FINAL REPORT

ON

THE 1982 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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SUMMARY REPORT

The 1982 NASA-ASEE Summer Faculty Fellowship Program (SFFP) at the NASA Goddard Space Flight Center (GSFC) was successfully conducted during the ten-week period from May 31, 1982 to August 6, 1982. Thirty-four (34) faculty members participated in SFFP at GSFC. Appendix 1 gives fellows' names, ranks, institutions and their colleagues at GSFC. Howard University (HU) provided administrative support for the 1982 SFFP at GSFC under terms of the NASA Training Grant NGT 09-011-060.

Here are some statistics on the 1982 Summer Faculty Fellows (SFF). Of the thirty-four SFF twenty-three (23) were first-year SFF and eleven (11) were returnees from the 1981 SFFP at GSFC. The percentage of 1981 first-year SFF returning is approximately fifty-three percent (53%) comparable to years past. Eight (8) SFF were from local institutions within commuting distance from GSFC and twenty-six (26) are nonlocal requiring temporary housing for the summer. Nine (9) SFF were from engineering or computer-science departments and twenty-four (24) were from various science depart-ments. One (1) SFF was from humanities. There were three (3) female SFF, five (5) black SFF and one (1) oriental SFF. Eight (8) SSF were from historically black institutions.

Four (4) of the ten (10) Directorates at GSFC participated in the 1982 SFFP. The four directorates are Mission and Data Operations Directorate (5 SSF), Sciences Directorate (14 SFF), Engineering Directorate (4 SFF) and Applications Directorate (11 SFF).

It is regrettable that the Engineering Directorate at GSFC decided to reduce drastically its level of participation in the 1982 SFFP by selecting only one (1) first-year SFF among many highly qualified applicants from engineering colleges. One (1) SFF was on station at Wallops Island, Virginia. The Wallops Flight Center was recently merged into GSFC.

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 SSF also made a ten-to twenty-minute oral presentation on his/her research project to other SFF. Highlights from these research activities are

*Two grants were awarded to SFF at their institutions.

*Nine proposals were pending or planned including one for establishing a cooperative program.

*Two consulting arrangements resulted from this summer's activities.

*Thirty-five papers and reports were published, submitted for publication or under preparation.

*Four new courses will be offered by SFF at their institutions as spin-offs of their summer experience.

The number of applications received by the 1982 SFFP at GSFC is the highest in recent memory. A total of one hundred forty four (144) applications was received. Of these one hundred and two (102) indicated SFFP at GSFC as their first choice. (See Table for comparing figures of the last five years.) Considerations of award were given primarily to first-choice applicants. Thirty-two (32) applicants were from historically black institutions.

TABLE SHOWING NUMBER OF APPLICANTS

Year	1st Choice	2nd Choice	Total
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 twenty-one (21) 1981 first-year SFF, fifteen (15) were invited to participate as 1982 second-year SFF. Twelve (12) accepted the invitation to return, but one (1) resigned subsequently a week before the '82 program was to begin. Twenty-four (24) first-year SFF accepted the fellowship again one (1) resigned at a very late date. Efforts to refill these vacancies were not successful. As a result thirty-four (34) SFF participated in the 1982 SFFP at GSFC.

Recruitment trips were made by co-directors prior to the application deadline to historically black institutions in the District of Columbia and in Maryland. The campuses visited were Howard University, University of the District of Columbia, Bowie State College, and the University of Maryland (Eastern Shore). Responses from these institutions were in general favorable. The number of applications received from the four institutions were, respectively, seven (7), six (6), five (5) and none (0).

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 visit to GSFC by first-year non-local fellow as granted only upon recommendation by his/her GSFC colleague.

Only one request for pre-program visit was received and it was granted.

Non-local SFF were, in general, satisfied with their summer housing. They received a list of available summer rooms, apartments and houses from HU in March 1982 with two subsequent updates sent in April and early May. The list and updates were compiled from responses to periodic advertisements in the Diamondback (the University of Maryland newspaper) and the GSFC newspaper. 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 the first day of the program. 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.

There were three scheduled social activities during the ten weeks. The traditional Annual SFFP Picnic at GSFC was held on June 10, 1982. The event was sponsored by the Department of Mechanical Engineering at HU. (See Appendix 4) Coordinated by the Chairman of Social Activities (elected among SSF) an after-work happy hour was held in a restaurant near GSFC in the later weeks of the program. It was well attended by SFF. In addition a buffet luncheon was held during the ninth week at the EDR (Executive Dining Room) at GSFC. Again this was coordinated by the Chairman of Social Activities.

Seminars and tours constitute the approximately 10% educational activities of the SFFP at GSFC. Tour of GSCF was conducted for SFF on the second Friday of the program; and a separate tour of a steel plant was made on June 24, 1982.

