, Corp., and managed by NASA's Jet Propulsion Laboratory. ABE will conduct infrared spectroscopic observations to address important problems in astrobiology, astrochemistry, and astrophysics. The core observational program would make fundamental scientific progress in understanding the distribution, identity, and evolution of ices and organic matter in dense molecular clouds, young forming stellar systems, stellar outflows, the general diffuse ISM, HII regions, Solar System bodies, and external galaxies. The ABE instrument concept includes a 0.6 m aperture Ritchey-Chretien telescope and three moderate resolution (R = 2000-3000) spectrometers together covering the 2.5-20 micron spectral region. Large format (1024 x 1024 pixel) IR detector arrays will allow each spectrometer to cover an entire octave of spectral range per exposure without any moving parts. The telescope will be cooled below 50 K by a cryogenic dewar shielded by a sunshade. The detectors will be cooled to [similar to]7.5 K by a solid hydrogen cryostat. The optimum orbital configuration for achieving the scientific objectives of the ABE mission is a low background, 1 AU Earth driftaway orbit requiring a Delta II launch vehicle. This configuration provides a low thermal background and allows adequate communications bandwidth and good access to the entire sky over the [similar to] 1.5 year mission lifetime.
EI
Astrophysics; Bandwidth; Infrared Detectors; Orbits; Spectrometers

20030088188
An engineering concept and enabling technologies for a large Single Aperture Far-Infrared Observatory (SAFIR)
Amato, Michael J.; Benford, Dominic J.; Roman, Juan A.; Harvey Moseley, S.; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4850, Issue no. 2, p. 1120-1131; In English; IR Space Telescopes and Instruments, Aug. 24-28, 2002, waikoloa, HI, USA; Copyright; Avail: Other Sources

'To take the next step in exploring this important part of the spectrum [30-300 micron], the committee recommends the Single Aperture Far-Infrared Observatory (SAFIR).' - Astronomy and Astrophysics in the New Millennium, 2001(sup 1). In response to this recommendation, we have undertaken a study of the enabling technologies for a large single aperture far-infrared telescope such as SAFIR. A broad list of science investigations was produced and used to generate an explicit list of science requirements, from which top-level engineering requirements were derived. From these requirements, we developed a conceptual design for the SAFIR observatory based on NGST's current designs. A detailed analysis has been made of the changes and technologies necessary to produce SAFIR. Crucial technologies requiring innovation include lightweight deployable optics, cryogenic cooling of optical elements and instruments, and large arrays of sensitive detectors. Cryogen-free refrigeration technologies are necessary for SAFIR's long mission lifetime, and will have to provide significant ([similar to]100mW) cooling power at 4K to cool the mirrors while providing very low temperatures ([similar to]50mK) for detector arrays. The detector arrays require wide wavelength coverage, thousands of continuum elements, and compatibility with broadband and spectroscopic instruments.
EI
Bolometers; Cryogenics; Infrared Radiation; Observatories; Optical Equipment

20030088183
A cryogenic, insulating suspension system for the High resolution Airborne Wideband Camera (HAWC) and Submillemeter And Far Infrared Experiment (SAFIRE) Adiabatic Demagnetization Refrigerators (ADRs)
Voellmer, George M.; Jackson, Michael L.; Shirron, Peter J.; Tuttle, James G.; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4850, Issue no. 2, p. 1070-1079; In English; IR Space Telescopes and Instruments, Aug. 24-28, 2002, waikoloa, HI, USA; Copyright; Avail: Other Sources

The High Resolution Airborne Wideband Camera (HAWC) and the Submillimeter And Far Infrared Experiment (SAFIRE) will use identical Adiabatic Demagnetization Refrigerators (ADR) to cool their detectors to 200mK and 100mK, respectively. In order to minimize thermal loads on the salt pill, a Kevlar[registered trademark] suspension system is used to hold it in place. An innovative, kinematic suspension system is presented. The suspension system is unique in that it consists of two parts that can be assembled and tensioned offline, and later bolted onto the salt pill.
EI
Cameras; Demagnetization; Infrared Radiation; Kinematics; Refrigerators

20030088181
NGSS: The next generation sky survey
Eisenhardt, Peter R.; Wright, Edward L.; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4850, Issue no. 2, p. 1050-1057; In English; IR Space Telescopes and Instruments, Aug. 24-28, 2002, waikoloa, HI, USA; Copyright; Avail: Other Sources

The Next Generation Sky Survey (NGSS) is a Medium Explorer currently in Phase A study, with launch planned for 2007. NGSS will map the entire sky with unprecedented sensitivity from 3.5 to 23 microns. With over 500,000 times the sensitivity of COBE at 3.5 and 4.7 microns, and a thousand times that of IRAS at 12 and 25 microns, NGSS will establish an essential database for testing theories of the origins of planets, stars, and galaxies, and is the necessary precursor for NGST. The science objectives of NGSS include finding the most luminous galaxies in the universe, and the closest stars to the sun. NGSS will achieve these dramatic advances while minimizing mission cost and risk by using flight-proven technology for its spacecraft bus components and cryogenic instrument, as well as 2MASS data processing software.
EI
Astronomy; Cryogenics; Data Bases; Data Processing; Sensitivity

20030088180
Superfluid helium cryostat for the SIRTF cryogenic telescope assembly
Volz, Stephen M.; Schweickart, Russell B.; Heurich, Bruce; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4850, Issue no. 2, p. 1038-1049; In English; IR Space Telescopes and Instruments, Aug. 24-28, 2002, waikoloa, HI, USA; Copyright; Avail: Other Sources

The Space Infrared Telescope Facility (SIRTF) is the last of NASA's four great observatories, scheduled for launch in January 2003. At the heart of the SIRTF Observatory is the Cryogenic Telescope Assembly (CTA) that provides a 1.4 K heat sink for the SIRTF Science Instruments while cooling the telescope to as low as 5.5 K in order to achieve thea low photon background. This unique cryogenic/thermal system provides the necessary cooling through passive means combined with vapor cooling by the helium gas vented from a 360 liter superfluid helium cryostat. The passive cooling is made possible by the favorable thermal environment achieved in an Earth-trailing solar orbit, with the payload millions of miles from the Earth. The SIRTF Cryostat and integrated CTA have just completed an extended period of cryogenic system performance testing. This testing included mission lifetime assessment, luanch hold capability and in situ characterization and performance measurements of the porous plug liquid-vapor phase separator. We also encountered and recovered from an ice contamination incident within the cryostat. We report here the system and component test results. We also provide recommendations and lessons learned through the operations of the SIRTF system.
EI
Cryostats; Liquid Helium; Phase Separation (Materials); Sensors; Space Infrared Telescope Facility

20030088178
NASA advanced cryocooler technology development program
Ross, Jr. , R. G.; Boyle, R. F.; Key, R. W.; Coulter, D. R.; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4850, Issue no. 2, p. 1020-1028; In English; IR Space Telescopes and Instruments, Aug. 24-28, 2002, waikoloa, HI, USA; Copyright; Avail: Other Sources

Mechanical cryocoolers represent a significant enabling technology for NASA's Earth and Space Science Enterprises. Over the years, NASA has developed new cryocooler technologies for a wide variety of space missions. Recent achievements include the NCS, AIRS, TES and HIRDLS cryocoolers, and miniature pulse tube coolers at TRW and Lockheed Martin. The largest technology push within NASA right now is in the temperature range of 4 to 10 K. Missions such as the Next Generation Space Telescope (NGST) and Terrestrial Planet Finder plan to use infrared detectors operating between 6-8K, typically arsenic-doped silicon arrays, with IR telescopes from 3 to 6 meters in diameter. Similarly, Constellation-X plans to use X-ray

microcalorimeters operating at 50 mK and will require [similar to]6K cooling to precool its multistage 50mK magnetic refrigerator. To address cryocooler development for these next-generation missions, NASA has initiated a program referred to as the Advanced Cryocooler Technology Development Program (ACTDP). This paper presents an overview of the ACTDP program including programmatic objectives and timelines, and conceptual details of the cooler concepts under development.
EI

Brayton Cycle; Cooling; Cryogenic Cooling; Infrared Detectors; Stirling Cycle

20030088174

A parallel DSP data acquisition system for evaluating IR detector arrays

Ogilvie, William; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4850, Issue no. 2, p. 971-980; In English; IR Space Telescopes and Instruments, Aug. 24-28, 2002, waikoloa, HI, USA; Copyright; Avail: Other Sources

Infrared detectors have advanced to the point where current devices are capable of achieving noise figures that are comparable to the background noise of space. Characterization tests done on these detectors at the NASA Ames Research Center have helped select the best devices for space telescopes. A highly customized system that can do these specialized tests has been developed with commercial off the shelf hardware. The data acquisition component of this system uses a pipelined architecture of multiple processors to enhance its real-time performance. This system can be customized for almost any array architecture and as more real-time performance is needed, additional processors can be incorporated. This approach permits large arrays to be tested at their maximum clocking rate.
EI

Data Acquisition; Hardware; Infrared Detectors; Random Signals; Telescopes

20030088171

Ultralow-background large-format bolometer arrays

Benford, Dominic J.; Chervenak, James A.; Irwin, Kent D.; Moseley, S. Harvey; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4850, Issue no. 2, p. 944-953; In English; IR Space Telescopes and Instruments, Aug. 24-28, 2002, waikoloa, HI, USA; Copyright; Avail: Other Sources

In the coming decade, work will commence in earnest on large cryogenic far-infrared telescopes and interferometers. All such observatories - for example, SAFIR, SPIRIT, and SPECS - require large format, two dimensional arrays of close-packed detectors capable of reaching the fundamental limits imposed by the very low photon backgrounds present in deep space. In the near term, bolometer array architectures which permit 1000 pixels - perhaps sufficient for the next generation of space-based instruments - can be arrayed efficiently. Demonstrating the necessary performance, with Noise Equivalent Powers (NEPs) of less than 10(sup -20) W/ square root of Hz, will be a hurdle in the coming years. Superconducting bolometer arrays are a promising technology for providing both the performance and the array size necessary. We discuss the requirements for future detector arrays in the far-infrared and submillimeter, describe the parameters of superconducting bolometer arrays able to meet these requirements, and detail the present and near future technology of superconducting bolometer arrays. Of particular note is the coming development of large format planar arrays with absorber-coupled and antenna-coupled bolometers.
EI

Bolometers; Cryogenics; Interferometers; SQUID (Detectors); Telescopes

20030088165

Large format Si:As IBC array performance for NGST and future IR space telescope applications

Ennico, Kimberly; McKelvey, Mark; McCreight, Craig; McMurray, Jr. , Robert; Johnson, Roy; Hoffman, Alan W.; Love, Peter; Lum, Nancy; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4850, Issue no. 2, p. 890-901; In English; IR Space Telescopes and Instruments, Aug. 24-28, 2002, waikoloa, HI, USA; Copyright; Avail: Other Sources

A mid-infrared(5-30 micron) instrument aboard a cryogenic space telescope can have an enormous impact in resolving key questions in astronomy and cosmology. A space platform's greatly reduced thermal backgrounds (compared to airborne or ground-based platforms), allow for more sensitive observations of dusty young galaxies at high redshifts, star formation of solar-type stars in the local universe, and formation and evolution of planetary disks and systems. The previous generation's largest, most sensitive infrared (IR) detectors at these wavelengths are 256 x 256 pixel Si:As impurity band conduction (IBC) devices built by Raytheon Infrared Operations (RIO) for the SIRTF/IRAC instrument. RIO has successfully enhanced these

devices, increasing the pixel count by a factor of 16 while matching or exceeding SIRTF/IRAC device performance. NASA-Ames Research Center in collaboration with RIO has tested the first high performance large format (1024 x 1024) Si:As IBC arrays for low background applications, such as for the mid-IR instrument on NGST and future IR Explorer missions. These hybrid devices consist of radiation-hard SIRTF/IRAC-type Si:As IBC material mated to a readout multiplexer that has been specially processed for operation at low cryogenic temperatures (below 10 K), yielding high device sensitivity over a wavelength range of 5-28 microns. In this paper, we present laboratory test results from these benchmark devices. Continued development in this technology is essential for conducting large-area surveys of the local and early universe through observation and for complementing future missions such as NGST, TPF, and FIRST.
EI
Astronomy; Cameras; Cryogenics; Infrared Detectors

20030088159
Deconvolving infrared telescope images as point sources on a grid
Elliott, David G.; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4850, Issue no. 2, p. 813-823; In English; IR Space Telescopes and Instruments, Aug. 24-28, 2002, waikoloa, HI, USA; Copyright; Avail: Other Sources

Deconvolution of infrared telescope images can partially recover the distribution of light in the sky. The light from point sources and extended sources is modeled as a grid of closely-spaced points. A matrix of influence coefficients contains the response of the telescope-instrument combination to light at the grid points. A non-negative least-squares routine finds the sky flux densities that reproduce the instrument data. A personal computer program and examples of infrared telescope data deconvolution are presented.
EI
Astrophysics; Computer Programs; Image Reconstruction; Infrared Instruments; Infrared Radiation

20030088155
Ultra-high resolution, absolute position sensors for cryostatic applications
Leviton, Douglas B.; Frey, Bradley J.; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4850, Issue no. 2, p. 776-787; In English; IR Space Telescopes and Instruments, Aug. 24-28, 2002, waikoloa, HI, USA; Copyright; Avail: Other Sources

Recent advances in new technology, optical pattern recognition encoders at NASA have resulted in high speed, reliable, compact position sensors for use in cryostatic space flight mechanisms. New encoder scale patterns and image processing algorithms combine with digital signal processors (DSP) and field programmable gate array (FPGA) logic elements to enable encoders with conversion rates in excess of 1.5 kHz (suitable for high speed servo motion control for mechanisms), linear resolutions of less than 10 nm, and angular resolutions in the single digit milli-arcseconds in relatively compact packages. Fiber optic light guides allow encoders to function in cryostats with extremely low power dissipation. Ambient test data for fiber optic configurations suitable for cryogenic environments are presented. Cryostatic test capabilities under development are discussed. Potential applications exist for NGST and other infrared and sub-millimeter missions, such as fine guidance sensing, attitude control, mirror segment position sensing, and mirror scanning.
EI
Cryostats; Pattern Recognition; Pipes (Tubes); Sensors; Space Flight; Tracking (Position)

20030088144
THz frequency receiver instrumentation for Herschel's Heterodyne Instrument for Far Infrared (HIFI)
Pearson, J. C.; Mehdi, I.; Schlecht, E.; Maiwald, F.; Maestrini, A.; Gill, J.; Martin, S.; Pukala, D.; Ward, J.; Kawamura, J.; McGrath, W. R.; Hatch, W. A.; Harding, D.; Leduc, H. G.; Stern, J. A.; et al., T; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4850, Issue no. 2, p. 650-661; In English; IR Space Telescopes and Instruments, Aug. 24-28, 2002, waikoloa, HI, USA; Copyright; Avail: Other Sources

The Heterodyne Instrument for Far Infrared (HIFI) on ESA's Herschel Space Observatory is comprised of five SIS receiver channels covering 480-1250 GHz and two HEB receiver channels covering 1410-1910 GHz. Two fixed tuned local oscillator sub-bands are derived from a common synthesizer to provide the front-end frequency coverage for each channel. The local oscillator unit will be passively cooled while the focal plane unit is cooled by superfluid helium and cold helium vapors. HIFI employs W-band GaAs amplifiers, InP HEMT low noise IF amplifiers, fixed tuned broadband planar diode multipliers, and novel material systems in the SIS mixers. The National Aeronautics and Space Administration's Jet Propulsion

Laboratory is managing the development of the highest frequency (1119-1250 GHz) SIS mixers, the highest frequency (1650-1910 GHz) HEB mixers, local oscillators for the three highest frequency receivers as well as W-band power amplifiers, varactor diode devices for all high frequency multipliers and InP HEMT components for all the receiver channels intermediate frequency amplifiers. The NASA developed components represent a significant advancement in the available performance. The current state of the art for each of these devices is presented along with a programmatic view of the development effort.
EI
Heterodyning; Infrared Radiation; Observatories; Oscillators; Receivers

20030088120

PSF monitoring and in-focus wavefront control for NGST

Ohara, Catherine M.; Redding, David C.; Shi, Fang; Green, Joseph J.; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4850, Issue no. 1, p. 416-427; In English; IR Space Telescopes and Instruments, Aug. 24-28, 2002, Waikoloa, HI, USA; Copyright; Avail: Other Sources

A technique for measuring the low-order wavefront aberrations in segmented-mirror telescopes using in-focus point-spread functions - 'PSF Monitoring' - has been developed for the Next Generation Space Telescope (NGST). PSF Monitoring will enable the continuous monitoring of the mirror segment alignment using the PSFs readily available in science data. An extension of PSF Monitoring - in-focus wavefront control, or the explicit determination and correction of wavefront errors from in-focus images - may allow for the nominal maintenance of the NGST mirror alignment without detracting from valuable science observing time. PSF Monitoring and in-focus wavefront control have been rigorously tested on the segmented aperture system of the NGST Wavefront Control Testbed (WCT). This paper presents the results of our experiments and simulations to characterize the capture range and accuracy on WCT, as well as a two-wavelength algorithm that has been used to extend the piston capture range. A real-time PSF Monitoring and control experiment on WCT will also be presented. Finally, we show preliminary simulation results of PSF Monitoring on the two candidate NGST systems.
EI
Algorithms; Computers; Optics; Telescopes; Wave Fronts

20030088119

New cryogenic optical test capability at Marshall space flight center's space optics manufacturing technology center

Kegley, Jeff; Eng, Ron; Engberg, Robert; Hadaway, James; Hogue, William; Reily, Cary; Russell, Kevin; Stahl, Phillip; Wright, Ernie; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4850, Issue no. 1, p. 407-415; In English; IR Space Telescopes and Instruments, Aug. 24-28, 2002, Waikoloa, HI, USA; Copyright; Avail: Other Sources

Marshall Space Flight Center (MSFC) has been performing optical wavefront testing at cryogenic temperatures since 1999 in the Space Optics Manufacturing Technology Center's (SOMTC's) X-ray/Cryogenic Facility (XRCF). Recently the cryogenic optical testing capability has been extended to a smaller chamber. This smaller horizontal cylindrical vacuum chamber has been outfitted with a helium-cooled liner that can be connected to the existing helium refrigeration system bringing the kilowatt of refrigeration capacity to bear on a 1 x 2 meter test envelope. Cryogenic cycles to 20 Kelvin, including setup and chamber evacuation/backfill, are now possible in only a few days. Since activation and chamber characterization tests in September 2001, the new chamber has been used to perform a number of proprietary cryogenic tests on mirrors, adhesives, and actuators. A vibration survey has also been performed on the test chamber. Chamber specifications and performance data, vibration environment data, and optical test capability will be discussed.
EI
Cryogenics; Helium; Optics; Refrigerating; Stainless Steels

20030088118

NGST phase retrieval camera design and calibration details

Faust, Jessica A.; Lowman, Andrew E.; Redding, David C.; Basinger, Scott A.; Green, Joseph J.; Ohara, Catherine M.; Shi, Fang; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4850, Issue no. 1, p. 398-406; In English; IR Space Telescopes and Instruments, Aug. 24-28, 2002, Waikoloa, HI, USA; Copyright; Avail: Other Sources

Experience and infrastructure from NGST's Wavefront Control Testbed (WCT) were utilized to develop a portable wavefront sensor, the Phase Retrieval Camera (PRC). The PRC is useful for the testing of optics in high-jitter environments. The principal uses of the PRC will be testing and experimenting with NGST technology demonstration mirrors as well as

exploring other issues of wavefront sensing and control not easily studied using the WCT. This presentation will detail the packaging and hardware chosen for the PRC, the PRC software, and calibration of the instrument.
EI
Cameras; Computer Programs; Mirrors; Sensors

20030088116
Segmented mirror coarse phasing with white light interferometry: Modeling and experiment on NGST's wavefront control testbed
Shi, Fang; Redding, David C.; Lowman, Andrew E.; Ohara, Catherine M.; Burns, Laura A.; Petrone, III, Peter; Bowers, Charles W.; Basinger, Scott A.; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4850, Issue no. 1, p. 380-387; In English; IR Space Telescopes and Instruments, Aug. 24-28, 2002, Waikoloa, HI, USA; Copyright; Avail: Other Sources

A method of coarse phasing segmented mirrors using white light interferometry (WLI) has been developed for the Next Generation Space Telescope (NGST) wavefront sensing and control. Using the broadband point PSF of the segmented mirrors taken during a segment piston scan, the WLI can accurately detect small residual piston errors. WLI does not rely on extra optics and uses only the final imaging camera. With its high sensitivity to small segment piston error WLI can be used as a complementary phasing algorithm to the dispersed fringe sensor (DFS) for NGST. This paper will present the results from modeling and experiment on the NGST's Wavefront Control Testbed (WCT).
EI
Cameras; Imaging Techniques; Interferometry; Mirrors; Wave Fronts

