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FINAL REPORT

ON

THE 1984 ASEE-NASA SUMMER FACULTY FELLOWSHIP PROGRAM

(AERONAUTICS AND RESEARCH)

at

THE NASA GODDARD SPACE FLIGHT CENTER

GREENBELT, MARYLAND

NASA TRAINING GRANT NGT 09-011-060

to

HOWARD UNIVERSITY, WASHINGTON, D.C.

Prepared by Co-directors:

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and

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September 1984

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SUMMARY REPORT

The 1984 NASA-ASEE Summer Faculty Fellowship Program (SFFP) at the NASA Goddard Space Flight Center (GSFC) in Greenbelt, Maryland was conducted during the ten-week period nominally from May 28, 1984 to August 3, 1984. A two-week latitude from the nominal dates was found necessary to accommodate the wide scatter of academic calendars of SFF's universities and colleges. Howard University (HU) under terms of the NASA Training Grant NGT 09-011-060 provided administrative support for the SFFP at GSFC. Mr. Jerry Hodge of the Sciences Directorate at GSFC as the center co-director and Dr. Dah-Nien Fan of the Department of Mechanical Engineering at HU as the university co-director were responsible for the administration of the SFFP. Dr. Fawzi P. Emad of the Department of Electrical Engineering at the University of Maryland (UM) in College Park, another university co-director, participated in the program activities from time to time to ensure some continuity of the present (1984) SFFP from the past (1983) and to the future (1985) programs. Mrs. Charlotte Irving of HU and Mrs. Sharon Smith of GSFC provided administrative and secretarial assistance to the co-directors in the 1984 SFFP. As in past programs close cooperation was maintained among co-directors throughout the year, and smooth and efficient operation was continuously assumed.

Thirty-three (33) faculty members representing thirty (30) universities and colleges across the country participated in the 1984 SFFP at GSFC. Their names, ranks, institutions and their research colleagues at GSFC are given in Appendix 1. Here are some statistics on the 1984 Summer Faculty Fellows (SFF).

* 18 first-year SFF vs 15 returning SFF.

* 11 local/commuting SFF vs 22 out-of-town SFF.

* 7 SFF were from engineering departments, 8 from mathematics/computer science; 13 from physics; 2 from chemistry; 1 each from geology, geography, and humanity.

* 7 SFF were from minority institutions.

* There were 3 black SFF, 3 oriental SFF, 1 Hispanic SFF, and 5 female SFF.

* 1 SFF at the Wallops Flight Facility, Virginia vs 32 SFF at the GSFC proper in Greenbelt, Maryland.

* Four Directorates at GSFC participated in the 1984 SFFP with 14 (Applications Directorate Code 900), 12 (Sciences Directorate Code 600), 4 (Mision and Data Operations Directorate Code 500), and 3 (Engineering Directorate Code 700) SFF, respectively.

* 30 SFF were supported by the 1984 NASA Headquarters grant to HU, 1 SFF by the 1983 NASA Headquarters grant to UM, 1 SFF by funds from Code 900 GSFC, and 1 SFF by U.S. Navy at no cost to NASA.

Abstracts of individual research projects prepared by SFF were included in the report as Appendix 2. These projects are of mutual interest to individual SFF and their respective GSFC colleagues. Most of the research topics are coupled with on-going projects at GSFC. Each SFF also made a ten-minute oral presentation on his/her research project to other SFF. Highlights from these research activities are

* Three grants were awarded to SFF at their institutions.

* Nine proposals were pending or planned.

* Seven technical papers were published or presented.

* Twenty-one papers and reports were under preparation for publication.

The number of applications received by the 1984 SFFP at GSFC is the third highest in recent years. A total of one hundred ten (110) applications was received. Of these, seventy-eight (78) indicated SFFP at GSFC as their first choice. (See Table for comparative figures of the last eight years.) Considerations of award were given primarily to first-choice applicants. Thirty-two (32) applicants were racial minorities or female. Information on all applicants was compiled using the "NASA/ASEE Summer Faculty Fellowships

1st Year Applicants/Appointments" form supplied by the Office of Resources,
Management & University Programs at NASA Headquarters, and was periodically
reported to the forementioned office on these forms.

TABLE SHOWING NUMBER OF APPLICANTS

Year	1st Choice	2nd Choice	Total
1984	78	32	110
1983	92	40	132
1982	102	42	144
1981	54	19	73
1980	48	33	81
1979	66	42	108
1978	56	28	84
1977	35	27	·62

Of the seventeen (17) 1983 first-year SFF, sixteen (16) were invited
to participate as 1984 second-year SFF. Fourteen (14) accepted the invi-
tation to return, but one (1) resigned subsequently due to medical reasons.
One (1) fellow who had to withdraw at the end of the third week into the
1983 SFFP due to illness rejoined this summer to complete his unfinished
tenure as a second-year fellow. The percentage of 1983 SFF returning for a
second summer is approximately 76% substantially higher than that of 1981
when 53% decided to rejoin.

As in previous years pre-program communications between non-local SFF
and their respective colleagues were conducted mainly by telephone calls
and letters. Because of budget limitation pre-program visits to GSFC by
first-year non-local fellows was granted only upon recommendation by his/her
GSFC colleague. However no requests for pre-program visits were received.

Non-local SFF were, in general, satisfied with their summer housing and
housing assistance. They received a list of available summer rooms, apart-

ments and houses from HU in March 1984 with subsequent updates sent to them in April and early May. The list and updates were compiled from responses to periodic advertisements in the Diamondback (the University of Maryland newspaper), the GSFC newspaper, and the Journal newspapers (Montgomery and Prince George's counties of Maryland). Appendix 3 gives the content of the advertisement placed and a sample copy of the housing list.

Eighty percent (80%) of the fellowship was issued by HU to each fellow on May 29, 1984, the first day of the program (May 28 was a holiday). The remaining twenty percent (20%) was paid upon a fellow's fulfillment of all SFFP requirements. Travel reimbursements to SFF were handled according to HU regulations. All SFF were quite satisfied with the payment schedule.

The only scheduled social activity for the 1984 SFFP was the traditional Annual SFFP Picnic at GSFC. It was held on June 8, 1984 at the GSFC Recreational Center. The event was sponsored by the Department of Mechanical Engineering at HU (See Appendix 4.) The picnic was well attended by SFF, their family members, and their GSFC colleagues. Representatives from ASEE were also present at the picnic.

Seminars and tours constituted the approximately 10% educational activities of the SFFP at GSFC. As in years past, an introduction to GSFC (a slide show) and a bus tour of GSFC were conducted for SFF on the first and second Friday's of the program, respectively, by the Office of Public Affairs at GSFC. Additional tours of NASA Headquarters, the National Air and Space Museum, and the GSFC Wallops Flight Facility at Wallops Island, Virginia were cancelled due to lack of participation by SFF. The remaining Fridays (from 1:00 to 2:00 pm) were used by SFF to present their research projects to the group (See Appendix 5). Each SFF was allowed 10 minutes to present his/her research with a 2 minute discussion. Many SFF also attended weekly

seminars/colloquia organized by various GSFC Directorates.

Evaluation of the 1984 SFFP at GSFC by fellows and colleagues was requested by co-directors. (See Appendix 6 for formats of evaluation forms). Some of the feedback was incorporated in this report. Also a program review session was held in conjunction with the meeting of representatives of ASEE Faculty Programs Committee visiting GSFC and SFF. Here are some selected quotes from 1984 SFF at GSFC on the NASA-ASEE SFFP at GSFC:

- ".. the environment for research was a fantastic experience."

- "I have incorporated a circuit simulation package into computer facility of home institution and plan to continue noise simulation studies."

- "I have enabled the GSFC group to work on more complex organic molecules through my project and my own work has become more astronomy oriented."

- "A new remote sensing course is being developed and research cooperation between myself and NASA is to continue for several years."

Here are some selected quotes from GSFC colleagues:

- "It is my opinion that work done by this fellow deserves grant support from NASA on a longer term basis."

- "Has afforded an extra measure of satisfaction beyond both his and my expectations."

- "Fellow saved NASA at least a year of work in what he contributed."

- "Kept our hurricane research program alive at a crucial time."

- "NASA has found another very capable and interested scientist."

- "Fellows research has been exceptionally valuable to us, his work will influence future activities of this laboratory."

- "He was a stimulating colleague."

- "The addition of a unique talent, point of view, and experience enhanced the quality and productivity of our research program."

