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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:

Dah-Nien (Dan) Fan
Howard University

Jerry R. Hodge
Goddard Space Flight Center

and

Fawzi P. Emad
University of Maryland at College Park

September 1984
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</thead>
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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-Mien 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 (Mission 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

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</tr>
<tr>
<td>1977</td>
<td>35</td>
<td>27</td>
<td>62</td>
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Of the seventeen (17) 1983 first-year SFF, sixteen (16) were invited to participate as 1984 second-year SFF. Fourteen (14) accepted the invitation 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 CSFC:

- ".. 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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<tr>
<th>NAME</th>
<th>UNIVERSITY</th>
<th>COLLEAGUE/CODE</th>
</tr>
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<tbody>
<tr>
<td>Bird, Bruce L.</td>
<td>Associate Professor Dept. of Physics</td>
<td>C. Korb/913</td>
</tr>
<tr>
<td></td>
<td>Anne Arundel Community College</td>
<td></td>
</tr>
<tr>
<td></td>
<td>101 College Parkway</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Arnold, MD 21012</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(301)269-7262</td>
<td></td>
</tr>
<tr>
<td>Bogart, Theodore F.</td>
<td>Associate Professor Electronics Program Coordinator</td>
<td>B. Joyce/663</td>
</tr>
<tr>
<td></td>
<td>University of South Mississippi So. Sta. Box 8246</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hattiesburg, MS 39401</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(601)266-4899</td>
<td></td>
</tr>
<tr>
<td>Brush, Harold</td>
<td>Macon Gardens #1A</td>
<td>D. Lokerson/724</td>
</tr>
<tr>
<td></td>
<td>Tuskegee Institute, Alabama 36088</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(205)727-8298 or 3383</td>
<td></td>
</tr>
<tr>
<td>Carlson, Patricia A.</td>
<td>Associate Professor Rose-Hulman Inst. of Tech. Humanities</td>
<td>D. Perkins/933</td>
</tr>
<tr>
<td></td>
<td>5500 Wabash Ave.</td>
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<tr>
<td></td>
<td>Terre Haute, IN 47803</td>
<td></td>
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<tr>
<td></td>
<td>(812)477-1511 x284</td>
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<tr>
<td>Caton, Daniel B.</td>
<td>Assistant Professor Dept. of Physical Sciences</td>
<td>D. Klingspeth/684</td>
</tr>
<tr>
<td></td>
<td>Salisbury State College</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Salisbury, MD 21801</td>
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</tr>
<tr>
<td></td>
<td>(301)543-6486</td>
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<tr>
<td>Chen, James R.</td>
<td>Associate Professor Physics Dept.</td>
<td>J. Ormes/661</td>
</tr>
<tr>
<td></td>
<td>State University of New York/Geneseo</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Geneseo, NY 14454</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(716)245-5284</td>
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<tr>
<td>Eli, Robert N.</td>
<td>Associate Professor Dept. of Civil Engineering</td>
<td>T. Schmugge/924</td>
</tr>
<tr>
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<td></td>
<td>College of Engineering</td>
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<tr>
<td></td>
<td>West Virginia University</td>
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<tr>
<td></td>
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<tr>
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</table>
Glenar, David A.  
Assistant Professor  
Dept. of Physics and Astronomy  
Colgate University  
Hamilton, NY 13346  
(315)824-1000 x 723

Heckman, Timothy M.  
Assistant Professor  
Astronomy Program  
University of Maryland  
College Park, MD 20742  
(301)454-5886

Hunt, Fern Y.  
Assistant Professor  
Dept. of Mathematics  
Howard University  
Washington, D.C. 20059  
(202)636-6830

Nunez, Edwin  
Assistant Professor  
Physics dept.  
University of Puerto Rico  
Rio Piedras, Puerto Rico 00931  
(809)764-0000 x 2550

Reber, Jerry D.  
Professor  
Dept. of Physics  
SUNY/Geneseo  
Geneseo, NY 14454  
(716)245-5281

Simoson, Andrew  
Assistant Professor  
Dept. of Mathematics  
King College  
Bristol, TN 37620  
(615)968-1187 x 308

Ulanski, Stan L.  
Assistant Professor  
Dept. of Geology  
James Madison University  
Harrisonburg, VA 22807  
(703)433-6130

Weatherford, Charles A.  
Associate Professor  
Box 981  
Physics Dept.  
Florida A&M University  
Tallahassee, FL 32307  
(904)599-3470

M. Mumma/693  
D. Weistrop/681  
D. Smith/921  
J. Simpson/914  
B. Teegarden/661  
W. Truszkowski/502  
J. Simpson/914  
A. Temkin/680
1984 NASA-ASEE SUMMER FACULTY FELLOWSHIP PROGRAM
AT THE GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND 20771

