REPORT FOR:

"Cooperative Program In Space Science"

Cooperative Agreement #NCC 5 - 637

For the base period April 1, 2002 – June 30, 2003

Submitted To:

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From:

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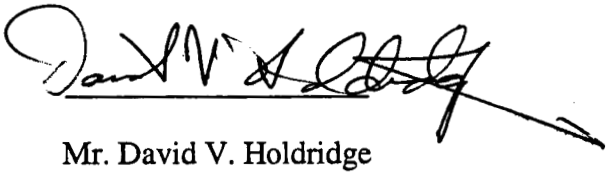
Dr. David Black, PI



Mr. David V. Holdridge
Program Manager

INTRODUCTION:

The Universities Space Research Association received a follow-on award for the Cooperative Agreement #NCC 5 - 637 on April 1, 2002. The mission of this activity, know as the Cooperative Program in Space Sciences (CPSS), is to conduct space science research and leading-edge instrumentation and technology development, enable research by the space sciences communities, and to expedite the effective dissemination of space science research, technology, data, and information to the educational community and the general public.

To fulfill this mission, USRA recruits and maintains a staff of scientific researchers, operates a series of guest investigator facilities, organizes scientific meetings and workshops, and encourages various interactions with students and university faculty members.

This is the final report for the base period of performance for this award, April 1, 2002 – June 30, 2003.

FINANCIAL & OPERATIONS SUMMARY:

The original award amount totaled $ 8,101,964.00. This was increased by $ 3,521,237.00 as the two optional extensions were activated at the end of June 2003, thus bringing the total awarded amount to $11,623,201.00. The actual costs, as of June 30, 2003, were $ $7,628.098.51.

As of June 30, 2003, USRA had 38 Total Direct Staff Members under employment. There were 36 Active Staff Scientists (one on TDY to INTEGRAL Data Center in Geneva, Switzerland), one On-Site Administrator (CGRO/GLAST), and one Research Assistant. Thirty-one of these employees work in Code 660, six in Code 690, and one in Code 680. The staff turnover has been running at a level of 20% over the last 10 years experience in the GSFC Space Sciences Directorate. Over the last year, there were six new hires (one more due to start in July 2003), and three* departures (*we expect two of our scientists to be leaving in August, 2003 to join the NRC and NASA HQ respectively). These individuals arrive from and return to a mixture of Government, university, industry, and foreign organizations. The vast majority of new hires are a result of national recruitments. In this time frame, April 2002 – June 2003, we conducted 5 different recruitment exercises, resulting in four new hires.

178 short-term visitors and 61 consultants were brought in to support the mission of the Space Sciences Directorate through USRA during the base period. USRA scientists led 17 teacher and k-12 student space science education workshops. We conducted a successful recruitment exercise (Space Science Research Opportunities - SSRO) to interest and attract summer students to the GSFC Space Sciences Directorate. Over 104 qualified students applied and ten were placed. USRA scientists and administrative personnel combined to run and support 12 scientific meetings and/or workshops between April 2002 and June 2003.

ACCOMPLISHMENTS:

Scientific Research and Instrument Development:

As an indication of scientific research accomplishments, USRA scientists working under this Cooperative Agreement submitted 83 PI-level research and education proposals during the year. Indicative of the high level of community action, a majority (75) of these submitted proposals were made in conjunction with a university-based collaborator. There were 53 awarded (thus far) – sixteen with observing time only, and nine grants totaling $1,593,091.00 ($1,059,632.00 to USRA). (Fourteen proposals are currently in the Phase I selection process, with three others in Phase II awaiting budget approval). Approximately 96 papers were published; 77% in refereed journals, averaging 2.9 published papers per Ph.D. staff member (papers with multiple USRA co-authors were counted as one). A publication list is attached to this report.

What follows are excerpts from individual technical accomplishment reports of the USRA scientific staff:

LABORATORY FOR HIGH ENERGY ASTROPHYSICS (660)

Detector Technology Development

DR. JOHN KRIZMANIC:

1. OWL: Continue the development of an independent Monte Carlo simulation of the generation of airshowers, atmospheric fluorescence generation of light, atmospheric attenuation, and model of the OWL instrument. The Monte Carlo is sufficiently developed to be used as a tool to understand the mission performance. Working with Pierre Sokolsky, who was on sabbatical at GSFC from the University of Utah, the OWL Monte Carlo was used to generate simulated airshowers and then generate 3-dimensional tracks from the observed portion of the airshowers using the stereo reconstruction technique. These simulated tracks were then superimposed over a variety of actual cloud measurement scenes from the MODIS instrument to determine the efficiency of observing tracks in cloud-free portions of the atmosphere. This has led to the submission of an initial paper to Astroparticle Physics and the analysis is being taken to a more detailed phase with the goal of a second paper submission. In more general terms, the OWL simulation effort and results have been instrumental in demonstrating the physics potential of OWL.

2. Fresnel Lens Gamma Ray Mission: I have been working with physicists (N. Gehrels; NASA/GSFC and Gerry Skinner; CESR, Toulouse, France) to develop the Fresnel Gamma Ray Mission. The Fresnel Gamma Ray Mission was supported through NASA's Revolutionary Aerospace System Concepts (RASC) funding, and I have been responsible for interfacing with the RASC manager supplying reports and presentations detailing the progress. The Fresnel Lens research and development has focused on developing Phase Fresnel Lenses for a ground test at the Marshall X-ray Calibration Facility (MXCF) to demonstrating the high-energy photon imaging potential of these optics. I have been working with a group at the University of Maryland, led by Prof. Reza Ghodssi, to fabricate silicon Phase Fresnel Lenses, for a ground test, using a novel technique known as gray-scale lithography. From the design parameters I provided, the group has fabricated initial test structures that are being employed to develop the process to produce lenses with the appropriate micron-scale structures. I also have been interfacing with the MXCF staff and other physicists to develop the ground-test experiment configuration and arrange for the eventual run.

3. High energy neutrino astrophysics: I have been working in a collaboration with physicists from the University of Arizona and the University of Iowa to develop a detailed Monte Carlo simulation to accurately quantify the ability of space-based experiments to measure upward-moving airshowers from neutrino interactions in the Earth. Specifically, we are investigating tau-flavor interactions as the astrophysical flux of these neutrinos will be significant, given neutrino oscillations, and the specific decay properties of the interaction products will produce a unique signature. With the university physicists providing the flux of tau leptons emerging from the Earth, I have been developing a tau airshower simulation to generate the signal-inducing cascades. This is work in progress, but I have accomplished the task of generating the appropriate tau-decay particles with the appropriate energy distributions based upon the copious branching ratios of the tau decay.

4. Detector Research and Development: Served as a consultant in-house at LHEA for researchers to aid in the development of novel particle detectors and related electronics. In particular, served as an informal on-call scientist to aid in troubleshooting the various detector characterization experiments especially semiconductor detector characterization.

Gamma Ray Large Area Space Telescope / Anti-Coincidence Detector (GLAST/ACD)

DR. ALEXANDER MOISEEV:

1. LAT ACD.

   a) In January 2003 ACD team successfully passed ACD CDR and in May 2003 – LAT CDR where my contribution was ACD Conceptual Design (with David Thompson), ACD Detectors design and tests, ACD Performance Demonstration simulations.

   The main requirement to ACD is to provide 0.9997 efficiency for the detection of charged particles over the entire segmented area (~8 m, 89 segments). It is demonstrated by the simulation which includes the complex geometry and exact performance of every segment (internal notes).

   b) The design of all scintillating tiles (TDA) and fiber ribbons is completed and proven by the final performance tests (internal notes). The TDA's production has started in Fermilab under our supervision and

regular inspections. The experimental setup for the TDA Acceptance test has been developed and tested ("Tomography", internal notes).

c) Several environmental tests have been conducted: TDA thermal, TDA + PMT vibration, TDA + PMT thermal/vacuum. The test results have been analyzed and proved the design (internal notes).

The "PMT Quality Plan and Test Procedure" has been developed. The acceptance test of 240 flight PMT's and data analysis is under way.

d) The beam test at CERN to study the backsplash effect was performed last July. The data analysis was completed; the internal report has been written (with the paper to follow). Obtained results confirm the ACD design and give us more margins in the ACD operation.

2. BESS. Analysis of the data collected in previous BESS flight is being performed mainly in Japan with regular (bi-monthly) discussion on TV-conferences. The number of papers based on these results have been submitted and published.

3. ACCESS.

a) To support the idea of "cubic" design for high-energy calorimeter the 2003 DDF proposal to do the experiment with calorimeter small prototype has been submitted and granted. This idea assumes the design of the prototype based on performed simulations (internal notes) and beam test in 2004.

b) The idea of "cubic" calorimeter was extended to high-energy electrons. The preliminary simulations demonstrated that this experiment can be successful. These materials submitted for this August ICRC in Tokyo.

Gamma Ray Large Area Space Telescope / Space Science Center (GLAST/SSC) and Astronomy Picture of the Day (APOD)

DR. JERRY BONNELL:

- Developed detailed GRB and GRB trigger simulation software for GLAST LAT. The simulations employ an extrapolation of GRB temporal and spectral properties to LAT energies. Simulation results were presented to GLAST SWG February 10, 2003. Defined GLAST LAT alert data transmission packets for GRB alerts. First author of GLAST project internal document detailing LAT GRB alert packet contents. Contributor to GLAST Project LAT-GBM interface control document. Analyze temporal and spectral properties of gamma-ray bursts. Investigate spectral evolution of bursts at GeV (GLAST LAT) energies. Simulate gamma-ray burst observations with the GLAST LAT instrument and analyze LAT burst data when available.
- Member of FITS definition working group for GLAST SSC.
- Produced substantial public outreach material for 2002/2003 APOD web site. Provided science content for E/PO and PR material for GLAST and gamma-ray astronomy. Supported outreach efforts for GLAST and gamma-ray astronomy. Presented projects include the production of gamma-ray astronomy tutorials in comic book form.
- Produced Astronomy Picture of the Day web pages. Maintain NASA/GSFC APOD website content and organization.
- Major contributor to GLAST gamma-ray astronomy tri-fold brochure printed and distributed in September 2003.

INTERNATIONAL GAMMA RAY ASTROPHYSICS LABORATORY GUEST OBSERVATORY FACILITY (INTEGRAL)

DR. GEORG WEIDENSPOINTNER: (TERM. 5/31/03)

A large fraction of my time with USRA was spent on developing a Monte Carlo simulation code that is capable of modeling the instrumental background of gamma-ray instruments for astronomy, particularly of TGRS on board WIND and the SPI spectrometer on board INTEGRAL. Most of this work has been done in close collaboration with Drs. M. Harris (NASA/GSFC and USRA) and C. Ferguson (University of Southampton, UK). This code, named MGGPOD, is capable of simulating prompt as well as delayed background components. Prompt backgrounds include the hadronic and electromagnetic showers initiated by primary cosmic-ray particles and the prompt de-excitation of secondary nuclei produced in nuclear interactions. The delayed backgrounds arise from the radioactive decay of radioisotopes produced within the Instrument and spacecraft materials.

Preliminary results of these modelling efforts have repeatedly been presented at workshops and conferences. The MGGPOD code is now among the best available for this purpose, and arguably the most thoroughly tested. A refereed publication describing MGGPOD and its application to TGRS is in its final stages of preparation and will soon be submitted.

Since the launch of the INTEGRAL observatory on Oct. 17, 2002, my main focus has been to apply MGGPOD to SPI to understand its instrumental background and to exploit this knowledge for background modelling. A first application is the identification of the more than 150 lines and spectral features that can be discerned in the SPI spectrum. This inventory in itself already provides a wealth of information, and will be published in a special A&A edition dedicated to INTEGRAL by the end of this year.

The next step is to study energy ranges of special interest for the analyses of diffuse gamma-ray line emission from the Galaxy, particularly due to the decays of 26Al and 60Fe, and the annihilation of positrons. The latter will be the focus of my future work at the Centre d'Etude des Rayonnements in Toulouse, France, were I expect to spend the next 2 years as an External ESA Fellow.

Advanced Composition Explorer (ACE)
(April – August 2002)

DR. ERIC CHRISTIAN:

I am continuing to do research in support of two cosmic ray balloon instruments. Nightglow is a instrument that measures the ultraviolet glow from the atmosphere in support of a future mission called OWL. I spent one month down in Alice Springs, Australia this year for flight operations. The instrument worked, but the balloon ruptured and it was not a successful flight. I also led an active outreach program for Nightglow, including web journaling, student Q&A, and school presentations in both Australia and the US.

On TIGER, I have been assisting in the repair and refurbishment in preparation for a December 2003 re-flight from Antarctica. I will be traveling to Antarctica for that flight.

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GEORGIA DENOLFO: (August, 2002 – June, 2003)

1. ACE/CRIS SOFT detection efficiencies are understood to within 25% for helium and 12% for lithium. The detection efficiencies have been characterized for all four telescopes of CRIS.

2. The relative isotopic abundances have been determined for Li, Be, B, and C and also for He and comparisons with model predictions are underway.

3. Two TIGER integration trips were made to Washington University in order to contribute to the assembly and testing of both Cherenkov counters. Integration of the entire instrument is now underway.

4. Fifty-three photomultiplier tubes have been characterized for relative gains and quantum efficiencies. In addition, these 53 PMTs have been extensively tested under vacuum conditions in order to assess reliability during balloon-flight. A remaining 30 spare PMTs need to be characterized over the next several months. These spare PMTs are currently being potted for operation under vacuum.

5. Contribute to the TIGER data analysis and guidance of Washington University graduate students. One Washington University graduate student will be receiving his thesis on TIGER results this summer.

6. EP/O & Outreach: volunteer at the "Cosmic & Heliospheric Learning Center" and at the "Ask a High Energy Astronomer" websites, answering questions on astronomy from around the world.