Before concluding the Summary Report it should be mentioned that two very important visitations of SFFP at GSFC took place in the summer of 1984. In his continuing effort of evaluating the long-term effectiveness

of SFFP's in general, Mr. Charles H. Carter of ASEE and the three co-directors of SFFP at GSFC met in the morning of July 13, 1984. Prior to the meeting Mr. Carter had interviewed extensively past and present GSFC colleagues, and had surveyed a large number of SFF of yesteryears at GSFC. Some of Mr. Carter's suggestions of improving SFFP at GSFC made in the meeting have already been adapted in the UM Proposal to NASA for the 1985 SFFP at GSFC. On August 1, 1984 a team of two members of the ASEE Faculty Programs Committee visited SFFP at GSFC. They were Professor Daniel Frederick, Chairman of the Committee and Professor Russel C. Jones, Member. The purpose of the visit was to observe the program and to share observations with the entire committee. They were briefed by co-directors upon their arrival on the 1984 SFFP at GSFC, and conducted on-site visits to two demonstrations and presentations by selected SFF and their colleagues. In the afternoon the visiting members had informal discussions with all the 1984 SFF at GSFC during a sixty-minute program-review session. Please see Appendix 7 for the agenda of visitation by the ASEE Summer Programs Committee. The co-directors of SFFP at GSFC are eager to learn recommendations and comments to improve further the SFFP at GSFC resulting from these visitations, and pledge their full cooperation in implementing these recommendations.

APPENDIX 1

1984 NASA-ASEE SUMMER FACULTY FELLOWSHIP PROGRAM

AT THE GODDARD SPACE FLIGHT CENTER

GREENBELT, MARYLAND   20771

Second-Year Faculty Fellows and Their GSFC Colleagues

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1984 NASA-ASEE SUMMER FACULTY FELLOWSHIP PROGRAM

AT THE GODDARD SPACE FLIGHT CENTER

GREENBELT, MARYLAND 20771

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APPENDIX 2

Research Abstracts

1984 NASA-ASEE Summer Faculty Fellowship Program

at

THE NASA GODDARD SPACE FLIGHT CENTER

Work Summary of the 1984 Summer Faculty

Fellowship Program Performed at Goddard Spaceflight Center

Effects of multiple scattering on laser beam propagation through
nonhomogeneous media

Bruce L. Bird

Environmental Center
Anne Arundel Community College
Arnold, Maryland 21012

NASA Colleague: Dr. Larry Korb, Code 913

A proposal was developed to investigate the effect multiple scattering processes
have on the power received by a detector for a laser beam propagating through
turbid aqueous suspensions. The power received by the detector will be measured
as a function of optical depth, field-of-view of the detector, and scattering
particle characteristics. Experimental results will be compared to published
theoretical descriptions of multiple scattering corrections to the Beer-Lambert
law for the case of a Gaussian beam and a detector with a variable field of
view.

Work Summary of the 1984 Summer Faculty

Fellowship Program Performed at Goddard Spaceflight Center

NASA-wide Automated Information Management

Rebecca R. Bogart
Department of Computer Science and Statistics
University of Southern Mississippi
Hattiesburg, MS   3940]

NASA Colleague: Dr. Peter Kurzhals, Code 500

We have begun preliminary plans for a performance measurement and
evaluation of the proposed NASA-wide Automated Information Management (AIM)
Plan. This Plan, if adopted, would entail creating compatible, online
administrative information systems and communications systems for Headquarters
and all NASA Centers throughout the United States.

Using the National Bureau of Standards' Guidelines on Requirements
Analysis for Automated Information Management Systems, we have begun work
with Booz-Allen-Hamilton, which is under contract with NASA, to design a
proposed performance measurement and evaluation based upon the seven goals
written by the Strategic Office Automation Plan Team (STEAM).

The Plan and accompanying performance evaluation recommendations are
currently being submitted to NASA Headquarters and to STEAM for approval.
Several iterations are expected.

I have additionally reviewed the literature regarding automated
information management and its evaluation and have submitted a paper for
presentation at the 1985 ACM Computer Science Conference in New Orleans.

Faculty research fellow: Theodore F. Bogart, Jr.
Professor and Electronics Program Coordinator
University of Southern Mississippi
Southern Station Box 8246
Hattiesburg, MS   39401

NASA Colleague: Robert M. Joyce, Code 663

As a second-year fellow, I continued work begun last year on the simulation of electrical noise in solid-state radiation detectors. The goal of this work is to obtain reliable models that can be used to optimize shaping amplifiers and thereby improve the resolution of radiation measurements. The work I performed was also a continuation of investigations conducted under a NASA research grant that I received as an outgrowth of last year's work.

The work this summer was focused on refining SPICE (Simulation Program with Integrated Circuit Emphasis) so that it could be used to predict noise accurately in reverse-biased diodes, a capability it did not originally have. This effort has been successful. I also developed a SPICE computer model that accurately simulates the pulses developed in a two-dimensional radiation detector. The responses produced by this model closely resemble those obtained in experimental investigations and reported in the literature.

Work Summary of the 1984 Summer Faculty
Fellowship Program Performed at Goddard Spaceflight Center

Digital Packet Radio Networking of Personal Computers:
Terrestrial Experiments in support of PACSAT 1986

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NASA Colleague: Dr. Richard Kutz, Code 974

VITA, a major non-profit organization that provides technical assistance to third world countries and AMSAT, the world-wide amateur satellite organization are combining resources to launch a digital store-and-forward message system satellite, PACSAT, in 1986. The satellite will provide whole world coverage at least twice a day to simple, portable ground station terminals. A modified version of X.25 will be used for both up and down links.

Preliminary efforts this summer involved study of the ARGOS and TIROS space communications system for possible technology transfer and design and construction of a briefcase terminal and local terrestrial network for evaluation. A digital repeater was temporarily installed at Goddard and used to link into the Washington DC local area packet network on 145.010 Mhz. Due to the terrestrial range limitations of VHF, an HF to VHF bridge system was developed to extend the local area network to several thousand miles on 10.147 MHz. As the first such bridge in the country, software and firmware development was an evolutionary process. By the end of the summer, the network consisted of over 25 users on VHF and 10 on HF from as far away as Arizona and British Columbia linked by three repeaters and the bridge system.

Talks and demonstrations of the terrestrial packet radio system were given to the Man, Computer and Cybernetics Society of the IEEE, to several community service amateur radio organizations, and to the Goddard Summer Faculty Fellows to give visibility to the PACSAT program and help gather interest in further development. The results of this project will be presented at the IEEE COMPCON 84 and published in the proceedings.

Work Summary of the 1984 Summer Faculty
Fellowship Program Performed at Goddard Space Flight Center

Simulation of Microwave Transmission Lines
Using Computer Techniques

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Tuskegee Institute
Tuskegee Institute, Alabrma 36088

NASA Colleague: Don Lokerson, Code 724.3

Our research project is concerned with accomplishing three
main goals; first, to convert lumped inductance to
transmission line inductance; second, to optimize parameters
to build a microstripline; and last, to determine the
necessary geometric dimensions for a 50 ohm microstripline
on a chip.

We accomplished our goals for frequencies ranging from 2 to
4 GHz.

Our first two goals were accomplished using a software
program "COMPACT" (Computerization of Microwave Passive and
Active Circuits), which is an ideal tool to design linear
circuits in the frequency/microwave region. The program has
five main functions, but we only used two, analysis and
optimization. We used analysis to perform the required
inductance conversion and optimize the width and electrical
length for the microstripline. The inductance conversion
results indicated that a 2 mH lumped inductance can be
converted to a 2.3 mH transmission line inductance. The
optimization results are indicated in the table below:

Impedance	Width	Length
43.6 ohms	437.5 mils	127 mils
59.3 ohms	268.8 mils	235 mils
100 ohms	100 mils	83.3 mils

We developed a computer program to accomplish the third
goal. This program was used to calculate the geometric
dimensions (length, width, and height) necessary to build
the microstripline. We used COMPACT to test the feasibility
of printing the microstripline on a silicon wafer chip. The
results indicated that it was not possible to print it
mainly, because the chip is done using standard process in
which they only print a line of certain multiple width.

This work grew out of a discussion with my colleague at the
Goddard Space Flight Center, Don Lokerson, and was motivated
by problems posed by Dave Buhl.

Work Summary of the 1984 Summer Faculty
Fellowship Program Performed at Goddard Space Flight Center

Guidelines for Writing User Documentation

Patricia Ann Carlson
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Terre Haute, Indiana 47803

NASA Colleagues
David R. Howell
Dorothy C. Perkins
Code 933

This ten-week project deals with the areas of rhetoric and document design. My NASA colleagues asked me to investigate the ways in which user documentation was being written in Code 930 and to suggest methods for improvement. The goals were (1) to make the process efficient and (2) to make the product effective.