20030088115
Wavefront control testbed integrated software system
Burns, Laura A.; Basinger, Scott A.; Beck, Terrence L.; Deering, Jennifer E.; Tonnu, Daoanh; Lindler, Don J.; Lowman, Andrew E.; Morris, Robert O.; Ohara, Catherine M.; Petrone, III, Peter P.; Redding, David C.; Schott, Jeffrey C.; Stoner, Sara M.; Wheeler, J. Ladd; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4850, Issue no. 1, p. 370-379; In English; IR Space Telescopes and Instruments, Aug. 24-28, 2002, Waikoloa, HI, USA; Copyright; Avail: Other Sources

The Wavefront Control Testbed (WCT) is used to demonstrate the wavefront sensing and control algorithms and procedures that will be used on the Next Generation Space Telescope (NGST). The Segmented Telescope Control Software, written in MATLAB[registered trademark], is the primary development and operational tool used. The software has an extensive graphical user interface that allows the user to interact with the hardware and algorithms. A variety of additional software programs support the Segmented Telescope Control Software (STCS). Various hardware control software interacts with MATLAB via TCP/IP connections. When access to the hardware is unnecessary or undesirable, we can access the model server that simulates the system. A stand-alone safety monitoring LabVIEW[registered trademark] program alerts technicians if a hardware failure occurs. A C program gives the operator a graphical way of monitoring the network connections to the various systems. An Interactive Data Language[registered trademark] (IDL) data archiving routine creates a database to monitor and maintain the testbed data and executes the MATLAB to Flexible Image Transport System (FITS) translator. Additionally we have implemented a web-based bug tracking and plan to add experiment scheduling and a document archive. Due to the nature of the testbed, these software programs are constantly evolving, causing a variety of challenges over the years. This poster will describe these software elements and the issues that have arisen trying to use them together.
EI
Algorithms; Computer Programs; Computers; Graphical User Interface; Wave Fronts

20030088114
Wavefront sensing and control software for a segmented space telescope
Basinger, Scott A.; Burns, Laura A.; Redding, David C.; Shi, Fang; Cohen, David; Green, Joseph J.; Ohara, Catherine M.; Lowman, Andrew E.; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4850, Issue no. 1, p. 362-369; In English; IR Space Telescopes and Instruments, Aug. 24-28, 2002, Waikoloa, HI, USA; Copyright; Avail: Other Sources

The Segmented Telescope Control Software (STCS) uses science camera information to align and phase a deployable segmented optical telescope. It was developed the for the Next Generation Space Telescope (NGST) and has been successfully utilized on the Wavefront Control Testbed (WCT) for NGST and a portable phase retrieval camera (PPRC) system. The

software provides an operating environment that will be used for the prime contractor's testbeds for NGST, and will eventually evolve into the Wavefront Sensing and Control (WFS&C) ground support software for NGST. This paper describes the engineering version of the STCS, the algorithms it incorporates, and methods of communicating with the testbed hardware. EI

Algorithms; Cameras; Computer Programs; Telescopes; Wave Fronts

20030088112

Interferometric validation of image-based wave front sensing for NGST

Green, Joseph J.; Redding, David C.; Beregovski, Yuri; Lowman, Andrew E.; Ohara, Catherine M.; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4850, Issue no. 1, p. 345-352; In English; IR Space Telescopes and Instruments, Aug. 24-28, 2002, Waikoloa, HI, USA; Copyright; Avail: Other Sources

To achieve and maintain excellent imaging performance, the Next Generation Space Telescope (NGST) will employ image-based phase retrieval methods to control its segmented primary mirror. In this paper, we present the experimental validation of a focus-diverse wave front sensing (WFS) algorithm with comparative interferometric measurements of a perturbed test mirror. Using sets of defocused point-spread functions measured with the NGST phase retrieval camera, we estimate the aberrations of the test optic in a perturbed and unperturbed state. Interleaved with the focus-diverse sets, we measure the surface figure of the mirror using a ZYGO interferometer. After briefly reviewing the basic WFS algorithm and describing the experimental setup, we show that we can obtain agreement that is better than 1/100th of a wave rms in the difference of the wave front estimates obtained in the perturbed and unperturbed states. Although this experiment does not establish the errors that are solely attributable to our WFS approach, it nevertheless validates the accuracy of our image-based methods for NGST, demonstrating that they are generally competitive with standard industrial optical metrology instruments. EI

Aberration; Cameras; Image Analysis; Imaging Techniques; Mirrors

20030088111

NGST high dynamic range unwrapped phase estimation

Cohen, David; Redding, David C.; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4850, Issue no. 1, p. 336-344; In English; IR Space Telescopes and Instruments, Aug. 24-28, 2002, Waikoloa, HI, USA; Copyright; Avail: Other Sources

We report on an algorithm enabling estimation of high dynamic range pupil phase without wrapping ambiguity. This algorithm was developed and validated using the NGST Wavefront Control Testbed (WCT-1), which permits introduction of aberrations and subsequent correction using 2 deformable mirrors. The algorithm is an extension of a Modified Gerchberg-Saxton iterative technique that incorporates both an evolving trial estimate as well as intermediate unwrapping. We will discuss results from WCT-1 that illustrate phase estimation when varying degrees of aberration are introduced. EI

Aberration; Algorithms; Iterative Solution; Mirrors

20030088110

Segmented mirror coarse phasing with a dispersed fringe sensor: Experiment on NGST's wavefront control testbed

Shi, Fang; Redding, Dave C.; Lowman, Andrew E.; Bowers, Charles W.; Burns, Laura A.; Petrone, III, Peter; Ohara, Catherine M.; Basinger, Scott A.; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4850, Issue no. 1, p. 318-328; In English; IR Space Telescopes and Instruments, Aug. 24-28, 2002, Waikoloa, HI, USA; Copyright; Avail: Other Sources

A piston sensing and control algorithm for segmented mirror coarse phasing using a dispersed fringe sensor (DFS) has been developed for the Next Generation Space Telescope (NGST) wavefront sensing and control. The DFS can detect residual piston errors as large as the order of a depth-of-focus and can phase the segment mirrors with accuracy better than 0.1 microns, which is well within the capture range of fine phasing for NGST. A series of experiments have been carried out on the NGST's Wavefront Control Testbed (WCT) to validate the modeling results, evaluate the DFS performance, and systematically explore the factors that affect the DFS performance. This paper reports the testbed results for several critical issues of DFS performance, including DFS dynamic range, accuracy, fringe visibility, and the effects of segment mirror aberrations. EI

Aberration; Algorithms; Mirrors; Sensors; Wave Fronts

20030088098

The James Webb Space Telescope (JWST): Hubble's scientific and technological successor

Seery, Bernard D.; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4850, Issue no. 1, p. 170-178; In English; IR Space Telescopes and Instruments, Aug. 24-28, 2002, Waikoloa, HI, USA; Copyright; Avail: Other Sources

The James Webb Space Telescope (JWST) - the 21(sup st) century follow-on to NASA's highly successful Hubble Space Telescope - has moved one step closer to becoming a reality. In addition to selecting the instrument and science teams, NASA announced on September 10, 2002 that TRW Space and Electronics and its partners - Ball Aerospace and Eastman Kodak - had won the prime contract to build the high-profile observatory, formerly known as the Next Generation Space Telescope. It will be up to the contractor team and NASA to finalize designs and begin laying the groundwork for assembling one of the largest single-aperture telescopes ever flown. This article provides a general overview of the JWST mission - a centerpiece of NASA's Origins Program - and describes some of the technological challenges that NASA and TRW face.

EI

Aerospace Sciences; Astrophysics; Infrared Detectors; Infrared Radiation

20030088084

Development of the Space Infrared Telescope Facility (SIRTF)

Gallagher, David B.; Irace, William R.; Werner, Michael W.; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4850, Issue no. 1, p. 17-29; In English; IR Space Telescopes and Instruments, Aug. 24-28, 2002, Waikoloa, HI, USA; Copyright; Avail: Other Sources

SIRTF, the Space Infrared Telescope Facility, is to be launched by NASA early in 2003. SIRTF will be an observatory for infrared astronomy from space with an 85cm aperture telescope operating at 5.5K and a 2.5-to-5 year cryogenic lifetime. SIRTF's three instruments with state of the art detector arrays will provide imaging, photometry, and spectroscopy over the 3-180um wavelength range. SIRTF will provide major advances for the study of astrophysical problems from the solar system to the edge of the Universe. SIRTF will complete NASA's family of Great Observatories and serve as a cornerstone of the Origins program. Over 75% of the observing time will be awarded to the general scientific community through the usual proposal and peer review cycle. SIRTF will demonstrate major advances in technology areas critical to future infrared missions. These include lightweight cryogenic optics, sensitive detector arrays, and a high performance thermal system, combining radiative and cryogenic cooling, which allows the telescope to be launched warm and to cool in space. These thermal advances are enabled by the use of an Earth-trailing solar orbit which carries SIRTF to a distance of [similar to]0.6 AU from Earth in 5 years. This paper will provide an overview of the SIRTF mission, telescope, cryostat, instruments, spacecraft, orbit, and operations in preparation for an accompanying set of detailed technical presentations.

EI

Aerospace Sciences; Airborne Equipment; Astronomy; Infrared Radiation; Observatories; Space Infrared Telescope Facility; Telescopes

20030085726

Optical design tools for reflective optical systems

Howard, Joseph M.; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4849, p. 407-412; In English; Highly Innovative Space Telescope Concepts, Aug. 22-23, 2002, Waikoloa, HI, USA; Copyright; Avail: Other Sources

Imaging constraints are applied in lens design software macros for automatic generation of Ritchey-Chretien, Three-Mirror-Anastigmat (TMA), and plane symmetric configurations of spherical, conic, and general aspheric mirrors. These tools provide rapid development of telescope and instrument designs by reducing the available degrees of freedom confronting the designer while maintaining the desired set of image properties (e.g. focal length and aberration control). A brief example of a Ritchey-Chretien telescope is presented.

EI

Asphericity; Design Analysis; Lenses; Mirrors; Optical Equipment

20030085718

Fabrication and testing of ultra lightweight Gossamer class composite mirrors

Chen, Peter C.; Oliversen, Ronald J.; Romeo, Robert C.; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4849, p. 339-347; In English; Highly Innovative Space Telescope Concepts, Aug. 22-23, 2002, Waikoloa, HI, USA; Copyright; Avail: Other Sources

The development of composite mirror technology under NASA Gossamer Spacecraft Initiative program was reported. The objectives were to produce moderate aperture, extremely low areal density mirrors with smooth surfaces and good optical figure. Preliminary examinations of the optical surfaces showed that the 3.4 kg/m(sup 2) mirror, made using extremely thin 35 gsm material and a stiffening ring, had a fair optical figure but showed some mid - and high - frequency features.
EI
Composite Materials; Mirrors; Optics; Stiffness

20030085692
Development of nanolaminate thin shell mirrors
Hickey, Gregory S.; Lih, Shyh-Shiuh; Barbee, Jr. , Troy; Proceedings of SPIE - The International Society for Optical Engineering; 2002; ISSN 0277-786X; Volume 4849, p. 63-76; In English; Highly Innovative Space Telescope Concepts, Aug. 22-23, 2002, Waikoloa, HI, USA; Copyright; Avail: Other Sources

The space science community has identified a need for ultra-light weight, large aperture optical systems that are capable of producing high-resolution images of low contrast. Current mirror technologies are limited due either to not being scalable to larger sizes at reasonable masses, or to lack of surface finish, dimensional stability in a space environment or long fabrication times. This paper will discuss the development of thin-shell, nano-laminate mirror substrates that are capable of being electro-actively figured. This technology has the potential to substantially reduce the cost of space based optics by allowing replication of ultra-lightweight primary mirrors from a master precision tool. Precision master tools have been shown to be used multiple times with repeatable surface quality results with less than one week fabrication times for the primary optical mirror substrate. Current development has developed a series of 0.25 and 0.5 meter spherical nanolaminate mirrors that are less than 0.5 kg/m(sup 2) areal density before electroactive components are mounted, and a target of less than 2.0 kg/m with control elements. This paper will provide an overview of nanolaminate materials for optical mirrors, modeling of their behavior under figure control and experiments conducted to validate precision control.
EI
Image Analysis; Mirrors; Optical Equipment; Resolution

20030061998
Controlling a telescope chopping secondary mirror assembly using a signal deconvolution technique
Houde, Martin; Holt, Lynn C.; Yoshida, Hiroshige; Nelson, Patrick M.; Review of Scientific Instruments; August 2003; ISSN 0034-6748; Volume 74, Issue no. 8, 3802-3806; In English; Copyright

We describe a technique for improving the response of a telescope chopping secondary mirror assembly by using a signal processing method based on the Lucy deconvolution technique. This technique is general and could be used for any systems, linear or nonlinear, where the transfer function(s) can be measured with sufficient precision. We demonstrate how the method was implemented and show results obtained at the Caltech Submillimeter Observatory using different chop throw amplitudes and frequencies. No intervention from the telescope user is needed besides the selection of the chop throw amplitude and frequency. All the calculations are done automatically once the appropriate command is issued from the user interface of the observatory's main computer. [copyright] 2003 American Institute of Physics.
Author (AIP)
Image Processing; Mirrors; Radio Telescopes; Signal Processing; Transfer Functions

20030058141
A Survey of Nearby Main-Sequence Stars for Submillimeter Emission
Holmes, E. K.; Butner, H. M.; Fajardo-Acosta, S. B.; Rebull, L. M.; The Astronomical Journal; June 2003; ISSN 0004-6256; Volume 125, Issue no. 6, 3334-3343; In English; Copyright

We searched for submillimeter emission around 10 Vega-type stars and one Herbig Ae star with the four-color bolometer at 1300 [mu]m and the 19 channel bolometer array at 870 [mu]m using the Heinrich Hertz Telescope at the Submillimeter Telescope Observatory. All of our sources were undetected at 870 [mu]m. In the case of HD 131156, we have a 3 [sigma] detection at 1300 [mu]m. We report a flux of 6. 25[plus-or-minus]1.88 mJy for the HD 131156 disk and a corresponding dust mass of 2.4[plus-or-minus]0.7 lunar masses. However, we did not detect HD 131156 at 870 [mu]m, so we are cautious about the 1300 [mu]m detection. We performed follow-up infrared observations of HD 131156 using MIRLIN at the Palomar 200 inch telescope, which resolved both components of the binary. The data are photospheric, implying that the system does not

have a hot, inner dust component. We report submillimeter upper limits on fluxes for the remaining systems.
Author (AIP)
A Stars; Accretion Disks; Astronomical Observatories; Astronomy; Cosmic Dust; Main Sequence Stars; Mass; Stars; Stellar Envelopes; Stellar Radiation; Submillimeter Waves

20030057785 Lawrence Livermore National Lab., Livermore, CA
Development of Large-Aperture, Light-Weight Fresnel Lenses for Gossamer Space Telescopes
Dixit, S.; Hyde, R.; Weisberg, A.; Early, J.; Rushford, M.; Apr. 20, 2002; In English
Report No.(s): DE2003-15002884; UCRL-JC-148223; No Copyright; Avail: Department of Energy Information Bridge

In order to examine more distant astronomical objects, with higher resolution, future space telescopes require objectives with significantly larger aperture than presently available. NASA has identified a progression in size from the 2.4m aperture objective currently used in the HUBBLE space telescope, to 25m and greater in order to observe, e.g., extra-solar planets. Since weight is a crucial factor for any object sent into space, the relative weight of large optics over a given area must be reduced. In this paper we discuss our development of large aperture Fresnel lenses for use in future space telescopes such as the Gossamer.
NTIS
Spaceborne Telescopes; Fresnel Lenses

20030054347 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Technologies and Mission Concepts for NHST
Oegerle, William R.; [2003]; In English, 28 May 2003; No Copyright; Avail: Other Sources; Abstract Only

A technology workshop entitled 'Innovative Designs for the Next Large Aperture Optical/UV Telescope' was held on April 10-11 at the Space Telescope Science Institute in Baltimore. This workshop was held to consider the technologies that will be required to support optical/UV space missions designed to carry out the science envisioned by the Hubble Science Legacy meeting held in April 2002 in Chicago. Subjects covered at the workshop included: optical designs, wavefront control, mirror technologies, spectrographs, coronagraphs, detector technologies, and in-space construction. A summary of the workshop and near-term plans for investigating several mission concepts will be provided. Funding for this workshop was provided by NASA.
Author
Ultraviolet Astronomy; Apertures; Spaceborne Telescopes; Mission Planning

20030053177 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Far-IR/Submillimeter Interferometry Missions in NASA's Roadmap: SPIRIT and SPECS
Leisawitz, David T.; [2003]; In English, May 6, 2003, Cambridge, MA, USA; No Copyright; Avail: Other Sources; Abstract Only

Information vital to the attainment of the major scientific objectives of NASA's Origins and Structure and Evolution of the Universe themes is uniquely available in the far-IR and submillimeter (FIR/SMM). NASA is studying concepts and investing in technologies for FIR/SMM observatories that could fly in the period 2010 - 2025 and provide enormous increases in measurement capabilities to extend the legacy of the next-generation missions SIRTF and Herschel. Future FIR/SMM space observatories will have the sensitivity needed to reach back in time to the formation epoch of the first luminous objects, the angular resolution needed to image proto-planetary systems and distinguish the emissions of individual galaxies, and the spectral resolution needed to probe the physical conditions and measure the flows of interstellar gas in young galaxies, nascent stars, and the dust-enshrouded nuclei of galaxies that harbor massive black holes. NASA's roadmap includes the JWST-class Single Aperture Far-IR (SAFIR) telescope and 1 km maximum-baseline FIR/SMM interferometer. This talk will focus on the niche for FIR/SMM interferometry and describe two missions: SPECS, the Submillimeter Probe of the Evolution of Cosmic Structure, and the pathfinder mission SPIRIT, the Space Infrared interferometric Telescope. I will give the scientific motivation for these missions, describe mission concepts and telescope measurement capabilities, and compare these capabilities with those of the next-generation IR telescopes, and with the complementary JWST and ALMA.
Author
Far Infrared Radiation; Infrared Interferometers; Submillimeter Waves; Evolution (Development); Galactic Nuclei

20030047930

A filled bolometer array camera for ground-based observations

Reveret, Vincent; Agnese, Patrick; Andre, Philippe; Doumayrou, Eric; Gastaud, Rene; Pennec, Jean Le; Rodriguez, Louis; AIP Conference Proceedings; May 08, 2002; ISSN 0094-243X; Volume 616, Issue no. 1, 270-272; In English; EXPERIMENTAL COSMOLOGY AT MILLIMETRE WAVELENGTHS: 2K1BC Workshop, 9-13 July 2001; Copyright

This paper describes the design of a bolometer camera using a filled array, for submillimeter ground astronomy. The architecture of the array is presented, as well as the calculated performances of a (16 x16) pixels array, mounted on a 3 m diameter telescope, such as KOSMA. [copyright] 2002 American Institute of Physics.

Author (AIP)

Antenna Arrays; Astronomy; Bolometers; Cameras; Optical Equipment; Submillimeter Waves

20030047923

Measuring CMB polarization with ESA PLANCK subMM-wave telescope

Yurchenko, Vladimir; AIP Conference Proceedings; May 08, 2002; ISSN 0094-243X; Volume 616, Issue no. 1, 234-238; In English; EXPERIMENTAL COSMOLOGY AT MILLIMETRE WAVELENGTHS: 2K1BC Workshop, 9-13 July 2001; Copyright

We analyze the polarization properties of the tilted off-axis dual-reflector submillimeter-wave telescope on the ESA PLANCK Surveyor designed for measuring the temperature anisotropies and polarization characteristics of the cosmic microwave background. [copyright] 2002 American Institute of Physics.

Author (AIP)

Background Radiation; Cosmic Rays; Electromagnetic Radiation; European Space Agency; Polarization (Waves); Polarization Characteristics; Radio Frequencies; Radio Telescopes; Submillimeter Waves; Temperature Measurement

20030047917

Submillimeter and millimeter wave sky mapping in the space project submillimetron

Gromov, Vladimir D.; Kardashev, Nikolay S.; Kuzmin, Leonid S.; AIP Conference Proceedings; May 08, 2002; ISSN 0094-243X; Volume 616, Issue no. 1, 205-209; In English; EXPERIMENTAL COSMOLOGY AT MILLIMETRE WAVELENGTHS: 2K1BC Workshop, 9-13 July 2001; Copyright

Submillimetron is an international project of the space telescope for astronomical studies at submillimeter and millimeter wavelengths using free-flying spacecraft and facilities of the Russian segment of the International Space Station. The payload is the 60-cm telescope cooled to liquid helium temperature with arrays of a novel type detector, Normal-metal Hot-Electron Bolometer (NHEB). The angular resolution is 1-10 arcmin, field of view-about 1 degree, detectors sensitivity-about 10(sup -18) W/Hz(sup 1/2), spectral region -0.2-2 mm. Parameters of the instrument and complementarity to other experiments including CMB measurements are discussed. [copyright] 2002 American Institute of Physics.