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International Focusing Optics Collaboration for MicroCrab Sensitivity (InFOCμS) and Swift

DR. HANS KRIMM:

1. **Swift BAT Ground Software management and development.** I have taken on the role of leader for BAT Ground Software development. I have primary responsibility for ensuring that all of the BAT science analysis tools for the Swift Science Data Center (SDC) pipeline and for general scientific users are delivered on schedule to the Swift Science Support Center (SSC), and that these tools meet the requirements defined in the BAT Ground Software Requirements Document. I am also responsible for writing, testing, and delivering several of these BAT software tools, a task which required that I learn in detail the specifications of CFITSIO and the High Energy Astrophysics Data Analysis System. I run and set the agenda for weekly meetings attended by an average of six scientists and programmers. In these meetings we discuss general analysis goals and procedures as well as descriptions and requirements of specific software tools and data products. In my role as software manager I directly supervise the work of one programmer who I helped to hire, providing detailed software requirements, answering questions, and checking the performance of the tools she develops. I have the primary responsibility for defining the format of all BAT science data products, making sure that the formats meet HEASARC specifications, and working with the SDC programmers to make sure that the files are being produced in the proper format. I am also working with the SDC programmers to define, develop and test the BAT component of the SDC analysis pipeline. I have produced a large number of documents describing the BAT software, analysis pipeline and data products. I have also been asked to attend a review of the SDC and to serve on the panel reviewing the ground science software for the Ultraviolet/Optical Telescope on Swift. I also report on the status of the BAT ground software at each Swift Science Team meeting.

2. **Swift BAT Flight Science Software verification.** I have been selected by Swift project management to take primary responsibility for science team verification of the BAT flight science software (FSW). This task involves checking the output of flight software test runs against a set of checkpoints, which trace back to the Flight Software Requirements Document. I provide direct and immediate feedback on the science checkpoints to the flight software team at Los Alamos National Laboratory and weekly reports to the full BAT software development team and management. To help streamline this process and provide direct graphical feedback to the FSW team, I have worked with another LHEA scientist to develop a set of automatically generated web pages, which give summaries of BAT data products. These pages have proven so useful to the team that we have agreed to use them as part of the instrument verification after Swift launch. Since I have been so deeply involved with flight software verification I was asked to help organize, attend, and report on a major review of the BAT FSW in December, 2002.

3. **Swift Science Team member.** I participate in weekly meetings to discuss BAT scientific and technical issues. I have run the BAT instrument during numerous instrument calibration shifts, including overnight runs, and performed preliminary data processing and analysis of the calibration results. These runs provide full verification of the instrument and are being used to derive the detailed response of the BAT to hard X-ray photons. I continue to work on plans for the BAT hard X-ray survey. I organized and ran a workshop in July, 2002 to discuss the survey with Swift colleagues from many nations and institutions. During the summer of 2002 I was the primary Goddard contact for a visiting postdoc from Italy, Piotr Banat, who continues to work on developing techniques for fitting and removing the time variable component of the BAT background. I have organized bi-weekly international teleconferences to discuss Piotr's work and that of colleagues in England who have developed a sophisticated simulation of the BAT. I participate in biannual Swift Science Team meetings and in frequent meetings with our colleagues from Los Alamos National Laboratory and Japan. I also serve as the BAT representative at bi-weekly meetings of the Swift Mission Readiness Testing Team. I am a member of five and leader of two of the Swift key science projects.

4. **Development of improvements to InFOCμS.** The proposal to fund InFOCμS for the next three years was successful, so the InFOCμS team has been reassembled and is preparing for a balloon flight in either

the fall of 2003 or spring of 2004. I have started to again run weekly meetings on the status of InFOCμS development and represent the scientific team at meetings with the Goddard Guidance, Navigation and Control (GNC) branch to discuss software for the pointing system. I have helped a GNC programmer adapt my star camera analysis code for the redeveloped system. I work closely with the GNC engineers and with LHEA scientists and engineers to help understand the behavior of the pointing system in the 2001 flight and to determine the most effective ways to correct the problems from that flight. I help to study simulations of proposed pointing systems modifications and help determine the best solutions. I have also been asked several times to show the InFOCμS instrument to laboratory visitors and to present its capabilities and scientific goals to various audiences. This included the July 2002 visit of Presidential Science Advisor John Marburger.

5. **Other scientific research and outreach work.** I presented three Swift papers at international high energy astrophysics meetings, including an invited paper summarizing the Swift mission for scientists interested in making follow-up observations of Swift discoveries. I also gave an invited talk on Swift and GRB research at Hampden-Sydney College. I also keep current on GRB research with an emphasis on how new results impact Swift mission planning.

Micro-well Detectors (GMSD)

DR. PHILIP DEINES-JONES:

1. Demonstrated a micropattern detector with active-matrix readout. This device is the first micropattern detector (and first proportional counter of any sort) directed read out with an active matrix device.

2. Demonstrated the polarization sensitivity of this detector to 4.5 keV x-rays.

An active-matrix readout allows this device to be ~50 times larger than previous micropattern polarimeters, and several times larger than the beam spot of a high throughput, conical foil x-ray mirror. These demonstrations strengthened, and perhaps enabled, the AXP SMEX proposal recently submitted by GSFC.

Numerical Relativity (GravityWave)

Dae-Il (Dale) Choi:

1. "Hahndol" code has been upgraded to incorporate the latest state-of-the-art techniques in numerical relativity and further tested with strong gravitational waves (strong enough to form blakcholes).

2. "AMRMG" code has been tested and validated with both strong gravitational waves solution and blackhole solutions.

3. "Hahndol" code now has a prescription to handle blackhole systems more efficiently and was tested with a single blackhole solutions.

4. Wrote and submitted a paper to a journal, Journal of Computational Physics.

5. Delivered seminars at the scientific meetings.

6. Helped writing a proposal that was accepted.

Laser Interferometer Space Antenna (LISA)

PAUL MCNAMARA:

1. Reached frequency stabilization level of 45Hz/√Hz at 1mHz using cavity stabilization. This measurement corresponds to a length stability measurement of 45fm/√Hz over 1000seconds. This is currently the lowest frequency noise measurement ever made using a room temperature reference cavity over 1000 second timescales. Currently data is being taken which is expected to show a frequency noise level below 30Hz/√Hz at 1mHz.

2. Laser is locked to hyperfine transition of iodine gas. Stability measurements are currently under way.

3. Apparatus has been developed to allow measurements of length stabilities of $45 \times 10^{-15} m/\sqrt{Hz}$ at 1mHz to be made.

4. Design study for interferometric displacement sensor to measure fluctuations in separation of spacecraft (1km) to a resolution of 1nm over hour long timescales has begun.

X-Ray Optics

DR. KAI-WING CHAN:

1. **Development of XRT for the *Astro-E2* mission:**

   a. **Detailed analysis of axial figure errors in the replication process** of individual reflectors (which was determined to be the major error term limiting the angular resolution of the *Astro-E2* telescopes from my work in the previous year), from the measurements of axial curvatures of reflectors, replication mandrels, thermo-forming mandrels, and aluminum substrates. The result is published in an SPIE conference in August 2002. This provides a direction of future research---removal/reduction of the limiting axial curvature in the replication mandrels can lead to improvement towards sub-arc-minute angular resolution of telescope of this type. (through 8/2002). This is followed up by my specification and procurement of a wide-beam (150 mm) optical interferometer for the purpose of efficiently mapping axial profiles up to that dimension. (5/2002-1/2003)

   b. **Plan and analysis of x-ray performance tests** of pre-flight quadrants of telescopes, and of flight telescopes XRT-1 (and XRT-2, the tests of which are coming up in May and June of 2003.) Analysis also demonstrated the dependence on various parameters such as temperature and orientation of the telescope. 24 x-ray tests were carried out and analyzed for the flight quadrants of XRT-1 alone, showing the performance in angular resolutions and their dependences on reflector radii, telescope orientation and azimuthal sectors, and the effect of defocusing due to differential focal lengths. (12/2002-3/2003)

   c. **Integration of the first *Astro-E2* XRT** (in conjunction with Y. Soong; J. Lehan and a few colleagues from Japan also contributed to this first integration, especially in the alignment of optical axes). XRT was shipped to ISAS, Japan for x-ray pencil beam tests and for the installation of the pre-collimator. The overall integration is my primary responsibility. My main contribution is on the analysis and characterization of optical axes and of the focal points of this first XRT. (3/3/2003-3/31/2003). Preliminary result from the x-ray measurement from Japan confirmed the better performance of this first *Astro-E2* XRT: angular resolution of 1.65 arc-minutes overall (better than the 2.0' of Astro-E1), the result would have be even better ~1.3' if not for a manufacturer's error (see (d) below) of the alignment bar; the optical axes are within 0.5 arc-minutes (2 times better aligned than before); focal points are within 0.2' of each other (similar to Astro-E1); the effective area is up 8% overall.

   d. **Analysis of effects of differential focal lengths** (non-focality of XRT quadrants) due to machining errors of the alignment bars (manufacturer's error) and the corrective effect of shimming the primary and secondary telescope housings. The corrective methods, though not perfect, optimize the telescope's performance. (3/2003-ongoing)

2. **Development of segmented foil for future mission:**

   a. Successful proposal to obtain GSFC center-wide Technical Equipment funding for a large format x-ray charge-coupled device ($51K) for mirror characterization; its specification and procurement. (7/2002-4/2003)

   b. Participation in weekly Constellation-X soft x-ray telescope (SXT) development meetings and support (resources) of Constellation-X's reflector replication effort. Future involvement is expected to increase as the relative priority of Constellation-X becomes higher.

3. **Analytical research in cosmic ray astrophysics:**

a. Development/refinement of a hydrodynamic model of interaction of cosmic rays in a stellar wind. Analytical integrals of the steady state solution of a simply model are found. A preliminary result was published in an IAU proceeding.

4. **Education and outreach:**

   a. Participation in GSFC's "Ask a High Energy Astronomer" program.

   b. Participation in USRA's "Speaker Bureau" program.

DR. YANG SOONG:

1) Astro-E2 mirror fabrication is underway at the expected pace
2) New schemes are being developed, showing a potential two-fold angular resolution improvement (from 1 arc-minute to 0.5 arc-minute)
3) Coordinating the work force between USRA (2 scientists), Mentor Technology (2 engineers and 5 technicians), and Goddard (2 scientists, 2 engineers, and 1 technician)
4) Three publications (1 on SPIE, and 2 on Applied Optics)
5) Support given has accelerated the preparation of the research activity (in terms of hardware and process)
6) Consultation on the hiring process (2 technicians through Mentor Technology, Inc., and 2 scientists through USRA) and outreach program through LHEA

DR. JOHN LEHAN:

1. New lower-shrinkage stress epoxy curing protocol for optical replication.
2. More thermally stable replicated Pt foils for ASTRO-E2 mission.
3. Developed a general adhesion scheme applicable to both single and multiplayer replication.
4. New fabrication technique for soft x-ray telescopes in collaboration with Peter Serlemitsos (on-going)
5. New test method for mandrels and foil axial figure (implementation on-going)
6. Diagnosis and repair of telescope test fixture.
7. Permanent release layer for replicated optics (on-going).
8. Conception of non-replicative mirror figuring technique for high resolution grazing incidence optics (to be proposed with Will Zhang in next DDF cycle).
9. Delivery of first two telescopes for ASTRO-E2.

DR. STEPHEN HENDERSON:

1. Vacuum chambers, etc:
   - completed design for mandrel holding and mandrel transport fixtures.
   - holding fixture fabrication initially tried off-site, but contractor failed to meet specs. Second attempt for fabrication underway now in NASA shops in an effort to contain quality issues.
   - transport fixture procurement delayed by NASA procurement freeze.
   - sputter vacuum chamber and replication vacuum chamber designed and submitted to NASA procurement for bid ($0.8 million) – delivery in 2004.
2. Robotic glass cutter:
   - robot project initiated with Swales prior to my arrival in June '02.
   - semi-complete robot delivered by Swales to GSFC late 2002
   - major mechanical errors found in design – software quality also abysmal
   - Swales contract terminated (Dec). Swales work judged unsalvageable

- decide to pursue commercial alternative of purchasing a computerized machining center and customizing this into a similar robot.

3. Researching new materials and processes:
   - discovered several new potential mold release materials to be used for reflector fabrication: CVD boron nitride, PVD TiAlN, and several BN composite materials. The first two of these are undergoing further development at this point in time.
   - discovered special diamond tools used in semiconductor industry to dice chips that is being studied now for application to the glass foils.
   - discovered Hysitron company that does makes ultra-precise scribing machines which are under evaluation now
   - discovered superior (wrt CTE and viscosity) glue for bonding gold to the foils, which will soon be tested. This bonding is a key element in the telescope's final performance. It can also be CTE matched to the structural elements supporting the foils.
   - discovered superior titanium alloy that is now the currently adopted support material for the foils. This titanium 21S improved the CTE match to our glass by a factor of two over the best efforts of the NASA engineers.
   - discovered an even better Be-BeO material to be used as the support material for the foils. Even though technically superior to titanium, more education of key GSFC personnel is needed before it will be adopted.

4. Glass etching R&D:
   - introduced concept of etching glass foils to impart additional strength needed to survive launch stresses.
   - designed procedure for testing this. This was re-designed twice by Code 500 and after many months of delays, the study will soon start using the procedure that I *originally* suggested.
   - discussions with Will have revealed a need and possibility of developing this methodology to actually lower surface roughness.

5. Purchase major equipment:
   - purchased Nikon microscope.
   - purchased three PC's, and two printers, one plotter, and many peripherals.
   - researched buying new furnace, but funding limits have delayed purchase
   - purchased nearly 200 miscellaneous items, including specialized tools and metrology equipmentipherals.

6. Solid modeling design:
   - purchased and installed SolidWorks, to use for general design and professional concept illustrations for proposals.
   - this program also provides the groundwork for the later addition of a mechanical modeling package to study stress and strain in models that awaits available funding.