(See Appendix 5.) A tour of the Laboratories at the National Bureau of Standards (NBS) could not be arranged because of budget reductions at NBS. SFF were introduced to facilities and history of GSFC, the Space-Shuttle program, and the Get-away-Special Project by speakers within GSFC. A SFF volunteered to make a presentation on astronomy. The remaining three Fridays were for SSF to present their own projects. Inputs from SFF were incorporated in the planning of educational activities; and the majority of SFF was pleased with this new approach.

Evaluation of the 1982 SFFP at GSFC by fellows and colleagues was requested by co-directors. (See Appendix 6 for formats of evaluation forms.) Some of these feedbacks were incorporated in this report. Also a program-review session was held after the buffet luncheon at the end of the ninth week.

As in past programs close cooperation was maintained among all three co-directors throughout the year, and smooth and efficient operation was continuously assured. Though the University of Maryland at College Park was not funded in 1982, Dr. Fawzi P. Emad made the effort to participate from time to time in activities of 1982 SFFP at GSFC. This has projected continuity into the 1983 SFFP at GSFC which, if funded will be conducted by the University of Maryland.

To conclude the Summary Report here are some selected quotes from 1982 SFF at GSFC on the NASA-ASEE SFFP:

- "Outstanding program- keep it."

- "The program is money well spent ..."

- "I have contributed new ideas .... The result (is) that
  three papers have been generated with my colleagues ...."

- "... Provision of a device that will be incorporated into NASA's Infrared Heterodyne Spectrometer ...."

- "
  ... Allowing NASA personnel to get in touch with fundamental concepts in their field, which is the forte of academic people ...."

- "... It is a great benefit to those of us who have large teaching loads and little opportunity for research. The program provides first-hand experience with space science ...."

- "This summer's work will help to motivate a discussion of group theory in my mathematical physics course ... has provided me with ideas for undergraduate laboratory projects and for lecture demonstrations ...."

APPENDIX 1

1982 NASA-ASEE SUMMER FACULTY FELLOWSHIP PROGRAM
AT THE GODDARD SPACE FLIGHT CENTER
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APPENDIX 2

Research Abstracts

1982 NASA-ASEE Summer Faculty Fellowship Program

at

THE NASA GODDARD SPACE FLIGHT CENTER

Cross Section for Positronium Formation In
Positron-H$^-$ Collisions

Rutherford H. Adkins
Richard J. Drachman, Colleague

We have considered the formation of a positronium atom in its n=1, 2, & 3 states due to collisions of low energy positrons and H$^-$. The formation cross-sections are of interest in some astrophysical problems.

We have used Born approximation with Coulomb wave functions for the incoming positrons. H$^-$ and H are taken in their ground states. Exact as well as averaged Coulomb potentials are used in the interaction.

Twelve scattering amplitudes are being calculated corresponding to s- and p-wave scattering into each of the six final states of the positronium atom.

Extensive analysis indicates that only one of the scattering amplitudes is analytic.

Numerical calculations have begun, using the capabilities of the MACSYMA symbolic manipulation system, a very versatile computer programming system written in LISP and used for performing symbolic as well as numerical mathematical manipulations.

An early result of an s-wave cross section which is larger than expected is being tested.

Later work will extend the analysis to Distorted Wave Born Approximation, variational techniques, and more sophisticated wave functions for H$^-$.

Blackbody Radiation Calculations
and
Computer Displays

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James B. Heaney
NASA Colleague

The Optical Research Section of the Engineering Directorate is involved with optical components for use on the Cosmic Background Explorer (COBE). The optical filters for the Diffuse Infrared Background Experiment (DIRBE) were the components with which I was involved.

Although the filter properties had been measured earlier, there was a need for improved graphical displays of the results and computer programs to determine from the measurements if these filters met specifications. The display and calculation programs will be useful also to the on-going work of the section.

The display programs were designed to operate on the Nicholet 8000 HV Michelson Fournier Transform Spectrometer Computer. The measurements are made on and stored in this apparatus. Although there are general purpose display programs available, there were none which permitted the log of transmission vs. wave length or log of the wave length. Programs for such displays were written, tested, and used for DIRBE filters.

Both the general work of the section and the DIRBE effort requires the ability to make blackbody radiation calculations over a large range of wavelength and temperatures. Recent advances in technology have extended the ranges of wavelength and temperature beyond those normally covered by traditional graphs, tables or slide-rules. One method for such calculations uses Laguerre polynomials. Papers related to this method were studied and programs written for a HP-85 computer and the Nicolet using the Laguerre method. The Nicolet program for blackbody radiation calculation was expanded to use the well known Rayleigh and Wein approximations where wavelength and temperature ranges make these approximations useful and valid.