Large, commercial software firms have a branch dedicated to writing the documentation library that will accompany a new product. However, most Goddard units do not have this special talent available. And if they do, it is a contractor service, not an "in-house" resource. Therefore, the functional specifications, manuals, and reference materials needed to install and operate a new system, in many cases, are written by NASA software developers and system designers.

My work during the ten-weeks was divided between two specific activities. First, I wrote a set of guidelines for designing documentation. Second, I served as coordinator for two distinct documentation projects.

In the first category of activities, I completed a thorough literature search on current methodologies for writing computer documentation. The resultant Guidelines for Designing User Documentation is based on the latest procedures in information development and document design. The Guidelines will be published as a NASA Technical Memorandum.

In the second category of activities, I oversaw the writing of parts of the documentation library for the Landsat Assessment System (LAS) and for the Display Management Subsystem (DMS) of the Transportable Applications Executive (TAE). The approach was to develop the documents through a "step-wise refinement" method, using four major phases: (1) Definition, (2) Selection, (3) Composition, and (4) Evaluation. I met with both groups (consisting of approximately 10 person each) on a weekly basis to discuss strategy. I also functioned as general editor and managed tactical issues such as establishing document conventions, setting up work timetables, and scheduling support services. In all, eight separate documents were produced.

Work Summary of the 1984 Summer Faculty Fellowship Program
Performed at Goddard Space Flight Center

3D Graphics Software for Image Processing

Daniel B. Caton
Department of Physics & Astronomy
Appalachian State University
Boone, North Carolina 28608

NASA Colleagues:

Daniel Klinglesmith and Richard Fahey
Code 684

·The Regional Data Analysis Facility (RDAF) at Goddard Space Flight Center supports a number of services, including providing the tools to analyze data from the International Ultraviolet Explorer (IUE), and to process images. Astronomical images include galaxies, nebulae and comets. The RDAF will provide support for analysis of images of comet Halley during its current passage.

The image processing system software currently in use (DIDCS) is written in FORTH. Last summer's Fellowship work included adding some floating point plotting features, and the beginnings of a 3D plotting package. That work was extended this summer.

The original 3D software provided an orthogonal projection of data. This turned out to not lend itself well to changing the viewing aspect of the image. This system was rewritten with a fully rigorous perspective projection, using rotation matrices. This allows the image to be viewed from any aspect. Hidden line routines were explored and a simplified algorithm was developed.

Work Summary of the 1984 Summer Faculty
Fellowhip Program Performed at Goddard Spaceflight Center

High Energy Electron and Anti-Proton
Cosmic Ray Experiments

James R. Chen
Department of Physics and Astronomy
State University of New York/Geneseo
Geneseo, NY 14454

NASA Colleague: Dr. Jonathan F. Ormes, Code 661.0

Our purpose is to study cosmic rays using detectors to be carried in balloons and on the space shuttle. In particular the detection of ultra high energy ($\cong$ 10 TeV) electrons by their emitted synchrotron radiation in the Earth's magnetic field is expected to provide information on the distribution of sources and on the propagation of cosmic rays in the solar neighborhood. In addition, the detection of anti-protons below the kinematic threshold using a calorimetric technique will address the question of the presence of appreciable quantities of anti-matter in our Universe.

A prototype large area plastic scintillation counter capable of detecting synchrotron radiation emitted by the electrons was constructed and tested using a wide range of radioactive sources. The anti-proton calorimeter is designed around a thick lead-glass Cherenkov counter located within a timing shield that covers the surface of a 1-meter-radius geodesic sphere. Following construction of the calorimeter, calibration tests using accelerator-generated protons and anti-protons are scheduled. Monte Carlo studies have been done to investigate the efficiencies of the detectors and the effects of various background reactions.

The work is being carried out in collaboration with V. K. Balasubrahmanyan, J. F. Ormes, and R. E. Streitmatter.

Work Summary of the 1984 Summer Faculty
Fellowship Program at Goddard Space Flight Center

Analysis of High Resolution Fourier
Transform Infrared Spectrum of the 13.37µm
of Propane Gas Recorded at Kitt Peak

Stephen J. Daunt
Department of Physics & Astronomy
The University of Tennessee
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The first high resolution laboratory FT-IR spectra of propane
(C_3H_8) gas has been recorded on the 1m FTS instrument at the McMath
Solar Telescope at Kitt Peak. The instrument was reconfigured in a
new mode to obtain this data, essentially doubling the frequency
resolution available (0.0025 cm^{-1}).

This particular band centered near 748 cm^{-1} has been observed as
a feature in the Voyager IRIS data and tentatively identified recently
in Saturn from the IRTF on Mauna Kea. However there has never been an
analysis of the rovibrational structure of this band reported that is
needed for modelling atmospheric and photochemical processes. With our
new data it was possible to resolve and assign essentially all of the
structure for the fundamental band.

Over 4000 individual transitions have been measured and assigned
covering K quantum numbers up to 20 and J values to 40. The propane
molecule is an asymmetric rotor with an asymmetry parameter $\kappa \approx 0.91$ so
that it is a near symmetric rotor. The 748 cm^{-1} band is a C-type band
exhibiting a strong central Q branch due to asymmetry splitting of the
low K subbands and perpendicular symmetric rotor structure in the outer
wings (higher K values). Through an analysis by computer simulations
plus ground state combination differences the individual lines were
assigned. They were then fit to a full 6th order Watson asymmetric
rotor Hamiltonian (S-type).

The molecular constants obtained can reproduce the observed data
to better than 0.001 cm^{-1}. The propane data is currently being added to
the Titan atmospheric model by the GSFC IRIS group. The results of this work
will also be used for laser heterodyne detection experiments by our group.

Work Summary of the 1984 Summer Faculty
Fellowship Program Performed at Goddard Space Flight Center

Computation and Analysis of Averaged Monthly Annual Zonal and Global Albedos at the Top of the Atmosphere using Nimbus-7 Data of Albedos

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We have been involved in the analysis of the model of computation of *albedos of the top of the atmosphere developed by Harbans Dhuria and Dr. Curran. We computed the averaged monthly zonal cloud fractions using albedo data (Jan. 1979 - Oct. 1982) from Nimbus-7, albedos for cloud-free atmosphere and albedos for cloudy atmosphere. We computed the albedos (Jan. 1979 - Oct. 1982) using the cloud fractions, albedos for cloudy atmosphere, albedos for cloud-free atmosphere, solar zenith angle, sun's declination and latitudinal bands of $4.5^\circ (90^\circ N - 90^\circ S)$. The computed zonal albedos were averaged over northern hemisphere and southern hemisphere and global. The technique of computing averaged values of global albedo was modified to include appropriate weighting functions

Ratio analysis and difference analysis was performed for computed albedos with observed data from Nimbus-7 and diurnal adjusted albedo data. Through analysis we found that the values of albedos were within expected range of values.

*Albedos: Averaged monthly, annual zonal and global albedos at the top of the atmosphere.

The Nimbus-7 satellite is sun synchronized. The Albedo data collected from the satellite (Nimbus-7) represent the values at noon time of the day. The assumption is that averaged daily albedo is the function of the length of the day and characteristics of the latitude and the sun's declination.

Work Summary of the 1984 Faculty
Fellowship Program Performed at Wallops Flight Center

Electromagnetic bias of
laser backscatter from the ocean surface

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Recent measurements of ocean wave height by the NASA Wallops
Flight Center Airborne Oceanographic Lidar (AOL) yielded apparently
anomalous results. This off-nadir laser system produced a positive
electromagnetic bias (higher backscatter return from crests than
from troughs) for waves under low-wind conditions; and a negative
bias (greater power from troughs) for waves under high-wind condi-
tions. These results contrast with the results obtained by nadir-
looking instruments where the bias is negative under all wind
conditions.

The backscatter power distribution is proportional to the
joint probability density function of wave slope and wave elevation.
The present study analyzed two recently developed joint probability
density functions which were obtained over a wide range of sea-
states by entirely different approaches. Analytic expressions for
the electromagnetic bias, as a function of specular angle, were ob-
tained for both models. The functional forms of the bias for these
models are identical and are quantitatively consistent with the
Airborne Oceanographic Lidar results. Additionally, under condi-
tions of equivalent sea-state, both models are shown to give simi-
lar joint probability density functions and quantitative bias pre-
dictions.

Work Summary of the 1984 Summer Faculty Fellowship Program
Performed at Goddard Spaceflight Center

Performance Analysis of Microwave Snow Depth Models Using Nimbus-7 SMMR Data

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NASA Colleague: Thomas J. Schmugge, Code 924

The primary goal of the subject study is to evaluate the performance of several snow depth models using a large ground truth data set. Secondary goals are to conduct an analysis of model deficiencies and make recommendations for improvements in model performance.