ROSSI X-ray Timing Explorer Space Operations Center (RXTE-SOC)/GLAST/SSC

DR. ROBIN CORBET:

1. **Programatics** : *RXTE, GLAST, and Swift.*

RXTE is now in its 8th successful year of highly successful operations continuing with a very small staff in the Science Operations Facility. The utility of RXTE's observation program is demonstrated by the fact that in the last proposal round the number of proposals actually **increased** compared to the previous year. The unique ability of RXTE to undertake highly time-constrained observations including Target of Opportunity observations is a major factor in its success and coordinated observations with other major observatories such as Chandra, XMM, and Integral form a large portion of the observations. The observing program is the responsibility of the SOF.

The computing hardware in the RXTE SOF is aging - most of the Sun workstations were bought before launch - and some computer failures have occurred. A transition is now being made to using Apple Macintosh computers running Linux. This decision was based on the factors that: (1) Linux is now very widely used in LHEA, (2) the Apple computers, unlike Intel based machines, use the same byte ordering as Suns which makes porting vastly easier, (3) the Apple machines are significantly cheaper than most Sun workstations. Although the transition has been more tricky than anticipated most of the software has been ported and the required hardware has been purchased. The new

system will process data more quickly and reliability is anticipated to be increased because of the relative youth of the new system.

RXTE produces several sets of data from the same observation, each being a trade-off of quality over speed of production. A popular form of the data products ("pseudo production") is now provided in a form which more closely resembles the final data products (making analysis simpler and faster) without losing any production speed.

GLAST is presently scheduled for launch at the end of 2006. I am participating in the Science Support Center with responsibility for operations done by the SSC including scheduling. Scheduling software is now being evaluated - it is likely that the "TAKO" will be used. TAKO was originally developed for Astro-E and will be used by Swift. (TAKO may also be used for RXTE as it would allow the use of the new hardware which is not possible with the current scheduling software). However, depending on exactly what types of observations GLAST will undertake, it is likely that additional "support" software may be required. This is partly a consequence of GLAST exceptionally large field of view compared to other missions and also the fact that most GLAST time will be spent performing surveys rather than pointed observations. The GLAST MOC has been chosen and will be located at GSFC (operated by Omitron). Discussions with MOC personnel are underway to define SSC/MOC interfaces, operational procedures etc. A key decision that is being worked on is whether we can use the DTS data transfer system that is used for missions such as XMM. (The question to be resolved is whether DTS can be made sufficiently secure that it can be used for operations purposes).

Swift - I continue to maintain and answer questions on my observation simulation software. The amount of effort on this project was at a lower level than in previous years.

2. **Astrophysics.** *Pulsars in the SMC.* This long running monitoring program of the Small Magellanic cloud continues to be extremely productive. (It is hoped that the program can be continued through the lifetime of RXTE). Additional time to continue the program was awarded in XTE AO8. In brief, the aim of this program is to investigate the X-ray pulsars in the SMC which are much more numerous than would be expected simply scaling the number of such systems in the Milky Way by the relative mass of the SMC. My intention is to both discover new systems (which can also, to a certain extent, be done by other satellites) and measure orbital periods through regular monitoring (essentially impossible for Chandra and other relatively inflexible satellites). Several new SMC pulsars have been discovered since my last annual report and and a 7.77s period pulsar (discovered early last year) was found to have a very clear 45 day orbital period. This source has been detected in outburst nine times, each detection was completely consistent with the 45 day orbital period. From previous observations a number of candidate orbital periods for other SMC systems have been found but this is the best measurement to date (partly because the orbital period is relatively short). This definite orbital period measurement is thus extremely encouraging that we will be able to conclusively determine other orbital periods with continued monitoring. (Orbital periods are fundamental properties of these systems and will be invaluable for e.g. investigating the evolution of the SMC binaries as part of the determination of why these systems are so numerous). The spin and orbital periods of the 7.77s pulsar are also completely consistent with the correlation between orbital and spin periods exhibited for Galactic Be star systems (marked with "B" in the figure, "R" = Roche-love overflow powered sources, and "W" = sources accreting from a wind). This consistency with Galactic systems suggests that, in spite of chemical abundance differences, the system properties such as mass loss rates and neutron star magnetic fields are actually similar between the Milky Way and the SMC.

In addition to collaborators in LHEA (F. Marshall & C. Markwardt) I am also working with Dr. Malcolm Coe's group at Southampton on the SMC project. Silas Laycock used this SMC data to form the bulk of his PhD thesis at which he successfully defended at the end of 2002. (Laycock is now working with J. Grindlay at CfA). William Edge, another Southampton PhD student has also visited me to continue this work.

3. **Astrophysics.** *Hunting the Period in GX13+1.* GX13+1 is a well-known low mass X-ray binary. Observations with the RXTE's All Sky Monitor during the first year of RXTE operations showed a possible period of ~24 days which I published in an IAU circular. It was expected that additional ASM observations would clearly demonstrate whether this period was real or not. Instead the additional data appeared to be, at best, ambiguous (e.g. Bandyopadhyay et al. 2002) suggesting this was not a real period. However, by using a new "optimal" filtering technique I developed for the analysis of the ASM data from this source I find that this 24 day period does indeed appear to be real (Corbet 2003 - Ap.J. submitted). In addition, the period has very different modulation properties at different energies. The period is apparently the orbital period of the system and is rather longer than most other known orbital periods for LMXBs. The physical cause of the modulation is still unclear and may be different from the causes of modulation in other LMXBs. RXTE Proportional Counter observations covering several 24 day cycles were obtained earlier and will be investigated to see if they help to unravel this mystery. The figure shows power

spectra of the ASM light curve of GX13+1 obtained in five different ways. (a) Unweighted power spectrum of daily average light curve; (b) Weighted power spectrum of daily average light curve; (c) Unweighted power spectrum of daily average light curve with data filtered to exclude points with large error bars (i.e. "optimal screening"); (d) Weighted power spectrum of individual dwell data; (e) Unweighted power spectrum of individual dwell data.

ROSSI X-Ray Timing Explorer Guest Observer Facility (RXTE-GOF) & SWIFT Science Center

DR. ALAN SMALE: (4/1/02 - 3/22/03)

1. Manager of the RXTE GOF

   a) Organized the RXTE Guest Observer Program; prepared the Cycle 7 Announcements and Appendices for NASA HQ; organized the RXTE Cycle 7 Peer Review (2001 Nov 11-13); sorted proposals, verified proposal contents, assigned numbers to proposals, divided proposals and reviewers into panels, performed technical feasibilities, assigned primary and secondary reviewers, led the logistical effort for the Review itself, and taken overall charge of the conduct of the Review;

   b) Implemented fully-electronic proposal submission and processing for Cycle 7. Electronic submission of the cover forms was achieved via RPS, with scientific justification texts submitted electronically in PostScript format. Proposers no longer had to supply 15 printed copies of each proposal.) This innovation -- along with the enforced deadline delay and compressed schedule due to the 9/11 events -- made this a particularly challenging Cycle;

   c) Oversaw the release to the community (in February) of enhanced background estimation tools, accounting for the loss of the propane window in PCU0. (I did quite a bit of testing and verification myself for this.)

   d) Continued to populate the RXTE Archive with improved Standard Products (cleaned spectra and light curves from the PCA and HEXTE, selected and background-subtracted using the best calibrations). We have now completed products from the start of the mission through to the end of Cycle 4, handily passing the half-way mark;

   e) Led data troubleshooting and community notification during a loss of (RXTE) attitude control in November 2001;

   f) Performed continuing work on archive issues, calibration, and community support. I participate on an equal footing with the other GOF members in staffing the Email hotseat, writing recipes, and testing software.

2. Manager of the Swift Science Center

   My work on the Swift ground systems now consumes half of my programmatic time, as anticipated. I now lead a five-person team (self, Padi, Mike Tripicco, Sue Valett, Bob Wiegand) and I chair team meetings every two weeks to review progress. My Swift efforts include the following:

   a) Continued to define the role of the Swift Science Center, and design data analysis software for the UVOT instrument;

   b) Authored the SSC Requirements Document, the Swift Data Center-Swift Science Center Interface Control Document, documents covering UVOT software detailed design and UVOT FITS file formats, and the SSC development schedule and test plan;

   c) Presented the SSC plan at the Swift Ground Systems Critical Design Review in November 2001;

   d) Delved into SAS code written for the XMM/OM in search of templates, algorithms and approaches that could be followed in Swift UVOT software. Analyzed OM data, assessed image processing packages;

   e) Helped drive the development of the HEADAS -- a new next-generation modular FTOOLS structure and philosophy, more 'friendly' to missions like Swift with distributed software development;

   f) Led the Build 0 (proof-of-concept, Sep 2001) and Build 1 (Mar-Apr 2002) releases of UVOT software, and integration of instrument team software deliveries (from the Italian team) into the HEADAS system;

   g) Participated in biweekly telecons with other Ground System team members, and occasional telecons with instrument teams members and other Swift players.

3. Science research

a) Observed the low mass X-ray binary X1254-690 with RXTE in 2001 May and December, and performed detailed modeling of the spectra during dips. I find that in the deep dipping that occurs in the May observation, the blackbody component is totally absorbed while a small fraction of Comptonized emission remains. Dip spectra are well-fit using a progressive covering approach in which the point-like blackbody emitter is instantaneously covered, while the extended Comptonized emission associated with the accretion disk corona is progressively overlapped by the absorber, with the covering fraction rising to 94% in the deepest portion of the dip. This is work done with Mike and Monika Church (U. Leicester, England); I'll be lead-authoring this paper. Dipping did not occur during the December observation, but remarkably, both bursting and flaring were observed contemporaneously. This will be the subject of a future paper, probably to be led by Monika.

b) Analyzed extensive RXTE data from LMC X-2 obtained in 1997 Dec, 2001 Feb, Aug-Sep and Dec, and 2002 Feb, following up on an original investigation by Smale & Kuulkers (2000; paper [71] in my attached resume). The full dataset indicates that LMC X-2 may be a Z-source spending most of its time in the Flaring Branch with excursions onto the Normal Branch, behavior reminiscent of the Z-sources GX17+2 and GX 349+2. This would make LMC X-2 the eighth Z-source known and the first outside our Galaxy. I presented these results at the AAS in Washington DC in Jan 2002, and a paper is in progress.

c) Co-authored (with Padi Boyd) a press release for the Pasadena AAS meeting entitled "Method uncovered in madness of black hole and neutron star eruptions" based on the poster "Disk Disruptions and X-ray Intensity Excursions in Cyg X-2, LMC X-3 and Cyg X-3" by Boyd and Smale. The release was widely referred to in spacey places like spaceflightnow.com, Spacelink, space.com, NASA Quest etc, but did not, alas, make the front page of the New York Times. A paper is now close to submission.

d) Conducted two surveys of all existing archival RXTE data from LMXBs, searching for (a) hard (i.e. high-energy) emission tails in bursters, and (b) bright radius-expansion bursts. Tails were discovered in two or three bursters, though I doubt that's interesting enough to make a serious paper out of. No previously unknown radius-expansion bursts were found lurking in the archive.

e) Continued to analyze incoming data for a long-term monitoring and eclipse-timing program on X1658-298 -- the paper will probably be lead-authored by Mike Wolff from NRL, since I'd rather concentrate on the projects above.

f) Continued to be involved at the co-I level with many other science projects, providing contributions for papers, comments on drafts, RXTE expertise, etc.

4. Public Outreach

While not conducted during work hours, I continue to work on community outreach through the AstroCappella project that I co-lead with Padi Boyd. Our full-length music CD and CD-ROM, "AstroCappella 2.0" was released in September 2001, with 13 original, astronomically-correct songs and CD-ROM materials including curriculum notes, lesson plans and activities for each song, movies, slide shows, etc. We continue to give concerts with our a cappella group, The Chromatics, including shows last November at the Air and Space Museum and the Maryland Science Center, and more recently at the Montgomery County Planetarium.

"AstroCappella 2.0" has been featured by Sky & Telescope, Astronomy Today, and the Baltimore Sun and is available via the Astronomical Society of the Pacific Educational Products catalog (hardcopy and online). We've sung AstroCappella songs live on the radio for "Damian's Diner" on WRNR. In March 2002 our song about the Sun was featured on NASA Connect's show "Having a Solar Blast" and our Swift song was played on the nationally-broadcast PBS show "What's In the News?" One of the songs I wrote for "AstroCappella 2.0" (A Little Bit of Rock, about comets, meteors and asteroids) was a finalist for a CARA (Contemporary A Cappella Recording Award) in the 'Music for Kids' category. More shameless promotion for the AstroCappella project can be found at www.astrocappella.com.

High Energy Astrophysics Science Archive Research Center (HEASARC)

DR. MICHAEL CORCORAN:

1. Scientific Research

Published 6 papers in refereed journals this FY. Had 1 Chandra proposal accepted (PI), 2 XMM proposal accepted (PI) and one RXTE proposal accepted (PI). Supervised postdocs Aaron Flores (CONACYT) in analysis of XMM HD 5980 imaging data and Kenji Hamaguchi (Kyoto) in studies of X-ray emission from Herbig AeBe stars. Continued monitoring and analysis of RXTE observations of Eta Car and e-mail periodic reports to community, and support the Eta Car observing campaign website (http://lheawww.gsfc.nasa.gov/users/corcoran/eta_car/2003.5/) Organize and coordinate the XMEGA group and website and coordinated analysis of XMEGA observations of NGC 3603 (Chandra) and NGC 346 (XMM). I was also the PI on a successful Chandra "Large Project" to obtain five 100 ksec HETG observations of Eta Car (500 ksec total observing time) during the X-ray eclipse in July 2003. Also served on the organizing committee for the "Eta Car: Reading the Legend" meeting, Crystal Mountain, WA, July 2003. One of the international coordinators for the upcoming observing campaign for the Eta Car eclipse, one of the largest astronomical observing campaigns ever planned

2. HEASARC Picture of the Week

Authored 52 HEASARC picture of the week pages

3. LHEA Seminars

Scheduled 21 Tuesday and special seminars before turning over scheduling duties to Robin Corbet

4. HETE2 Archive

Developed first FITS-formatted data products for the HETE-2 archive, GRB multi-color lightcurves

5. GLAST Archive

Reviewed interface requirement documents; discussed GLAST archive requirements with GLAST team members. Began design of the GLAST archive, and development of a Memorandum of Understanding (MOU) between the HEASARC and the GLAST SSC.