First-Year Faculty Fellows and Their GSFC Colleagues

Bogart, Rebecca R.  Instructor
Dept. of Computer Sci. and
Statistics
Univ. of Southern Mississippi
So. Station Box 8246
Hattiesburg, MS 39401
(601)266-4118

Bruninga, Robert E.  Instructor
U.S. Naval Academy
Electrical Engineering
Annapolis, MD 21402
(301)267-3492

Daunt, Stephen J.  Assistant Professor
Dept. of Physics & Astronomy
University of Tennessee
Knoxville, TN 37991-1200
(615)974-7849

Dhuria, Harbans L.  Assistant Professor
Dept. of Computer Information and
Systems Science
Univ. of the District of Columbia
900 F Street, N.W.
Room 518
Washington, D.C. 20004
(202)727-2704

Dudis, Joseph J.  Assistant Professor
Dept. of Mathematics & Computer Sci.
Univ. of Maryland - Eastern Shore
Princess Anne, MD 21853
(301)651-2200 x 647

Grayzeck, Edwin J.  Chairman
Department of Physics
University of Nevada
Las Vegas, NV 89154
(702)739-3507

Groves, James R.  Assistant Professor
Virginia Military Institute
Civil Engineering Dept.
Lexington, Va. 24450
(703)463-6331

P. Kurzhals/500
R. Kutz/974
M. Mumma/693
L. Kyle/931
J. McGoogan/970
D. Klinglesmith/684
T. Schmugge/924
Hayden, Robert S.  
Associate Professor of Geography  
Department of Public Affairs  
George Mason University  
4400 University Drive  
Fairfax, Va. 22030  
(703)323-2063

Huang, Jacob W.  
Professor  
Physics Department  
Towson State University  
Baltimore, MD. 21204  
(301)321-3009

Hudson, Reggie L.  
Assistant Professor  
Chemistry Department  
Eckerd College  
St. Petersburg, FL. 33733  
(813)867-1166 x 457

Jackson, Keith  
Assistant Professor  
Department of Physics & Astronomy  
2355 5th Street, N.W.  
Howard University  
Washington, D.C. 20059  
(202)636-6245

Lawrence, Vivian  
Assistant Professor  
Department of Mathematics  
Wellesley College  
Wellesley, MA. 02181  
(617)235-0320 x 3102

Leach, Ronald J.  
Associate Professor  
Mathematics Department  
Howard University  
Washington, D.C. 20059  
(202)636-6830

Nelson, Robert N.  
Associate Professor  
Chemistry Department  
Georgia Southern College  
Box 8064  
Statesboro, GA. 30460-8064  
(912)681-5681

-10-
Pavikh, Josephine A.
Associate Professor
Southern Conn. State University
Computer Science Department
501 Crescent Street
New Haven, CT. 06515
(203)397-4524

Sciremammano, Frank, Jr.
Assistant Professor
Department of Mechanical Engineering
Rochester Inst. of Technology
Rochester, NY 14623
(716)475-6819

Soldano, Benny A.
Professor of Physics
Department of Physics
Furman University
Greenville, S.C. 29613
(803)294-3437 or 294-2207
APPENDIX 2

Research Abstracts
1984 NASA-ASEE Summer Faculty Fellowship Program
at
THE NASA GODDARD SPACE FLIGHT 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 39401

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.
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.
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:

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<tr>
<td>59.3 ohms</td>
<td>268.8 mils</td>
<td>235 mils</td>
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<tr>
<td>100 ohms</td>
<td>100 mils</td>
<td>83.3 mils</td>
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</table>

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.
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.
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.
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 (≥ 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.
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
Knoxville, Tennessee 37996-1200

NASA Colleague: Dr. Michael Mumma, Code 693

The first high resolution laboratory FT-IR spectra of propane (C₃H₈) 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 κ=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.
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° (90° N - 90° 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.
Electromagnetic bias of
laser backscatter from the ocean surface

Joseph J. Dudis
Department of Mathematics and Computer Science
University of Maryland Eastern Shore
Princess Anne, MD 21853

NASA Colleague: Dr. Frank E. Hoge, Code 971

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 conditions. 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 obtained 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 conditions of equivalent sea-state, both models are shown to give similar joint probability density functions and quantitative bias predictions.
Performance Analysis of Microwave Snow Depth Models Using Nimbus-7 SMR Data

Robert N. Eli

Department of Civil Engineering
West Virginia University
Morgantown, West Virginia 26506

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

David A. Glenar
Department of Physics and Astronomy
Colgate University
Hamilton, NY 13346

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 CO₂ gas lasers as local oscillators (LO's).