The summer of 1983 was largely spent acquiring and processing the ground truth data and the Nimbus-7 microwave data for a large section of the upper Great Plains region of the United States. The study encompassed an area within 93 degrees West to 107 degrees West longitude and 38 degrees North to 52 degrees North latitude. Ground truth was supplied by more than 1000 climatic stations within the study area. Nimbus-7 SMMR data consisted of 50 day and night passes over the study area during the winter of 1978 and 1979. The microwave data was available for 5 bands ranging from 6.6 to 37 GHz, for both horizontal and vertical polarizations.

The models presented by Kunzi, Chang and Tiuri were tested against ground truth snow depth within the study area using a 56 by 56 array of 1/4 degree square cells. The latter portion of the 1984 Summer was spent in statistical analyses of the performance of these models. Predicted depths were compared to actual depths and the statistics of the deviations showed that the Kunzi model performed superior to that of Chang and Tiuri. The superior performance was determined to be due to the higher correlation of the 37 GHz - 18 GHz gradient brightness temperature to snow depth as compared to the 37 GHz alone as used in the Chang model. The Tiuri model also uses gradient temperatures, but averages the horizontal and vertical polarizations. This latter approach is almost as effective as the horizontal polarization used alone (Kunzi model), but is masked by poorly fitted model parameters.

Future work will concentrate on the time series data set in order to more fully understand the interrelationship between the microwave signature and snowpack properties during melt-refreeze cycles. Current models perform best if the pack remains fully frozen during the snowpack buildup process. The presence of liquid water in the snowpack during melt conditions causes a strong response in the microwave signature that disrupts the correlation of gradient temperature with snow depth. It is anticipated that inclusion of the low and high air temperature history into the snow depth model will yield improvements by providing more information about snowpack behavior during the melting phase.

Summary of Work Performed During the 1984 Summer
Faculty Fellowship Program at the
Goddard Space Flight Center

A Long Wavelength Infrared Heterodyne Spectrometer
for Solar Spectroscopy and Atmospheric Motion Studies

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NASA Colleague: Dr. Michael J. Mumma, Code 693

An infrared heterodyne spectrometer for observations of solar features at high spectral and spatial resolution was largely completed during the 1983 SFFP. This summer it was upgraded to operate using either continuously tunable diode lasers (TDL's) or stable fixed frequency CO_2 gas lasers as local oscillators (LO's).

A line-tunable CO_2 laser with a lock-loop frequency stabilizer was constructed and added to the optics of a TDL heterodyne spectrometer as an alternative local oscillator. In its present configuration, the instrument may be continuously tuned using TDL's fabricated for any portion of the 7-13 micron atmospheric window. This operating mode permits observations of spectral features which are inaccessible using fixed frequery y laser LO's. On the other hand, the use of a stabilized CO_2 laser LO allows the spectrometer to operate as an ultra-precise frequency meter. By recording the doppler shifted frequencies of spectral lines, radial velocities as small as ~ 10 ms^{-1} can be measured in this operating mode.

The instrument is now being relocated at the Goddard optical site 0.6 m reflecting telescope to be used for studies of periodic motions in sunspots. Power spectrum analyses of the measured velocities should provide information about the sub-surface magnetic field configuration in the region of the spot.

Work Summary for 1984 SFFP at Goddard

IADAF FORTH Image Processing System:

Comet Contour Maps

Dr. Edwin J. Grayzeck

Physics Dept

The University of Nevada Las Vegas

1984 NASA Colleague: Dr. D. Klinglesmith

LASP, Code 684

The main purpose of this summer fellowship was to participate in the development of the FORTH image processing system for the International Comet Halley Watch. The astronomical images will be sent to Goddard for digitization and analysis. The IADAF has a unique image analysis facility that is very flexible for the scientist user. In addition to simple plots of the data, a false color image screen is available in which the data can be enhanced to full potential. To provide the user with flexibility in studying the comet images, a number of peripheral graphics devices are available, e.g., the Tek 4010 terminal. It was the desire of the IADAF staff to implement both contour mapping and 3-dimensional imagery of the data. My main interest has been the implementation of a contouring package for astronomical images.

As part of this project, we also implemented a new version of the false color imagery package (DIDCS) which was used on galaxy data from a previous project. These two color images were used to test the enhancement routines for faint and extended objects. Finally, the orientation and filtering of these data provided useful tests of the analysis system. A new filtering technique of additive noise suppresion was successfully implemented. The FORTH image processing system is a powerful tool for quick look analysis which is particularly useful in the upcoming study of the time varying morphology expected in Comet Halley.

Work Summary of the 1984 Summer Faculty
Fellowship Program Performed at Goddard Spaceflight Center

Physically Based Hydrologic Modeling
Using Remotely Sensed Data

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Validation and sensitivity tests were conducted for a physically based single event hydrologic model previously developed under joint NASA-U.S. Department of Agriculture (USDA) sponsorship. The model makes use of a geographic information system incorporating remotely sensed data and includes innovative infiltration and soil moisture redistribution components.

The validation testing used observed rainfall-runoff records from an agricultural watershed in Iowa. In its present form, the model was found to provide good estimates of streamflow for large storms in excess of 2 inches (5 cm) total rainfall, but less satisfactory results for smaller storms. Planned modifications in estimating initial hydrologic abstractions should improve small storm modeling.

The model demonstrates the expected sensitivity to antecedent soil moisture conditions and to several empirical parameters used to estimate soil moisture content in the absence of reliable data. Such results serve to emphasize the importance of the ongoing research efforts in remote sensing of soil moisture.

A number of changes were made in the structure of the model to increase computational efficiency and to improve the interpretation of model results.

Assistance was also provided to a USDA Hydrology Laboratory project testing the model on an experimental watershed in Oklahoma. This project includes modification of the model to incorporate a different form of rainfall data and revised procedures to assign soil hydraulic parameters.

WORK SUMMARY OF THE 1984 SUMMER FACULTY FELLOWSHIP PROGRAM

PERFORMED AT GODDARD SPACE FLIGHT CENTER

2-4 GHz Low-Noise GaAs FET Amplifier

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A low-noise amplifier with bandwidth 2-4 GHz using GaAs FET MGF-1402
or MGF-1412 was designed and built. The design consists of three steps:

1) Computing the optimum noise source impedance.

2) Designing the input matching network.

3) Designing the output matching network and check stability.

The optimum noise source impedance is computed from the MGF-1402
s-parameters and its optimum noise figure F_{min} using a simplified noise
model consisting of an input noise current source and an uncorrelated output
noise current source. The input impedance of the noise model is calculated
from s_{11}. The input matching network consists of three transmission lines.
The high impedance series transmission line at the gate is employed to
resonate with the reactance of the conjugate of the optimum noise source
impedance. The parallel open and short transmission lines that follow
provide the necessary broadband match that the series line could not.
COMPACT is used to optimize the initial network to provide a return loss
of -14 dB or below. No output matching network is employed because attempts
to obtain an amplifier gain above 12 dB using output matching networks that
match s_{22} to 50Ω have caused it to oscillate. The amplifier has gain
between 9.6 dB - 11.8 dB over 2 GHz band. Stability analysis indicates
that it is stable over its bandwidth.

WORK SUMMARY - 1984 SUMMER FACULTY FELLOWSHIP PROGRAM
Goddard Spaceflight Center, Greenbelt Maryland

Geomorphological Mapping from Landsat Imagery

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Geomorphological Mapping, a major research tool of geomorphologists in Europe and other parts of the world, has been little used in the United States. To date, most of the mapping has been done using aerial photographs coupled with extensive field work. Satellite imagery has had limited application though a number of workers have suggested its value, particularly in research on larger regional landforms.

The main thrust of my summer research has been writing a chapter on geomorphological mapping for the book, Regional Landforms from Space, edited by Dr. Short. The book is due for publication in 1985. As a part of this, we have been working on the development of techniques of regional geomorphological mapping using Landsat and other space imagery. Our objective has been to test the applicability of space imagery to investigations of regional landform systems and the interactions of various processes operating within such systems.

Studies have been focused on Landsat MSS imagery of the Colorado River Delta in Baja California, Mexico, and on Landsat Thematic Mapper imagery of the region around Tuscon Arizona.