6. Oversight of the ROSAT data and results archives at GSFC and associated HEASARC public access databases

Supervised Ms. Si Tran (a Parkdale High School student) in creation of links of ROSAT data to published ROSAT papers.

7. . Oversight of the HEASARC CALDB.

1. Planned significant update to CALDB to incorporate additions needed by Chandra. Also started implementation of SWIFT and GLAST CALDB.

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DR. STEPHEN DRAKE:

1. In the last full calendar year of 2002, we added or substantially modified 35 catalogs or database tables to our BROWSE database systems, compared to an average of about 45 tables per year in the five previous calendar years. In the first 4 months of 2003, an additional 5 catalogs were added or substantially modified. We have also continued to `automate' a number of these tables (6 in CY2001), such that cron jobs check ascii or html tables on web pages at remote sites, and then update their Browse implementations if the latter have changed.

My part in this activity involves (i) working closely with the database technical person who actually runs the software to ingest these catalogs and to convert them into a browsable database, and, perhaps most importantly, (ii) ensuring that these new databases are accurate representations of the original catalogs and that the help documentation accurately describes the HEASARC's online versions of these database tables. These latter activities can be very labor-intensive but are essential in order that the integrity of the original catalogs not be compromised. Indeed, in a number of cases, as a result of this verification, errors in the original tables have been found.

Given that we now offer access to all CDS Vizier tables via our Web BROWSE system, I concentrated in 2002 (as in 2001) on adding X-ray tables and general tables of wide interest, and on updating a number of our older tables which were either out-of-date or poorly structured or documented. A list of the tables created and updated in 2003 is available at:

http://heasarc.gsfc.nasa.gov/docs/heasarc/databases/databases.html

while a similar list for 2002 is available at:

http://heasarc.gsfc.nasa.gov/docs/heasarc/databases/databases_2002.html

2. The HEASARC's On-Line Service comprises its website, including the Browse utility for browsing our databases and catalogs on the web, as well as the `traditional' xray account XOBSERVER/BROWSE service, and our Anonymous ftp server. My major OLS role is to help ensure the integrity of the data and software that is accessible to the user community, including working with the other HEASARC scientists in coordinating and improving the appearance and functionalities of the HEASARC Website. As part of this latter role, I continued to chair a series of fortnightly meetings on the HEASARC Website and BROWSE utility which address both stylistic enhancements and improvements in their capabilities. These meetings have proven very useful, I believe, in helping us plan, prioritize, and allocate resources for the development of our Website and software.

I have continued to act as `Mr. Answer Man' to the steady trickle (a few per week) of messages that are sent to the main HEASARC helpdesk, making sure that all valid messages are answered appropriately and in a timely fashion, or forwarded to the correct Help Desk if misdirected. I also surprisingly often have received good comments and questions from LHEA scientists, particularly Rich Mushotzky, Zaven Arzoumanian and Ilana Harrus, which I have either taken care of myself or forwarded to the more appropriate people, e.g., the HEASARC Browse team.

I continued to monitor the ftp and web activity on the HEASARC site., and the size and growth of the physical archive. Both continued to grow at a strong pace in 2002, and the relevant statistics can be viewed at:

http://heasarc.gsfc.nasa.gov/docs/heasarc/display/sld012.htm

Note that over a 5-year period the amount of data transferred by ftp has increased by a factor of 4, and the amount of web pages, data and software transferred by http has increased by a factor of 7. By early 2003, the amount of data in the HEASARC's ftp area had grown to almost 3 Terabytes, with RXTE having the largest amount (over 1 TB).

I have continued to personally maintain a number of Web pages on the HEASARC site in order to help people in the high-energy astronomy community keep abreast of important new occurrences in the field:

http://heasarc.gsfc.nasa.gov/docs/heasarc/headates/headates.html contains information on `High Energy Astrophysics Deadlines & Events' such as Upcoming Proposal Deadlines, Previous AOs or NRAs for which Lists of the Accepted Targets or Proposals are now Available, Other Significant Events for High-Energy Astronomy in the Future, and Deadlines/Events in the Recent Past,

http://heasarc.gsfc.nasa.gov/docs/heasarc/meetings.html contains information on `Upcoming Meetings of Potential Interest to X-ray and Gamma-ray Astronomers' such as High Energy Astrophysics meetings, Other Selected Astronomy, Physics and Space Science meetings, and Selected Astronomy-related WWW, Computing, and Information Services Meetings,

http://heasarc.gsfc.nasa.gov/docs/heasarc/databases/databases.html contains information on `New, Updated and/or Revised HEASARC Databases

http://heasarc.gsfc.nasa.gov/docs/heasarc/databases/new-catalogs.html contains a list of possible new catalogs that being considered as candidates to be ingested into the HEASARC Browse system.

http://heasarc.gsfc.nasa.gov/docs/heasarc/headates/heahistory.html and associated pages contain a chronology of mostly high-energy astronomy and related space missions, which is particularly focused on the post-Sputnik era. This material was extensively revised and expanded in 2002 and early 2003, and now covers from 239 BC (the first recorded appearance of Halleys' Comet: hey, comets are X-ray sources!) to April 29, 2003 (the reentry over the Pacific of the BeppoSAX satellite).

http://heasarc.gsfc.nasa.gov/docs/heasarc/heasites/heasites.html contains a list of organizational websites that specialize in high-energy astronomy.

I have also worked with Karen Smale in continuing our publication of timely alerts of breaking news that should be of interest to HEASARC users, by means of a "What's New?" box prominently displayed on the HEASARC home page, as well as a dedicated page (http://heasarc.gsfc.nasa.gov/docs/heasarc/databases/whatsnew.html) which we strive to update on a regular basis, aiming to add at least one new item every week: e.g., we have 6 items for April 2003 currently listed.

3. Some miscellaneous activities, in no particular order:

I. I attended the High Energy Astrophysics Data Center Co-ordination meeting that was held in Cambridge, Mass., on November 13, 2002.

II. I attended the American Astronomical Society meeting in Seattle that was held from January 6 – 9, 2003, and gave a contributed oral presentation on the X-ray and radio emission properties of Magnetic Early-Type Stars; I also helped to staff the HEASARC Display Booth.

III. I attended the HEASARC Users' Group meeting that was held on February 14, 2003.

IV. I continued to assist Tom McGlynn as a Co-I of his AISRP-funded Class-X proposal.

4. My high-energy astronomy research continues to focus on the X-ray emission and spectra of non-degenerate stars, such as late-type stars with coronae and early-type stars with strong magnetic fields. I have also continued doing a small amount of radio astronomy research, primarily in support of parallel high-energy observations (radio data provide valuable information on magnetic field strengths and the non-thermal particle populations, whereas X-ray data constrain the thermal particles and their properties).

The only `new' dataset that I analyzed was a 36 kilosecond XMM-Newton AO-1 observation of the nearby inactive K giant Beta Hydri that took place in March 2002. This star was several times weaker than in ROSAT, and thus the accumulated XMM spectrum is too underexposed to do more than a coarse analysis. I speculate that this variability may be due to an activity cycle phenomenon similar to that known for the Sun and many other solar-age main sequence stars in the solar neighborhood, but other instrumental possibilities are still being explored. A single-component VMEKAL plasma model in which the N, O, Ne, Mg and Fe abundances are allowed to vary fits the observed spectrum well (reduced chi-squared of 1.13 for 85 dof) and implies a temperature of 2.5 MK and coronal abundances that are about half the solar photospheric value. There is no evidence for either a solar-like FIP-effect (elements with low First Ionization Potentials being overabundant) or an active star-like anti-FIP effect (high FIP elements like Ne being overabundant).

The analysis of my Chandra AO-3 observation of HD 155555 which occurred in July 2002 is continuing, and a poster on this observation will be presented at the IAU in Sydney, Australia in the summer of 2003 by Marc Audard, one of my collaborators.

I obtained a small amount of VLA time in 2002, in which I observed a number of magnetic early-type stars, including 56 Tau (for which I wrote an XMM AO3 proposal in April 2003, as it is both radio-bright and X-ray bright for this type of object), and the prototypical star Alpha(2) CVn.

5. The EUVE Archive is now essentially complete so that I devoted only a very small fraction of my time to this activity. We did add another EUVE table (the 2nd EUVE Right Angle Program catalog) to our Browse set of EUVE tables in 2002.

LORELLA ANGELINI:

SWIFT : Swift is a new mission dedicated to the study of the GRBs and their afterglows and will be launched in December 2003. The HEASARC is the designated US archive for Swift and also it provides the following other services : software development environment, software distribution, and the Web server. I lead within the HEASARC this activity which I documented via a memorandum of understanding with the project and technical agreements with Swift groups that interface with the HEASARC. Last year the following has been achieved:

a) Contrary to other missions, Swift will populate the archive from the first day of the mission and the data are made available to the users on shorter time scale. Copy of the archive is also sent to the Italian and UK data centers. For these reasons the archive procedure has been completely automated by using 3 different protocols : DTS, DAS, and DBSI. The first protocol originally taken from XMM is used to transfer data from the processing site (SDC) to the archives, the second ingests the data in the physical archive and the last populates the database system with Swift tables. DAS and DBSI system were completely developed by HEASARC and DTS was modified by the HEASARC to cope with the Swift needs. I have designed the overall archiving procedure and protocols and supervising their implementation (Micah Johnson). The strategy is describing in document available at the http://heasarc.gsfc.nasa.gov/dts/ together with the software and test scripts and test data beds. The same archive procedure (and software) has been adopted by the Italian data center. The UK currently uses DTS and partially the other two protocols. I lead the testing of the protocols by organizing test run with the participation of the SDC , the Italian archive and UK archive (June, September 2002 and April 2003). These tests were precursors of the 'official' Swift data flow test that will occur within this summer and fall.

b) I have promoted and supervised the first Swift test software distribution (made available in April 2003 to the

Swift team) to ensure that the software could be transparently installed within the current HEAsoft distribution. The Swift software is developed by three different teams using the HEASARC software environment, delivered to the Swift Science Center and distributed by HEASARC.

c) Promote within the HEASARC database system new capabilities to facilitate the search and retrieval of the Swift data. Most of the Swift databases are by design related via key parameters that facilitates the navigation of the different tables. I have been working with the HEASARC Browse developing team (McGlynn & Williams) to develop these new capabilities and to create a new access page dedicated to Swift.

d) I have been working on a prototype web service to ingest data obtained by the Swift follow-up team with ground base telescopes http://heasarc.gsfc.nasa.gov/dts/swtmp/

e) I have planned together with the system manager the overall hardware organization for the Swift physical archive.

f) I have written two additional documents. The first is on the "Observation definition" adopted by Swift and used to divide the data into the archive (status: signed). The second is an interface document for the delivery of the UVOT survey to the archive (status: completed and reviewed the first draft).

g) I am closely collaborating with the Italian data center for the developing of the Swift XRT software, the FITS file format of their calibration data and the FITS format of their telemetry data.

h) I have been discussing OGIP FITS standard for the UVOT and BAT instruments with the SSC and BAT team which have the responsibilities for the UVOT and BAT software development.

2. XRONOS and XIMAGE

Ximage (4.1) and Xronos (5.19) were released with the 5.2 HEAsoft package in June 2002.

The next released of XIMAGE will contain several changes related to the new FITS approved standards for coordinates system. Specifically the AST library available from Starlink was included in the software. This required radical changes in some part of the code. With this new library in place, XIMAGE is currently capable of reading and mapping images in most of the coordinates systems supported in the FITS standards. It also maintains memory of the coordinates when plotting several overlay images and does not longer use randomization when rotating the images. New commands were implemented ('curve' to plot curveline when projecting large part of the sky, 'moperation' to make operation on images, and commands to create a temporary array) and other modified (insert a FITS output in detect, include more options in the 'write' and 'contour' command). For XRONOS there have been only bug fixes. Micah Johnson is working with me on both projects. I have been answering the help line for both software packages (on average 2 questions per week)

3. Last year research activities focus on the following topics:

(a) *Anomalous X-ray Pulsars: Are the AXP Magnetar ?* In collaboration with the G. Israel and L. Stella (Observatory of Rome) and others we are studying the nature of these objects, AXP, via infrared optical and X-ray observations. These objects have similarities with the Gamma Ray Repeaters and theories predict that both classes of sources are isolated pulsars with super-strong magnetic fields, from which the name magnetar. In past year we have published two papers on the variability observed in the infrared emission and on the possible detection of absorption line in the X-ray spectrum obtained with BeppoSAX that could be interpreted as signature of high magnetic fields (e.g. further evidence of the magnetar scenario).

b) *Jets from 4U1755-33.* I have analyzed (in collaboration with N. White) the XMM data of the LMXRB system 4U1755-33 in quiescence and discovered the presence of outflows that we interpreted as X-ray jets, fossil signature of the accretion activities of the source when was active. This is the second low mass X-ray binary for which jets have been detected in X-ray. The presence of the jets strengthens the identification of 4U1755-33 as black hole.

(c) *Spectroscopy of the accretion disk corona (ADC): 2S 0921-63.* I have collaborating with T. Kallman in the analysis of Chandra and XMM data of the LMXRB 2S0921-63 and in the interpretation of the results. The study of ADC sources is important to constrain the properties of the accretion disk and the nature of LMXRB in general. The spectrum of this object shows many lines as expected from an ADC that however imply a low gas density. This in turn constrains the intrinsic luminosity of the neutron star to be comparable to what we observed. Therefore obscuration is not a significant effect in this system, contrary to what have been invoked to explain variation of line

emissions in another ADC system, e.g. 4U1822-371.