Author (AIP)

Astronomical Maps; Astronomy; Background Radiation; Bolometers; Cosmic Rays; International Cooperation; International Space Station; Millimeter Waves; Radio Astronomy; Radio Frequencies; Radio Telescopes; Spaceborne Telescopes; Submillimeter Waves

20030047896

Millimeter and submillimeter observations from the South Pole

Stark, Antony A.; AIP Conference Proceedings; May 08, 2002; ISSN 0094-243X; Volume 616, Issue no. 1, 83-91; In English, 9-13 July 2001; Copyright

During the past decade, a year-round observatory has been established at the geographic South Pole by the Center for Astrophysical Research in Antarctica (CARA). CARA has fielded several millimeter- and submillimeter-wave instruments: AST/RO (the Antarctic Submillimeter Telescope and Remote Observatory, a 1.7-m telescope outfitted with a variety of receivers at frequencies from 230 GHz to 810 GHz, including PoleSTAR, a heterodyne spectrometer array), Python (a degree-scale CMB telescope), Viper (a 2-m telescope which has been outfitted with SPARO, a submillimeter-wave bolometric array polarimeter, ACBAR, a multichannel CMB instrument, and Dos Equis, a HEMT polarimeter), and DASI (the Degree-Angular Scale Interferometer). These instruments have obtained significant results in studies of the interstellar medium and observational cosmology, including detections of the 1[deg] acoustic peak in the CMB and the Sunyaev-Zel'dovich effect. The South Pole environment is unique among observatory sites for unusually low wind speeds, low absolute humidity, and the consistent clarity of the submillimeter sky. The atmosphere is dessicated by cold: at the South Pole's average

annual temperature of -49 C, the partial pressure of saturated water vapor is only 1.2% of what it is at 0 C. The low water vapor levels result in exceptionally low values of sky noise. This is crucial for large-scale observations of faint cosmological sources--for such observations the South Pole is unsurpassed. [copyright] 2002 American Institute of Physics.
Author (AIP)
Antarctic Regions; Astronomical Observatories; Astronomy; Background Radiation; Cosmic Rays; Millimeter Waves; Radio Astronomy; Radio Frequencies; Radio Telescopes; Submillimeter Waves

20030047889
Millimeter and submillimeter observations from the Atacama plateau and high altitude balloons
Devlin, Mark; AIP Conference Proceedings; May 08, 2002; ISSN 0094-243X; Volume 616, Issue no. 1, 44-51; In English, 9-13 July 2001
Contract(s)/Grant(s): NRA-99-01-SPA-015; Copyright

A new generation of ground-based and sub-orbital platforms will be operational in the next few years. These telescopes will operate from high sites in Chile and Antarctica, and airborne platforms where the atmosphere is transparent enough to allow sensitive measurements in the millimeter and submillimeter bands. The telescopes will employ state-of-the-art instrumentation including large format bolometer arrays and spectrometers. I will discuss the results of our observations in the Atacama region of Chile (MAT/TOCO), our future observations on the Balloon-borne Large Aperture Submillimeter Telescope (BLAST) now under construction, and our proposed Atacama Cosmology Telescope (ACT). [copyright] 2002 American Institute of Physics.
Author (AIP)
Astronomy; Background Radiation; Balloons; Bolometers; High Altitude Balloons; Millimeter Waves; Radar Astronomy; Radio Astronomy; Radio Telescopes; Submillimeter Waves

20030046528
High performance silicon hot electron bolometers
Moseley, H.; McCammon, D.; AIP Conference Proceedings; February 05, 2002; ISSN 0094-243X; Volume 605, Issue no. 1, 103-106; In English; LOW TEMPERATURE DETECTORS: Ninth International Workshop on Low Temperature Detectors, 22-27 July 2001, Madison, Wisconsin, USA; Copyright

High performance Si bolometers can be made using the electron-phonon conductance in the heavily doped Si to provide thermal isolation from the cryogenic bath. Thermal conductance, response time, noise, and signal frequency resistance are predicted based on laboratory measurements of larger samples. The predictions show that such detectors can be built with thermal conductances suitable for a wide range of applications, ranging from the low backgrounds of cryogenic space telescopes to ground based imaging and spectroscopy. Their noise performance is expected to be near thermodynamic limits, allowing background limited performance for many far infrared and submillimeter photometric and spectroscopic applications. [copyright] 2002 American Institute of Physics.
Author (AIP)
Bolometers; Doped Crystals; Frequency Response; Hot Electrons; Low Temperature; Semiconductor Devices; Semiconductors (Materials); Silicon; Silicon Radiation Detectors; Thermal Conductivity

20030037454
Prospects for Future Observations in the Mid/Far IR
Mather, John C.; AIP Conference Proceedings; May 27, 2003; ISSN 0094-243X; Volume 666, Issue no. 1, 347-354; In English; THE EMERGENCE of COSMIC STRUCTURE: Thirteenth Astrophysics Conference, 7-9 October 2002, College Park, Maryland, USA; Copyright

The rapid advancement of telescope and detector technology enables a sequence of ambitious new airborne and space missions to observe in the mid- and far-infrared. I review the scientific forces that push us to these wavelengths, and the observatories that are planned or conceived to meet the goals. This decade and several more promise to be the 'age of the infrared,' with marvelous discoveries yet to come. I describe the main scientific objectives and the missions conceived to meet them, beginning with the SIRTF (Space Infrared Telescope Facility) planned for launch in early 2003, to the SPECS (Submillimeter Probe of the Evolution of Cosmic Structure), which may be decades in the future. [copyright] 2003 American Institute of Physics
Author (AIP)
Cosmology; Infrared Astronomy; Infrared Detectors; Space Missions; Spaceborne Telescopes; Telescopes

20030033862 NASA Goddard Space Flight Center, Greenbelt, MD, USA

Design and Fabrication of Two-Dimensional Semiconducting Bolometer Arrays for the High Resolution Airborne Wideband Camera (HAWC) and the Submillimeter High Angular Resolution Camera II (SHARC-II)

Voellmer, George M.; Allen, Christine A.; Amato, Michael J.; Babu, Sachidananda R.; Bartels, Arlin E.; Benford, Dominic J.; Derro, Rebecca J.; Dowell, C. Darren; Harper, D. Al; Jhabvala, Murzy D.; [2002]; In English, 22-28 Aug. 2002, Waikoloa, HI, USA; Original contains black and white illustrations; Copyright; Avail: CASI; A02, Hardcopy

The High resolution Airborne Wideband Camera (HAWC) and the Submillimeter High Angular Resolution Camera II (SHARC II) will use almost identical versions of an ion-implanted silicon bolometer array developed at the National Aeronautics and Space Administration's Goddard Space Flight Center (GSFC). The GSFC 'Pop-up' Detectors (PUD's) use a unique folding technique to enable a 12 x 32-element close-packed array of bolometers with a filling factor greater than 95 percent. A kinematic Kevlar(trademark) suspension system isolates the 200 mK bolometers from the helium bath temperature, and GSFC - developed silicon bridge chips make electrical connection to the bolometers, while maintaining thermal isolation. The JFET preamps operate at 120 K. Providing good thermal heat sinking for these, and keeping their conduction and radiation from reaching the nearby bolometers, is one of the principal design challenges encountered. Another interesting challenge is the preparation of the silicon bolometers. They are manufactured in 32-element, planar rows using Micro Electro Mechanical Systems (MEMS) semiconductor etching techniques, and then cut and folded onto a ceramic bar. Optical alignment using specialized jigs ensures their uniformity and correct placement. The rows are then stacked to create the 12 x 32-element array. Engineering results from the first light run of SHARC II at the Caltech Submillimeter Observatory (CSO) are presented.
Author

Microelectromechanical Systems; Semiconductors (Materials); Bolometers; Arrays; Cameras

20030032985 NASA Goddard Space Flight Center, Greenbelt, MD, USA

Removing Fringes from STIS Slitless Spectra and WFC3 CCD Images

Malumuth, E. M.; Hill, R. S.; Gull, T.; Woodgate, B. E.; Bowers, C. W.; Kimble, R. A.; Lindler, D.; Hill, R. J.; Cheng, E. S.; Cottingham, D. A.; [2002]; In English; Hubble Space Telescope Workshop, 17-18 Oct. 2002, Baltimore, MD, USA; Original contains black and white illustrations; Copyright; Avail: CASI; A01, Hardcopy

We have developed a model that allows us to defringe slitless 2-dimensional spectra taken with the Space Telescope Imaging Spectrograph (STIS). An IDL tool has been developed which allows the user to defringe any spectrum obtained with the G750L grating on STIS. This technique has been employed to model the fringing on Wide Field Camera 3 (WFC3) flight candidate CCDs.
Author

Imaging Techniques; CCD Cameras; Spaceborne Telescopes; Interference; Diffraction Patterns; Spectrographs

20030032982 NASA Goddard Space Flight Center, Greenbelt, MD, USA

Coronagraphic Imaging with HST and STIS

Grady, C. A.; Proffitt, C.; Malumuth, E.; Woodgate, B. E.; Gull, T. R.; Bowers, C. W.; Heap, S. R.; Kimble, R. A.; Lindler, D.; Plait, P.; [2002]; In English, 17-18 Oct. 2002, Baltimore, MD, USA

Contract(s)/Grant(s): NAS5-26555; GO-7088; GO-8037; GO-8491; GO-8896; GO-9241; Copyright; Avail: CASI; A03, Hardcopy

Revealing faint circumstellar nebulosity and faint stellar or substellar companions to bright stars typically requires use of techniques for rejecting the direct, scattered, and diffracted light of the star. One such technique is Lyot coronagraphy. We summarize the performance of the white-light coronagraphic capability of the Space Telescope Imaging spectrograph, on board the Hubble Space Telescope.
Author

Coronagraphs; Hubble Space Telescope; Imaging Techniques; Astrophysics

20030032467 NASA Goddard Space Flight Center, Greenbelt, MD, USA

Optimal Extraction with Sub-sampled Line-Spread Functions

Collins, Nicholas R.; Gull, Theodore; Bowers, Chuck; Lindler, Don; [2002]; In English, 17-18 Oct. 2002, Baltimore, MD, USA; Copyright; Avail: CASI; A01, Hardcopy

STIS long-slit medium resolution spectra reduced in CALSTIS extended-source mode with narrow extraction heights (GWIDTH=3 pixels) show photometric uncertainties of +/- 3% relative to point-source extractions. These uncertainties are introduced through interpolation in the spectral image rectification processing stage, and are correlated with the number of

pixel crossings the spectral profile core encounters in the spatial direction. The line-spread-function may be determined as a function of pixel crossing- position from calibration data sub-sampled in the spatial direction. This line spread function will be applied to science data to perform optimal extractions and point- source de-blending. Wavelength and breathing effects will be studied. Viability of the method to de-convolve extended source 'blobs' will be investigated.
Author
Image Processing; Spectral Resolution; Line Spectra; Image Analysis; Astronomical Photometry; Data Processing; Computer Programs

20030032205 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Dynamic Testing of a Subscale Sunshield for the Next Generation Space Telescope (NGST)
Ross, Brian; Johnston, John; Smith, James; [2002]; In English, 22-24 Oct. 2002, Ellicott City, MD, USA; Original contains black and white illustrations; No Copyright; Avail: CASI; A03, Hardcopy

The NGST sunshield is a lightweight, flexible structure consisting of pretensioned membranes supported by deployable booms. The structural dynamic behavior of the sunshield must be well understood in order to predict its influence on observatory dynamic performance. A 1/10th scale model of the sunshield has been developed for ground testing to provide data to validate modeling techniques for thin-film membrane structures. The validated models can then be used to predict the behavior of the full-scale sunshield. This paper provides an overview of two test series performed on the 1/10th scale sunshield and a comparison of the results from the tests.
Author
Dynamic Tests; Next Generation Space Telescope Project; Solar Radiation Shielding; Scale Models; Sun; Structural Design

20030020623 Johns Hopkins Univ., Baltimore, MD, USA
Scientific and Technical Development of the Next Generation Space Telescope
Burg, Richard; January 2003; In English
Contract(s)/Grant(s): NAG5-4736; No Copyright; Avail: CASI; A01, Hardcopy

The Next Generation Space Telescope (NGST) is part of the Origins program and is the key mission to discover the origins of galaxies in the Universe. It is essential that scientific requirements be translated into technical specifications at the beginning of the program and that there is technical participation by astronomers in the design and modeling of the observatory. During the active time period of this grant, the PI participated in the NGST program at GSFC by participating in the development of the Design Reference Mission, the development of the full end-to-end model of the observatory, the design trade-off based on the modeling, the Science Instrument Module definition and modeling, the study of proto-mission and test-bed development, and by participating in meetings including quarterly reviews and support of the NGST SWG. This work was documented in a series of NGST Monographs that are available on the NGST web site.
Author
Next Generation Space Telescope Project; Spaceborne Telescopes; Astronomical Observatories; Design Analysis; Systems Engineering; Cryogenics; Optical Equipment

20030016758 Space Telescope Science Inst., Baltimore, MD USA
Study of the Imaging Capabilities of SPIRIT/SPECS Concept Interferometers
Allen, Ronald J.; Dec. 23, 2002; In English
Contract(s)/Grant(s): NAG5-11024; STScI Proj. J0332; No Copyright; Avail: CASI; A02, Hardcopy

Several new space science mission concepts under development at NASA-GSFC for astronomy are intended to carry out synthetic imaging using Michelson interferometers or direct (Fizeau) imaging with sparse apertures. Examples of these mission concepts include the Stellar Imager (SI), the Space Infrared Interferometric Telescope (SPIRIT), the Submillimeter Probe of the Evolution of Cosmic Structure (SPECS), and the Fourier-Kelvin Stellar Interferometer (FKSI). We have been developing computer-based simulators for these missions. These simulators are aimed at providing a quantitative evaluation of the imaging capabilities of the mission by modeling the performance on different realistic targets in terms of sensitivity, angular resolution, and dynamic range. Both Fizeau and Michelson modes of operation can be considered. Our work is based on adapting a computer simulator called imSIM which was initially written for the Space Interferometer Mission in order to simulate the imaging mode of new missions such as those listed. This report covers the activities we have undertaken to provide a preliminary version of a simulator for the SPIRIT mission concept.
Derived from text
Space Missions; Computerized Simulation; Michelson Interferometers; Imaging Techniques; Computer Techniques

20030016517 Space Telescope Science Inst., Baltimore, MD USA

A Study of Imaging Interferometer Simulators

Allen, Ronald J.; Dec. 23, 2002; In English

Contract(s)/Grant(s): NAG5-11360; STScI Proj. J0352; No Copyright; Avail: CASI; A02, Hardcopy

Several new space science mission concepts under development at NASA-GSFC for astronomy are intended to carry out synthetic imaging using Michelson interferometers or direct (Fizeau) imaging with sparse apertures. Examples of these mission concepts include the Stellar Imager (SI), the Space Infrared Interferometric Telescope (SPIRIT), the Submillimeter Probe of the Evolution of Cosmic Structure (SPECS), and the Fourier-Kelvin Stellar Interferometer (FKSI). We have been developing computer-based simulators for these missions. These simulators are aimed at providing a quantitative evaluation of the imaging capabilities of the mission by modelling the performance on different realistic targets in terms of sensitivity, angular resolution, and dynamic range. Both Fizeau and Michelson modes of operation can be considered. Our work is based on adapting a computer simulator called imSIM, which was initially written for the Space Interferometer Mission in order to simulate the imaging mode of new missions such as those listed. In a recent GSFC-funded study we have successfully written a preliminary version of a simulator SISIM for the Stellar Imager and carried out some preliminary studies with it. In a separately funded study we have also been applying these methods to SPECS/SPIRIT.

Derived from text

Computerized Simulation; Submillimeter Waves; Imaging Techniques; Michelson Interferometers

20030002751 NASA Goddard Space Flight Center, Greenbelt, MD USA

Finite Element Analysis of Wrinkled Membrane Structures for Sunshield Applications

Johnston, John D.; Brodeur, Stephen J., Technical Monitor; [2002]; In English; 43rd AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, 22-25 Apr. 2002, Denver, CO, USA

Report No.(s): AIAA Paper 2002-1456; Copyright; Avail: CASI; A03, Hardcopy; Distribution as joint owner in the copyright

The deployable sunshield is an example of a gossamer structure envisioned for use on future space telescopes. The basic structure consists of multiple layers of pretensioned, thin-film membranes supported by deployable booms. The prediction and verification of sunshield dynamics has been identified as an area in need of technology development due to the difficulties inherent in predicting nonlinear structural behavior of the membranes and because of the challenges involved. in ground testing of the full-scale structure. This paper describes a finite element analysis of a subscale sunshield that has been subjected to ground testing in support of the Next Generation Space Telescope (NGST) program. The analysis utilizes a nonlinear material model that accounts for wrinkling of the membranes. Results are presented from a nonlinear static preloading analysis and subsequent dynamics analyses to illustrate baseline sunshield structural characteristics. Studies are then described which provide further insight into the effect of membrane. preload on sunshield dynamics and the performance of different membrane modeling techniques. Lastly, a comparison of analytical predictions and ground test results is presented.

Author

Finite Element Method; Membrane Structures; Structural Analysis; Prediction Analysis Techniques; Scale Models; Sun

20030000770 NASA Marshall Space Flight Center, Huntsville, AL USA

Thermal Analysis of Next-Generation Space Telescope (NGST) Mirrors During Optical Testing in the X-Ray Calibration Facility (XRCF)

Page, Tim; Sutherlin, Steven; Twelfth Thermal and Fluids Analysis Workshop; July 2002; In English; Original contains color illustrations; No Copyright; Avail: CASI; A03, Hardcopy

This paper presents Thermal Analysis of the Next Generation Space Telescope (NGST) Mirrors During Optical Testing in the X-Ray Calibration Facility (XRCF). The contents include: 1) NGST Spacecraft Concept; 2) NGST Mirror Development Testing; 3) NGST Development Mirror; 4) Knudsen Number; 5) Free-Molecular Conduction; 6) Accomodation Coefficient; and 7) Results and Recommendations. This paper is presented in viewgraph form.