A line-tunable CO₂ 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 frequency LO's. On the other hand, the use of a stabilized CO₂ 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
\( \approx 10 \text{ ms}^{-1} \) 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 suppression 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.
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 takes 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.
2-4 GHz Low-Noise GaAs FET Amplifier

Tri T. Ha
Department of Electrical Engineering
Virginia Polytechnic Institute and State University
Blacksburg, VA 24060
NASA Colleague: Dr. David Buhl, Code 693

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.
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 Tucson Arizona.
The Nature of Low Redshift Quasars

Timothy M. Heckman
Astronomy Program
Univ. of Maryland
College Park, MD 20742

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 galaxy 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 \( \chi^2 \)) 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 \( Z > 0.1 \) 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 (~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 facilitate nuclear activity.
The measurement of mirror surface profiles and characterization 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 specially 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

Reggie L. Hudson
Collegium of Natural Sciences
Eckerd College
St. Petersburg, FL 33733

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
Fern Hunt
Dept. of Mathematics
Howard University
Washington, DC 20059

NASA Colleague: David Smith, Code 921

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.
Monolithic X-Ray Bolometer

Keith H. Jackson
Department of Electrical Engineering
Howard University
Washington, D.C. 20059

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 techniques 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.
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.
The problem I considered this summer was the feasibility of certain computer graphics models for the Control Systems Branch. This problem involved the analysis of the performance of both the hardware and software components of computer graphics display systems. Most systems, even in the more priced personal computers have the capacity to display static pictures with low resolution. The requirements in the Control Systems Branch (Code 511) are for relatively high resolution displays with frequent updates and for rapid communication with host computers and with other display terminals.

Real-time computer graphics requires a considerable amount of the graphics routines to be in the hardware since scaling, clipping, and rotating of complex pictures must be done fast enough for refreshing the screen thirty times every second. These operations must be performed within the requirements of both incoming telemetry and interfaces with local area networks (LANs) to console operators.

The hardware evaluation portion of my project involved consideration of data transmission speeds for both video output and network interface. Several systems were tested for these features and for compliance with the two most common standards, GRAPHCORE and GKS. Several benchmark programs were developed.

The software portion of my project had many facets. I was able to speed up a rotation algorithm so that the image of a satellite was able to be displayed in real time. Many other problems present themselves in the context of the efficient display of data within the system requirements. The typical picture here complex with a considerable amount of updating to be done both as a "main" picture and many subpictures every second. Options being considered include: storing complex pictures in a database and searching for the picture, having multiple terminals for multiple displays, having one main picture always in memory with other necessary pictures drawn as windows overlaying portions of the main picture.
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 (SiH₄) 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.
Tropical Storm Moisture and Subsidence Patterns
Inferred from the VISSR Atmospheric Sounder (VAS) Water Vapor Channel

Edwin Núñez
Physics Department
University of Puerto Rico
Rio Piedras, PR 00931

NASA Colleague: Dr. Joanne Simpson, Head, Code 914

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

Jo Ann Parikh
Computer Science Department
Southern Connecticut State University
New Haven, Connecticut 06515

NASA Colleague: Dr. Hariprapuram 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 processing 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

Jerry D. Reber, Chairman
Department of Physics and Astronomy
SUNY/Geneseo
Geneseo, NY 14454

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.
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. Unfortunately, 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 meaningful 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.
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.
Gravitational Resonance and the Secular Fractional Decrease
of the Lageos Semi Diameter

Benny A. Solduno
Dept. of Physics, Furman University
Greenville, SC 29613

NASA Colleague: Dr. S. Sofia/Code 960.1

~ 60% of the secular fractional decrease \( \frac{\Delta a}{a \text{ day}} \) 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)

\[
\left( \frac{\Delta a}{a \text{ day}} \right) = \frac{J_2^\oplus \sqrt{u_L^2 v_\oplus^2} 2L_\oplus P_L}{J_2^\oplus \sqrt{v_\oplus^2 R_\oplus^2} 2L_\oplus P_\oplus P_{18.61 \text{ yrs}}} \tag{1}
\]

where \( J_2^\oplus \) is the secular decrease in the earth's quadrupole 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 \( P_{18.61 \text{ yrs}} \) an 18.61 yr. tide due to lunar node precession \( 2L_\oplus, 2L_\oplus \) the Schwarzschild radii of the sun and the earth respectively;

\( L_\oplus \) is a quantum specified length that couples the total fermion spin of the sun to its gravitational binding non equivalence of \( f \) \( \left( \frac{M_G - M_L}{M_G} \right) \). Its magnitude \( (3.02 \times 10^3 \text{ km}) \) is comparable to the empirical post Newtonian length introduced by Hoffet into the field equations of general relativity.