(d) *GRBCAT: a catalog of all pre-Swift Gamma Ray Bursts* With the imminent launch of Swift, the first Gamma-ray/X-ray mission dedicated to the study of the GRBs and their afterglows, the time seems right to create a comprehensive catalog of GRBs prior Swift. In collaboration with Neil Gehrels , Barbara Mattson, and Kevin Hurley I have been working for the creation of GRBCAT. GRBCAT is a compilation of all GRBs (since their discovery) obtained mainly from papers already published in refereed journals, unpublished papers, and PhD thesis that include lists of GRBs. Most of the information for GRBCAT were not available in electronic form and were manually created in computer form. GRB lists were also derived from the GRBs databases already present in the HEASARC database system. The beta version of the catalog is available at the Web address: http://grbcat.gsfc.nasa.gov/grbcat/grbcat.html and currently includes all bursts detected before BeppoSAX.

4. BeppoSAX archive and user support:

The BeppoSAX operations ended on the 30 April 2002 with the final reentry on the 29 April 2003. Last year I have continued the ingest of the BeppoSAX Narrow Field Instruments data (arriving on CD media) in the HEASARC archive. These data include replacements of data sets re-processed with the latest software and several new data sets that became public. The BeppoSAX NFI archive at HEASARC includes now 95% of the public BeppoSAX archive. I have ingested also the final observation log for the NFI and the WFC instrument in the HEASARC database system, updated the BeppoSAX Web sites (http://heasarc.gsfc.nasa.gov/docs/sax/saxgof.html) with the latest news on the mission, the archive and the data analysis. I have been acting as user support by answering questions via the BeppoSAX help-line at HEASARC.

With the cessation of the operations, the BeppoSAX data center in Rome has planned an homogenous reprocessing of all data that will be transferred to the HEASARC. Currently the HEASARC archive does not include the WFC data. HEASARC and the ASI Science data center (ASDC), responsible in Italy for the BSAX archive, have signed (Feb 2003) a memorandum of understanding for the final delivery of the NFI re-processed data, the first delivery of the WFC raw data and their products. Data will be transferred via DTS (electronically) rather than via CDs. As result of this agreement I have received currently 40 Gbyte of the raw WFC data that soon will be put on-line at HEASARC. It is foreseen that this activity will last at least one more year.

5. Restoration of the EXOSAT data and other related activities:

The EXOSAT ME data is the last data set of the old missions to be reformatted in FITS. This project had in the past only marginal progress due to personnel turn over. A new programmer (Chris Baluta) started in September 2002 and the reprocessing of the data should begin in June 2003. I had designed the overall process and the FITS file structure. I have been closely supervising the implementation to timely intervene when problems erased. The time estimate for project completion is 5 months, however I am currently seeking for more computer resources to speed up the process.

The software packages for EXOSAT OSO-8 and HEAO-1 were released with HEAsoft 5.2 9 (June 2002). Before the release I have created test beds and test scripts to facilitate the software verification on the different platforms and for future releases.

6. Miscellaneous

- I maintain (specifically update information and fixing problems as obsolete links) the web pages associated to the old missions and general observatories description available from http://heasarc.gsfc.nasa.gov/docs/corp/observatories.html and the web site for WGACAT and GRBCAT http://wgacat.gsfc.nasa.gov/wgacat/wgacat.html http://grbcat.gsfc.nasa.gov/grbcat/grbcat.html
- I updated the table of GRBs detected via the IPN (one ingest every 2 months) maintained by Kevin Hurley .
- I have been answering user questions coming to the WGACAT the help line for (20 queries last year) and helping the ClassX project (McGlynn PI) by answering questions related to the parameters derivation and source classification in WGACAT. ClassX uses WGACAT to test the classification procedure.

Advanced Satellite for Astrophysics and Cosmology Guest Observer Facility (ASCA-GOF)

DR. KOJI MUKAI:

1. I have spent 3 months at Columbia University (mid Aug-mid Nov 2002). During this sabbatical, and soon thereafter, I have submitted 3 papers in refereed journal as the lead author, and several more are in preparation. I have also initiated several new research projects.

2. Dr. Dotani at ISAS, Dr. Yaqoob at JHU, and I have mostly completed ASCA SIS final calibration. Some implementation issues remain as of April 2003. With the GIS team and Dr. Gotthelf of Columbia University, we are developing the final reprocessing plan.

3. I am in the process of updating the Astro-E2 PDMP, coordinating with Dr. Ueda (ISAS) on software development and testing, and working with Dr. Yamasaki (ISAS) on observation database and mission planning issues.

4. Ask a High Energy Astronomer service continues to receive about 150 questions per month; I have coordinated the team of hotseaters, and updated the archive to reduce overload of questions.

5. I have released PIMMS v3.3 with additional capabilities and with updated Chandra and XMM-Newton effective areas, and discussing plans to include GLAST and Swift.

X-Ray Multi-Mirror Mission-Newton Guest Observer Facility (XMM-Newton-GOF)

DR. ILANA HARRUS:

1) For the XMM-Newton GOF, we help users analyze their data (both by e-mail and during GO site visits). Help organize (create the website, registration page, help with the logistic) and run SAS workshop in September 2003, also test programs coming from ESTEC (SAS). Update edition of the XMM-Newton ABC guide of analysis. Participate in the user working group meeting. Assisted GOs during the proposal writing, data analysis and submission process of proposals. Use the biweekly teleconferences of the OM calibration group to gather information for the US user community. Interact with local scientists from Swift to help them with the UVOT (Similar instrument than the OM).

2) Involvement in the EPO effort in the Lab. Answer questions from the public (about 170 questions from May 02 to May 03). Part of the team working on the "Your cosmic connection to the elements" poster, contributed to the "Extreme Universe II" CD, and to the APOD project. Ongoing participation in the "Imagine the Universe" project. Participate in the NASA OSS Education Product Review. Gave talk to teachers at the Science Center in Baltimore (Oct 17). Collaborate closely with the group at Sonoma State University for an XMM-Newton poster and for activities on supernova remnants using spectroscopy. Investigate possible collaboration with "Take-off.com".

3) Presented results at meetings (IAU 214 August 2002; AAS January 2003). Paper submitted to ApJ as first author (working on the referee report). Submitted proposals for Chandra AO5 and XMM-Newton AO3 (results pending). Co-I on several successful proposals (Chandra (AO4) and HST) Invited to give talks (colloquium at Manitoba University (postponed), seminar at Tel-Aviv university). Referee article for ApJ. Asked to be an observer to the AAS EC meeting. Asked to run for EC of the Forum on History of Physics (lost the elections). Served as a referee for the GSFC Space Achievement Awards.

4) HEAD press officer: Member of the EC of the HEAD. Participate to all EC meetings (give presentation at all the meetings). Write and edit articles for the AAS and HEAD newsletters on current events, HEAD in the news, any items pertaining to HEAD business. Responsible for all press activities at the HEAD meeting (Mt Tremblant, March 2003). The work consisted in A) writing media alert for science journalists, B) selecting the news worthy abstracts among about 300 submitted, C) organizing the press conferences and press releases by contacting the scientists and securing their participation, D) presenting the press conferences at the meeting, E) staffing the press room daily, F) organizing a "virtual" press room to allow journalists to follow PC remotely. Responsible for the complete organization of the Schramm award (award for science journalists) from the advertisement, organization of the selection committee, distribution of the material and selection of the winner(s). Start lobbying efforts to get a "Chandra" stamp approved by the postal office (got the backing of the AAS on that project).

5) The X-ray Astronomy School is a USRA/GSFC/CXC collaboration. Last year school at Coolfont (W Va) was a smashing success. Co-Organizer of the school (with Keith Arnaud and Sandy Barnes). Responsible for all the logistics. Write the final report submitted to Nick White and Rob Petre for review. In charge of the website

(schedule and lectures on the net). Compile the results of the after-school survey. The school is also going on this year (Wallops Island – May 12-16).

6) Part of the Astro-E2 group. For the EPO group: involved in the realization of the video about the story of Astro-E2. In charge of the organization of the competition student program. Attend SWG meeting at GSFC (input on SNRs).

7) Help desk of ASCA. Answering exclusively questions about a program I wrote during my first year at GSFC and which is used to mosaic separate observations.

DR. STEVEN SNOWDEN:

1. The *XMM-Newton* GOF continues to function quite well. Support activities over the last year have included the maintenance of the US data archive and distribution of GO and GT data to US PIs, updates of the "ABC Guide" for the analysis of *XMM-Newton* data, distribution of GO grants for successful AO-1 and AO-2 proposals, support for the AO-2 budget proposal and AO-3 science proposal submission processes, and of course, directly aiding the US users community through helpdesk, visitor, and outreach activities. My contributions were the over-all direction of the GOF, oversight of the grant distribution process, general editor of the "ABC Guide" and authorship of the Introduction and EPIC sections, support of the users community through the helpdesk, and producing and providing documentation and information through the WWW. A productive SAS (SAS is the *XMM-Newton* data analysis software package) workshop was held at GSFC for the US community (although because of GSFC security procedures the venue had to be changed to USRA offices the day before the workshop was to start)
2. In the last year I attended the EPIC Calibration/Operations meeting in Germany. The Cal-Ops meeting was very useful to learn the current calibration status of the EPIC. At the Cal-Ops meeting I presented updated results on my cross-calibration studies between *XMM-Newton*, *Chandra*, *ASCA*, and *ROSAT* and the progress being made on characterizing the EPIC non-cosmic backgrounds. Residual systematic errors in the calibrations are of concern and supporting the public release of SAS continues to be a big issue as well.
3. I updated the QuickSim observation simulation program for AO-3 using up-to-date calibration data and directed the modifications of the HEASARC SXRB tool (based on my *ROSAT* maps of the diffuse X-ray background) to provide Xspec compatible spectra that can be used to constrain the fits of *XMM-Newton* data.
4. Since the last report, I've had three co-authored either published or accepted for publication in refereed journals.
5. The ESAS software package continues to be extensively used in the *ROSAT* community, and it is still the only means of undertaking the analysis of certain aspects of *ROSAT* observations (the soft X-ray diffuse background and large-scale extended sources). Currently all that I'm doing with this software is general maintenance and answering a few questions now and then. During my trip to Germany last year I found out that the ability to cast new maps from the diffuse background data that was the result of my post-doc at MPE, is now a lost art (the software and data files were specific to the VMS system). I have recovered that ability, and intend to make that capability available to the community at large.

Education and Public Outreach

DR. JAMES LOCHNER:

My chief work continues to be the development and maintenance of the Imagine the Universe! Web site and its related activities. I accomplish much of this work by managing a small, but dedicated, team consisting of a web programmer (1.0 FTE), graphic designer (0.2), curriculum developers (0.50), science writer (0.2) and product distribution manager (0.75). Scientists in the Lab also contribute their time to developing and reviewing scientific content.

This year we completed our work on the "What is Your Cosmic Connection to the Elements?" materials. This work was started last year on INTEGRAL E/PO funding, with the initial concept of the life cycle of matter in the

universe. It developed into tracing the cosmic origin of the chemical elements. We have gone through a number of steps to develop the poster, information/activity booklet, and teacher workshop.

We successfully held the "Elements 2002 Educator Workshop" in Aug 2002 for a group of 10 teachers from the US East Coast, Canada, and Italy. We presented the content material to them, and gave them an opportunity to give us feedback on the draft version of the poster. During the workshop, they initiated work on classroom activities to accompany the material. They completed these activities by the end of September, after which the activities were reviewed and classroom tested by a group of outside teachers. We held a follow-on workshop for the original participants in Nov 2002 to review the comments on the activities. The activities were subsequently revised as needed. Dr. Ilan Chabay (The New Curiosity Shop) provided invaluable assistance throughout this process.

During this time we also continued our work on the poster. We utilized the feedback from the Elements 2002 participants to make substantial changes to the earlier draft. In Jan 2003, through our contact with Chabay, we reviewed our work with Dr. Frank Burnet (Univ. of West of England), a scientist who specializes in graphic and media presentation of science. In March, we field-tested the resulting changes with junior high school and high school students in Pennsylvania and Maryland, and with teachers in Pennsylvania. We completed work on the poster in late March, and submitted it to the printer in April.

In the Jan-March time frame I worked with Suzanne Kinnison (AESP-GSFC) to develop a 1-hr workshop on this material for the NSTA National Convention in Philadelphia. We chose one of the activities for participants to do during the workshop, and another activity to demonstrate. I had the opportunity to refine the presentation for a NASA workshop given at the National Organization for Black Chemists and Chemical Engineers in April.

During this time we also wrote the information/activity booklet to accompany the poster. Kim Cochrane (Bowie High School), our summer teacher intern in 2002, wrote the initial draft, and Gail Rorhbach (SP Systems) expanded upon it. It was subsequently revised by Kim, and checked by me and other scientists. In late April, the draft was prepared for review during the month of May by outside teachers. After revising according to the feedback, the booklet will go to print in early June 2003.

The poster and booklet will be available for distribution early this summer. We will add them to the Imagine web site for email distribution, and add the workshop to our repertoire of available professional development experiences for teachers.

I also continue to work on maintaining and updating the Imagine the Universe! web site. This has included routine updating of Imagine site with news features, a new featured scientist, and completing one of the sections on the site.

An ongoing effort is to complete various sections and features of the Imagine site. Working with Barbara Matteson (Emergent), we completed the "data" portion of the "Satellites and Data" section of the web site. During the summer of 2002, I worked with teacher intern Kim Cochrane (Bowie High School) to develop additional "Try This" activities. For each of the Imagine science articles, these short activities extend an aspect of topic. Ms. Cochrane developed 8 new activities. Also, Gail Rorhbach (SP Systems) completed the 8th in our series of "Featured Scientists".