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

Analysis of IUE Spectra of Planetary Nebulae

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A planetary nebula system consists of an incandescent, slowly expanding (20 kmls) symmetrical shell of gas surrounding a compact hot star from which it was recently expelled and which is the source of the nebular florescence.

During the period 1978 to 1982, spectra spanning the wave length range 1100 $\overset{\circ}{A}$ to 2000 $\overset{\circ}{A}$ for over 70 of these objects in the Galaxy and Magellanic Clouds have been taken using the International Ultraviolet Explorer (IUE) satellite. The first task this summer consisted in converting the spatially resolved spectral images to extenction-free UV flux curves in order to sample the stellar and nebular fluxes at strategic regions in the spectrum. From these measurements, the following quantities have been calculated: apparent magnitudes of the central stars at 1300 $\overset{\circ}{A}$ and 1830 $\overset{\circ}{A}$, the Zanstra temperature, and the blackbody color temperature. Using data extracted from the literature, the distance from the solar system, the nebular radius, and the absolute magnitudes at 1300 and 1800 $\overset{\circ}{A}$, as well as the absolute visual magnitude, have been calculated for each object. Finally, two galactic population parameters have been calculated: $|Z_{kpc}|$, the height of a particular object above or below the galactic planes, and ΔV_r, the difference between the observed radical velocity of a particular planetary nebula and that expected for an object lying at the same distance from the galactic center on a circular orbit. From a comparison of plots of absolute magnitude versus nebular radius with theoretical mass curves, it is shown that the mass range for central stars is very narrow. Yet population characteristic over this narrow range are sharply distinct - lower mass stars are found in the halo, higher mass stars are confined to the disk.

Work Summary of the 1982 Summer Faculty Fellowship Program
Performed at Goddard Space Flight Center

Self-Documenting Database Systems: a database logic approach
to documentation for production-based artificial intelligence
systems.

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A self-documenting database system is one capable of autonomously document-
ing architectural (schema) and state (structural) changes necessary for
maintaining the systems performance goals.

This summer's work consisted in exploring database logic as a conceptual
framework for formalizing various concepts of self-documentation arising
from the study of production-based artificial intelligence (AI) systems.

Motivation for this summer's activities was provided by a report of the NASA/
ASEE Summer Study conducted at the University of Santa Clara in 1980, which
examined the feasibility of using advanced artificial intelligence and automa-
tion techniques in future NASA space missions.

Of the many AI systems formulated for the representation and use of knowledge,
production systems have been among the most promising. A production system
consists of a set of modules or procedures called productions and a database
on which the production acts. Each production denotes a condition-action
pair, the condition having to be satisfied by a state of the database before
the production can be applied to the state and the action (database changes)
specifying the result can be realized. Production-based AI systems require
autonomous database changes to maintain their performance goals and, there-
fore, serve as prime models for investigation.

Current efforts are devoted to constructing illustrative examples of databases
arising in production-based AI systems and specifying the sorts of documentation
that are required. Areas of research include documentation for state maintenance,
search strategy, and procedural control. This investigation is expected to
continue following the termination of the current summer program.

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

LIDAR MODIFICATIONS TO ACQUIRE BACKGROUND SPECTRAL DATA

Richard E. Berry
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The airborne oceanographic Lidar is mounted on a P-3 aircraft and flown over the coastal regions. There are two modes of operation, bathymetry and fluorosensing. The bathymetry mode measures the time of return of surface and bottom reflections to measure water depth. The fluorosensing mode measures the spectrum of the fluorescence induced by the laser pulse.

The modifications to the Lidar were in the 40 channel spectrometer used for the fluorescence measurements. The original photomultiplier tube pre-amplifiers contain gated high-pass inputs to block the steady background spectral data while amplifying the fluorescence pulse data. The modification is to parallel the gated high-pass amplifiers with D.C. coupled low-pass amplifiers and obtain background spectral data. The background data is to be acquired and saved on magnetic tape without reducing the pulse rate of the Lidar.

The project requires designing a 40 channel multiplexed A/D converter system. The conversions and data formatting are under 8085 microprocessor control. Interface and control programs are in EPROM with DMA data transfer to the HP 21MX data acquisition system. The system has been bench tested and is expected to start flight tests in August 1982.

INTERPRETATION AND DOCUMENTATION OF LANDFORMS FROM SPACE

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The ultimate goal of this project is to produce, along with my colleague Nick Short, a reference picture-book which will document and interpret various regions of the Earth as seen from Landsat imagery. We envision three stages to complete this project.