A related term,

\[
\left( \frac{J_2^\oplus}{J_2^\oplus v_\oplus} \right)^2
\]
where \( v_\oplus \), the earth's escape velocity, provides an estimate of the Riemann tensor for absorption of gravitational radiation (~ \( 10^{-42} \text{ cm}^{-2} \)) one comparable to that of Weber's. Spin induced variations in \( J^0_2 \) (see Soldano) account for the minor cyclic dependency of \( \frac{\Delta a}{a \ \text{day}} \). 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 \( Z \) neutral current intermediary for weak interactions and a Weinberg angle of \( 27.93^\circ \) (\( \sin^2 \theta_W = .2194 \)).

I am pleased to acknowledge a very informative conversation with Dr. David Rubincam, Code 921.0, that led to my reexamination of this subject.

I wish to thank Dr. S. Sofia for sponsoring my stay at Goddard that made this work possible; and Dr. L. Twigg and A. Endal for helpful discussions and computational assistance in the work covered by the 2nd abstract.
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 $^3\text{He}$ to $^4\text{He}$ concentration ratio (c) the site of $^7\text{Li}$ burning (d) the concentration dependency of solar oscillations.

Schatzman claims that the multiplication of the sun's molecular kinematic viscosity 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 $\nu_\text{mol} = \lambda \cdot v_\text{eq}$, is described by strictly measurable quantities. For example $\lambda$ is given by eq. (1), that

$$\lambda = R_\odot \left[ \frac{3}{2} J_2 + \frac{1}{2} \frac{v_\text{eq}^2}{g} \right]$$

follows from a description of solar oblateness where $J_2$ is the sun's quadrupole moment. The velocity term $v_\text{eq}$ involves in part a second order thermal doppler shift (i.e.) $1/2 \frac{L}{G} \frac{C T}{C^2}$ 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 $t_{fa} = \left( \frac{1}{G \rho_a} \right)^{1/2}$; 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 $\sigma$.

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

<table>
<thead>
<tr>
<th>Fraction $f$ of Solar Radius</th>
<th>Theoretical</th>
<th>Sofia-Endal</th>
<th>Schatzman</th>
</tr>
</thead>
<tbody>
<tr>
<td>.102</td>
<td>5.5</td>
<td>4.3</td>
<td>5.95</td>
</tr>
<tr>
<td>.300</td>
<td>9.0</td>
<td>5.1</td>
<td>7.0</td>
</tr>
<tr>
<td>.503</td>
<td>12.5</td>
<td>9.84</td>
<td>10.0</td>
</tr>
<tr>
<td>.773</td>
<td>17.86</td>
<td>16.6</td>
<td>24.0</td>
</tr>
</tbody>
</table>

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.
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-8 scale. In particular, mid- and upper-tropospheric divergence occurred well upwind (75-100 km) and over the tornadic storms. Maximum divergence (4 x 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.
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

WANTED

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.
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.
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 all-weather 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

Fridays, 1:00 P.M.  Room 200, Building 26

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)
FELLOWSHIP PROGRAMS AT GSFC

EVALUATION QUESTIONNAIRE
(to be filled out by Faculty Fellows)

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 activities 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?

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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.

5. A typical group of 100 scientists at this level might be expected to divide about like this —

<table>
<thead>
<tr>
<th>Trait Description</th>
<th>Below Average</th>
<th>Average</th>
<th>Somewhat Above Average</th>
<th>Good</th>
<th>Unusual</th>
<th>Outstanding</th>
<th>Truly Exceptional</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Degree of mastery of fundamental knowledge in the general field</td>
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<td>(b) Knowledge of and ability to use basic research techniques in this field</td>
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<td>(c) Self-reliance and independence in scientific work</td>
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<tr>
<td>(d) Motivation toward a successful, productive scientific career</td>
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</table>

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.

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

Equal to  Very Above Average  Average  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: Overall 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?

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<thead>
<tr>
<th></th>
<th>Below Average</th>
<th>Average</th>
<th>Somewhat Above Average</th>
<th>Good</th>
<th>Unusual</th>
<th>Outstanding</th>
<th>Truly Exceptional</th>
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<tr>
<td>Lowest 10</td>
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<td>Middle 10</td>
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<td>Next Highest 10</td>
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<tr>
<td>Highest 10</td>
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</table>

Signature of Colleague  Date
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

July 24, 1984

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 Fellows
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 Hqrs.
Fawzi P. Emad, EE Dept., University of Maryland