As with previous years, we produced the annual *Imagine the Universe!* CD-ROM (the 7th edition), containing captures of the Imagine site, StarChild, and the previous year's Astronomy Picture of the Day. Working off our success from previous years, I organized a team of 10 editors to edit the APOD pages in the fall. The 3 sites were captured in Dec 2002, and the CD sent to print in mid-January. We received the completed CDs in late Feb, and distributed 3500 of them at the NSTA meeting in Philadelphia, PA in late March. We also sent 300 to the ITEA meeting in mid March, and 1500 to the NCTM meeting in mid April. We expect to distribute the remaining 17,000 CDs through the course of the year via workshops, email requests, OSS Broker/Facilitators, NASA Education Resource Centers and Aerospace Education Specialists, and regional teacher meetings.

During the course of the year, we have continued to support a variety of educator workshops and conferences (see attached list). These range from small, local workshops, to state and regional conferences, to national conferences. At the larger conferences we have both staffed NASA exhibit booths and presented workshops as part of the conference program. Many of the PowerPoint presentations for these workshops are now available on the Imagine web site for teachers and workshop providers to use.

I continue to oversee the overall development of E/PO projects in the Lab, primarily through biweekly meetings with staff and scientists. We review progress on various E/PO projects, and I keep them informed with regard to wider NASA E/PO issues which may affect our work.

I have continued to stay connected to the wider E/PO world through interactions with the Structure and Evolution of the Universe Education Forum (SEUEF), the Sun-Earth Connection Education Forum (SECEF) and the NASA Office of Space Science Education Support Network. I have participated fully in the SEUEF, contributing to their monthly telecons, and planning future projects. I have kept the SEUEF E/PO community informed on our progress on the Cosmic Elements project, and as a result have received request from them for the workshop materials. I have continued to attend OSS Education Council meetings, which provide information on latest trends in E/PO, and the directions and projects which OSS is undertaking. This has been particularly important this year with the new NASA Code N Education Enterprise. I also continue to maintain good working relations with the OSS Broker/Facilitators, providing them our materials for their use in workshops and re-distribution.

My collaborations with the GSFC Education Office continue to increase. Suzanne Pleau Kinneson (AESP) worked with us on the Cosmic Elements poster, the "Elements 2002 Follow-on Workshop, and developing a 1 hour educator workshop. I have planned a day of SEU theme science for the Vermont Space Science Institute, organized by Rosemary Millham (AESP) to be held in Aug 2003.

Following my work on the Beyond Einstein Roadmap team last year, I have worked with Paul DeMinco (NASA/GSFC) on initiating the Beyond Einstein E/PO plan. We have talked chiefly about how to go about developing a plan for a long-term program, and for missions that won't fly for another 10 years. We will soon involve Lynn Cominksy (Sonoma State Univ.) and Roy Gould (SEUEF) in these discussions.

Staying abreast of developments in space science is part-in-parcel to managing the "Features" on the Imagine Web site. I continue to work with Chris Wanjek (SP Systems) on news articles on latest discoveries. This past year, the Imagine site has featured discoveries and events from a number of satellites, including Chandra, HETE, WMAP, RXTE, XMM-Newton, and INTEGRAL.

I continued to implement the Astro E2 E/PO program. I finalized plans for the Astro E2 Educational Video with Mike McClare (Honeywell-TSI), putting in place the contract for the work to be done and the statement of work for the project. Last summer we held a 2-day workshop at GSFC with 4 teachers from to develop the broad outline for the content of the video. Ilana Harrus (USRA) continues to work on preparations for the student competition, and Koji Mukai is working on preparing the Astro E2 Learning Center web site.

I continued our work on the educator interface for HERA, which was initiated with William Pence (NASA/GSFC) as a result of winning a GSFC Director's Discretionary Funding grant in FY 2002. We contracted with Allie Haijan (SP Systems) to develop guided projects for students to perform, utilizing scaled down selection of the FTOOLS analysis package via the HERA interface. I oversaw and guided her work on projects involving timing analysis of x-ray binary systems, and the development of accompanying web pages for the student. This work remains in progress, as those initial projects are being tested by students, and as we start the development of a project using x-ray imaging tools.

International Gamma Ray Astrophysics Laboratory Guest Observatory Facility (INTEGRAL-GOF)

DR. KEN EBISAWA: (ON DETAIL TO INTEGRAL SCIENCE DATA CENTER, GENEVA, SWITZERLAND)

1a. At ISDC, I am mainly responsible for the Quick Look Analysis system. The INTEGRAL satellite was successfully launched on October 17, 2002, and the QLA system has been working extremely well.

1b. Together with the INTEGRAL GOF and FTOOLS team staff at GSFC, I have been working to improve the INTEGRAL analysis system for general users.

2. When I visited GSFC in June 2002, I have reprocessed ASCA GIS data using the latest gain calibration. The reprocessed data are put in the archives.

3a. With Japanese and US ASTRO-E2 team members, we have created responses for ASTRO-E2 simulation in January, 2003.

3b. I have participated in the ASTRO-E2 meeting in Japan in March 2003. Future plan of the software development was discussed.

4. I wrote several research proposals. I have been actively participating in scientific meetings, publishing results. Using the ADP grant, I visited ISAS in March 2003, and completed the FITS conversion of the GINGA telemetry data. The GINGA archives will be soon released from ISAS, and the mirror will be put at HEASARC.

5. Gave an introductory talk participated in a proposal review. Participated in the Chandra AO4 review in June 2002.

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DR. CHRIS SHRADER:

1. GOF: A peer-review of the INTEGRAL stage-II (grant) proposals was completed, and notification letters sent. Planning is underway for accommodation of copies of the INTEGRAL public data archive and software repository at GSFC for support of the US user community. Analysis of the Performance Verification Phase data is being analyzed at GSFC for the validation and calibration purposes. In a coordinated effort with the NASA INTEGRAL Program Scientists at NASA HQ, I drafted a solicitation for INTEGRAL AO-2 stage-II proposals. This solicitation is for budget support of US INTEGRAL Guest Observers.
2. ISDAG: Maintenance and testing of delivered software was conducted during the reporting period. This includes a number of necessary modifications to accommodate revised telemetry modes, necessitated by the unexpectedly high instrumental background count rates. Another major activity, for which I have maintained a leading role, is the development of INTEGRAL-specific capabilities to be incorporated in the XSPEC version 12 release scheduled for late 2002. In each case, I worked closely with members of our team; 1 USRA scientists and 1 EITI programmer. A presentation describing INTEGRAL spectral data analysis was made at the Gamma 2001 symposium.
3. CGRO SSC: This activity is ramping down and will be terminated by the end of FY-03. I am currently responsible for supervision of approximately 0.5 FTE technical support staff who are performing testing, minor software changes, and documentation.
4. Research: I have continued to participate in two scientific collaborations, both related to the study of spectral and temporal properties of accreting black hole X-ray binaries. In a recently accepted manuscript, we perform extensive temporal analysis, including tomographic imaging (from X-ray-to-optical signal delay structure) of the accretion disk, and cross-correlation analysis of the UU-optical to X-ray time series.

I am first author on a manuscript entitled "A methods of for Black Hole Mass Determination in Accretion Powered X-Ray Sources" which will be submitted this month.

I am a co-author on an extensive paper cataloging the CGRO/BATSE database of Earth-occultation source analsyes covering the 9 year CGRO mission.

I made presentations on topics drawn from each of these publications (and related analysis) at the AAS meeting and the AAS-HEAD meeting.

I gave an invited talk at the "X-Ray Binaries in the Chandra and XMM Era" at MIT.

I was also the PI on a successful Guest Observer proposals (RXTE), and a co-I on an approved HST proposal. I submitted two XMM proposals and one Chandra (as Co-I), the fate of which is as ye unknown.

Finally, I served as a referee for an ApJ Letter on a model which attempts to reproduce the spectral and temporal properties of accretion-driven X-ray binaries, and I have been recruited to serve as a peer-review panelist for the Chandra Cycle-5 proposal review in June 2003.

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DR. STEVEN STURNER:

1. Analysis of RXTE and XMM-Newton data on the supernova remnant IC 443. I have analyzed an RXTE observation of the supernova remnant IC 443 in order to better understand its spatially integrated nonthermal x-ray emission above 10 keV. The results were presented at the 34th COSPAR Scientific Assembly in Houston, Texas in October 2002. This work has resulted in a refereed paper in press:

   Sturner, S.J., Keohane, J.W., & Reimer, O. 2003, "Observation of Non-Thermal Emission from the Supernova Remnant IC 443 with *RXTE*", Adv. Space Research, in press

2. I have also begun the analysis of public XMM-Newton data on IC 443. Preliminary results were to have been presented at the High Energy Astrophysics Division of the American Astronomical Society meeting at Mt. Tremblant in March 2003. Unfortunately I was unable to make attend the meeting due to illness. I am beginning to write a paper on this work to be submitted to *The Astrophysical Journal.*

3. Analysis of INTEGRAL/SPI ground calibration data. I was tasked within the SPI collaboration to perform my own analysis of the SPI ground calibration data in order to derive the SPI efficiency as a function of incident photon energy. I was to compare my results with those of other team members in France and to form a consensus result. I was also to compare these results with those derive from my Monte Carlo simulations of the calibration runs. This task was completed and I presented the results at the SPI team meeting in Garching, Germany in June 2002. The simulations agreed well with the ground calibration data given the complexity of the system.

4. Analysis of INTEGRAL/SPI flight data and testing of analysis software. This analysis had multiple functions. In my position with the INTEGRAL Guest Observer Facility, it let me familiarize myself with the use of the analysis software. It was also useful in discovering bugs in the software and suggesting improvements. Lastly, it was essential for assessing the accuracy of the SPI response and implementing revised correction factors. The ISDC has had its first public release of analysis software developed there and at INTEGRAL instrument team institutions, such as NASA/GSFC, following testing using flight data. Chris Shrader and I are currently analyzing flight calibration data from the Crab Nebula and pulsar. The Crab is the canonical calibration target. We are currently analyzing the SPI Crab data using two different spectral analysis techniques to assess the absolute and relative accuracies of the two methods and the accuracy of the SPI response. We will use these data to derive new correction factors for the IRFs, especially in energy regimes that were poorly sampled by the ground calibration.

5. Production of the INTEGRAL/SPI Imaging Response Functions or IRFs. One of the major tasks allocated to NASA/GSFC within the INTEGRAL/SPI team is the production the instrument response using Monte Carlo simulations. Using the latest SPI mass model and the latest version of our MGEANT simulation package I have generated a full set of 51 SPI IRFs (one for each of the 51 reference photon energies). I also derived a set of corrections to these IRFs based on comparisons of simulation and ground calibrations results. This led to a set of 51 corrected IRFs that were delivered to the INTEGRAL Science Data Center (ISDC) at the end of October 2002 prior to the launch of INTEGRAL. I am currently writing a paper that discusses the method for producing the SPI response for a special INTEGRAL issue of *Astronomy & Astrophysics*. This paper is a part of the SPI team contribution to the issue.

6. Monte Carlo simulations of INTEGRAL/SPI observations in support of the production of a SPI Pulse Shape Discriminator (PSD) simulator and PSD response generation. The SPI IRFs mentioned in the previous sections do not have components for PSD events because of the lack of knowledge of how to simulate the PSD electronics. Georg Weidenspointner and myself entered a collaboration with those elements of the SPI team at UC-San Diego, UC-Berkeley, and CESR in Toulouse that best understood the PSD electronics in order to find a way to simulated it. Georg and I implemented a new option in our MGEANT simulation software that would output all the information on a recorded event that would be required by the PSD electronics. We produced a set of simulated data in this format and distributed it to the collaboration to be used in producing a PSD software simulation package that could be used in producing a SPI PSD response. The other members of the collaboration are currently attempting to implement the PSD simulation software.

7. I simulated multiwavelength, non-thermal spectra for supernova remnants using a computer code I have developed. These results were used by my collaborators to fit observations of SN 1006 and G347.3-0.5. This work has resulted in two refereed papers and a conference poster:

   Pannuti, T.G., Allen, G.E., Houck, J.C., & Sturner, S.J. 2003, "*RXTE*, *ROSAT*, and *ASCA* Observations of G347.3-0.5 (RX J1713.7-3946): Probing Cosmic-Ray Acceleration by a Galactic Shell-Type Supernova Remnant", ApJ, in press

   Allen, G.E., Houck, J.C., & Sturner, S.J. 2003, "Fits to X-Ray, Radio, and TeV Data for the Eastern Rim of SN 1006", Adv. Space Research, submitted

   Allen, G.E., Houck, J.C., & Sturner, S.J. 2002, "Fits to X-Ray, Radio, and TeV Data for the Eastern Rim of SN 1006", Adv. Space Research, presented at the 34th COSPAR Scientific Assembly, Houston, TX

SWIFT Science Center

DR. MARTIN STILL:

We (the GOF) operate a help desk (by phone and email) and support Guest Observer (GO) visits to GSFC for direct interaction. Wherever possible we use existing mechanisms developed by the HEASARC for interacting with the community in order to provide continuity with previous missions. We communicate with the general US scientist via electronic status reports, booths at major science meetings and through the US User committee that we have set up.

We are currently supporting the AO-3 proposal process for US users. AOs have been typically heavily oversubscribed by 9:1, with 25% of worldwide astronomers involved in proposal applications for AO-2. Despite this, a third of all previous proposals have a US principle investigator and two thirds have US involvement.

Our efforts in bench-testing development versions of the XMM analysis software for ESA programmers using flight data means that we provide a significant role in the production of software for community consumption.

The support of RGS data analysis has again required special attention this year. A major advantage of the RGS is its ability for high-resolution spectroscopy of extended sources. However, there was no public XMM software for this type of analysis. Working with the Columbia instrument team, we have created a community-friendly tool for spectral analysis of extended sources, which was released in the HEASoft package v5.2.