Work Summary of the 1984 Summer Faculty
Fellowship Program Performed at Goddard Spaceflight Center

The Nature of Low Redshift Quasars

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NASA Colleagues: Drs. Donna Weistrop and
                  William Romanishin, Code 681.0

We have analyzed deep (limiting magnitude $\sim$27 V mag. per square arcsec) CCD images of 30 low redshift (Z = 0.06 – 0.35) quasars. The data were obtained with the 4m telescope at the Cerro Tololo Interamerican Observatory, and were analyzed using an image deconvolution program written by W. Romanishin (NASA/GSFC). Each quasar image was modeled as the sum of a point – source (quasar) plus underlying "host" galaxy, convolved with the image point – spread – function. The latter was determined explicitly by one or more stars located in the same CCD field as the quasar. The adjustable parameters in the model were quasar – to – galaxy luminosity ratio, the scale – length of the galxy surface brightness distribution, and the galaxy Hubble type (effectively the bulge – to – disk ratio). In practice, only two galaxy models were used, corresponding to an elliptical galaxy and an Sb spiral galaxy. The model parameters were varied iteratively until an acceptable fit (minimization of χ^2) was obtained.

We find (in agreement with previous studies based on less sensitive and/or nonlinear data) that low redshift quasars are almost invariably surrounded by faint nebulosity ("fuzz") whose properties are consistent with those of an underlying host galaxy. Both spiral and elliptical hosts are found, although for Z $\gtrsim$ 0.1 it is difficult to distinguish between the two types. The galaxy luminosities and scale – sizes are typical for normal galaxies. Within our sample, we find no evidence for strong systematic differences between the host galaxies of radio – loud and radio – quiet quasars.

Finally, we find that many ($\sim$50%) of the host galaxies appear morphologically distorted at low surface – brightness levels, and/or are apparently associated with companion galaxies. This supports the widely – proclaimed view that galaxy interactions in some way facillitate nuclear activity.

Work Summary of the 1984 Summer Faculty Fellowship Program

Performed at Goddard Space Flight Center

Heterodyne Interferometer Measurement of Mirror Profiles

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The measurement of mirror surface profiles and charcterization of the statistical properties of the surfaces are important in the instrumentation of the space telescopes. Unevenness on optical surfaces produces scattered light , surface absorption, and poor image quality. High quality mirrors are essential parts of space telescope to collect electromagnetic waves in the optical region of the spectrum(that is wavelength longer than X ray and shorter than radio waves) and to obtain spatial as well as spectral information of celestial objects. FUSE(Far Ultra-violet Spectroscopic Explorer), a space telescope satellite, also named Columbus, scheduled to be in space in 1992, has a paraboloid and hyperboloid serving as primary and secondary mirrors respectively.

I **investigated** . several up-to date methods to measure the surface profiles and the characterization of their statistical properties. A heterodyne interferometer system is speciallly designed to measure these mirror - profiles.

Work Summary of the 1984 Summer Faculty

Fellowship Program Performed at the Goddard Space Flight Center

Laboratory Studies of S_2 Under Simulated

Cometary Conditions

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NASA Colleagues: Dr. Bertram Donn and Dr. Marla Moore, Code 690

Comet IRAS-Araki-Alcock, 1983d, passed the earth at a closer distance than any comet of the last two centuries. This close approach allowed the comet to be observed with excellent spatial resolution using the International Ultraviolet Explorer (IUE) satellite facilities at NASA's Goddard Space Flight Center. Diatomic sulfur, S_2, was among the molecules detected by IUE scientists, with its distribution indicating that it came from the comet's nucleus and that its parent might be CS_2.

My work at Goddard has been to assist in setting up, testing, and operating equipment for an experiment to generate S_2 in the laboratory under simulated cometary conditions. A vacuum line, pumping station, cryostat for reaching temperatures below 15 K, an infrared spectrometer, and an optical multichannel analyzer have been utilized to date. Preliminary experiments indicate that proton radiolysis, used to simulate cosmic ray bombardment, indeed decomposes CS_2. Warming of irradiated CS_2 samples produces a blue luminescence which may be due to S_2 emission. Future studies will record the spectrum of the blue light and attempt to assign it to a chemical species.

Report on NASA/ASEE Summer Program
by
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TECHNIQUES FOR COMPRESSION OF LAGEOS DATA

Ground based lasers can emit short pulses of light and record the round trip travel time for the pulse to return. This laser ranging is used to precisely determine the Earth's gravity field.

Compression of data from laser range measurements to the satellite LAGEOS is currently achieved by using GEODYN a computer program for satellite orbit determination. The compression technique is applied to the residual data, the result of subtracting the GEODYN orbit from the raw range data.

Although the use of GEODYN results in very accurate residuals it is also very expensive to use. We are developing alternate less expensive and hopefully equally accurate methods for producing residuals.

Work Summary of the 1984 Summer Faculty
Fellowship Program Performed at Goddard Spaceflight Center

Monolithic X-Ray Bolometer

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NASA Colleague: Harvey Mosley

We have designed and are in the process of producing a prototype X-ray
bolometer. This device will have an energy resolution 50 times better than
present solid state detectors. The operating principle of the device is
the following. An ultrasensitive thermistor is ion implanted in Silicon.
When an X-ray of a particular energy passes through the thermistor it
deposits an amount of heat proportional to its energy. This X-ray induced
temperature rise is measured by the thermistor. The device relies on the
low heat capacity of silicon and 100 mk operation temperature. Such a
bolometer is expected to have a theoretical energy resolution of 1eV on a
10 keV X-ray.

Since the device is made out of silicon, it is possible to bring to
bear all the techniques of silicon processing to make the device. Indeed,
my specific task this summer was to use standard silicon processing tech-
niques to fabricate an integrated circuit bolometer. The primary problem
was how to etch the device out of silicon. This involved the creation of
a new mask set and experimentation with different chemical etches.

Work Summary of the 1984 Summer Faculty
Fellowship Program Performed at Goddard Space Flight Center

Applications of Artificial Intelligence to
Command Management Systems

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NASA Colleague : George Sauble, Code 514.3

We have investigated the applicability of artificial intelligence
to the development of an Interactive Experimenter Planning System
(IEPS). IEPS is to be a software tool to aid scientists in
scheduling experiments for spacecraft missions.

Artificial intelligence techniques were found to be of potential
benefit in addressing the requirements of such a system by virtue of
their use of heuristics, their modularity of knowledge representation,
and the availability of natural-language interfaces.

We reviewed existing software that has been developed for
similar tasks, including JPL's DEVISER (an automated scheduling
program) and MITRE's KNEECAP (an interactive scheduler with a natural-
language interface). Both are artificial intelligence systems with
desirable properties, but neither was found to be well-suited to the
problem at hand.

Based on the current technology, we developed a tentative set of
features for IEPS (to be chosen among later on the advice of prospective
users), and identified potential problem areas in the development of
the system.

Work Summary of the 1984 Summer Faculty
Fellowship Program at Goddard Space Flight Center

ANALYSIS OF REAL-TIME COMPUTER GRAPHICS SYSTEMS

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The problem I considered this summer was the
\sibility of certain computer graphics models for the Control
\ter Systems Branch. This problem involved the analysis
performance of both the hardware and software components of
\puter graphics display systems. Most systems, even in the
\er priced personal computers have the capacity to display
\tic pictures with low resolution. The requirements in the
\trol Center Systems Branch (Code 511) are for relatively high
\solution displays with frequent updates and for rapid
\munication with host computers and with other display terminals.
Real-time computer graphics requires a considerable
\unt of the graphics routines to be in the hardware since
\ scaling, clipping, and rotating of complex pictures must be
\e fast enough for refreshing the screen thirty times every second.
\ese operations must be performed within the requirements of both
\oming telemetry and interfaces with local area networks (LANs)
\ console operators.
The hardware evaluation portion of my project involved
\sideration of data transmission speeds for both video output
\ network interface. Several systems were tested for these
\tures and for compliance with the two most common standards,
\GRAPH Core and GKS. Several benchmark programs were developed.
The software portion of my project had many facets. I
\ able to speed up a rotation algorithm so that the image of a
\ellite was able to be dispalyed in real time. Many other
\blems present themselves in the context of the efficient display of
\ta within the system requirements. The typical picture here
\ complex with a considerable amount of updating to be done both
\ a "main" picture and many subpictures every second. Options being
\sidered include : storing complex pictures in a database and
\arching for the picture, having multiple terminals for multiple
\splays, having one main picture always in memory with other necessary
\tures drawn as windows overlaying portions of the main picture.

Work Summary of the 1984 Summer Faculty
Fellowship Program performed at Goddard Space Flight Center

STUDY OF SMALL REFRACTORY GRANULES

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The formation of small (10-500nm) refractory particles under controlled conditions will be studied in a cluster beam system. In a typical reaction ;a dilute mixture of Silane (SiH_4) in Hydrogen will be reacted with Oxygen at low pressure (1 Torr) and high temperature (1000-1800°C) to form SiO. The SiO will be cooled and expanded under controlled conditions to form "clusters" - small groups of atoms or molecules, and the properties of these clusters $(SiO)_n$ studied by mass spectrometry and in some cases, collected and studied by optical spectroscopy. The apparatus is currently undergoing tests and our first runs may be carried out within the next few weeks. To date we have completed modifications to the vacuum system, and electronics, and are now checking out the new quadrapole mass spectrometer. We are installing a higher current power supply for the oven so that we can reach the necessary temperatures.