CASI

Mirrors; Thermal Analysis; Next Generation Space Telescope Project; X Ray Optics; Spaceborne Telescopes

20030000575 NASA Marshall Space Flight Center, Huntsville, AL USA

Production of Ultra-Light Normal Incidence Mirrors

Jones, Ruth; Muntele, Iulia; Muntele, Claudiu; Zimmerman, Robert L.; Ila, Daryush; Burdine, Robert V., Technical Monitor; [2002]; In English; Astronomical Telescopes and Instrumentation, 22-28 Aug. 2002, Waikoloa, HI, USA; No Copyright; Avail: Other Sources; Abstract Only

Mirrors fabrication for large aperture telescopes is an important aspect in space exploration programs. One of the cost effective techniques to obtain such mirrors is electroplating of Ni-Co alloys from sulfamate solution. The Center for Irradiation of Materials at Alabama A&M University - Research Institute has been involved in a NASA-MSFC project for producing ultra-light Ni-Co alloy mirrors since the summer of year 2000. The goal of this project is to obtain ultra-light, high strength electroformed large aperture normal incidence replicated mirrors, (weighting less than 5 kg/m2), free of stress, with a good figure and reproducible thickness variation. In order to simplify the control of parameters such as temperature gradient, concentration gradient, distribution of the electric field lines and flow control, the proposed geometry involves a cylindrical main tank contained in another cylindrical tank, which plays the role of a weir. Designs were created to accommodate the new horizontal position of the mandrel and the pipes fitting through the outer tank's lid. The inner tank contains the working electrodes and a series of sensors for monitoring temperature, flow, stress and pH. The outer tank holds the electric heaters, the filters and a part of the piping system. Another two tanks complete the setup and serve for rinsing/preheating and equilibrating the electroplating bath. This paper will describe advantages of the new experimental setup and the parameters achieved in the electroplating bath for the proposed geometry.
Author
Mirrors; Fabrication; Electroplating; Electroforming

20030000539 NASA Marshall Space Flight Center, Huntsville, AL USA
Study of Lightweight Ni-Co Alloy Mirrors Obtained by Electroforming Techniques
Jones, Ruth; Muntele, Iulia; Muntele, Claudiu; Zimmerman, Robert; Ila, Daryush; Smith, W. Scott, Technical Monitor; [2002]; In English; Astronomical Telescopes and Instrumentation, 22-28 Aug. 2002, Waikoloa, HI, USA; No Copyright; Avail: Other Sources; Abstract Only

One contribution in reducing the costs of optics in space can be provided by production of ultralight mirrors. The decrease in the weight of the primary mirror of a telescope is anticipated to lead to the possibility of increasing the size of the telescopes, therefore increasing the amount and distance from which information is received. An electroplating process of ultralight replica mirrors from nickel sulfamate solution will be described. Based on an experimental setup with cylindrical symmetry, flat mirrors with a diameter of 7 inches and thickness of 1.5 mm are made from a Ni-Co alloy. The composition of the resulting deposit is analyzed using Rutherford Backscattering Spectrometry (RBS) and Proton Induced X-ray Emission (PIXE). In order to resolve Ni and Co, 10 MeV nitrogen ions are used as projectiles in the RBS measurements. Solution parameters monitored during the deposition process using optical absorption and polarography will be correlated with the final concentration of Ni and Co in the deposit. Bath parameters like temperature, current density, agitation level and acidity are chosen at certain values and maintained constant from one sample to another throughout the deposition process. The purpose of the experiment is to obtain mirrors with near zero stress, and predetermined composition and hardness. This study is an intermediate step in obtaining through the same process, but with a larger scale setup, ultralight large aperture replica mirrors.
Author
Mirrors; Fabrication; Electroforming; Electroplating

20030000481 TRW, Inc., Redondo Beach, CA USA
Compositionally-Graded Shape Memory Film for Self-Deployment of Membrane Reflectors and Optics
Hill, Lisa; Carman, Greg; Brantley, Lott W., Sr., Technical Monitor; [2002]; In English; 2002 ASME International Mechanical Engineering Congress and Exposition, 17-22 Nov. 2002, New Orleans, LA, USA
Contract(s)/Grant(s): NAS8-01127; No Copyright; Avail: Other Sources; Abstract Only

The next generation of space systems will require large apertures in order to image faint targets or cover large areas of Earth. These large apertures must be able to fit inside a launch vehicle fairing, be light enough for launch into orbit, and deploy on orbit with repeatability and reliability. The current state-of-the-art in flight optics is represented by the 4 meter LAMP telescope, with an areal density of 10 km sq m. Development of a Beryllium mirror demonstration article for NGST (Next Generation Space Telescope) at the University of Arizona indicate areal densities of 0.5 kg sq m with flight hardware in the 12 meter range. With progressive improvements in existing deployment, packaging, and structural technologies, the size of optics and reflectors will continue to increase, while mass is reduced. However, without a breakthrough in materials, packaging and/or deployment technologies, the goal for Gossamer structures of 0.1 kg sq m is unachievable for the near and mid-term NASA missions. Membrane technology provides the best hope of achieving such low areal densities. In combination with advances in membrane materials and structures, development of revolutionary techniques for deployment systems can provide significant improvements in large aperture technology. In this paper, the results of a six-month Phase I research effort to demonstrate the application of thin film NiTi to aerospace-qualified membrane and mesh materials are presented. Deposition of shape memory thin film was achieved Astromesh (trademark) metal mesh and CP-1, and optical-quality polymer membrane.

Not only was full-coating deposition demonstrated, but also small segment deposition which holds potential for local surface control. Deployment of these materials was also demonstrated, setting the stage for the development of a larger test article. Author

Apertures; Spaceborne Telescopes; Research and Development; Thin Films; Materials Selection; Membrane Structures; Deposition

20020093116 NASA Marshall Space Flight Center, Huntsville, AL USA

Rapid Maturation of Edge Sensor Technology and Potential Application in Large Space Telescopes with Segmented Primary Mirrors

Montgomery, Edward E., IV; Smith, W. Scott, Technical Monitor; Jan. 10, 2002; In English; SPIE Conference on Astronomical Telescopes and Instrumentation, Power Telescopes and Instrumentation into the New Millenium, 21-28 Aug. 2002, Waikoloa, HI, USA; No Copyright; Avail: Other Sources; Abstract Only

This paper explores the history and results of the last two year's efforts to transition inductive edge sensor technology from Technology Readiness Level 2 to Technology Readiness Level 6. Both technical and programmatic challenges were overcome in the design, fabrication, test, and installation of over a thousand sensors making up the Segment Alignment Maintenance System (SAMs) for the 91 segment, 9.2-meter. Hobby Eberly Telescope (HET). The integration of these sensors with the control system will be discussed along with serendipitous leverage they provided for both initialization alignment and operational maintenance. The experience gained important insights into the fundamental motion mechanics of large segmented mirrors, the relative importance of the variance sources of misalignment errors, the efficient conduct of a program to mature the technology to the higher levels. Unanticipated factors required the team to develop new implementation strategies for the edge sensor information which enabled major segmented mirror controller design simplifications. The resulting increase in the science efficiency of HET will be shown. Finally, the on-going effort to complete the maturation of inductive edge sensor by delivering space qualified versions for future IR (infrared radiation) space telescopes.

Author

Spaceborne Telescopes; Segmented Mirrors; Design Analysis; Design Optimization; Technology Utilization; Sensors

20020084568 NASA Goddard Space Flight Center, Greenbelt, MD USA

Parametric Study of the Effect of Membrane Tension on Sunshield Dynamics

Ross, Brian; Johnston, John D.; Smith, James; Feb. 04, 2002; In English, 22-25 Apr. 2002, Denver, CO, USA

Report No.(s): AIAA Paper 2002-1459; No Copyright; Avail: CASI; A03, Hardcopy

The NGST sunshield is a lightweight, flexible structure consisting of pretensioned membranes supported by deployable booms. The structural dynamic behavior of the sunshield must be well understood in order to predict its influence on observatory performance. A 1/10th scale model of the sunshield has been developed for ground testing to provide data to validate modeling techniques for thin film membrane structures. The validated models can then be used to predict the behaviour of the full scale sunshield. This paper summarizes the most recent tests performed on the 1/10th scale sunshield to study the effect of membrane preload on sunshield dynamics. Topics to be covered include the test setup, procedures, and a summary of results.

Author

Membrane Structures; Dynamic Structural Analysis; Sun; Tension; Scale Models; Acceleration (Physics)

20020083254 Air Force Inst. of Tech., Wright-Patterson AFB, OH USA

Smart Structures for Control of Optical Surfaces

Sobers, D. M., Jr; Mar. 2002; In English

Contract(s)/Grant(s): AF Proj. 02185

Report No.(s): AD-A405969; AFIT/GA/ENY/02-2; No Copyright; Avail: CASI; A08, Hardcopy

The development of lightweight, large-aperture optics is of vital importance to the Department of Defense and the US Air Force for advancing remote sensing applications and improving current capabilities. Synthetic polymer optics offer weight and flexibility advantages over current generation glass mirrors, but require active control to maintain tight surface figure tolerances. This research explores the feasibility of using imbedded piezoelectric materials to control optical surfaces. Membrane-based and stiff piezo-controlled mirrors were constructed to develop and validate control techniques. Test results verified that surface control on the order of tens of wavelengths is possible using these systems.

DTIC

Smart Structures; Adaptive Optics; Smart Materials; Membrane Structures; Polyvinyl Fluoride; Mirrors; Flexibility

20020083228 NASA Goddard Space Flight Center, Greenbelt, MD USA

Scientific Goals and Opto-Mechanical Challenges of the Next Generation Space Telescope (NGST)

Mather, John C.; Lawrence, Jon F.; Oegerle, William, Technical Monitor; [2002]; In English; American Institute of Aeronautics and Astronautics Meeting, 24 Apr. 2002, Denver, CO, USA; No Copyright; Avail: Other Sources; Abstract Only

The Next Generation Space Telescope will push the boundaries of astronomy far beyond anything, possible with an Earth-bound observatory, or even with the Hubble Space Telescope. I will outline the scientific objectives of the NGST and show how they fit into the NASA strategic plan for space astronomy. The NGST will not be the end of the line, and adaptive and active structures will enable even more powerful space observatories, capable of seeing even closer to the dawn of time, and of measuring the light from planets around other stars.

Author

Mechanical Devices; Spaceborne Astronomy; Next Generation Space Telescope Project; Optics

20020082930 NASA Goddard Space Flight Center, Greenbelt, MD USA

Starting A New Project: Thoughts from NGST

Mather, John C.; Oegerle, William, Technical Monitor; [2002]; In English; Hubble Science Legacy Conference, 5 Apr. 2002, Chicago, IL, USA; No Copyright; Avail: Other Sources; Abstract Only

Some key elements of the history of NGST (Next Generation Space Telescope) that made a new mission possible will be reviewed, from the very beginnings to the present moment in the middle of selecting a prime contractor. A few forecasts of the possible discoveries will be made that may precede the launch of a new UV telescope, in hopes of inspiring sufficiently ambitious goals that they will still be exciting in 15 or 20 years. We will also discuss the enabling technology for NGST and my thoughts on enabling technology for a UV telescope Flint: they are not all about detectors and Mirrors!

Author

Ultraviolet Telescopes; Next Generation Space Telescope Project

20020081321 NASA Goddard Space Flight Center, Greenbelt, MD USA

Ideal Integrating Bolometer

Kogut, Alan; DiPirro, Michael; Fisher, Richard R., Technical Monitor; [2002]; In English; 2nd Workshop on New Concepts for Far-IR/Submillimeter Space Astronomy, 7-8 Mar. 2002, MD, USA; No Copyright; Avail: Other Sources; Abstract Only

We describe a new 'ideal integrator' bolometer as a prototype for a new generation of sensitive, flexible far-IR detectors suitable for use in large arrays. The combination of a non-dissipative sensor coupled with a fast heat switch provides breakthrough capabilities in both sensitivity and operation. The bolometer temperature varies linearly with the integrated infrared power incident on the detector, and may be sampled intermittently without loss of information between samples. The sample speed and consequent dynamic range depend only on the heat switch reset cycle and can be selected in software. Between samples, the device acts as an ideal integrator with noise significantly lower than resistive bolometers. Since there is no loss of information between samples, the device is well-suited for large arrays. A single SQUID readout could process an entire column of detectors, greatly reducing the complexity, power requirements, and cost of readout electronics for large pixel arrays.

Author

Bolometers; Infrared Detectors; Switches; Integrators

20020080834 NASA Goddard Space Flight Center, Greenbelt, MD USA

Ecological Niches for Space Missions in the Far-Infrared

Benford, D. J.; Fisher, Richard R., Technical Monitor; [2002]; In English; 2nd Workshop on New Concepts for Far-IR/Submillimeter Space Astronomy, 7-8 Mar. 2002, MD, USA; No Copyright; Avail: Other Sources; Abstract Only

The far-infrared and submillimeter region (30 micron-750 micron) has perhaps the greatest potential of all wavelengths for advancement in astronomy. When viewed in terms of the cosmic backgrounds, the far-IR is extremely important: half of the total luminosity in the Universe is emitted at rest wavelengths approximately 80-100 microns. At the highest known galaxy redshifts, this energy is redshifted to approximately 600 microns. Existing and planned missions have a broad range of capabilities defined in terms of their spectral coverage, spectral resolution, angular resolution, survey speed, and sensitivity. In this parameter space, the opportunity for future far-IR and submillimeter missions with great discovery potential is evident. Such missions will answer fundamental questions about the history of energy release in the Universe, the formation and evolution of galaxies, and formation of stellar and protoplanetary systems. We discuss the parameter space that can be filled

by a few well-chosen space missions, specifically a submillimeter all-sky survey and a far-IR to submillimeter observatory. Author

Space Missions; Ecology; Sky Surveys (Astronomy); Far Infrared Radiation; Protoplanets

20020080833 NASA Goddard Space Flight Center, Greenbelt, MD USA

Probing Galaxy Formation and Submillimeter Surveys

Dwek, Eli; Arendt, Richard G.; Benford, Dominic J.; Moseley, Harvey S.; Shafer, Richard A.; Staguhn, Johannes G.; Fisher, Richard R., Technical Monitor; [2002]; In English; 2nd Workshop on New Concepts for Far-IR Submillimeter Space Astronomy, 7-8 Mar. 2002, MD, USA; No Copyright; Avail: Other Sources; Abstract Only

Multiwavelength observations of galaxies have revealed that a significant fraction of the their stellar or accretion luminosity is absorbed and reradiated by dust at far-infrared (FIR) and submillimeter (submm) wavelengths. Submillimeter (850 micron) surveys conducted by the SCUBA instrument on the JCMT have detected a population of high redshift (z approximately equal to 1-4) ultraluminous infrared galaxies, that dominate the luminosity densities at those redshifts. Their cumulative contribution to the cosmic infrared background (CIB) detected by the COBE satellite is comparable to the observations, suggesting that at 850 microns the CIB is resolved into its constituent sources. This suggests that the early universe was much more dust enshrouded than the present one. FIR and submm surveys can therefore address fundamental questions regarding the early processes of galaxy formation and their evolution in number and luminosity over cosmic history. The scientific information that can be obtained from such surveys depend on a number of parameters, the most important of which are the diameter of the telescope and the wavelengths of the survey. We summarize the effect of these parameters on the scientific return from such surveys.

Author

Galactic Evolution; Submillimeter Waves; Sky Surveys (Astronomy); Far Infrared Radiation; Telescopes

20020076854

Calculation of vectorial three-dimensional transfer functions in large-angle focusing systems

Schonle, Andreas; Hell, Stefan W.; Journal of the Optical Society of America A: Optics, Image Science, and Vision; October 2002; ISSN 0740-3232; Volume 19, Issue no. 10, 2121-2126; In English; Copyright

The optical transfer function (OTF) is used in describing imaging systems in the Fourier domain. So far the calculation of the OTF of a large-aperture imaging system has been difficult because the vectorial nature of light breaks the cylindrical symmetry of the pupil function. We derive a simple line integral solution for calculating the vectorial three-dimensional OTF. We further extend this approach to imaging through a planar interface of two media with mismatched refractive indices. In general, our formalism allows for calculation of the Fourier transform of any product of two arbitrary vector components of the electromagnetic field. Arbitrary phase or amplitude modifications of the pupil function can be taken into account. [copyright] 2002 Optical Society of America

Author (AIP)

Algebra; Fourier Transformation; Imaging Techniques; Integral Equations; Lenses; Mirrors; Optical Transfer Function; Transfer Functions; Vectors (Mathematics)

20020071075 NASA Goddard Space Flight Center, Greenbelt, MD USA

Ultralow-Background Large-Format Bolometer Arrays

Benford, Dominic; Chervenak, Jay; Irwin, Kent; Moseley, S. Harvey; Oegerle, William, Technical Monitor; [2002]; In English; SPIE Workshop, 22-28 Aug. 2002, Waikoloa, HI, USA; No Copyright; Avail: Other Sources; Abstract Only

In the coming decade, work will commence in earnest on large cryogenic far-infrared telescopes and interferometers. All such observatories - for example, SAFIR, SPIRIT, and SPECS - require large format, two dimensional arrays of close-packed detectors capable of reaching the fundamental limits imposed by the very low photon backgrounds present in deep space. In the near term, bolometer array architectures which permit 1000 pixels - perhaps sufficient for the next generation of space-based instruments - can be arrayed efficiently. Demonstrating the necessary performance, with Noise Equivalent Powers (NEPs) of order 10-20 W/square root of Hz, will be a hurdle in the coming years. Superconducting bolometer arrays are a promising technology for providing both the performance and the array size necessary. We discuss the requirements for future detector arrays in the far-infrared and submillimeter, describe the parameters of superconducting bolometer arrays able to meet these requirements, and detail the present and near future technology of superconducting bolometer arrays. Of particular note

is the coming development of large format planar arrays with absorber-coupled and antenna-coupled bolometers.
Author
Bolometers; Product Development; Design Analysis; Satellite-Borne Instruments; Wavelength Division Multiplexing

20020071072 NASA Goddard Space Flight Center, Greenbelt, MD USA
Progress Towards High-Sensitivity Arrays of Detectors of Sub-mm Radiation using Superconducting Tunnel Junctions with Radio-Frequency Single-Electron Transistors
Stevenson, T. R.; Hsieh, W.-T.; Li, M. J.; Stahle, C. M.; Wollack, E. J.; Schoelkopf, R. J.; Krebs, Carolyn, Technical Monitor; [2002]; In English; Second Workshop on New Concepts for Far-IR Submillimeter Space Astronomy, 7-8 Mar. 2002, Greenbelt, MD, USA; No Copyright; Avail: Other Sources; Abstract Only

The science drivers for the SPIRIT/SPECS missions demand sensitive, fast, compact, low-power, large-format detector arrays for high resolution imaging and spectroscopy in the far infrared and submillimeter. Detector arrays with 10,000 pixels and sensitivity less than 10(exp 20)-20 W/Hz(exp 20)0.5 are needed. Antenna-coupled superconducting tunnel junction detectors with integrated rf single-electron transistor readout amplifiers have the potential for achieving this high level of sensitivity, and can take advantage of an rf multiplexing technique when forming arrays. The device consists of an antenna structure to couple radiation into a small superconducting volume and cause quasiparticle excitations, and a single-electron transistor to measure currents through tunnel junction contacts to the absorber volume. We will describe optimization of device parameters, and recent results on fabrication techniques for producing devices with high yield for detector arrays. We will also present modeling of expected saturation power levels, antenna coupling, and rf multiplexing schemes.
Author
Tunnel Junctions; Wavelength Division Multiplexing; Transistors; Stellar Spectrophotometry; Product Development; Systems Engineering; Submillimeter Waves

20020071044 NASA Goddard Space Flight Center, Greenbelt, MD USA
Superconducting Bolometer Array Architectures
Benford, Dominic; Chervenak, Jay; Irwin, Kent; Moseley, S. Harvey; Shafer, Rick; Staguhn, Johannes; Wollack, Ed; Oegerle, William, Technical Monitor; [2002]; In English; SPIE Meeting, 22-28 Aug. 2002, Waikoloa, HI, USA; No Copyright; Avail: Other Sources; Abstract Only

The next generation of far-infrared and submillimeter instruments require large arrays of detectors containing thousands of elements. These arrays will necessarily be multiplexed, and superconducting bolometer arrays are the most promising present prospect for these detectors. We discuss our current research into superconducting bolometer array technologies, which has recently resulted in the first multiplexed detections of submillimeter light and the first multiplexed astronomical observations. Prototype arrays containing 512 pixels are in production using the Pop-Up Detector (PUD) architecture, which can be extended easily to 1000 pixel arrays. Planar arrays of close-packed bolometers are being developed for the GBT (Green Bank Telescope) and for future space missions. For certain applications, such as a slewed far-infrared sky survey, feedhorncoupling of a large sparsely-filled array of bolometers is desirable, and is being developed using photolithographic feedhorn arrays. Individual detectors have achieved a Noise Equivalent Power (NEP) of -10(exp 17) W/square root of Hz at 300mK, but several orders of magnitude improvement are required and can be reached with existing technology. The testing of such ultralow-background detectors will prove difficult, as this requires optical loading of below IfW. Antenna-coupled bolometer designs have advantages for large format array designs at low powers due to their mode selectivity.
Author
Bolometers; Antenna Arrays; Antenna Design; Infrared Detectors

20020069312
Comparison of designs of off-axis Gregorian telescopes for millimeter-wave large focal-plane arrays
Hanany, Shaul; Marrone, Daniel P.; Applied Optics; August 01, 2002; ISSN 0003-6935; Volume 41, Issue no. 22, 4666-4670; In English; Copyright

We compare the diffraction-limited field of view (FOV) provided by four types of off-axis Gregorian telescopes: the classical Gregorian, the aplanatic Gregorian, and the designs that cancel astigmatism and both astigmatism and coma. The analysis is carried out with telescope parameters that are appropriate for satellite and balloonborne millimeter- and submillimeter-wave astrophysics. We find that the design that cancels both coma and astigmatism provides the largest flat FOV, [approx]21 square deg. We also find that the FOV can be increased by [approx]15% by means of optimizing the shape

and location of the focal surface. [copyright] 2002 Optical Society of America
Author (AIP)
Aberration; Antenna Arrays; Errors; Field of View; Microwave Antennas; Millimeter Waves; Mirrors; Photometers; Spaceborne Telescopes; Telescopes

20020068980 NASA Goddard Space Flight Center, Greenbelt, MD USA
Probing Galaxy Formation and Evolution with Space Born Sub-Millimeter Telescopes
Dwek, Eli; Arendt, Richard G.; Moseley, Harvey; Benford, Dominic; Shafer, Richard; Mather, John; Oegerle, William, Technical Monitor; [2002]; In English; SPIE Meeting, 22-28 Aug. 2002, Waikoloa, HI, USA; No Copyright; Avail: Other Sources; Abstract Only