Swift activity in the lab has been ramping up over the last six months in preparation for launch in Dec 2003, I am currently responsible for ensuring that UVOT analysis software and calibration products are ready for the post-launch verification phase. This has required working closely with the instrument teams at Penn State and MSSL as well as the FTOOL programmers and the HEASARC archive. Pending unforeseen banana skins, we are on-course for software and calibration delivery.

Super Nova Remnant Research

DR. ZAVEN ARZOUMANIAN:

- Co-authored one refereed paper describing mass measurements for neutron stars in a relativistic binary pulsar system (accepted 09/02);
- Presented four first/sole-author papers at conferences (manuscripts in preparation for refereed publication); co-authored an additional five conference presentations;
- Completed analysis of Chandra Guest Observer (GO) data for pulsar J1740+1000 (publication in preparation);
- Submitted 16 proposals, 7 as PI
- Oversaw one new Chandra GO observation (target: DA 495) and carried out 17 observing runs using the Green Bank and Arecibo radio telescopes (typically a few hours in duration each, but some lasting a few days). Most of this observing was done remotely (i.e., via the Internet), while some required travel to an observatory;
- Developed software and carried out hardware tests to demonstrate basic functionality of newly-developed "SPIGOT" data-acquisition system at NRAO-Green Bank, for future high-sensitivity pulsar searches;
- Developed data-capture and system-integration software for MAXIM testbed experiment, contributing significantly to a major milestone: the first detection of X-ray fringes at Goddard, and also at the shortest wavelength achieved anywhere, 8.35 Angstroms.

National Virtual Observatory (NVO)

DR. JEONGIN LEE:

1. Conversion of the Gamma Ray Burst service demo to the Data Inventory Service (DIS)

2. Modification of the request and display pages.

3. Management of cached result files from DIS.

4. Research on technical methods to build interfaces of DIS and the NVO-Registry service.

X-Ray Astrophysics Research

DR. JAMES REEVES:

1.Significant amount of time spent in March and April 2003 preparing and submitting science proposals for Chandra AO-5 (deadline March 15th 2003) and for XMM-Newton AO-3 (deadline April 30th 2003). A total of 5 proposals submitted as principle investigator and 13 co-Investigator proposals, collaborating with researchers at various institutes around the world.

2.Sucessfully awarded observing time and granted funded through proposals in Chandra AO-4 (1 proposal) and XMM-Newton AO-2 (3 proposals).

3. Research activities during the last year have led to the publication (as first author or co-author) of 7 refereed papers since January 2003, either already appearing in press or accepted for publication by the journal. A further 2 additional papers have been submitted since (including one about to be submitted to Nature).

4.Efforts have been made to continue, and indeed extend, my collaborations with co-researchers at various academic institutions around the world. This has led to the submission of various papers and also proposals for future observing projects as has been outlined below. Visits made to Imperial College London, to work with Dr. K. Paul Nandra and University of Leicester, to extend collaborations there, especially on XMM-Newton observing proposals.

LABORATORY FOR ASTRONOMY AND SOLAR PHYSICS (680)

Solar and Heliospheric Observatory (SOHO)

SCOTT MCINTOSH: (started 3/19/03)

- Devised, requested and accomplished the "Comprehensive Footpoint Study" Joint Observing Program (JOP) 161 (URL) for SOHO and TRACE. This observation formed was SOHO's first multi-instrument analysis of the roots of the magnetic loops that ubiquitously thread the Sun's atmosphere. The data acquired on April 15th & 16th 2003 runs of JOP 161 provide an unprecedented opportunity to understand the dynamics and energetics of magnetic loops.
- Was approached to be a scientific co-investigator on the proposed RAISE sounding rocket project (NRA-02-OSS-01-SHP) and the NEXUS Small Explorer mission (AO-OSS-03-02).
- Was invited by the "Solar Physics" journal to write a review article on the inference of remotely sensed plasma quantities from Solar UV emission spectra. This article is in preparation.
- Was invited to give a review on "Solar Nano and Micro Flares" at the Space Congress of the COSPAR meeting in Houston, TX October 2002. Unfortunately, I had to decline due to other commitments (wedding).
- Was a co-investigator (non-funded, to date) on a successfully proposal "Novel Approaches to Spectroscopic Measurements: Observations, Simulation and Theory" (NRA-01-OSS-01-SHP). This work will follow up on some of my Ph.D. thesis research which is already done, and therefore requires very little of my time.
- Was successful, with Dimitris Vassiliadis, in proposing a Space Weather course to be taught at the University of Maryland from the Fall 2003 Semester.

LABORATORY FOR EXTRATERRESTRIAL PHYSICS (690)

Electrodynamics Forecast Modeling

DR. DIMITRIS VASSILIADIS:

1. Energetic electron flux modeling:
    i. Discovery of third region, P_2, in outer radiation belt (following to region P_0 identified in 2001). The P_2 region is outside the long-term trapping boundary and therefore supports very low fluxes for relatively brief times (1-2 days). Paper submitted to GRL, accepted with revisions (5/03).
    ii. Comparison of 17 interplanetary and magnetospheric parameters as drivers of the electron flux. Most (15) of the parameters fall in three groups with similar characteristics in their data-model correlation: a hydrodynamic-interaction group (most prominent: solar wind velocity), a magnetic-interaction group (prominent: IMF B_{South}), and a loss-scattering group (prominent: F10.7). Paper in preparation for GRL.
2. Modeling and prediction of high-latitude electrodynamic system.
    i. Correlation of ground geomagnetic disturbance at a fixed latitude-local-time position with an interplanetary or magnetospheric driver. Development of finite-impulse-response (FIR) models. Use the FIR impulse response to identify modes of response in time and spatial development.
3. SOC studies:
    i. Use the FIR impulse response (from #2) to classify geomagnetic fluctuations for each substorm phase and as a function of position in a high-latitude 2D grid. Use the FIR response to measure the susceptibility of geomagnetic fluctuations as a diagnostic for SOC.
4. Two papers and two NSF proposals were reviewed. A NASA-OSS and an NSF-ATM proposal were submitted.

Space Plasma Physics

DR. YIHUA ZHENG:

1. Simulation studies show that pitch angle diffusion due to whistler hiss has little effect on the radiation belt particle fluxes and energy diffusion due to whistler mode chorus is a possible mechanism to generate energetic electrons and to increase the electron flux level during magnetic storms.
2. Through a combined effort of the RBE (Radiation Belt Environment) team and staff at APL, the RBE model version is now running in real time at APL. The description of the project, input and output of the model, and the updated (every 15 minutes) RBE images are posted at the UPOS web page at http://sd-www.jhuapl.edu/UPOS/RBE/index.html. The software and the related documents will be delivered to the Air Force after a final check.
3. We find that during the recovery phase of a storm, the inductive electric field naturally accompanying a time-varying B configuration energizes and causes trapping of plasmas, and is able to enhance electron fluxes near the geosynchronous orbit. The model itself and the simulation results of the inductive electric field have been written into a paper and submitted to *Space Weather*, a new AGU journal.
4. Radiation dosage of any orbit can be obtained. This suits any customer's individual needs.
5. Improved the total ion outflow calculation. The correlation study between the ionospheric ion outflow and the magnetospheric energy input has been performed for many events. A paper will be written on this soon.

Space Plasma Physics

DR. PHILIP WEBB: (started 6/10/03)

Working with Dr. Mei-Ching Fok on modeling and data analysis of Space Plasma Physics data obtained from IMAGE missions and relevant data sets from the ISTP Solar Max database.

DR. YUSUKE EBIHARA: (started 5/22/03)

Working with Dr. Mei-Ching Fok on modeling and data analysis of Space Plasma Physics data obtained from IMAGE missions and relevant data sets from the ISTP Solar Max database.

Interplanetary Physics

DR. SHING-HSIEN (SEAN) CHEN:

1. Recently, I have done the study in characterizing the properties of plasmas of ionospheric origin near the subsolar magnetopause. The plasmas are discovered to be important to physical processes of the interaction of solar wind plasma and magnetospheric plasma. I have presented the research work on the last Fall AGU meeting and have documented the work, titled "Dayside flow bursts in the Earth's Outer Magnetosphere", and submitted to the Journal of Geophysical Research for publication. I have co-worked on a study related to the motion of the magnetospheric cusp using data set from IMAGE/LENA and Polar/TIDE. The study is conducted by the colleague Satoshi Taguchi. He is presenting the work on 2003 Earth and Planetary Science meeting at Tokyo Japan in May and 2003 IUGG meeting in Sapporo Japan in July.

2. Developed tools in C/C++ and IDL to process and present the TIDE data set. Also developed tools to combine data set from other instrument on Polar such as magnetometer MFE, electric field EFI and plasma instrument HYDRA and TIMAS as well as instrument on other spacecraft such as the solar wind observers WIND and ACE.

3. Submitted a proposal to SR&T Geopace last July and will submitted one in May this year.

Interplanetary Physics

BEN PILKERTON: (Became full-time research assistant on 3/26/03)

A Research Assistant, Mr. Pilkerton conducts data analysis using data obtained from the Low Energy Neutral Atom Imager on the IMAGE spacecraft (LENA), and other programmatic activities involving information disseminated via the LENA website.

Magnetospheric Physics

DR. NIKOLAI TSYGANENKO:

*1. Compilation of new data bases, including recent magnetospheric and solar wind magnetic fields and plasma observations, as well as ground-based magnetometer data, with the goal to make maximal use of all available experimental information to derive the global structure and dynamics of the Earth's magnetosphere.

*2. Devising new mathematical methods to represent the magnetic field in the Earth's magnetosphere and development on that basis of advanced quantitative models of the geomagnetic field.

*3. Development of computer codes for the data-based modeling of the geomagnetic field and plasma environment in the Earth's magnetosphere, calibration of the model parameters by fitting them to spacecraft data, and evaluation of the accuracy of the new models.

4. Making the new models available to the national and international scientific communities in the field of magnetospheric physics via publications in scientific journals and presentation of papers at conferences, meetings, seminars, etc., by maintaining a modeling website, and by providing the modeling products to the National Space Science Data Center (NSSDC/GSFC).

5. Providing consultations and advising the researchers in this country and abroad on using the data-based magnetospheric models in their studies. Assisting the space physics community by refereeing papers on request from the JGR-A Editors and participating in NASA's and/or NSF proposal peer reviews.

6. Preparation and submission of proposals for the above described modeling studies. Participation in the proposals of other US research groups, that critically rely on advanced magnetosphere models.

Electrodynamics of Magnetic Storm Time Auroral Disturbances

DR. JESPER GJERLOEV:

- What is the configuration of the ionospheric electrojets during the substorm growth phase? Paper is submitted to Geophysical. Res. Lett. Understanding the behavior of the auroral electrojet indices and refining them. Paper is about to be submitted and a NASA proposal has been submitted and awarded.
- Publication of five articles in refereed journals (first author on one); submitted two additional first-author articles to scientific journals, awaiting approval.
- Made presentations at five national/international meetings.
- Was awarded full funding on two proposals as PI:
    - Gjerloev, J. W., R. A. Hoffman, L. A. Frank, and R. Greenwald, NASA-Supporting Research and Technology (SR&T), "Electrodynamics of magnetic storm time auroral disturbances", 2003. (~$265K)
    - Gjerloev, J. W., R. A. Hoffman, L. A. Frank, and R. Greenwald, NASA-Living With a Star, "Refining and understanding the auroral electrojet indices", 2002. (~$265K)
- Data analysis is the very foundation of all the research that I perform. For all achievements this last half year extensive data analysis has been performed.

USRA CPSS 2002 - 2003 Scientific Publications List

1. Allen, G. E.; Houck, J. C.; & **Sturner, S. J.;** 2002: *"Fits to X-Ray, Radio, and TeV Data for the Eastern Rim of SN 1006;"* Adv. Space Research, presented at the 34th COSPAR Scientific Assembly, Houston, TX.

2. **Angelini, L.**; White, N. E.; 2003: *"An XMM-Newton Observation of 4U 1755-33 in Quiescence: Evidence of a Fossil X-Ray Jet;"* ApJ, 586, 71.

3. Berendse, F.; Owens, S. M.; Serlemitsos, P. J.; Tueller, J.; **Chan, K.-W.; Soong, Y.; Krimm, H.;** Baumgartner, W. H.; Kunieda, H.; Misaki, K.; Ogasaka, Y.; Okajima, T.; Tamura, K.; Tawara, Y.; Yamashita, K.; Haga, K.; Ichimuru, S.; Takahashi, S.; Gotou, A.; Kitou, H.; Fukuda, S.; Kamata, Y.; Furuzawa, A.; Akimoto, F.; Yoshioka, T.; Kondou, K.; Haba, Y.; Tanaka, T.; 2002: *"Production and Performance of the InFOCμS 20-40 keV Graded Multilayer Mirror;"* Appl. Opt. 42 (10), 1856-1866.

4. Black, J. K., (Forbin Scientific); Brunton, A. N.;* Bannister, N. P.;* **Deines-Jones, P.,** (USRA); Jahoda, K., (GSFC); 2003: *"The Imaging X-ray Detector for Lobster-ISS;"* accepted, Nucl. Instr. Meth. A.

5. Bogdan, T. J.; Carlsson, M.; Hansteen, V.; McMurry, A.; Rosenthal, C. S.; Stein, R. F.; **McIntosh, S. W.**; and Nordlund, Å.; 2003: *"Waves in the Magnetized Solar Atmosphere II: Waves from Localized Sources in Magnetic Flux Concentrations;"* In press, Astrophysical Journal.

6. Bogdan, T. J.; Rosenthal, C. S.; Carlsson, M.; Hansteen, V. H.; McMurry, A.; Zita, E. J.; Johnson, M.; Petty-Powell, S. J.; **McIntosh, S. W.**; Nordlund, Å; Stein, R. F.; Dorch, S. B. F.; 2002: *"Waves in Magnetic Field Concentrations: The Critical Role of Mode Mixing and Interference;"* Astronomisch Nachricten, 323, 196.