Some work has also been performed on graphite and amorphous carbon particles which are collected (by sedimentation of graphite or deposition of carbon "smoke") and studied by optical spectroscopy and scanning electron microscopy. This project is also continuing.

Work Summary of the 1984 Summer Faculty Fellowship
Program Performed at Goddard Space Flight Center

Tropical Storm Moisture and Subsidence Patterns
Inferred from the VISSR Atmospheric Sounder
(VAS) Water Vapor Channel

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VISSR Atmospheric Sounder (VAS) water vapor channel and visible images are examined for several hurricanes and tropical storms. In particular, Beryl, Irene, Debbie, Emily, Harvey, Chris, and Gert were studied. Most of the storms showed a large dry region on their western side and a large wet region to the east. Water vapor channel images have been shown to be indicative of the upper-tropospheric moisture. The dry region was interpreted as resulting from a general area of upper-level subsidence serving as a preferred area for the return flow of the tropical storm's active convection. The wet region to the east was caused by the upper-level moisture which resulted from the storm's previous 12 to 24 hour convection. It was found also that the dry region's area varies directly with the storm's intensity, indicating that they are coupled. Vertical motion calculations were possible for some of the systems where closer time resolution pictures were available, indicating motions on the order of 2 mb/sec.

The results of the present study agree well with the findings of Frank (1976) and Núñez (1981), who used a rawinsonde compositing technique around tropical storms and hurricanes. A mid-tropospheric region of low relative humidity was found on the western side, along with a moist region to the east. It is possible that an interaction between the storm and the

surrounding environmental flow creates a preferred scale of 500-600 km for the return flow.

Work Summary of the 1984 Summer Faculty
Fellowship Program Performed at Goddard Space Flight Center

Development of Automatic Techniques for
Extraction of Lineaments from Remote Sensing Imagery

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NASA Colleague: Dr. Hampapuram K. Ramapriyan, Code 932.1

After reviewing the literature on techniques for enhancement and extraction of lineaments, it became evident that an automatic system for extraction of lineaments would have to incorporate several computationally intensive low-level image processing algorithms to achieve consistent results. A preliminary systems framework was designed for integrating geological expertise, information from ancillary data, and the outputs from the low-level image processsing algorithms.

We are now testing several edge detection, line detection, and road tracking algorithms on LANDSAT data to determine which techniques should be included in the system and how the parameters for each of the selected techniques should be tuned. We are also testing a minimum path algorithm for tracking linear features from one side of a window to another.

In the future we plan to implement and test high-level procedures for manipulation of decision rules in the knowledge base and for controlling the sequence of low-level operations to be performed. We are also interested in development of parallel search techniques.

HIGH RESOLUTION GAMMA-RAY SPECTROSCOPY

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NASA Colleague: Bonnard Teegarden
                  Code 661

The low energy gamma-ray astronomy group that I was a part of have been conducting high-resolution gamma-ray measurements of various celestial gamma-ray sources. They have two different type high purity Germanium detectors: planar detectors for measuring gamma-ray energies between 20 -100 keV and a coaxial arrangement for the gamma-ray energy range 100 keV-10 MeV. The apparatus is flown approximately 20 miles above the earth's surface using high altitude balloons.

In the Fall of 1982 the group received funding to design a completely new detector arrangement which will have the capability to cover the complete gamma-ray energy range from 20 keV to 10 MeV and an imaging capability of less than 1°. The anticipated first flight of the new experimental set up will be Fall 1986.

My work this summer was divided between three projects. The first project which took 80% of my time was to evaluate a new detector system which is a "first attempt" by Princeton Gamma Tech to construct a detector similar to the one that will be used in the new system. At this time there still appears to be many technical problems which need to be solved. The second project was to design a star camera system to point the balloon flown apparatus with an accuracy of less than 0.5°. The third project was to help understand a Monte Carlo calculation for gamma-ray interactions in different type materials.

All three projects are still in progress and will be ongoing for the next two years. Plans are now being made to spend a sabbatical year at Goddard in 1985 to continue working on all three projects.

Work Summary of the 1984 Summer Faculty
Fellowship Program Performed at Goddard Spaceflight Center

Southern Ocean Mesoscale Variability
from SEASAT Altimeter Data

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An analysis of SEASAT altimeter data over the Southern Ocean
has been performed to develop a methodology for the measurement
and characterization of the mesoscale variability and its zonal
distribution. This is important because available long term,
in-situ measurements indicate that the mesoscale variability may
be important in global budgets of heat, salt, silica, and
momentum. Unfortunatly, the in-situ measurements are limited in
their spatial coverage and it is not clear that they are
representative of the entire Southern Ocean. The SEASAT altimeter
gives us a short time record that is nearly synoptic and from
which basin wide statistics can be derived.

Two approaches to the data were taken. In the first,
collinear repeat tracks from SEASAT were extracted for a number
of representative areas of the Southern Ocean. Statistical
measures of the along track (spatial) variability were derived
and compared. This is in contrast to previous investigations in
which the temporal variability between repeat tracks was used as
a   measure   of   the variability. The results indicate that
meaningfull zonal variations can be mapped in this manner with
residual variance, correlation length scale, and peak spectral
wavelength being good candidates as indicators of pronounced
activity. Simulations indicate that care must be exercised in
interpreting these measures in physical terms due to aliasing
introduced in the processing of the data for geoid removal.

The second approach, which is still in progress, involves
the use of minimized orbit crossover differences to obtain a time
series of variability of sea surface height at a particular
location. This mission length record can then be compared to
coincident current meter records available for an area off New
Zealand to check the validity and accuracy of the concept.
Extension of the method to other areas will provide data on the
temporal variability of the Southern Ocean during the entire
SEASAT mission.

Work Summary of the 1984 Summer Faculty
Fellowship Program Performed at Goddard Spaceflight Center

Cooperation Protocols Among Processors
in Quasi-Distributed Systems

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NASA Colleague: Walter Truszkowski, Code 502

Our general project is to characterize and model cooperation among
processors. Towards this end we have

- developed a concurrent graph searching algorithm which
  solves a multiple Traveling Salesman Problem;

- studied synchronization protocols among processors such
  as the Firing Squad Problem using deterministic automata
  and the Dining Philosophers Problem using a randomization
  element;

- utilized the general Distributed Communication System of Reif
  and Spirakis implemented in the Communicating Sequential
  Processes Language of Hoare;

- proposed a long-term project illustrating cooperation wherein
  processors will prepare/peruse reports with understanding.
  Such a project entails the use of a basic vocabulary, grammar
  rules, structural report frames, hierarchical trees delineating
  relationships between components of a report, and behavioural
  archetypes.

Work Summary of the 1984 Summer Faculty Fellowship Program Performed at

Goddard Space Flight Center

Gravitational Resonance and the Secular Fractional Decrease
of the Lageos Semi Diameter

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NASA Colleague: Dr. S. Sofia/Code 960.1

~ 60% of the secular fractional decrease ($\frac{\Delta a}{a\ day}$) in the semi diameter of Lageos is attributed to ion drag. However, the data contains a cyclic oscillation that is inconsistent with ion drag. Further increased solar activity should alter the concentration of ions and therefore the amount of drag; an effect not yet detected. At least 40% of the change as well as its negative signature is explainable on the basis of gravitational tidal resonance eq. (1)

$$\begin{bmatrix} k_2 = .388 \\ \text{Love no} \\ \text{equivalent in magnitude} \\ \text{to non dimensional core} \\ \text{polar moment of} \\ \text{inertia } C = .387 \end{bmatrix}_\oplus \times \left(\frac{\Delta a}{a\ day}\right)_L = \frac{J^0_{2\oplus}\ \sqrt{(w^2_L\ \ell_\odot)\ 2L_\odot}\ \ P^2_L}{J_{2\oplus}\ \sqrt{(w^2_\oplus\ R_\oplus)\ 2L_\oplus}\ \ P_\oplus\ \ P_{18.61\ yrs.\ \mathbb{C}}} \tag{1}$$

where $J^0_{2\oplus}$ is the secular decrease in the earth's quadrapole moment

$J_{2\oplus}$; W_L, $W_\oplus$ the spin angular velocities of Lageos and the earth. P_L, $P_\oplus$

the orbital periods of Lageos and that of the earth; $R_\oplus$, the earth's radius

$P_{18.61}$ yrs. an 18.61 yr. tide due to lunar node precession

$2L_\odot$, $2L_\oplus$ the Schwarzschild radii of the sun and the earth respectively;

$\ell_\odot$ is a quantum specified length that couples the total fermion spin of the

sun to its gravitational binding non equivalence of $f_{g\odot}$ $\left(\frac{M_G - M_i}{M_G}\right)$. It's

magnitude (3.02×10^3 km) is comparable to the empirical post Newtonian length

introduced by Moffet into the field equations of general relativity.