A major unresolved question in cosmology is how the complex system of galaxies we see in the present universe evolved from an almost perfectly smooth beginning. Multiwavelength observations of galaxies have revealed that a significant fraction of their UV-visible starlight is absorbed and reradiated by dust at infrared JR) and submillimeter wavelengths. The cumulative IR-submm. emission from galaxies since the epoch of recombination, the cosmic IR background, has recently been recorded by the COBE satellite. The COBE observations in combination with recent submm surveys conducted with the SCUBA on the 15 m JCMT have shown that most of the radiation from star formation that has taken place in the early stages of galaxy evolution is reradiated by dust at submm wavelengths. Therefore, submm telescopes offer a unique probe of the early stages of galaxy formation and evolution. This talk will: (1) consider the impact of telescope diameter on the depth of the survey (what redshift can be probed) at different wavelengths; (2) discuss the relative scientific merits of high-resolution narrow-field surveys versus lower resolution deep surveys; and (3) show how both strategies offer complementary information crucial to our understanding of the structure and evolution of galaxies in the universe.
Author
Complex Systems; Galactic Evolution; Galactic Structure; Infrared Radiation; Infrared Spectra

20020068829 Mercer Univ., Macon, GA USA
Labview Implementation of Image Processing and Phasing Control for the SIBOA Segmented Mirror Testbed
Partridge, James D.; Research Reports: 2001 NASA/ASEE Summer Faculty Fellowship Program; July 2002, XLII-1 - XLII-5; In English; No Copyright; Avail: CASI; A01, Hardcopy

'NASA is preparing to launch the Next Generation Space Telescope (NGST). This telescope will be larger than the Hubble Space Telescope, be launched on an Atlas missile rather than the Space Shuttle, have a segmented primary mirror, and be placed in a higher orbit. All these differences pose significant challenges.' This effort addresses the challenge of implementing an algorithm for aligning the segments of the primary mirror during the initial deployment that was designed by Philip Olivier and members of SOMTC (Space Optics Manufacturing Technology Center). The implementation was to be performed on the SIBOA (Systematic Image Based Optical Alignment) test bed. Unfortunately, hardware/software aspect concerning SIBOA and an extended time period for algorithm development prevented testing before the end of the study period. Properties of the digital camera were studied and understood, resulting in the current ability of selecting optimal settings regarding saturation. The study was successful in manually capturing several images of two stacked segments with various relative phases. These images can be used to calibrate the algorithm for future implementation. Currently the system is ready for testing.
Author
Segmented Mirrors; Alignment; Image Processing

20020068826 Mercer Univ., Macon, GA USA
Experimental Validation of a Neuro-Fuzzy Approach to Phasing the SIBOA Segmented Mirror Testbed
Olivier, Philip D.; Research Reports: 2001 NASA/ASEE Summer Faculty Fellowship Program; July 2002, XXXVIII-1 - XXXVIII-5; In English; No Copyright; Avail: CASI; A01, Hardcopy

NASA is preparing to launch the Next Generation Space Telescope (NGST). This telescope will be larger than the Hubble Space Telescope, be launched on an Atlas missile rather than the Space Shuttle, have a segmented primary mirror, and be placed in a higher orbit. All these differences pose significant challenges. This effort addresses the challenge of aligning the segments of the primary mirror during the initial deployment. The segments need to piston values aligned to within one tenth of a wavelength. The present study considers using a neuro-fuzzy model of the Fraunhofer diffraction theory. The intention of the current study was to experimentally verify the algorithm derived earlier. The experimental study was to be performed on the SIBOA (Systematic Image Based Optical Alignment) test bed. Unfortunately the hardware/software for SIBOA was not ready by the end of the study period. We did succeed in capturing several images of two stacked segments with various relative

phases. These images can be used to calibrate the algorithm for future implementation. This effort is a continuation of prior work. The basic effort involves developing a closed loop control algorithm to phase a segmented mirror test bed (SIBOA). The control algorithm is based on a neuro-fuzzy model of SIBOA and incorporates nonlinear observers built from observer banks. This effort involves implementing the algorithm on the SIBOA test bed.
Author
Segmented Mirrors; Alignment; Diffraction; Algorithms

20020068449 Schafer Corp., Calabasas, CA USA
Silicon Lightweight Mirrors (SLMS) for Ultraviolet and Extreme Ultraviolet Imaging Mirrors
Goodman, W. A.; Keys, Andrew S., Technical Monitor; [2002]; In English; 2nd Annual Technology Days, 22-24 May 2002, Huntsville, AL, USA
Contract(s)/Grant(s): NAS8-01174; No Copyright; Avail: Other Sources; Abstract Only

Subtopic 01-S1.06 requires mirrors with a diameter of 0.5-2.4 meters, areal density less than 20 kg/sq m, a figure specification of 0.02-0.005 waves root mean square (rms) at 633 nanometers, a surface roughness 0.5-1 nanometers rms, and a midfrequency error of 1.0-2.5 nanometers rms for use in the infrared (IR) to extreme ultra violet (EUV) waveband. Schafer's Phase II objective is to use Silicon Lightweight Mirrors (SLMS), a novel, all-silicon, foam-core, lightweight mirror technology, to build three imaging mirrors for the Next Generation Space Telescope Near Infrared Camera (NIRCam) Engineering Test Unit: M0 (a flat), M2 (a concave sphere) and M3R (an oblate spheroid). The surface figure error specification for the NIRCam imaging mirrors is 8 nanometers rms (0.013 waves rms at 633 nanometers), equivalent to that required for ultraviolet (UV) and EUV mirrors, and this figure must be maintained at the 35 K operational temperature of NGST. The surface roughness required is 30 A rms since NIRCam operates in the visible to infrared (VIS/IR) (0.65-5 microns). We will produce mounts for mirrors M2 and M3R using the complementary thermally matched C/SiC material demonstrated by Schafer under another NASA SBIR, NAS8-98137.
Author
Mirrors; Porous Silicon; Next Generation Space Telescope Project; Ultraviolet Astronomy; Infrared Astronomy

20020068104 Eastman Kodak Co., Rochester, NY USA
Kodak AMSD Mirror Development Program
Matthews, Gary; Dahl, Roger; Barrett, David; Bottom, John; Russell, Kevin, Technical Monitor; [2002]; In English; 2nd Annual Technology Days, 22-24 May 2002, Huntsville, USA
Contract(s)/Grant(s): NAS8-00148; No Copyright; Avail: Other Sources; Abstract Only

The Advanced Mirror System Demonstration Program is developing minor technology for the next generation optical systems. Many of these systems will require extremely lightweight and stable optics due to the overall size of the primary mirror. These segmented, deployable systems require new technology that AMSD is developing. The on-going AMSD program is a critical enabler for Next Generation Space Telescope (NGST) which will start in 2002. The status of Kodak's AMSD mirror and future plans will be discussed with respect to the NGST program.
Author
Optical Materials; NASA Space Programs; Mirrors; Research and Development

20020066738 NASA Goddard Space Flight Center, Greenbelt, MD USA
The Fourier-Kelvin Stellar Interferometer Mission Concept
Danchi, W. C.; Allen, R.; Benford, D.; Gezari, D.; Leisawitz, D.; Mundy, L.; Oegerle, William, Technical Monitor; [2002]; In English; SPIE Conference, 22-28 Aug. 2002, Waikoloa, HI, USA; No Copyright; Avail: Other Sources; Abstract Only

The Fourier-Kelvin Stellar Interferometer (FKSI) is a mission concept for an imaging interferometer for the mid-infrared spectral region (5-30 microns). FKSI is conceived as a scientific and technological precursor to TPF as well as Space Infrared Interferometric Telescope (SPIRIT), Submillimeter Probe Evolution of Cosmic Structure (SPECS), and Single Aperture for Infrared Observatory (SAFIR). It will also be a high angular resolution system complementary to Next Generation Space Telescope (NGST). The scientific emphasis of the mission is on the evolution of protostellar systems, from just after the collapse of the precursor molecular cloud core, through the formation of the disk surrounding the protostar, the formation of planets in the disk, and eventual dispersal of the disk material. FKSI will also search for brown dwarfs and Jupiter mass and smaller planets, and could also play a very powerful role in the investigation of the structure of active galactic nuclei and extra-galactic star formation. We are in the process of studying alternative interferometer architectures and beam combination techniques, and evaluating the relevant science and technology tradeoffs. Some of the technical challenges include the

development of the cryocooler systems necessary for the telescopes and focal plane array, light and stiff but well-damped truss systems to support the telescopes, and lightweight and coolable optical telescopes. The goal of the design study is to determine if a mid-infrared interferometry mission can be performed within the cost and schedule requirements of a Discovery class mission. At the present time we envision the FKSI as comprised of five one meter diameter telescopes arranged along a truss structure in a linear non-redundant array, cooled to 35 K. A maximum baseline of 20 meters gives a nominal resolution of 26 mas at 5 microns. Using a Fizeau beam combination technique, a simple focal plane camera could be used to obtain both Fourier and spectral data simultaneously for a given orientation of the array. The spacecraft will be rotated to give sufficient Fourier data to reconstruct complex images of a broad range of astrophysical sources.
Author
Astrophysics; Imaging Techniques; Interferometers; Fourier Transformation; Protostars; Stellar Evolution; Space Missions

20020061309 NASA Goddard Space Flight Center, Greenbelt, MD USA
Design, Fabrication, Optical Testing, and Performance of Diamond Machined Aspheric Mirrors for Ground-Based Near-IR Astronomy
Ohl, Raymond G.; Mink, Ronald; Chambers, V. John; Connelly, Joseph A.; Mentzell, J. Eric; Tveekrem, June L.; Howard, Joseph M.; Preuss, Werner; Schroeder, Mechthild; Sohn, Alex; Krebs, Carolyn, Technical Monitor, et al.; [2002]; In English; SPIE Conference, 21-30 Aug. 2002, Kona, HI, USA; No Copyright; Avail: Other Sources; Abstract Only

Challenges in fabrication and testing have historically limited the choice of surfaces available for the design of reflective optical instruments. Spherical and conic mirrors are common, but, for future science instruments, more degrees of freedom are necessary to meet challenging performance and packaging requirements. These instruments will be composed of unusual aspheres located far off-axis with large spherical departure, and some designs will require asymmetric surface profiles. In particular, single-surface astigmatism correction in spectrographs necessitates a toroidal surface, which lacks an axis of rotational symmetry. We describe the design, fabrication, optical testing, and performance of three rotationally symmetric, off-axis, aspheric mirrors and one toroidal, off-axis, biconic camera mirror on aluminum substrates for the Infrared Multi-Object Spectrograph (IRMOS) instrument. IRMOS is a facility instrument for the Kitt Peak National Observatory's Mayall Telescope (3.8 m) and an engineering prototype for a possible design of the Next Generation Space Telescope/Multi-Object Spectrograph. The symmetric mirrors range in aperture from 94x86 mm to 286x269 mm and in f-number from 0.9 to 2.4. They are various off-axis, convex and concave, prolate and oblate ellipsoids. The concave biconic mirror has a 94x76 mm aperture, Rx=377 mm, kx=0.0778, Ry=407 mm, and ky=0.1265 and is decentered. by -2 mm in x and 227 mm in y. The mirrors have an aspect ratio of approximately 4:1. The surface error fabrication tolerances are less than 63.3 nm RMS figure error and less than 10 nm RMS microroughness. The mirrors are attached to the instrument bench via a semi-kinematic, integral flexure mount. We describe mirror design, diamond machining, the results of figure testing using computer-generated holograms, and imaging and scattered light modeling and performance.
Author
Aspheric Optics; Diamonds; Fabrication; Mirrors; Near Infrared Radiation; Infrared Astronomy; Performance Prediction

20020056037
SPIFI: a direct-detection imaging spectrometer for submillimeter wavelengths
Bradford, C. Matt; Stacey, Gordon J.; Swain, Mark R.; Nikola, Thomas; Bolatto, Alberto D.; Jackson, James M.; Savage, Maureen L.; Davidson, Jacqueline A.; Ade, Peter A. R.; Applied Optics; May 01, 2002; ISSN 0003-6935; Volume 41, Issue no. 13, 2561-2574; In English
Contract(s)/Grant(s): NAGW-3925; NAGW-4503; Copyright

The South Pole Imaging Fabry-Perot Interferometer (SPIFI) is the first instrument of its kind--a direct-detection imaging spectrometer for astronomy in the submillimeter band. SPIFI's focal plane is a square array of 25 silicon bolometers cooled to 60 mK; the spectrometer consists of two cryogenic scanning Fabry-Perot interferometers in series with a 60-mK bandpass filter. The instrument operates in the short submillimeter windows (350 and 450 [mu]m) available from the ground, with spectral resolving power selectable between 500 and 10,000. At present, SPIFI's sensitivity is within a factor of 1.5-3 of the photon background limit, comparable with the best heterodyne spectrometers. The instrument's large bandwidth and mapping capability provide substantial advantages for specific astrophysical projects, including deep extragalactic observations. We present the motivation for and design of SPIFI and its operational characteristics on the telescope. [copyright] 2002 Optical Society of America
Author (AIP)
Bolometers; Imaging Techniques; Infrared Imagery; Infrared Spectroscopy; Noise; Resonators; Spectral Line Width; Telescopes

20020054308 NASA Ames Research Center, Moffett Field, CA USA

Large Format Si:As IBC Array Performance for NGST and Future IR Space Telescope Applications

Ennico, Kimberly; Johnson, Roy; Love, Peter; Lum, Nancy; McKelvey, Mark; McCreight, Craig; McMurray, Robert, Jr.; DeVincenzi, D., Technical Monitor; [2002]; In English; IR Space Telescopes and Instruments VII Conference, 22-28 Aug. 2002, Waikoloa, HI, USA

Contract(s)/Grant(s): NAS2-97075; No Copyright; Avail: Other Sources; Abstract Only

A mid-IR (5-30micrometer) instrument aboard a cryogenic space telescope can have an enormous impact in resolving key questions in astronomy and cosmology. A space platform's greatly reduced thermal backgrounds (compared to airborne or ground-based platforms), allow for more sensitive observations of dusty young galaxies at high redshifts, star formation of solar-type stars in the local universe, and formation and evolution of planetary disks and systems. The previous generation's largest, in sensitive IR detectors at these wavelengths are 256x256 pixel Si:As Impurity Band Conduction (IBC) devices built by Raytheon Infrared Operations (RIO) for the Space Infrared Telescope Facility/Infrared Array Camera (SIRTF)/(IRAC) instrument. RIO has successfully enhanced these devices, increasing the pixel count by a factor of 16 while matching or exceeding SIRTF/IRAC device performance. NASA-ARC in collaboration with RIO has tested the first high performance large format (1024x 1024) Si:As IBC arrays for low background applications, such as for the middle instrument on Next Generation Space Telescope (NGST) and future IR Explorer missions. These hybrid devices consist of radiation hard SIRTF/IRAC-type Si:As IBC material mated to a readout multiplexer that has been specially processed for operation at low cryogenic temperatures (below 10K), yielding high device sensitivity over a wavelength range of 5-28 micrometers. We present laboratory testing results from these benchmark, devices. Continued development in this technology is essential for conducting large-area surveys of the local and early universe through observation and for complementing future missions such as NGST, Terrestrial Planet Finder (TPF), and Focal Plane Instruments and Requirement Science Team (FIRST).

Author

Silicon; Arsenic; Next Generation Space Telescope Project; Infrared Sources (Astronomy); Focal Plane Devices; Infrared Detectors

20020050242 NASA Goddard Space Flight Center, Greenbelt, MD USA

Microshutter Arrays for the NGST NIRSpec

Moseley, Harvey; Fisher, Richard R., Technical Monitor; [2001]; In English; American Astronomical Society Meeting, 6-10 Jan. 2002, Washington, DC, USA; No Copyright; Avail: Other Sources; Abstract Only

We are developing a programmable multiobject field selector for the NGST NIRSpec. This device is a microshutter array, a close-packed 2000 x 2000 array of 100 micrometer x 100 micrometer shutters fabricated with Micro-ElectroMechanical Systems (MEMS) technologies. The shutters are opened using a magnet scanned over the array. The shutters are held open by electrostatic potentials on adjacent vertical electrodes. Modeling of the magnetic actuation of the microshutters allowed optimization of the magnetic field configuration, the distance between magnet and shutters, and the force and torque produced by the magnet. The results of laboratory tests are consistent with our modeling. We have demonstrated actuation, latching and addressing. We are able to rotate shutters out of the plane up to 90 degree and more, to latch them electrostatically to the walls and release them selectively. During the last six month all critical elements of the array have been demonstrated. Fabrication processes were developed to deposit vertical electrodes on support grid side walls and insulated light-shields that block the gaps between shutters and the support grid. Physical optics analysis was performed to assess the expected optical performance of the microshutters. A preliminary Fourier optics analysis on the microshutter array performance has been carried out. More detailed analysis of wave propagation through 3D structures is a next step. An optical test station for verifying optical parameters of the shutter array at room temperature has been developed. It allows to measure parameters, such as transmission, scattering, contrast ratio, and diffraction of the array structure. Initial data have been acquired and are being analyzed and compared to theoretical predictions.

Author

Fabrication; Telescopes; Arrays; Near Infrared Radiation; Next Generation Space Telescope Project

20020046667 Textron Systems Corp., Wilmington, MA USA

HI-CLASS on AEOS: A Large Aperture Laser Radar for Space Surveillance/ Situational Awareness Investigations

Uroden, M.; Brown, D.; Eng, R.; Kovacs, M.; Lewis, P.; Apr. 03, 2001; In English; Original contains color images

Report No.(s): AD-A400666; No Copyright; Avail: CASI; A02, Hardcopy

This paper describes the development overview operating concepts representative data and current status of pulsed high-power coherent CO2 laser radar systems at MSSS. The paper reviews the first generation kilowatt class ladar/lidar

HI-CLASS/LBD systems as the foundation for a second-generation ladar system that was developed under the AFRL/DE ALVA program for integration on the new AEOS 3.67m telescope.
DTIC
Optical Radar; Situational Awareness; Telescopes; Data Bases; Data Processing; Carbon Dioxide

20020038986 Cologne Univ., Germany
KOSMA's 490/810 GHz Array Receiver
Graf, U. U.; Heyminck, S.; Michael, E. A.; Stanko, S.; Proceedings of the Twelfth International Symposium on Space Terahertz Technology; December 2001, 553-562; In English
Contract(s)/Grant(s): 05-AH9PK1; SFB-494; No Copyright; Avail: CASI; A02, Hardcopy

We describe the front end design of KOSMA's new multifrequency superconductor insulator superconductor (SIS) array receiver, which is currently being built to be used at our submillimeter telescope. The receiver consists of two 2 x 4 mixer arrays. One array operates at a frequency of 490 GHz, the other one at 810 GHz. We can thus simultaneously observe eight spatial positions in two frequencies. After passing through a K-mirror type image rotator, the two frequencies are separated by polarization and individually combined with their local oscillators (LOs), using Martin-Puplett diplexers. Splitting of the LOs is performed with a new type of phase grating, the collimating Fourier grating. Because of space and weight restrictions at the 3m KOSMA telescope, most of the optics is outside the dewar. The dewar window is located at an image plane of the telescope pupil to reduce the window size. Inside the dewar the two polarizations are split and the individual beams are focused into the feed horns with a faceted mirror. The opto-mechanical design makes extensive use of our CNC machining capabilities. As far as possible we machine complete sub-units from monolithic blocks, in order to reduce the need for optical alignment. We describe the optical design of the instrument and present the first test results obtained in early 2001.
Author
Antenna Arrays; Cryogenic Equipment; Design Analysis; Microwave Antennas; Receivers

20020038985 Arizona Univ., Tucson, AZ USA
PoleStar: An 810 GHz Array Receiver for AST/RO
Walker, Chris; Groppi, C.; Golish, D.; Kulesa, C.; Hungerford, A.; DrouetdAubigny, C.; Jacobs, K.; Graf, U.; Martin, C.; Kooi, J.; Proceedings of the Twenlfth International Symposium on Space Terahertz Technology; December 2001, 540-552; In English; No Copyright; Avail: CASI; A03, Hardcopy

We have constructed a four-channel receiver at 810 GHz for use on the Antarctic Submillimeter Telescope and Remote Observatory located at the South Pole (AST/RO). The array was assembled and tested at the Steward Observatory Radio Astronomy Lab (SORAL) and then installed on AST/RO in November-December 2000. In this paper we describe the instrument and its performance both in the lab and on the telescope.
Author
Antenna Arrays; Microwave Antennas; Receivers; Performance Tests