7. Burnett, T.; Chektman, A.; Silva, E.; Dubois, R.; Flath, D.; Gable, I.; Grove, E.; Hartman, R.; Kamae, T.; Kavelears, A.; Kelly, H.; Kotani, T.; Kuss, M.; Lauben, D.; Lindter, T.; Lumb, N.; Mizuno, **Moiseev, A.;** Ozaki, M.; Rochester, L.; Schaefer, R.; Spandre, G.; Thompson, D.; Usher, T; Young, K.; August 2002: *"Gamma-Ray Large-Area Space Telescope (GLAST) Balloon Flight Data Handling Overview;"* IEEE Transactions of Nuclear Science, 49, 4, 1904.

8. **Chan, K. W.; Soong, Y.;** and Serlemitsos, P. J.; 2002: *"The X-Ray Mirrors for the Astro-E2 Mission;"* Proc. SPIE, 4851, 451-458. X-Ray and Gamma-Ray Telescopes and Instruments for Astronomy. Eds. J. E. Trümper & H. D. Tanabaum.

9. **Chan, Kai-Wing;** Serlemitsos, Peter J.; Okajima, Takashi; **Soong, Yang;** and **Lehan, John P.;** 2003: *"Status of Segmented Thin-Foil X-Ray Telescope;"* will be presented at 48th SPIE annual meeting at San Diego, and the paper will be on SPIE proceedings

10. **Corbet, R. H. D.;** 2003: *"Synchronized SETI - the Case for 'Opposition';"* Astrobiology, in press.

11. **Corbet, R.H.D. [(1)]; and Mukai, K. [(1)];** 2002: *"The Orbit and Position of the X-ray Pulsar XTE J1855-026 - an Eclipsing Supergiant System;"* ApJ 577, 923-928. ([(1)] NASA/GSFC and USRA.)

12. Derry, P. M.; O'Brien, P. T.; **Reeves, J. N.;** Ward, M. J.; Imanishi, M.; Ueno, S.; 2003: *"Detection of Type-2 Quasars in the Radio Galaxies B3 0731+438 and 3C 257;"* Monthly Notices of the Royal Astronomical Society, accepted for publication.

13. Drake, J. J. [(1)]; Wagner, R. M. [(2)]; Starrfield, S. [(3)]; Butt, Y. [(1)]; Krautter, J. [(4)]; Bond, H. E. [(5)]; Della Valle, M. [(6)]; Gehrz, R. D. [(7)]; Woodward, C. E. [(7)]; Evans, A. [(8)]; Orio, M. [(9)]; Hauschildt, P. [(10)]; Hernanz, M. [(11)], **Mukai, K.** [(12)]; and Truran, J. W. [(13)]; 2003: *"The Extraordinary X-ray Light Curve of the Classical Nova V1494 Aquilae (1999 No. 2) in Outburst: The Discovery of Pulsations and a "Burst";"* ApJ, 584, 448-452. ([(1)] CfA; [(2)] Large Binocular Telescope Observatory; [(3)] Arizona State; [(4)] Heidelberg-Koenigstuhl Landessternwarte; [(5)] STScI; [(6)] Spazio e Osservatorio Astronomico di Arcetri; [(7)] Univ. Minnesota; [(8)] Keele University; [(9)] Oss. Astronomico di Torino; [(10)] Hamburger Sternwarte; [(11)] Instituto de Ciencias del Espacio; [(12)] USRA and NASA/GSFC; [(13)] Univ. Chicago.)

14. Fraser, G.W.; Brunton, A. N.; Bannister, N. P.; Pearson, J. F.; Ward, M. J.; et al., including **Deines-Jones, P.**; 2002: *"Lobster-ISS: An Imaging X-ray All-sky Monitor for the International Space Station;"* Conference On X-Ray and Gamma-Ray Instrumentation for Astronomy XII, JUL 31-AUG 02, 2001, Proceedings of SPIE Vol. 4497, 115.

15. **Gjerloev, J. W.**; and Hoffman, R. A.; 2002: *"Implications of Ionospheric Substorm Electrodynamics Model;"* in Sixth International Conference on Substorms, University of Washington, Seattle, edited by R. M. Winglee, p. 123.

16. Gossler[1], S.; Casey[2], M. M.; Freise[1], A.; Grote[1], H.; Lueck[1], H.; **McNamara[3], P.;** Plissi[2], M. V.; Robertson[2], D. I.; Robertson[2], N. A.; Skeldon[2], K.; Strain[2], K. A.; Torrie[2], C. I.; Ward[2], H.; Willke[1], B.; Hough[2], J.; and Danzmann[1], K.; 2002: *"The Modecleaner System and Suspension Aspects of GEO 600;"* Class. Quant. Grav., 19(7), 1835-1842. ([1]University of Hannover; [2]University of Glasgow; [3]USRA/GSFC.)

17. Hellier, C. [(1)]; Beardmore, A. P. [(1)]; and **Mukai, K.** [(2)]; 2002: *"The Spin Pulse of the Intermediate Polar V1062 Tauri;"* A&A, 389, 904-907. ([(1)] Keele University; [(2)] NASA/GSFC and USRA.)

18. Hynes, R. I.; **Shrader, C. R.**; et al.; 2003: *"The Remarkable Rapid X-ray, Ultraviolet, Optical and IR Variability in the Black Hole XTE J1118+480;"* MNRS (accepted).

19. Israel, G. L.; Covino, S.; Stella, L.; Campana, S.; Marconi, G.; Mereghetti, S.; Mignani, R.; Negueruela, I.; Oosterbroek, T.; Parmar, A. N.; Burderi, L.; and **Angelini, L.**; 2002: "The Detection of Variability from the Candidate Infrared Counterpart to the Anomalous X-Ray Pulsar 1E 1048.1-5937;" ApJ, 580, L143.

20. Jennrich[1], O.; **McNamara[2], P.;** Robertson[3], D.; Rowan[4], S.; Ward[3], H.; and Hough[3], J.; 2002: *"Interferometry Developments for LISA and SMART-2;"* Class. Quant. Grav., 19(7), 1731-1737. [1] University of Glasgow; now at ESTEC, [2] USRA / GSFC, [3] University of Glasgow, [4] University of Glasgow and University of Stanford.

21. Kallman, T. R.; **Angelini, L.**; Boroson, B.; Cottam, J.; 2003: *"Chandra and XMM Observations of the Accretion Disk Corona Source 2S 0921-63;"* ApJ, 583, 861.

22. Ko, C. M.; and **Chan, K.-W.;** 2002: "Equatorial Stellar Winds with Galactic Cosmic Rays;" Proc. IAU 8th Asian-Pacific Meeting, Vol. 2, 157. Eds. S. Ikeuchi, J. Hearnshaw, & T. Hanawa.

23. **Krimm, H. A.;** Barbier, L. M.; Barthelmy, S. D.; Eftekharzadeh, A.; Fenimore, E. F.; Gehrels, N.; Hullinger, D. D.; Markwardt, C.; Palmer, D. M.; Parsons, A. M.; **Ozawa, H.;** Tueller, J.; and **Weidenspointner, G.;** 2002: *"Searches for Hard X-ray Gamma-Ray Burst Afterglows with the BAT on Swift;"* in Gamma-Ray Burst and Afterglow Astronomy, Proceedings of A Workshop Celebrating the First Year of the HETE Mission, Woods Hole, Massachusetts, November 5-9, 2001, edited by G.R. Ricker, AIP Conf. Proc. 662 (in press).

24. **Krizmanic, J. F.;** 2002: *"Future Experiments in Astrophysics;"* Proceedings of the 10th International Conference on Calorimetry in Particle Physics, 867-880, World Scientific.

25. Kuntz, K. D. [(1)]; **Snowden, S. L.** [(2)]; Pence, W. D. [(3)]; and **Mukai, K.** [(2)]; 2003: *"Diffuse X-ray Emission from M101,"* ApJ 588, 264-280. ([(1)] UMBC; [(2)] USRA and NASA/GSFC; [(3)] NASA/GSFC.)

26. Laycock, S.; **Corbet; R. H. D.;** Coe, M. J.; Marshall, F. E.; Markwardt, C.; & Edge W.; 2003: *"X-ray and Optical Observations of XTE J0052-723 a Transient Be/X-ray Pulsar in the Small Magellanic Cloud;"* MNRAS, 339, 435.

27. **Lehan, J. P.;** Yu, P. C.; Backfisch, D. L.; and Chambers, J. P.; 2002: *"Predictive Model Of The Optical Response Of Amorphous WO_3 To Ion Intercalation;"* J. Appl. Phys. 92 pp. 3608-3614.

28. Leske, R. A.; Mewaldt, R. A.; Cohen, C. M. S.; **Christian, E. R.**; Cummings, A. C.; Slocum, P. L.; Stone, E. C.; von Rosenvinge, T. T.; Wiedenbeck, M. E.; 2003: *"The Coronal Isotopic Composition as Determined Using Solar Energetic Particles;"* Solar Wind 10, AIP Conference Proceedings, in press.

29. Liu, H.; Charbonneau, P.; Pouquet, A.; Bogdan, T. J.; **McIntosh, S. W.**; 2002: *"Continuum analysis of an Avalanche Model for Solar Flares;"* Physical Review (E), 66, 056111.

30. Markowitz, A.; Edelson, R.; Vaughan, S.; Uttley, P.; George, I. M.; Griffiths, R. E.; Kaspi, S.; Lawrence, A.; McHardy, I.; **Nandra, K.;** Pounds, K.; **Reeves, J.**; Schurch, N.; Warwick, R.; 2003: *"X-ray Fluctuation Power Spectral Densities of Seyfert 1 Galaxies;"* The Astrophysical Journal, accepted for publication.

31. Mason, G. M.; Wiedenbeck, M. E.; Miller, J. A.; Mazur, J. E.; **Christian, E. R.;** Cohen, C. M. S.; Cummings, A. C.; Dwyer, J. R.; Gold, R. E.; Krimigis, S. M.; Leske, R. A.; Mewaldt, R. A.; Slocum, P. L.; Stone, E. C.; von Rosenvinge, T. T.; 2002: *"Spectral Properties of He and Heavy Ions in 3He-rich Solar Flares;"* Astrophysical Journal, vol. 574, Num 2, pp1039-1058.

32. **McIntosh, S. W.**; Fleck, B.; Judge, P. G.; 2003: *"Investigating the Role of Plasma Topography on Chromospheric Oscillations Observed by TRACE;"* In press, Astronomy and Astrophysics.

33. **McIntosh, S. W.**; Charbonneau, P.; Liu, H.; and Bogdan, T. J.; 2002: *"Geometrical Properties of Avalanches in Self-Organized Critical Models of Solar Flares;"* Physical Review (E), 65, 46125.

34. Mewaldt, R. A.; Cohen, C. M. S.; Leske, R. A.; **Christian, E. R.;** Cummings, A. C.; Stone, E. C.; von Rosenvinge, T. T.; Wiedenbeck, M. E.; 2002: *"Fractionation of Solar Energetic Particles and Solar Wind According to First Ionization Potential;"* Advances in Space Research, Vol 30, Num 1, pp 79-84.

35. Motoki, M.; Sanuki, T.; Orito, S.; Abe, K.; Anraku, K.; Asaoka, Y.; Fujikawa, M.; Fuke, H.; Haino, S.; Imori, M.; Izumi, M.; Maeno, T.; Makida, Y.; Matsui, N.; Matsumoto, H.; Matsunaga, H.; Mitchell, J.; Mitsui, T.; **Moiseev, A.;** Nishimura, J.; Nozaki, M.; Ormes, J.; Saeki, T.; Sasaki, M.; Seo, E. S.; Shikaze, Y.; Sonoda, T.; Streitmatter, R.; Suzuki, J.; Tanaka, K.; Ueda, I.; Wang, J. Z.; Yajima, N.; Yamagami, T.; Yamamoto, A.; Yamamoto, Y.; Yamato, K.; Yoshida, T.; Yoshimura, K.; (hereafter – BESS collaboration); April 2003*: "Precise Measurements of Atmospheric Muon Fluxes with the BESS Spectrometer;"* Astroparticle Physics, 19, 1, 113.

36. Mouchet, M. [(1)]; Bonnet-Bidaud, J.-M. [(2)]; Roueff, E. [(1)]; Beuermann, K. [(3)]; de Martino, D. [(4)]; Desert, J. M. [(5)];, Ferlet, R. [(5)]; Fried, R. E. [(6)]; Gaensicke, B. [(7)]; Howell, S. B. [(8)]; **Mukai, K.** [(9)]; Porquet, D. [(10)]; and Szkody, P. [(11)]; 2003: *"The Surprising Far-UV Spectrum of the Polar BY Camelopardalis,"* A&A 401, 1071-1076. ([(1)] Observatoire de Paris Meudon; [(2)] CE Saclay; [(3)] Universitaets- Sternwarte Goettingen; [(4)] Osservatorio Astronomico di Capodimonte; [(5)] Universite Paris 6; [(6)] Braeside Obs.; [(7)] Univ. Southampton; [(8)] Planetary Science Institute; [(9)] NASA/GSFC and USRA; [(10)] MPE; [(11)] Univ. Washington.)

37. **Mukai, K.** [(1,2)]; Kinkhabwala, A. [(2)]; Peterson, J. R. [(2)]; Kahn, S. M. [(2)]; and Paerels, F. [(2)]; 2003: *"Two Types of X-ray Spectra in Cataclysmic Variables;"* ApJLett, 586, L77-L80. ([(1)] NASA/GSFC - USRA, [(2)] Columbia University.)

38. **Mukai, K.** (USRA/GSFC); Pence, W. D. (GSFC); **Snowden, S. L.** (USRA/GSFC); Kuntz, K. D. (UMBC/GSFC); 2003: *"Chandra Observation of Luminous and Ultraluminous X-Ray Binaries in M101X-Ray Sources in M101,"* ApJ, 582, 184-189

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