A related term,

$$\left[\left(\frac{J^0_{2\oplus}}{J_{2\oplus}\ v_\oplus}\right)\right]^2$$

where $v_\oplus$, the earth's escape velocity, provides an estimate of the Riemann tensor for absorption of gravitational radiation ($\sim 10^{-42}$ cm^{-2}) one comparable to that of Weber's. Spin induced variations in $J_{2\oplus}^o$ (see Soldano) account for the minor cyclic dependency of $(\frac{\Delta a}{a\ day})$. Elements of this quantum gravitational approach provide a natural explanation for the Q.E.D. numerics used to quantify the renormalization radiative correction for weak interactions thereby leading to an estimate of 93 Gev for the mass of the $\overset{o}{Z}$ neutral current intermediary for weak interactions and a Weinberg angle of 27°.93 ($\sin^2\Theta_w$ = .2194).

The Molecular Kinematic Viscosity of the Sun and Solar Turbidity

At present several constraints exist on any solar model such as (a) explaining the relatively low neutrino emissions (b) the H_e^3 to H_e^4 concentration ratio (c) the site of L_i^7 burning (d) the concentration dependency of solar oscillations.

Schatzman claims that the multiplication of the sun's molecular kinematic viscosity V by empirical Reynolds numbers leads to regionally dependent diffusion coefficients that resolve the above questions by the introduction of a mild turbulence in the radiative zone of the sun. A complication encountered in any description of internal flow processes is the wide disparity between the flow rate of heat and that of angular momentum, a difference characterized by a Prandtl no of $\sim 10^{-6}$.

A model has been developed to describe the molecular kinematic viscosity of the sun as a function of solar penetration. The momentum density inherent in viscous flow and its gradient, one characterized by the dimensional relationship $V_{mol} = \lambda \times v_\lambda$, is described by strictly measurable quantities. For example λ is given by eq. (1), that

$$\lambda = R_i [3/2 \ J_2 \odot + 1/2 \ \frac{w^2 \mathscr{R}}{g}]$$

follows from a description of solar oblateness where $J_2 \odot$ is the sun's quadrapole moment. The velocity term v_λ involves in part a second order thermal doppler shift (i.e.) $1/2 \ \frac{C_p T}{c^2}$ of the 160 minute solar oscillation.

The doppler two shift is a consequence of strict equivalence between inertial and gravitational masses. Strict equivalence is modified by a doppler two

shift of the hydrostatic equilibrium time $t_{fa} = (\frac{1}{G \ \rho_a})^{1/2}$; one that involves

a mass non equivalence in the gravitational binding fraction of the sun. Significantly, the latter leads to a quantitative estimate of the second important time period involved in solar transfer processes, namely the Kelvin-time $= 16.5 \times 10^6$ yrs.

These three types of fluctuations are quantitatively related to each other through the three elements that describe the solar opacity, (i.e.) mass density, the charge no density and the photon absorption crosssection σ.

Table (1) compares the theoretically derived kinematic molecular viscosity of the sun with those phenomologically inherent in the solar models of Sofia-Endal and that of Sears used by Schatzman.

Comparison of Theoretical and Phenomological Solar Molecular Viscosities as a Function of Solar Radius

Fraction f of Solar Radius	Theoretical	Sofia-Endal	Schatzman
.102	5.5	4.3	5.95
.300	9.0	5.1	7.0
.503	12.5	9.84	10.0
.773	17.86	16.6	24.0

The model provides a natural explanation for the low solar neutrino emissions as well as a basis for interpretation of Schatzman's Reynolds numbers. The ultimate source of the mild turbidity in the solar radiative zone is traced to a spin dependent gravitational binding non equivalence.

Research Summary of the 1984 Summer Faculty Fellowship
Program Performed at Goddard Space Flight Center

A Study of Meso-β Scale Prrturbations
of the Wind Field by Thunderstorm Cells

Stan L. Ulanski
Department of Geology and Geography
James Madison University
Harrisonburg, VA 22807

Analysis of data from the high density storm-scale rawinsonde network of SESAME showed that modification of the environmental flow by the squall line and tornadic cells of 2 May 1979 is detectable on the meso-β scale. In particular, mid- and upper-tropospheric divergence occurred well upwind (75-100 km) and over the tornadic storms. Maximum divergence (4×10^{-4} s^{-1}) is found at the 200 mb level. It is suggested that the divergence results from a combination of 1) blocking of tropospheric environmental flow by the storm cells, which act as obstacles, 2) anvil outflows, particularly from the tornadic cells, and 3) the exit region of the jet stream.

South of the upper-level divergence region, net subsidence results from the superposition of upper-level convergence over low-level divergence. Calculations indicate a vertical motion doublet with ascent (-40 μb s^{-1}) over the squall line and descent ($+40$ μb s^{-1}) approximately 70 km south of the squall line. The subsidence may have been responsible for the dissipation of cirrus clouds between network sites Hinton and Chickasha.

Work Summary of the 1984 Summer Faculty
Fellowship Program Performed at Goddard Spaceflight Center

Exact Exchange Method for Non-separable Theory
of Electron-Nitrogen Molecule Scattering

Charles A. Weatherford
Physics Department
Florida A&M University
Tallahassee, FL 32307

NASA Colleague: Dr. Aaron Temkin, Code 680.1

We have made three improvements in the non-separable theory of
electron-nitrogen molecule scattering in the fixed-nuclei approximation
at low impact energies: (1) a new procedure has been implemented
whereby non-local potentials, such as electron exchange, can be
incorporated in the non-iterative procedure, maintaining the block-
tridiagonal form of the coefficient matrix - this is done without
approximation; (2) a new technique for using an arbitrary non-zero
boundary for extraction of the r-dependent reaction matrix has been
implemented; and (3) a new procedure has been installed for integrating
the variable phase equation resulting from the reaction matrix out to an
r-boundary where the reaction matrix is a constant. Good agreement with
existing literature results has been obtained.

As a result of these improvements, a new level of accuracy and
stability has been reached in electron-molecule scattering.

APPENDIX 3

<u>WANTED</u>

Need someone to take care of and pay for your house or apartment this summer? Do you have an extra room for added income? Professors from across the USA are visiting this area for a fellowship/research program from May 29 to August 3, 1984 (dates are flexible). If interested, call Mrs. Irving at 636-6600.

Howard University
Washington, D.C. 20059

THE SCHOOL OF ENGINEERING
MECHANICAL ENGINEERING

April 16, 1984

TO: Out of Town Faculty Fellows

FROM: Mrs. C. Irving, Secretary

RE: Housing for the 1984 Summer NASA-ASEE Faculty Program

Below you will find some listings of rooms, apartments, or houses to sub-let or rent for this summer. A brief description and a contact person have been supplied for you. If you are interested, please call that person as soon as possible to make arrangements for summer housing. Good Luck!

2 Bedroom Apartment (only 1 bedroom is available) to share with other (man). Bath, kitchen, near Univ. of Md., car needed to get to NASA, $ 140.00 month. Call Hitten Padhier at 301-779-3151.

3-4 Bedroom furnished house   2½ baths   Prefer a family, located in W. Laurel, central air & cable TV, swimming optional, references and security deposit required, NOT AVAILABLE UNTIL JUNE 15th. $875 month plus utilities. Call Gordon Morse at 301-490-2015.

2 Bedroom Apartment (only 1 bedroom available) to share with other (man). Must be vegetarian or eat Kosher food. $187.50 & gas & phone per month. Near Univ. of Md. Call Steven Cravitz at 301-277-6423.

1 Bedroom & private bath in a house. Cooking facilities available. $175 per month. Car needed to get to NASA. Call Michelle Moore at 301-776-7762 at home or 301-454-5420 at work.

1 Bedroom apartment. Car needed to get to NASA. No air conditioning. $315 month (all utilities included) Call Pammy Pelnik at 301-277-4576. Non-smokers only.

1 Bedroom in a private home. Cooking privileges, air conditioned. Car needed to get to NASA. Non-smoker only. $200 month. Call Eileen Jacobs at 301-434-6548.

Large 3 Bedroom townhouse in prestigious Chevy Chase, Md. Three levels, 2 full baths, 2 half baths, private yard, air conditioned, security. Two or three women preferred. Family acceptable, but not with young children (have many antiques.) $900 month. Call Dr. Therrien at 301-656-5439 at home at night or on weekends.