20020038977 National Astronomical Observatory, Tokyo, Japan
SIS Photon Detectors for Submillimeter-Wave Observations
Matsuo, Hiroshi; Ariyoshi, Seiichirou; Takeda, Masanori; Noguchi, Takashi; Proceedings of the Twenlfth International Symposium on Space Terahertz Technology; December 2001, 476; In English; No Copyright; Abstract Only; Available from CASI only as part of the entire parent document

We propose to use superconducting direct detectors (superconductor insulator superconductor (SIS) photon detectors) for future instruments for submillimeter-wave wide field imaging arrays. Using low leakage (less than 10 pA) superconducting tunnel junctions, it is possible to realize submillimeter-wave direct detectors with noise equivalent power of less than 10(exp -17)W/Hz(exp 1/2). We have evaluated leakage current and current noise of 4-micron niobium SIS junctions with current density of 0.5-1 kA/sq cm at 0.3 K. The measured leakage current is 5 pA at 0.5 mV and current noise is 1.5 fA/Hz(exp 1/2) with white noise spectrum down to 5 Hz. Antenna coupled SIS photon detector is designed as a distributed junction arrays, which is expected to give good matching in wide frequency range in submillimeter-wave with low current density junctions. Since the leakage current of the niobium junction saturates at about 0.9 K, the operating temperature of the detector can be 0.9 K, which greatly ease cooling and readout electronics requirements. Further advantage over bolometric detectors come from their thin film fabrication process and direct photon sensitivity. Because of the thin film fabrication process, the uniformity of the junction is good and large format array can be realized rather easily, and would be less affected by cosmic rays. Because of the direct photon sensitivity, excess noise by temperature fluctuation or electrical interference are not critical

like bolometric detectors. Submillimeter-wave imaging arrays using the SIS photon detectors have been designed and being fabricated. The arrays will be evaluated in Atacama Submillimeter Telescope Experiment.
Author
Bolometers; Photons; Submillimeter Waves; Superconductivity; Radiation Counters

20020038972 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA USA
Novel Multiplexing Technique for Detector and Mixer Arrays
Karasik, Boris S.; McGrath, William R.; Proceedings of the Twenlfth International Symposium on Space Terahertz Technology; December 2001, 436-445; In English; No Copyright; Avail: CASI; A02, Hardcopy

Future submillimeter and far-infrared space telescopes will require large-format (many 1000's of elements) imaging detector arrays to perform state-of-the-art astronomical observations. A crucial issue related to a focal plane array is a readout scheme which is compatible with large numbers of cryogenically-cooled (typically \h 1 K) detectors elements. When the number of elements becomes of the order of thousands, the physical layout for individual readout amplifiers becomes nearly impossible to realize for practical systems. Another important concern is the large number of wires leading to a 0.1-0.3 K platform. In the case of superconducting transition edge sensors (TES), a scheme for time-division multiplexing of SQUID read-out amplifiers has been recently demonstrated. In this scheme the number of SQUIDs is equal to the number (N) of the detectors, but only one SQUID is turned on at a time. The SQUIDs are connected in series in each column of the array, so the number of wires leading to the amplifiers can be reduced, but it is still of the order of N. Another approach uses a frequency domain multiplexing scheme of the bolometer array. The bolometers are biased with ac currents whose frequencies are individual for each element and are much higher than the bolometer bandwidth. The output signals are connected in series in a summing loop which is coupled to a single SQUID amplifier. The total number of channels depends on the ratio between the SQUID bandwidth and the bolometer bandwidth and can be at least 100 according to the authors. An important concern about this technique is a contribution of the out-of-band Johnson noise which multiplies by factor N(exp 1/2) for each frequency channel. We propose a novel solution for large format arrays based on the Hadamard transform coding technique which requires only one amplifier to read out the entire array of potentially many 1000's of elements and uses approximately 10 wires between the cold stage and room temperature electronics. This can significantly reduce the complexity of the readout circuits.
Derived from text
Bolometers; SQUID (Detectors); Wire; Readout

20020038956 Massachusetts Univ., Amherst, MA USA
Terahertz Receiver with NbN HEB Device (TREND): A Low-Noise Receiver User Instrument for AST/RO at the South Pole
Yngvesson, K. S.; Musante, C. F.; Ji, M.; Rodriquez, F.; Zhuang, Y.; Gerecht, E.; Coulombe, M.; Dickinson, J.; Goyette, T.; Waldman, J., et al.; Proceedings of the Twelfth International Symposium on Space Terahertz Technology; December 2001, 262-272; In English
Contract(s)/Grant(s): NSF AST-99-87319; No Copyright; Avail: CASI; A03, Hardcopy

Based on the excellent performance of NbN hot electron bolometer (HEB) mixer receivers at THz frequencies which we have established in the laboratory, we are building a Terahertz Receiver with NbN HEB Device (TREND) to be installed on the 1.7 meter diameter AST/RO submillimeter wave telescope at the Amundsen/Scott South Pole Station. TREND is scheduled for deployment during the austral summer season of 2002/2003. The frequency range of 1.25 THz to 1.5 THz was chosen in order to match the good windows for atmospheric transmission and interstellar spectral lines of special interest. The South Pole Station is the best available site for TRz observations due to the very cold and dry atmosphere over this site. In this paper, we report on the design of this receiver. In particular, we report measured beam patterns and polarization sensitivity at THz frequencies for a log-periodic antenna/lens combination, accurate measurements of the frequencies of two laser lines which are suitable for two of the spectral lines of greatest interest (N(II) and CO), as well as the mixer block design and other aspects of the design of the receiver system.
Author
Bolometers; Mixing Circuits; Receivers; Design Analysis; Radiation Distribution; Polarization Characteristics

20020038946 Tohoku Univ., Sendai, Japan
Design of Submillimeter-Wave Camera with Superconducting Direct Detectors
Ariyoshi, Seiichirou; Matsuo, Hiroshi; Takeda, Masanori; Noguchi, Takashi; Proceedings of the Twenlfth International Symposium on Space Terahertz Technology; December 2001, 183-192; In English; No Copyright; Avail: CASI; A02, Hardcopy

We have designed and are fabricating a submillimeter-wave focal plane array based on superconducting direct detectors for Atacama Submillimeter Telescope Experiment (ASTE). Antenna-coupled superconductor insulator superconductor (SIS) junctions with low leakage current can be used as sensitive submillimeter-wave detectors. Distributed junction array coupled to log-periodic antenna is designed to realize high quantum efficiency and wide frequency coverage. The observing center frequency using Nb/Al-AlOx/Nb junctions is about 650 GHz (450 micrometers). The electrical characteristics of the single SIS junction are measured. The achieved leakage current and current noise at 0.5 mV-bias is 6.3 pA and 1.8 fA/Hz(exp 1/2), respectively. This measured current noise is consistent with the calculated shot-noise limited one. The expected noise equivalent power (NEP) is an order of 10(exp -18) W/Hz(exp 1/2). Bandwidth of the antenna-coupled SIS junctions is calculated to be more than 60 GHz (FWHM) at 650 GHz with J(sub c) = 1 kA/sq cm.
Author
Cameras; Focal Plane Devices; SIS (Superconductors); Submillimeter Waves; Josephson Junctions

20020038937 Composite Optics, Inc., San Diego, CA USA
Advances in Composites for Terahertz Radio Astronomy
Connell, S. J.; Giles, D. A.; Proceedings of the Twenlfth International Symposium on Space Terahertz Technology; December 2001, 121; In English; No Copyright; Abstract Only; Available from CASI only as part of the entire parent document

In recent years, Composite Optics, Inc. (COI) has made significant advances in the use of carbon fiber reinforced polymer (CFRP) composite materials for astronomical instrument applications. The inherent low density, high stiffness, and excellent thermal stability of CFRP makes this class of material a natural candidate for many astronomy applications, particularly for space-borne instruments. In recent years, research and development at COI has focused on how to reap these inherent benefits in astronomical applications where other demanding requirements also exist. Basic research has focused on material and process improvement, resulting in an 4-5 times improvement in the accuracy, homogeneity, isotropy, and thermal stability of the basic material. This has been accompanied by the design, fabrication, and test of large prototype reflectors that cover a broad wavelength spectrum of astronomical interests. Three examples are: a passively adjusted 3-meter aperture prototype reflecting surface for the Large Millimeter Telescope (LMT), the 2-meter aperture prototype mirror for the Far Infrared and Submillimeter Space Telescope (FIRST), and a 1.6-m prototype for the Next Generation Space Telescope (NGST). These recent accomplishments have two important implications for the design and fabrication of primary reflectors that can meet the requirements of terahertz astronomy. First, COI has demonstrated a variety of techniques for fabricating large reflecting surfaces from composites to a few microns of accuracy. In addition to high as-manufactured accuracy, an all-composite reflecting surface will have a coefficient of thermal expansion (CTE) of less than 0.1 ppm/C. This may be the only material that can meet the thermal stability requirements for a ground-based terahertz instrument approach. Secondly, material advances can be applied to primary and secondary support structure, where unparalleled thermal stability may also be enabling for terahertz instruments. New design and manufacturing approaches also have the potential to dramatically minimize the need for high-expansion metallic fittings in these areas.
Author
Carbon Fiber Reinforced Plastics; Optical Measuring Instruments; Thermal Stability; Radio Astronomy; Telescopes

20020009758 Communications Research Lab., Tokyo, Japan
Radio Telescope Interference from a Ground Transmitter
Nakajima, Junichi; Koyama, Yasuhiro; Sekido, Mamoru; Kurihara, Noriyuki; Kondo, Tetsuro; Shibata, Katsunori M.; Journal of the Communications Research Laboratory. Special Issue: Large Aperture Radio Telescopes at Kashima Space Research Center; March 2001; ISSN 0914-9260; Volume 48, Issue No. 1, 91-95; In English; Copyright; Avail: Other Sources

We report measurements of RFI (Radio Frequency Interference) from a mobile ground transmitter to a radio telescope system. Radio telescopes are equipped with a very sensitive LNA (low noise amplifier) in their focus. Although they are designed to have maximum sensitivity to extra-terrestrial radio sources with large aperture toward a pointing direction, the gain in undesired directions are still so high that they are apt to receive nearby terrestrial-based emissions. In this experiment the Global Star System mobile terminal with a frequency 1612.8 MHz was used as a transmitter and the Kashima 34-m radio telescope received the signal from 172 remote points. The received strength are evaluated based on the definition of the ITU recommendation RA.769-1. The signals are very strong and often harmful to radio-astronomical observation, But the strength of the RFI is absorbed by the transmitting distance and its transmitted area.
Author
Radio Telescopes; Radio Frequency Interference; Transmitters; Radio Observation

20020009532 Communications Research Lab., Tokyo, Japan

Structure Model Analysis of the Kashima 34m Telescope

Nakajima, Junichi; Saita, Takeshi; Horiguchi, Junji; Yuge, Kouhei; Nakamura, Toshio; Journal of the Communications Research Laboratory. Special Issue: Large Aperture Radio Telescopes at Kashima Space Research Center; March 2001; ISSN 0914-9260; Volume 48, Issue No. 1, 83-89; In English; Copyright; Avail: Other Sources

Deformation analysis of the Kashima 34-m radio telescope is performed. Although the telescope has a large aperture and accurate reflector panels, the dish support structures determine the high frequency performance. Especially in millimeter wavelengths, deformations above 1 mm greatly affect telescope efficiency. We have modeled the 34-m telescope into elements and used the Finite Element Method (FEM) to simulate accurate telescope deformations. The results of our analysis were found to agree well with realistic deformation. Future analysis and telescope evaluations based on computer are possible with this FEM model.

Author

Structural Analysis; Radio Telescopes; Parabolic Reflectors

20020006053 Communications Research Lab., Japan

Radio Telescope Interference from a Ground Transmitter

Nakajima, Junichi; Koyama, Yasuhiro; Sekido, Mamoru; Kurihara, Noriyuki; Kondo, Tetsuo; Shibata, Katsunori; Review of the Communications Research Laboratory; March 2001; ISSN 0914-9279; Volume 47, Issue No. 1, 91-97; In Japanese; Copyright; Avail: Other Sources

We report measurements of RFI (Radio Frequency Interference) from a mobile ground transmitter to a radio telescope system. Radio telescopes are equipped with a very sensitive LNA (low noise amplifier) in their focus. Although they are designed to have maximum sensitivity to extra- terrestrial radio sources with large aperture toward a pointing direction, the gain in undesired directions are still so high that they are apt to receive nearby terrestrial -based emissions. In this experiment the Global Star System mobile terminal with a frequency 1612.8 MHz was used as a transmitter and the Kashima 34m radio telescope received the signal from 172 remote points. The received strength are evaluated based on the definition of the ITU recommendation RA.769-1. The signals are very strong and often harmful to radio-astronomical observation. But the strength of the RFI is absorbed by the transmitting distance and its transmitted area.

Author

Radio Telescopes; Transmitters; Frequencies; Radio Frequency Interference; Amplifiers

20010114485 National Optical Astronomy Observatories, Tucson, AZ USA

Implementing The Decadal Survey: NOAO's Role

Mould, Jeremy; NOAO Newsletter; September 2001, Issue No. 67, 11; In English; No Copyright; Avail: CASI; A01, Hardcopy

In accordance with the Decadal Survey, the National Optical Astronomy Observatory (NOAO) will play an important role in fulfilling the drive to begin construction of the Giant Segmented Mirror Telescope (GSMT) as a complement of NASA's Next Generation Space Telescope (NGST). The actual future of the GSMT program will rely on the cooperation of private and public groups. Details on other NOAO priorities planned for the coming decade such as the Large-aperture Synoptic Survey Telescope (LSST) are available on the world wide web.

CASI

Research and Development; Telescopes; Next Generation Space Telescope Project; Astronomical Observatories

20010114479 National Optical Astronomy Observatories, Tucson, AZ USA

KPNO in the New NOAO

Green, Richard; NOAO Newsletter; September 2001, Issue No. 67, 29; In English; No Copyright; Avail: CASI; A01, Hardcopy

The Kitt Peak National Observatory (KPNO) will play an important role in the National Optical Astronomy Observatory's (NOAO) directive as it has been articulated by the National Science Foundation (NSF). The NSF has called upon the NOAO to implement three important programs including 1) the Giant Segmented-Mirror Telescope (GSMT), 2) the Large-Aperture Synoptic Survey Telescope (LSST), 3) the National Virtual Observatory (NVO). The financial situation will require KPNO to shift funds from pre-existing operations to these initiatives.

CASI

Project Planning; Telescopes; Information Management; Astronomical Observatories

20010114477 National Optical Astronomy Observatories, Tucson, AZ USA

LSST Science Drivers and Conceptual Design Moving Ahead

Wolff, Sidney; NOAO Newsletter; September 2001, Issue No. 67, 16; In English; No Copyright; Avail: CASI; A01, Hardcopy

The Large-aperture Synoptic Survey Telescope (LSST) was recommended by the Decadal Survey as being an important initiative for the National Optical Astronomy Observatory (NOAO). Weekly surveys of the entire visible sky would produce a database and data-mining tools which would support the National Virtual Observatory (NVO) and comprise the world's largest nonproprietary data set. Prior to the establishment of a final engineering design, the scientific needs are being analyzed from three research areas including solar system problems, the study of variable objects, and deep imaging. Ultimately, the LSST project will be instituted as a nonprofit corporation, and the cooperation of a broad group of organizations will be required for its successful implementation.

CASI

Imaging Techniques; Organizations; Telescopes; Research and Development; Astronomical Observatories

20010089365 NASA Goddard Space Flight Center, Greenbelt, MD USA

Integrated Modeling for the Next Generation Space Telescope 'Yardstick' Concept

Mosier, Gary E.; Broduer, Steve, Technical Monitor; [2001]; In English; FEMCI Workshop 2001: Innovative FEM Solutions to Challenging Problems, 16-17 May 2001, Greenbelt, MD, USA; No Copyright; Avail: Other Sources; Abstract Only

The so-called NASA 'Yardstick' design concept for the Next Generation Space Telescope presents unique challenges for systems-level analysis. Simulations that integrate controls, optics, thermal, and structural models are required to evaluate baseline performance, study design sensitivities, and perform design optimization. An integrated modeling approach was chosen using a combination of commercial off-the-shelf and 'in-house' developed codes. The resulting capability provides a foundation for linear and non-linear analysis, using both the time and frequency-domain methods. It readily allows various combinations of design parameters and environmental loads to be evaluated directly in terms of key science-related metrics, in this case the scalar RMS (root mean square) line-of-sight and RMS wavefront errors. This presentation first addresses the development of the component, or discipline, models for the Yardstick design. It will then proceed to present the integration of the component models, using linear-systems approaches, in order to support two of the most critical baseline performance analyses: jitter and thermal-elastic stability of the optical telescope assembly (OTA). The results of the jitter analysis indicate that disturbances from the reaction wheels coupled with the lightly-damped and highly-flexible structure present significant challenges to the baseline line-of-sight control architecture. Vibration isolation will be required to meet jitter error requirements. The results of the thermal-elastic analysis indicate that the mirror segment displacements due to ground-to-orbit cool-down of the telescope are within the expected capture range of the segment rigid-body control actuators. This means we will be able to align and phase the primary mirror. However, the results for the analysis of the thermal transient response following an attitude maneuver (slew) show that this telescope design is not sufficiently stable, passively, to meet the wavefront error requirements. Structural re-design is one possibility; alternatively, active thermal control of the OTA may be considered. The Yardstick integrated models were successfully used to demonstrate the feasibility of two thermal control strategies.

Author

Design Analysis; Computerized Simulation; Structural Vibration; Thermal Stability

20010089266 NASA Goddard Space Flight Center, Greenbelt, MD USA

Simulation of MEMS for the Next Generation Space Telescope

Mott, Brent; Kuhn, Jonathan; Broduer, Steve, Technical Monitor; [2001]; In English; FEMCI Workshop 2001: Innovative FEM Solutions to Challenging Problems, 16-17 May 2001, Greenbelt, MD, USA; No Copyright; Avail: Other Sources; Abstract Only

The NASA Goddard Space Flight Center (GSFC) is developing optical micro-electromechanical system (MEMS) components for potential application in Next Generation Space Telescope (NGST) science instruments. In this work, we present an overview of the electro-mechanical simulation of three MEMS components for NGST, which include a reflective micro-mirror array and transmissive microshutter array for aperture control for a near infrared (NIR) multi-object spectrometer and a large aperture MEMS Fabry-Perot tunable filter for a NIR wide field camera. In all cases the device must operate at cryogenic temperatures with low power consumption and low, complementary metal oxide semiconductor (CMOS) compatible, voltages. The goal of our simulation efforts is to adequately predict both the performance and the reliability of the devices during ground handling, launch, and operation to prevent failures late in the development process and during flight. This goal requires detailed modeling and validation of complex electro-thermal-mechanical interactions and very large non-linear deformations, often involving surface contact. Various parameters such as spatial dimensions and device response

are often difficult to measure reliably at these small scales. In addition, these devices are fabricated from a wide variety of materials including surface micro-machined aluminum, reactive ion etched (RIE) silicon nitride, and deep reactive ion etched (DRIE) bulk single crystal silicon. The above broad set of conditions combine to be a formidable challenge for space flight qualification analysis. These simulations represent NASA/GSFC's first attempts at implementing a comprehensive strategy to address complex MEMS structures.
Author
Microelectromechanical Systems; Computerized Simulation; Reliability Analysis; Performance Prediction

20010086595 NASA Marshall Space Flight Center, Huntsville, AL USA
COI Structural Analysis Presentation
Cline, Todd; Stahl, H. Philip, Technical Monitor; [2001]; In English; MSFC Technology Days, 9-10 May 2001, Huntsville, AL, USA
Contract(s)/Grant(s): NAS8-00187; No Copyright; Avail: Other Sources; Abstract Only

This report discusses the structural analysis of the Next Generation Space Telescope Mirror System Demonstrator (NMSD) developed by Composite Optics Incorporated (COI) in support of the Next Generation Space Telescope (NGST) project. The mirror was submitted to Marshall Space Flight Center (MSFC) for cryogenic testing and evaluation. Once at MSFC, the mirror was lowered to approximately 40 K and the optical surface distortions were measured. Alongside this experiment, an analytical model was developed and used to compare to the test results. A NASTRAN finite element model was provided by COI and a thermal model was developed from it. Using the thermal model, steady state nodal temperatures were calculated based on the predicted environment of the large cryogenic test chamber at MSFC. This temperature distribution was applied in the structural analysis to solve for the deflections of the optical surface. Finally, these deflections were submitted for optical analysis and comparison to the interferometer test data.
Author
Next Generation Space Telescope Project; Cryogenics; Structural Analysis; Mirrors; Deflection

20010081064 NASA Ames Research Center, Moffett Field, CA USA
An Explorer-Class Astrobiology Mission
Sandford, Scott; Greene, Thomas; Allamandola, Louis; Arno, Roger; Bregman, Jesse; Cox, Sylvia; Davis, Paul K.; Gonzales, Andrew; Haas, Michael; Hanel, Robert; DeVincenzi, Donald L., Technical Monitor, et al.; [2000]; In English; UV, Optical and IR Space Telescopes and Instruments, 26-31 Mar. 2000, Munich, Germany
Contract(s)/Grant(s): RTOP 632-70-04-03; No Copyright; Avail: CASI; A03, Hardcopy

In this paper we describe a potential new Explorer-class space mission, the AstroBiology Explorer (ABE), consisting of a relatively modest dedicated space observatory having a 50 cm aperture primary mirror which is passively cooled to T less than 65 K, resides in a low-background orbit (heliocentric orbit at 1 AU, Earth drift-away), and is equipped with a suite of three moderate order (m approx. 10) dispersive spectrographs equipped with first-order cross-dispersers in an 'echellette' configuration and large format (1024xl024 pixel) near- and mid-IR detector arrays cooled by a modest amount of cryogen. Such a system would be capable of addressing outstanding problems in Astrochemistry and Astrophysics that are particularly relevant to Astrobiology and addressable via astronomical observation. The observational program of this mission would make fundamental scientific progress in each of the key areas of the cosmic history of molecular carbon, the distribution and chemistry of organic compounds in the diffuse and dense interstellar media, and the evolution of ices and organic matter in young planetary systems. ABE could make fundamental progress in all of these areas by conducting an approximately one year mission to obtain a coordinated set of infrared spectroscopic observations over the 2.5-20 micrometers spectral range at spectral resolutions of R greater than or equal to 1000 of approximately 1000 galaxies, stars, planetary nebulae, and young star planetary systems.
Author
Astrophysics; Exobiology; Space Missions; Astronomical Models; Organic Compounds

20010078912 NASA Marshall Space Flight Center, Huntsville, AL USA
Recent Enhancements of the Phased Array Mirror Extendible Large Aperture (PAMELA) Telescope Testbed at MSFC
Rakoczy, John; Burdine, Robert, Technical Monitor; [2001]; In English; MSFC Technology Days, 9-10 May 2001, Huntsville, AL, USA; No Copyright; Avail: Other Sources; Abstract Only

Recent incremental upgrades to the Phased Array Mirror Extendible Large Aperture (PAMELA) telescope testbed have enabled the demonstration of phasing (with a monochromatic source) of clusters of primary mirror segments down to the

diffraction limit. PAMELA upgrades include in improved Shack-Hartmann wavefront sensor, passive viscoelastic damping treatments for the voice-coil actuators, mechanical improvement of mirror surface figures, and optical bench baffling. This report summarizes the recent PAMELA upgrades, discusses the lessons learned, and presents a status of this unique testbed for wavefront sensing and control. The Marshall Space Flight Center acquired the Phased Array Mirror Extendible Large Aperture (PAMELA) telescope in 1993 after Kaman Aerospace was unable to complete integration and testing under the limited SDIO and DARPA funding. The PAMELA is a 36-segment, half-meter aperture, adaptive telescope which utilizes a Shack-Hartmann wavefront sensor, inductive coil edge sensors, voice coil actuators, imaging CCD cameras and interferometry for figure alignment, wavefront sensing and control. MSFC originally obtained the PAMELA to supplement its research in the interactions of control systems with flexible structures. In August 1994, complete tip, tilt and piston control was successfully demonstrated using the Shack-Hartmann wavefront sensor and the inductive edge sensors.
Author
Phased Arrays; Apertures; Telescopes; Optical Equipment; Imaging Techniques; Actuators; Viscoelastic Damping

20010073391 NASA Goddard Space Flight Center, Greenbelt, MD USA
Far-Infrared Extragalactic Surveys: Past, Present, and Future
Moseley, Samuel H., Jr.; Fisher, Richard R., Technical Monitor; [2001]; In English; AAS Conference, June 2001; No Copyright; Avail: Other Sources; Abstract Only

As much as one third of the luminosity of the local universe is emitted in the far infrared. In order to understand the history of energy release in the universe, it is crucial to characterize this rest-frame far-infrared contribution from the present back to the era of initial galaxy formation. Over the redshift range from 0 to 10, this energy is received in the 80 micrometers to 1 mm spectral region. In the 1980's the Infrared Astronomy Satellite (IRAS) all-sky survey provided the first comprehensive view of the far infrared emission from the local universe. The diffuse background measurements by Cosmic Background Explorer Satellite (COBE) have provided constraints on the integral contributions from the high redshift universe. In the past five years, submillimeter measurements made using the SCUBA instrument have revealed powerful high redshift sources. To develop a clear history of energy release in the universe, we need numbers and redshifts of representative populations of energetically important objects. The near future will bring the Space Infrared Telescope Facility Multiband Imaging Photometer (SIRTF)(MIPS) survey, which will cover about 100 square degrees at wavelengths out to 160 micrometers, providing a large sample of energetically important galaxies out to z of approx.3. In 2005, the Japanese IRIS survey will provide a 160 micrometers full sky survey, which will provide larger samples of the high z galaxy populations and will find intrinsically rare high luminosity objects. The SPIRE instrument on the FIRST facility will extend these surveys to longer wavelengths, providing a view of the universe at higher redshifts in three spectral bands. A concept for an all-sky submillimeter survey is under development, called the Survey of Infrared Cosmic Evolution (SIRCE). With a 2 m cryogenic telescope, it can map the entire sky to the confusion limit in the 100 to 500 micrometers range in six months. This survey will provide photometric redshifts, number counts, and will find the most luminous objects in the universe. In the next decade, the opening of the submillimeter, combined with the near infrared capability of NGST will provide us with a clear picture of energy release in the early universe.
Author
Far Infrared Radiation; Sky Surveys (Astronomy); Galaxies; Telescopes; Infrared Astronomy Satellite

20010026436 NASA Goddard Space Flight Center, Greenbelt, MD USA
Modeling and Analysis of Structural Dynamics for a One-Tenth Scale Model NGST Sunshield
Johnston, John; Lienard, Sebastien; Brodeur, Steve, Technical Monitor; [2001]; In English; SDM, 16-19 Apr. 2001, Seattle, WA, USA
Report No.(s): AIAA Paper 2001-1407; Copyright; Avail: CASI; A03, Hardcopy

New modeling and analysis techniques have been developed for predicting the dynamic behavior of the Next Generation Space Telescope (NGST) sunshield. The sunshield consists of multiple layers of pretensioned, thin-film membranes supported by deployable booms. Modeling the structural dynamic behavior of the sunshield is a challenging aspect of the problem due to the effects of membrane wrinkling. A finite element model of the sunshield was developed using an approximate engineering approach, the cable network method, to account for membrane wrinkling effects. Ground testing of a one-tenth scale model of the NGST sunshield were carried out to provide data for validating the analytical model. A series of analyses were performed to predict the behavior of the sunshield under the ground test conditions. Modal analyses were performed to predict the frequencies and mode shapes of the test article and transient response analyses were completed to simulate impulse excitation tests. Comparison was made between analytical predictions and test measurements for the dynamic behavior of the

sunshield. In general, the results show good agreement with the analytical model correctly predicting the approximate frequency and mode shapes for the significant structural modes.
Author
Dynamic Characteristics; Dynamic Structural Analysis; Scale Models; Protectors; Next Generation Space Telescope Project

20010021170 NASA Marshall Space Flight Center, Huntsville, AL USA
Overview of Mirror Technology Development for Large Lightweight Space-Based Optical Systems
Smith, W. Scott; Stahl, H. P.; Rose, M. Frank, Technical Monitor; [2000]; In English; Intelligent Systems and Advanced Manufacturing, 5-8 Nov. 2000, Boston, MA, USA; No Copyright; Avail: Other Sources; Abstract Only

The Space Optics Manufacturing Technology Center of Marshall Space Flight Center is involved in the development of lightweight optics for spacebased'systems. The NGST and other future NASA programs require large aperture space-based instruments. This paper reviews the technologies under development for NGST including discussions of the environmental testing of candidate segment for the NGST primary mirror.
Author
Mirrors; Apertures; Satellite-Borne Instruments; Optical Equipment

20010020072 NASA Marshall Space Flight Center, Huntsville, AL USA
Mirror Technology Development at MSFC for the Next Generation Space Telescope and Other Space Telescope Missions
Stahl, H. Philip; Smith, W. Scott; Burdine, Robert, Technical Monitor; [2001]; No Copyright; Avail: Other Sources; Abstract Only

Large-aperture low-areal-density mirrors are critical to the success of the Next Generation Space Telescope (NGST) as well as other related space missions such as the Space Based Laser (SBL). Currently fabrication technology has demonstrated areal densities of 50 kg/sq m. NASA and its DOD partners are conducting a series of risk reduction projects to demonstrate mirror fabrication technology for mirror systems with areal densities of 15 kg/sq m. This talk will present an overview of these risk reduction experiments.
Author
Mirrors; Lasers; Space Missions

20010006500 California Inst. of Tech., Pasadena, CA USA
Quiescent Giant Molecular Cloud Cores in the Galactic Center
Lis, D. C.; Serabyn, E.; Zylka, R.; Li, Y.; [2000]; In English
Contract(s)/Grant(s): NSF AST-99-80846
Report No.(s): Rept-2000-14; No Copyright; Avail: CASI; A03, Hardcopy

We have used the Long Wavelength Spectrometer (LWS) aboard the Infrared Space Observatory (ISO) to map the far-infrared continuum emission (45-175 micrometer) toward several massive Giant Molecular Cloud (GMC) cores located near the Galactic center. The observed far-infrared and submillimeter spectral energy distributions imply low temperatures (approx. 15 - 22 K) for the bulk of the dust in all the sources, consistent with external heating by the diffuse ISRF and suggest that these GMCs do not harbor high- mass star-formation sites, in spite of their large molecular mass. Observations of FIR atomic fine structure lines of C(sub II) and O(sub I) indicate an ISRF enhancement of approx. 10(exp 3) in the region. Through continuum radiative transfer modeling we show that this radiation field strength is in agreement with the observed FIR and submillimeter spectral energy distributions, assuming primarily external heating of the dust with only limited internal luminosity (approx. 2 x 10(exp 5) solar luminosity). Spectroscopic observations of millimeter-wave transitions of H2CO, CS, and C-34S carried out with the Caltech Submillimeter Observatory (CSO) and the Institut de Radio Astronomie Millimetrique (IRAM) 30-meter telescope indicate a gas temperature of approx. 80 K, significantly higher than the dust temperatures, and density of approx. 1 x 10(exp 5)/cc in GCM0.25 + 0.01, the brightest submillimeter source in the region. We suggest that shocks caused by cloud collisions in the turbulent interstellar medium in the Galactic center region are responsible for heating the molecular gas. This conclusion is supported by the presence of wide-spread emission from molecules such as SiO, SO, and CH3OH, which are considered good shock tracers. We also suggest that the GMCs studied here are representative of the 'typical', pre-starforming cloud population in the Galactic center.
Author
Mapping; Infrared Imagery; Atomic Structure; Collisions; Continuum Modeling; Dust; Energy Distribution; Interstellar Matter; Molecular Clouds

20000118211 NASA Ames Research Center, Moffett Field, CA USA

The AstroBiology Explorer (ABE) MIDEX Mission

Greene, Thomas; Sandford, Scott; Allamandola, Louis; Arno, Roger; Bregman, Jesse; Cox, Sylvia; Davis, Paul; Gonzales, Andrew; Hanel, Robert; Hines, Michael; Hudgins, Douglas; DeVincenzi, Donald L., Technical Monitor, et al.; [2000]; In English; UV, Optical and IR Space Telescopes and Instruments, 26-31 Mar. 2000, Munich, Germany

Contract(s)/Grant(s): RTOP 632-70-04-03; No Copyright; Avail: Other Sources; Abstract Only

The Astrobiology Explorer (ABE) is a Medium-Class Explorer (MIDEX) mission concept currently under study at NASA's Ames Research Center. ABE will conduct infrared (IR) spectroscopic observations with much better sensitivity than Infrared Space Observatory (ISO) or the Stratospheric Observatory for Infrared Astronomy program (SOFIA) in order to address outstanding astrobiologically important problems in astrochemistry as well as important astrophysical investigations. The core observational astrobiology program would make fundamental scientific progress in understanding the cosmic history of molecular carbon, the distribution of organic matter in the diffuse interstellar medium, tracing the chemical history of complex organic molecules in the interstellar medium, and the evolution of organic ices in young planetary systems. The ABE instrument concept includes a 0.5 m aperture Cassegrain telescope and a suite of three moderate resolution (R = 1000 - 4000) spectrographs which cover the entire lambda = 2.5-20 micron spectral region. Use of large format (1024 x 1024 pixel or larger) IR detector arrays will allow each spectrograph to cover an entire octave of spectral range per exposure without any moving parts. The telescope is passively cooled by a sun shade to below 65 K, and the detectors are cooled with solid H2 cryogen to approximately 8 K. ABE will be placed in an Earth-trailing one AU solar orbit by a Delta II launch vehicle. This energetically favorable orbit provides a low thermal background, affords good access to the entire sky over the one year mission lifetime, and allows adequate communications bandwidth. The spacecraft will be stabilized in three axes and will be pointed to an accuracy of approximately one arcsecond at ABE's several thousand individual scientific targets.

Author

Bioastronautics; Exobiology; Infrared Detectors; Infrared Spectroscopy; Telescopes; Mission Planning

20000096519 NASA Goddard Space Flight Center, Greenbelt, MD USA

NASA's Long Term Space Astrophysics Program

2000; In English

Contract(s)/Grant(s): NAG5-3542; No Copyright; Avail: CASI; A01, Hardcopy

We have carried out a comprehensive, multiwavelength study of interstellar molecules using data obtained from the Infrared Space Observatory (ISO), the Hubble Space Telescope (HST), and the Submillimeter Wave Astronomy Satellite (SWAS). Molecular observations provide a unique probe of the astrophysical Universe and yield information of general astronomical importance that can obtained in no other way. Molecules are also of importance because they can dominate the cooling of astrophysical media. The key topics addressed by our study have been: (1) the cooling of the interstellar gas; (2) the chemistry and excitation of molecular hydrogen in shocks, diffuse molecular clouds, and X-ray heated regions; (3) the chemistry and excitation of interstellar halides in dense molecular clouds, and the discovery of interstellar hydrogen fluoride; (4) the chemistry and excitation of water vapor in shocks, circumstellar outflows, translucent molecular clouds, and dense molecular clouds; (5) future prospects for probing the high-redshift Universe with molecular and other spectroscopic observations.

Author

Interstellar Matter; Molecular Gases; Molecular Clouds; Stellar Envelopes; Submillimeter Waves

20000091589 Nobeyama Radio Observatory, Nobeyama, Japan

The Mt. Fuji Submillimeter-Wave Telescope

Sekimoto, Yutaro; Yamamoto, Satoshi; Ikeda, Masafumi; Maezawa, Hiroyuki; Ito, Tetsuya; Saito, Gaku; Tatematsu, Kenichi; Arikawa, Yuji; Aso, Yoshiyuki; Noguchi, Takashi, et al.; [July 2000]; ISSN 0911-5501; In English

Contract(s)/Grant(s): MOE-07CE2002

Report No.(s): NRO-516; Copyright; Avail: CASI; A03, Hardcopy; US Distribution and Sales Only

We have developed a 1.2 in submillimeter-wave telescope at the summit of Mt. Fuji to survey emission lines of the neutral carbon atom (C(sub I)) toward the Milky Way. A superconductor-insulator-superconductor (SIS) mixer receiver on the Nasmyth focus is used to observe the 492 GHz band in SSB and the 345 GHz band in DSB simultaneously. The receiver noise temperature is 300 K in SSB and 200 K in DSB for 492 and 345 GHz, respectively. The IF frequency is 1.8 - 2.5 GHz. An acousto-optical spectrometer (AOS) which has the total bandwidth of 0.9 GHz and 1024 channel outputs has been also developed. The telescope was installed at the summit of Mt. Fuji (alt. 3725 in) in July 1998. It has been remotely operated via a satellite communication system from Tokyo or Nobeyama. Atmospheric opacity at Mt. Fuji was 0.4 - 1.0 at 492 GHz

during 30 % of time and 0.07 - 0.5 at 345 GHz during 60% of time from November 1998 to February 1999. The system noise temperature was 1000 - 3000 K in SSB at 492 GHz and 500 - 2000 K in DSB at 345 GHz. We observed the CI ((sup 3)P(sub 1) - (sup 3)P(sub 0): 492 GHz) and CO (J = 3 - 2: 345 GHz) emission lines from nearby molecular clouds with the beam size of 2.2' and 3.1', respectively. We describe the telescope system and report the performance obtained in the 1998 winter.
Author
Submillimeter Waves; Telescopes; Sky Surveys (Astronomy); Neutral Atoms; Carbon; Emission Spectra; Line Spectra; Milky Way Galaxy

20000091030 NASA Goddard Space Flight Center, Greenbelt, MD USA
Minimizing Gravity Sag of a Large Mirror with an Inverted Hindle-Mount
Robinson, David W.; Powers, Edward I., Technical Monitor; [2000]; In English; 45th, Jul./Aug. 2000, San Diego, CA, USA; No Copyright; Avail: CASI; A02, Hardcopy

A method of minimizing the optical distortion from gravity sag on a suspended large autocollimating flat mirror has been devised. This method consists of an inverted nine-point Hindle-Mount. A conventional Hindle-mount is located underneath a sky-viewing mirror and is primarily under compression loads from the weight of the mirror. It is not suitable for the situation where the mirror is viewing the ground, since a mirror would tend to fall out of the mount when in an inverted position. The inverted Hindle-Mount design consists of bonded joints on the backside of the mirror that allow the mirror to be held or suspended above an object to be viewed. This ability is useful in optical setups such as a calibration test where a flat mirror is located above a telescope so that the telescope may view a known optic.
Author
Mirrors; Mounting; Assembling; Gravitational Effects

20000085881 NASA Goddard Space Flight Center, Greenbelt, MD USA
Selection of the Ground Segment for the Next Generation Space Telescope (NGST)
Gal-Edd, Jonathan; Isaacs, John C., III; Olson, Leonard E.; Pfarr, Thomas R.; Steck, Jane A.; [2000]; In English; No Copyright; Avail: CASI; A01, Hardcopy

The Next Generation Space Telescope (NGST) is a large aperture space telescope designated to succeed the Hubble Space Telescope (HST). NGST will continue the recent breakthroughs of HST in our understanding of the earliest origins of stars, galaxies and the elements that are the foundations of Life. It is expected that the costs of NGST should be kept within a fraction of those for HST. The ground segment has a goal of reducing the cost of NGST in comparison to HST by 50% to 75%. To mitigate risks for NGST a flight demonstrator called Nexus is planned for 2005. Nexus is a smaller scale telescope, which plans to test the deployment and optical stability of the telescope, the 'Wave Front Control' process, and the thermal performance of the sunshield. The Nexus Ground System will be developed by GSFC and STSci, and the NGST Ground System will be developed by STSci. The authors of this paper are engaged in a study to evaluate and recommend selection of a Command and Telemetry system for each of these Ground Systems. This paper focuses on the process of selecting the real-time Command and Telemetry system for NGST. We would like to use the conference as a sounding board as we make a selection.
Author
Telescopes; Cost Reduction; Costs; Deployment; Real Time Operation; Risk

20000084158 NASA Goddard Space Flight Center, Greenbelt, MD USA
A Near IR Fabry-Perot Interferometer for Wide Field, Low Resolution Hyperspectral Imaging on the Next Generation Space Telescope
Barry, R. K.; Satyapal, S.; Greenhouse, M. A.; Barclay, R.; Amato, D.; Arritt, B.; Brown, G.; Harvey, V.; Holt, C.; Kuhn, J., et al.; [2000]; In English; No Copyright; Avail: CASI; A03, Hardcopy

We discuss work in progress on a near-infrared tunable bandpass filter for the Goddard baseline wide field camera concept of the Next Generation Space Telescope (NGST) Integrated Science Instrument Module (ISIM). This filter, the Demonstration Unit for Low Order Cryogenic Etalon (DULCE), is designed to demonstrate a high efficiency scanning Fabry-Perot etalon operating in interference orders 1 - 4 at 30K with a high stability DSP based servo control system. DULCE is currently the only available tunable filter for lower order cryogenic operation in the near infrared. In this application, scanning etalons will illuminate the focal plane arrays with a single order of interference to enable wide field lower resolution hyperspectral imaging

over a wide range of redshifts. We discuss why tunable filters are an important instrument component in future space-based observatories.
Author
Near Infrared Radiation; Infrared Interferometers; Fabry-Perot Interferometers; Etalons