3 Bedroom house Full basement, 2 full baths, air conditioned, car needed to get to NASA. $650 per month and utilities. Call Cindy Rigg at 301-277-7947.

THE SCHOOL OF ENGINEERING
MECHANICAL ENGINEERING

APPENDIX 4

Invitations to the Picnic

May 16, 1984

AN INVITATION TO THE ANNUAL PICNIC OF
THE NASA-ASEE SUMMER FACULTY FELLOWSHIP PROGRAM (SFFP) AT
THE GODDARD SPACE FLIGHT CENTER (GSFC)

The co-directors of the NASA-ASEE SFFP at GSFC cordially invite you to the annual picnic supper in honor of the 1984 Summer Faculty Fellows at GSFC and their families on Friday, June the Eighth from 5:00 PM to 8:00 PM at the Rec Center (an <u>all-weather</u> facility), Goddard Space Flight Center, Greenbelt, Maryland.

R.S.V.P.
   (This picnic is sponsored by the Department of Mechanical Engineering at Howard University).

Please return to or call:

   Department of Mechanical Engineering
   School of Engineering
   Howard University
   Washington, D.C.   20059
   Attention: Mrs. Charlotte Irving
   Telephone: (202)-636-6600

Check One

   I will attend the picnic supper on June 8, 1984.

   I will not be able to attend.

_____   _____
       (Name)   Institutional Affiliation

1984 NASA-ASEE Summer Faculty Fellowship Program at GSFC

Research-Seminar Schedule

<u>Fridays, 1:00 P.M.</u>   <u>Room 200, Building 26</u>

June 15	James Chen Stan Ulanski
June 22	Theodore Bogart, Jr. Patricia Carlson Daniel Caton Robert Eli Fern Hunt Andrew Simoson
June 29	Edwin Grayzeck Tim Heckman Reggie Hudson Robert Nelson
July 6	Bruce Bird David Glenar Robert Hayden Jerry Reber Tri Ha
July 13	Robert Bruninga Harbans Dhuria James Groves Edwin Núñez Frank Sciremammano
July 20	Rebecca Bogart Steve Daunt Jacob Huang Keith Jackson Charles Weatherford
July 27	Harold Brush Vivian Lawrence Ronald Leach Jo Ann Parikh Benny Soldano
Excused:	Joseph Dudis (at Wallops Flight Facility)

EVALUATION QUESTIONNAIRE
(to be filled out by Faculty Fellows)

APPENDIX 6

ORIGI..

OF POOR QU...

Name _____

Home Institution _____

Research Colleague _____

Brief description of research topic _____

_____

_____

Did you have contact with your research colleague prior to your
arrival? If yes, briefly indicate nature and extent of contact.

_____

_____

The objectives of the Summer Faculty Fellowship Program (SFFP)
in Research are: (1) to further the professional knowledge of
qualified engineering and science faculty members, (2) to
stimulate and exchange of ideas between participants and NASA,
and (3) to enrich and refresh the research and teaching acti-
vities of the participants' institutions.

Comment below to what degree the above objectives were or are
being fulfilled. When responding to (2) please indicate the
average number of hours per week you interact technically with
your colleague/GSFC personnels.

_____

_____

_____

_____

_____

Principal benefits of Fellowship to NASA.

_____

_____

_____

_____

Principal benefits of Fellowship to yourself.

_____

_____

_____

_____

What arrangements, if any, have been/are expected to be made for
continuation of project(s) through grants or contracts to fellow
and his institution.

_____

_____

_____

_____

List articles/reports, if any, which have been published/are
planned as a result of your research in SFFP at GSFC.

_____

_____

_____

_____

Please give a summary evaluation of the seminar lectures.

_____

_____

_____

_____

How did you learn about the program?

_____

_____

2. (For Second-Year Fellows) What new activities, if any, have you instituted in your school as a result of your participation in last summer's program?

_____

_____

_____

_____

_____

3. Have your office/working conditions been satisfactory? If not please describe the nature of the problems and estimate the number of manhours lost as a result.

_____

_____

_____

4. How could the summer programs be improved? (Please make as specific recommendations as you can on housing assistance, social activities, seminars, luncheons, research presentations, program evaluations, and others.)

_____

_____

_____

_____

15. Add any other pertinent descriptive comments not covered by your other answers which will help assess the program. Comment on weaknesses as well as strong points. Your   frank judgments will be greatly appreciated.

_____

_____

_____

RESEARCH FELLOWSHIPS

EVALUATION OF FELLOW BY
RESEARCH COLLEAGUE

Name of GSFC Colleague _____   Name of Fellow _____

GSFC Telephone Number

1. Period of Tenure:_____

2. Give a brief statement of the fellow's research program, and comment on the progress
    and principal accomplishments, during tenure of the fellowship.

    _____

    _____

    _____

    _____

    _____

    _____

    _____

3. The objectives of the Summer Faculty Fellowship Program in Research are (1) to
    further the professional knowledge of qualified engineering and science faculty
    members, (2) to stimulate an exchange of ideas between participants and NASA, and
    (3) to enrich and refresh the research and teaching activities of the participants'
    institutions.
    Comment below to what degree the above objectives were or are being fulfilled.

    _____

    _____

    _____

    _____

    _____

    _____

4. (a) To what degree is the Fellow a critical thinker?

_____

_____

(b) To what degree is the Fellow an original thinker?

_____

_____

Note to Colleague: In the rating scale below, describe the Fellow by checking, after each trait to be evaluated, the box that most nearly represents your opinion. Compare the Fellow with a representative group of postdoctoral scientists and engineers you have known during your professional career who have had approximately the same amount of experience and training as the Fellow.

	BELOW AVERAGE	AVERAGE	SOMEWHAT ABOVE AVERAGE	GOOD	UNUSUAL	OUT- STAND- ING	TRULY EXCEP- TIONAL
5. A typical group of 100 scientists at this level might be expected to divide about like this →	Lowest 40	Middle 20	Next 15	Next Highest 15	Highest 10		
(a) Degree of mastery of fundamental knowledge in the general field:							
(b) Knowledge of and ability to use basic research techniques in this field:							
(c) Self-reliance and independence in scientific work:							
(d) Motivation toward a successful, productive scientific career:							

6. Principal benefits of fellowship to NASA.

_____

_____

_____

_____

_____

7. Principal benefits of Fellowship to yourself.

_____

_____

_____

_____

_____

8. Add any other pertinent descriptive comments not covered by your other answers which will help assess the fellow's ability. Comment on weaknesses as well as strong points.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

9. How does the fellow compare with other professional research scientists or engineers in your laboratory?

Equal to   Very   Above   Below
the best☐   Good☐   Average☐   Average☐   Average☐

10. Would you wish to have the fellow return for a second summer with you.

Yes ☐   No ☐   No Comment ☐

11.

Summary Evaluation: Over-all Scientific Ability. Comparing the Fellow with a representative group of postdoctorals who have had approximately the same amount of experience and training, how do you rate the Fellow?

BELOW AVERAGE	AVERAGE	SOMEWHAT ABOVE AVERAGE	GOOD	UNUSUAL	OUT- STANDING	TRULY EXCEP- TIONAL
Lowest 40	Middle 20	Next 15	Next Highest 15	Highest 10		

_____   _____
Signature of Colleague   Date

HOWARD UNIVERSITY
WASHINGTON, D.C. 20059

APPENDIX 7

July 24, 1984

MEMORANDUM

TO: Daniel Frederick, Engineering Science and Mechanics,VPI
           Russel C. Jones, Office of Academic Affairs, Boston
                                                        University

FROM: Dah-Nien Fan, Co-director at Howard University
           1984 NASA-ASEE SFFP at GSFC

SUBJECT: On-site Visit of SFFP at GSFC by ASEE Faculty
           Programs Committee

    Jerry Hodge, Co-director at GSFC and I have planned the
following tentative schedule for your visit to GSFC on August 1,
1984:

9:30 - 9:45 AM	Opening Statements/Remarks
9:45 - 10:30 AM	Reports by Co-directors Discussion
10:30 - Noon	On-site Visits to Two Demonstrations/ Presentations by Selected Faculty Fellows and Colleagues
Noon - 1:00 PM	Lunch
1:00 - 2:00 PM	Informal Discussions with 1984 Faculty Fellow
2:00 - 3:00 PM	Summary Meeting

    Please report first to Main Gate House (Building No. 9 on
the attached GSFC Location Map) when arriving in the morning.
The first scheduled event is to be held in Room 200, Building 26.

Enclosure: GSFC Location Map

cc: Frank Owens, NASA Hdqrs.
     Fawzi P. Emad, EE Dept., University of Maryland