20000080186 California Inst. of Tech., Pasadena, CA USA
A Low Noise NbTiN-Based 850 GHz SIS Receiver for the Caltech Submillimeter Observatory
Kooi, J. W.; Kawamura, J.; Chen, J.; Chattopadhyay, G.; Pardo, J. R.; Zmuidzinas, J.; Phillips, T. G.; Bumble, B.; Stern, J.; LeDuc, H. G.; 2000; In English
Contract(s)/Grant(s): NAG5-4890; NAGW-107; NAG2-1068; NSF AST-96-15025; No Copyright; Avail: CASI; A03, Hardcopy

We have developed a niobium titanium nitride (NbTiN) based superconductor- insulator-superconductor (SIS) receiver to cover the 350 micron atmospheric window. This frequency band lies entirely above the energy gap of niobium (700 GHz), a commonly used SIS superconductor. The instrument uses an open structure twin-slot SIS mixer that consists of two Nb/AlN/NbTiN tunnel junctions, NbTiN thin-film microstrip tuning elements, and a NbTiN ground plane. The optical configuration is very similar to the 850 GHz waveguide receiver that was installed at the Caltech Submillimeter Observatory (CSO) in 1997. To minimize front-end loss, we employed reflecting optics and a cooled beamsplitter at 4 K. The instrument has an uncorrected receiver noise temperature of 205K DSB at 800 GHz and 410K DSB at 900 GHz. The degradation in receiver sensitivity with frequency is primarily due to an increase in the mixer conversion loss, which is attributed to the mismatch between the SIS junction and the twin-slot antenna impedance. The overall system performance has been confirmed through its use at the telescope to detect a wealth of new spectroscopic lines.
Author
Electromagnetic Noise; Niobium; Titanium Nitrides; Receivers; Fabrication; Low Noise; SIS (Superconductors)

20000075644 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA USA
Spectroscopic Capabilities and Possibilities of the Far Infrared and Submillimeter Telescope Mission
Pearson, J. C.; [2000]; In English; No Copyright; Avail: Other Sources; Abstract Only

The Far Infrared and Submillimeter Telescope (FIRST) mission is the fourth European Space Agency corner stone mission. FIRST will be an observatory with a passively cooled (80 Kelvin) 3.5 meter class telescope and three cryogenic instruments covering the 670 to 80 mm spectral region. The mission is slated for a 4.5 year operational lifetime in an L2 orbit. It will share an Arian 5 launch with PLANCK in early 2007. The three payload instruments include the Spectral and Photometric Imaging Receiver (SPIRE), which is a bolometer array with Martin-Puplett FTS for 200-670 microns, the Photoconductor Array Camera and Spectrometer (PACS), which is a photoconductor array with a grating spectrometer for 80-210 microns and the Heterodyne Instrument for FIRST (HIFI), which is a series of seven heterodyne receivers covering 480-1250 GHz and portions of 1410-1910 GHz and 2400-2700 GHz. FIRST will make many detailed spectral surveys of a wide variety of objects previously obscured by the atmosphere and in regions of the spectrum seldom used for astronomical observations, With all of the spectroscopic capability on FIRST a great deal of laboratory spectroscopic support will be needed for accurate interpretation of the spectral data.
Author
Infrared Telescopes; Submillimeter Waves; Far Infrared Radiation; Imaging Techniques; Emission Spectra

20000073240 Smithsonian Astrophysical Observatory, Cambridge, MA USA
Infrared Submillimeter and Radio Astronomy Research and Analysis Program
Traub, Wesley A.; June 2000; In English
Contract(s)/Grant(s): NCC2-1012; No Copyright; Avail: CASI; A03, Hardcopy

This program entitled 'Infrared Submillimeter and Radio Astronomy Research and Analysis Program' with NASA-Ames Research Center (ARC) was proposed by the Smithsonian Astrophysical Observatory (SAO) to cover three years. Due to funding constraints only the first year installment of $18,436 was funded, but this funding was spread out over two years to try to maximize the benefit to the program. During the tenure of this contact, the investigators at the SAO, Drs. Wesley A. Traub and Nathaniel P. Carleton, worked with the investigators at ARC, Drs. Jesse Bregman and Fred Wittebom, on the following three main areas: 1. Rapid scanning SAO and ARC collaborated on purchasing and constructing a Rapid Scan Platform for the delay arm of the Infrared-Optical Telescope Array (IOTA) interferometer on Mt. Hopkins, Arizona. The Rapid Scan Platform was tested and improved by the addition of stiffening plates which eliminated a very small but noticeable

bending of the metal platform at the micro-meter level. 2. Star tracking Bregman and Wittebom conducted a study of the IOTA CCD-based star tracker system, by constructing a device to simulate star motion having a specified frequency and amplitude of motion, and by examining the response of the tracker to this simulated star input. 3. Fringe tracking. ARC, and in particular Dr. Robert Mah, developed a fringe-packet tracking algorithm, based on data that Bregman and Witteborn obtained on IOTA. The algorithm was tested in the laboratory at ARC, and found to work well for both strong and weak fringes.
Derived from text
Algorithms; CCD Star Tracker; Infrared Astronomy; Interferometers; Star Trackers; Submillimeter Waves

20000066601 NASA Marshall Space Flight Center, Huntsville, AL USA
Multi-Use Space Optics Test Facility
Reily, Jack C.; Kegley, Jeff; Keidel, John; Siler, Richard; Wright, Ernie; Jacobson, David; Smith, Scott; Eng, Ron; Stahl, Phil; [2000]; In English; Optical, 18-23 Jun. 2000, Quebec, Canada; No Copyright; Avail: Other Sources; Abstract Only

Marshall Space Flight Center has modified the X-ray Calibration Facility to test Next Generation Space Telescope developmental mirrors at cryogenic temperatures (35 degrees Kelvin) while maintaining capability for performance testing of x-ray optics and detectors. Marshall Space Flight Center (MSFC) has maintained and operated a world-class x-ray optics and detector testing facility since mid 1970. The ground test and calibration of the Chandra (previously AXAF) X-ray Observatory required extensive modifications to the X-ray Calibration Facility (XRCF). X-ray optical performance testing of the Chandra optics and detectors was successfully completed at the XRCF in 1997. The development phase for the Next Generation Space Telescope (NGST) program and the establishment of the Space Optics Manufacturing Technology Center at MSFC led to additional modifications to the XRCF to accommodate optical testing at cryogenic temperatures. NGST supported efforts include the Sub-Scale Beryllium Mirror Demonstrator (SBMD) and the NGST Mirror System Demonstrator (NMSD) programs. In addition, the Advanced Mirror System Demonstrator (AMSD) program will use the cryogenic test facility for mirror performance testing in 2001. In 1999 the facility was upgraded to perform cryogenic testing of lightweight visible optics, without compromising the existing x-ray testing capability. A thermal enclosure capable of 20 degrees Kelvin and a vibration isolated instrumentation mount were added. A vacuum-compatible five-axis motion table was modified to operate under cryogenic conditions in order to provide mirror steering under test conditions. This new cryogenic test facility will accommodate optics up to two meters in diameter, with radii of curvature of up to twenty meters. Several facility characterization tests and three NGST program mirror tests have been conducted at cryogenic temperatures to date. Data from these cryogenic tests will allow the development teams to perform final polishing operations on the mirrors, based on optical figure data collected at a temperature of 35 degrees Kelvin. Optical wavefront measurements were made at 35 degrees Kelvin with several instruments located at the radius of curvature of the mirror. The current wavefront measuring instruments include a Shack-Hartman wavefront sensor as the main instrument, a Point Diffraction Interferometer (PDI), a Point Spread Function (PSF) imager, and a radius of curvature measuring instrument. Planned enhancements to this system include the addition of a vibration insensitive phase shifting interferometer.
Author
Performance Tests; Test Facilities; X Ray Optics; Space Manufacturing; Calibrating; Next Generation Space Telescope Project; Optical Equipment

20000062729 NASA Goddard Space Flight Center, Greenbelt, MD USA
Overcoming Dynamic Disturbances in Imaging Systems
Young, Eric W.; Dente, Gregory C.; Lyon, Richard G.; Chesters, Dennis; Gong, Qian; [2000]; In English, 10-12 May 2000, Greenbelt, MD, USA; No Copyright; Avail: CASI; A03, Hardcopy

We develop and discuss a methodology with the potential to yield a significant reduction in complexity, cost, and risk of space-borne optical systems in the presence of dynamic disturbances. More robust systems almost certainly will be a result as well. Many future space-based and ground-based optical systems will employ optical control systems to enhance imaging performance. The goal of the optical control subsystem is to determine the wavefront aberrations and remove them. Ideally reducing an aberrated image of the object under investigation to a sufficiently clear (usually diffraction-limited) image. Control will likely be distributed over several elements. These elements may include telescope primary segments, telescope secondary, telescope tertiary, deformable mirror(s), fine steering mirror(s), etc. The last two elements, in particular, may have to provide dynamic control. These control subsystems may become elaborate indeed. But robust system performance will require evaluation of the image quality over a substantial range and in a dynamic environment. Candidate systems for improvement in the Earth Sciences Enterprise could include next generation Landsat systems or atmospheric sensors for dynamic imaging of individual, severe storms. The technology developed here could have a substantial impact on the development of new systems in the Space Science Enterprise; such as the Next Generation Space Telescope(NGST) and its follow-on the Next

NGST. Large Interferometric Systems of non-zero field, such as Planet Finder and Submillimeter Probe of the Evolution of Cosmic Structure, could benefit. These systems most likely will contain large, flexible optormechanical structures subject to dynamic disturbance. Furthermore, large systems for high resolution imaging of planets or the sun from space may also benefit. Tactical and Strategic Defense systems will need to image very small targets as well and could benefit from the technology developed here. We discuss a novel speckle imaging technique with the potential to separate dynamic aberrations from static aberrations. Post-processing of a set of image data, using an algorithm based on this technique, should work for all but the lowest light levels and highest frequency dynamic environments. This technique may serve to reduce the complexity of the control system and provide for robust, fault-tolerant, reduced risk operation. For a given object, a short exposure image is 'frozen' on the focal plane in the presence of the environmental disturbance (turbulence, jitter, etc.). A key factor is that this imaging data exhibits frame-to-frame linear shift invariance. Therefore, although the Point Spread Function is varying from frame to frame, the source is fixed; and each short exposure contains object spectrum data out to the diffraction limit of the imaging system. This novel speckle imaging technique uses the Knox-Thompson method. The magnitude of the complex object spectrum is straightforward to determine by well-established approaches. The phase of the complex object spectrum is decomposed into two parts. One is a single-valued function determined by the divergence of the optical phase gradient. The other is a multi-valued function determined by, the circulation of the optical phase gradient-'hidden phase.' Finite difference equations are developed for the phase. The novelty of this approach is captured in the inclusion of this 'hidden phase.' This technique allows the diffraction-limited reconstruction of the object from the ensemble of short exposure frames while simultaneously estimating the phase as a function of time from a set of exposures.
Author
Aberration; Image Resolution; Imaging Techniques; Dynamic Control; Optical Control; Spaceborne Photography; Wave Fronts

20000057333 California Inst. of Tech., Pasadena, CA USA
A Line Survey of Orion-KL from 607 to 725 GHz
Schilke, P.; Benford, D. J.; Hunter, T. R.; Lis, D. C.; Phillips, T. G.; [2000]; In English
Contract(s)/Grant(s): NSF AST-96-15025
Report No.(s): Rept-2000-10; No Copyright; Avail: CASI; A07, Hardcopy

With the Caltech Submillimeter Telescope, we have performed an unbiased line survey of Orion-KL in the frequency range 607-725 GHz. were able to identify lines down to a threshold of 1-2 K in main beam brightness temperature units, and found 1064 spectral features consisting of 2032 lines, partially blended. Apart, from the abundant diatomic rotors such as CO, CS, SO, the spectrum is dominated by CH3OH and SO2, both in terms of numbers of lines and integrated flux. The number of unidentified lines is 155 or 14%. We also report the tentative identification of the new molecule SiH in our data. For some complex organic molecules, we find rotation temperatures and column densities which are much higher than those found in earlier studies. It is likely the cause of this is a significant contribution from a very compact, hot component, of the Orion molecular cloud core which was not visible in lower frequency surveys.
Author
Sky Surveys (Astronomy); Orion Nebula; Interstellar Matter; Molecular Clouds; Spectrum Analysis; Emission Spectra; Radio Spectra; Line Spectra

20000056083 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA USA
The Gossamer Initiative
Chmielewski, Artur B.; Moore, Chris; Howard, Rick; [2000]; In English; Copyright; Avail: Other Sources

The Gossamer Spacecraft Initiative is a new NASA program to begin long-range development of enabling technologies for very large, ultra-lightweight structures and apertures. Large apertures include optical, infrared and submillimeter telescopes, 'photon buckets' for optical communications and 'non-coherent' imaging, solar concentrators, and radio frequency antennas. Developments in the very large ultra-light structures will be forces on one of their most challenging applications-solar sails. The sail structures will include both 3-axis stabilizing and spinning. Gossamer spacecraft technology will eventually allow NASA to undertake bold new missions of discovery, such as searching for the signs of life on planets orbiting nearby stars and sailing through space on beams of light of places beyond our solar system.
Author
Apertures; Infrared Telescopes; Solar Optical Telescope; Solar Instruments; Spacecraft Instruments; Spacecraft Equipment

20000053511 NASA Goddard Space Flight Center, Greenbelt, MD USA

Space Infrared Astronomy in the 21st Century

Mather, John C.; Fisher, Richard, Technical Monitor; [2000]; In English; Space Infrared Astronomy in the 21st Century, 12 Apr. 2000, MD, USA; No Copyright; Avail: Other Sources; Abstract Only

New technology and design approaches have enabled revolutionary improvements in astronomical observations from space. Worldwide plans and dreams include orders of magnitude growth in sensitivity and resolution for all wavelength ranges, and would give the ability to learn our history, from the Big Bang to the conditions for life on Earth. The Next Generation Space Telescope, for example, will be able to see the most distant galaxies as they were being assembled from tiny fragments. It will be 1/4 as massive as the Hubble, with a mirror 3 times as large, cooled to about 30 Kelvin to image infrared radiation. I will discuss plans for NGST and hopes for future large space telescopes, ranging from the Space UV Optical (SUVO) telescope to the Filled Aperture Infrared (FAIR) Telescope, the Space Infrared Interferometric Telescope (SPIRIT), and the Submillimeter Probe of the Evolution of Cosmic Structure (SPECS).

Author

Infrared Astronomy; Technology Assessment; Design Analysis; Sensitivity; Infrared Telescopes

20000048391 Schaeffer Magnetics, Inc., Chatsworth, CA USA

Development of a Cryogenic Nanometer-Class Repeatability Linear Actuator

Nalbandian, Ruben; Hatheway, Alson E.; 34th Aerospace Mechanisms Symposium; May 2000, 131-136; In English; No Copyright; Avail: CASI; A02, Hardcopy

The goal of the Nanometer Resolution Linear Actuator development project was to demonstrate an extremely light weight, very high precision and high stiffness actuator capable of operating uniformly well over the temperature range of 20K to 300K. The development was a joint effort between Alson E. Hatheway, Inc. (AEH) and Moog, Schaeffer Magnetics Division (SMD), for use in spacecraft optical instruments, notably the Next Generation Space Telescope (NGST). This paper describes the design challenge of developing a lightweight, compact (35 mm diameter by 100 mm length), high stiffness, low power, thermally stable linear positioning mechanism. The key to achieving high resolution, low power, and stability is to eliminate the closed-loop control system that is normally applied to overcome non-linearities and hysteresis inherent in some technologies, such as piezoelectric and magnetostrictive transducers. This was accomplished by using AEH's patented elastic Rubicon transducer techniques that are inherently linear and hysteresis free.

Author

Cryogenic Equipment; Cryogenics; Linearity; Actuators; Spacecraft Instruments; Next Generation Space Telescope Project; Spaceborne Telescopes

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Finite Element Modeling of a Semi-Rigid Hybrid Mirror and a Highly Actuated Membrane Mirror as Candidates for the Next Generation Space Telescope

Craig, Larry; Jacobson, Dave; Mosier, Gary; Nein, Max; Page, Timothy; Redding, Dave; Sutherlin, Steve; Wilkerson, Gary; [2000]; In English; International Symposium Astronomical Telescopes and Instrumentation 2000, 27-31 Mar. 2000, Munich, Germany; No Copyright; Avail: Other Sources; Abstract Only

Advanced space telescopes, which will eventually replace the Hubble Space Telescope (HTS), will have apertures of 8 - 20 n. Primary mirrors of these dimensions will have to be foldable to fit into the space launcher. By necessity these mirrors will be extremely light weight and flexible and the historical approaches to mirror designs, where the mirror is made as rigid as possible to maintain figure and to serve as the anchor for the entire telescope, cannot be applied any longer. New design concepts and verifications will depend entirely on analytical methods to predict optical performance. Finite element modeling of the structural and thermal behavior of such mirrors is becoming the tool for advanced space mirror designs. This paper discusses some of the preliminary tasks and study results, which are currently the basis for the design studies of the Next Generation Space Telescope.

Author

Finite Element Method; Mathematical Models; Mirrors; Next Generation Space Telescope Project; Spaceborne Telescopes

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Poster Presentation: Optical Test of NGST Developmental Mirrors

Hadaway, James B.; Geary, Joseph; Reardon, Patrick; Peters, Bruce; Keidel, John; Chavers, Greg; [2000]; In English, 27-31 Mar. 2000, Munich, Germany; No Copyright; Avail: Other Sources; Abstract Only

An Optical Testing System (OTS) has been developed to measure the figure and radius of curvature of NGST developmental mirrors in the vacuum, cryogenic environment of the X-Ray Calibration Facility (XRCF) at Marshall Space Flight Center (MSFC). The OTS consists of a WaveScope Shack-Hartmann sensor from Adaptive Optics Associates as the main instrument, a Point Diffraction Interferometer (PDI), a Point Spread Function (PSF) imager, an alignment system, a Leica Disto Pro distance measurement instrument, and a laser source palette (632.8 nm wavelength) that is fiber-coupled to the sensor instruments. All of the instruments except the laser source palette are located on a single breadboard known as the Wavefront Sensor Pallet (WSP). The WSP is located on top of a 5-DOF motion system located at the center of curvature of the test mirror. Two PC's are used to control the OTS. The error in the figure measurement is dominated by the WaveScope's measurement error. An analysis using the absolute wavefront gradient error of 1/50 wave P-V (at 0.6328 microns) provided by the manufacturer leads to a total surface figure measurement error of approximately 1/100 wave rms. This easily meets the requirement of 1/10 wave P-V. The error in radius of curvature is dominated by the Leica's absolute measurement error of VI.5 mm and the focus setting error of Vi.4 mm, giving an overall error of V2 mm. The OTS is currently being used to test the NGST Mirror System Demonstrators (NMSD's) and the Subscale Beryllium Mirror Demonstrator (SBNM).
Author
Errors; Mirrors; Next Generation Space Telescope Project; Optical Equipment; Test Equipment

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Analysis and Ground Testing for Validation of the Inflatable Sunshield in Space (ISIS) Experiment
Lienard, Sebastien; Johnston, John; Adams, Mike; Stanley, Diane; Alfano, Jean-Pierre; Romanacci, Paolo; [2000]; In English; 41st 41st Structures, Structural Dynamics, and Materials Conference, 3-6 Apr. 2000, Atlanta, GA, USA
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The Next Generation Space Telescope (NGST) design requires a large sunshield to protect the large aperture mirror and instrument module from constant solar exposure at its L2 orbit. The structural dynamics of the sunshield must be modeled in order to predict disturbances to the observatory attitude control system and gauge effects on the line of site jitter. Models of large, non-linear membrane systems are not well understood and have not been successfully demonstrated. To answer questions about sunshield dynamic behavior and demonstrate controlled deployment, the NGST project is flying a Pathfinder experiment, the Inflatable Sunshield in Space (ISIS). This paper discusses in detail the modeling and ground-testing efforts performed at the Goddard Space Flight Center to: validate analytical tools for characterizing the dynamic behavior of the deployed sunshield, qualify the experiment for the Space Shuttle, and verify the functionality of the system. Included in the discussion will be test parameters, test setups, problems encountered, and test results.
Author
Dynamic Structural Analysis; Inflatable Structures; Spaceborne Experiments; Heat Shielding; Next Generation Space Telescope Project

Subject Terms

Corporate Sources

NASA Marshall Space Flight Center

NASA

National Astronomical Observatory

National Optical Astronomy Observatories

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