1) Pick   space imagery mainly landsat, but possibly. Skylab and Apollo photo's which depict the style of landscape indicative of a particular landform. Examples include karst, alpine glaciation, tectonic landforms, etc.

2) Gather supportive stereo aerial photo's, oblique aerial photo's, ground photo's, and maps which illustrate the same scenery as observed from space.

3) Write an explanatory text which integrates the larger scale photo's with the space imagery and includes some interpretation.

Stage one will be complete by the termination of the 10 week program and some work involving stage two will bave been started. Approximately -100 landsat images will have been picked to illustrate major landforms and landscapes from around the world. These images include landscapes whose topography have been dominantly influenced by one or more of the following processes: coastal, eolian, fluvial, glacial, karst, periglacial, tectonic, structural, volcanism and mass wasting.

We anticipate the final completion of this project in three years if supplementary funding can be obtained.

DIODE LASER SPECTROSCOPY OF CH_3D

Robert James Boyle

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Monodeutrated methane (CH_3D) probably contributes to a feature at $\sim 1150 cm^{-1}$ in the Voyager I spectrum due principally to propane (Maguire, Hanel, Jennings, Kunde, and Samuelson, Science, 5/81) and may, along with ordinary methane, contribute to the noisy appearance of this spectrum beyond $1100 cm$. Hence an understanding of the spectroscopic properties of this molecule in this frequency region is necessary to further our understanding of the structure and complex chemistry of Titan's atmosphere. Boyle and D. E. Jennings of the Laboratory for Extraterrestrial Physics have carried out an extensive survey of over 300 transitions in the 1135 to $1290 cm^{-1}$ region with an infrared tuneable diode laser (TDL) spectrometer. The bulk of these transitions have been assigned to the ν_3 and ν_6 bands of CH_3D with the help of published grating spectrometer surveys of lower resolution.

Data aquistion and preliminary reductions were completed during the summer of 1981. We have achieved a precision in frequency determinations of $0.0004 cm^{-1}$ with an absolute accuracy limited only by the reliability of calibration line frequencies. Previously unobserved A1,A2 splittings due to Coriolis interactions are clearly visible in our spectra. These splittings generally exceed those predicted by Pinkley, Rao, Tarrago, Poussigue, and Dang-Nhu (J. Mol. Spec. 68, 195) and Tarrago, Rao, and Pinkley (J. Mol. Spec. 79, 31) by 9%, implying a possible revision in the coupling constants between ν_3 and ν_6 .

A substantial part of the summers's effort was directed towards the analysis of line intensities, with the ultimate aim of deriving accurate band strengths. Corrections for sample impurities and broadening due to laser line width and pressure were applied to strengths based on line depths and the assumption of doppler line profiles. Both an analysis of repeated measurements and the dependence of derived intensities on the appropriate Hönl-London factors argue for an accuracy of 7 to 12% for the final values. However, a comparison with the predicted relative strengths of Pinkley, et.al. and Tarrago, et. al. indicate different systematic variations within each sub-band pointing to complex interactions between the ν_3 and ν_6 bands beyond those already accounted for by their analyses. This suggests that it may be necessary to complete a joint full band analysis of both ν_3 and ν_6 before an adequate treatment of band strengths will be possible. Such an analysis is underway in collaboration with W. E. Blass of the University of Tennessee.

DESIGH OF STABILITY CONTROL SYSTEM MODEL

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The summer's project was done in conjunction with the Servo-mechanisms section of the Electro-Mechanical Branch of the Engineering division. Primary efforts were to design, illustrate, and analytically and experimentally test a workable control system model for the operation of a magnetically suspended bi-directional linear motor. The motor is to be used as the Dynamic Balancer for an experimental magnetically suspended and operated Stirling cycle refrigerator.

Efforts were separated into three parts:

(1) determine, illustrate, and test analytically and experimentally the control system for two separate parts;

    a. magnetic suspension and control ~~positions~~, and

    b. physical/mechanical portions

of the dynamic balancer;

(2) analytically and experimentally test the combined portions as one complete closed loop (unit), and

(3) determine the optimum compensation for the complete control system.

Preliminary results suggest that, following the procedure of analysis and experimental testing outlined above, a designer should be able to design a proper control system with confidence.

Evaluation of A Technique for Determining
Thunderstorm Heights and Intensities from
GOES Infrared Data

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Previous investigations have revealed that thunderstorm height is
correlated with minimum infrared brightness temperature observed from
satellites (T_{min}). Both of these quantities are well correlated with
instances of severe weather associated with thunderstorms. Due to their
coarse spatial resolution (10km), GOES satellites yield T_{min}'s signi-
ficantly warmer (5-30°C) than actual values obtained from aircraft and low
orbiting satellites. This could yield a significant underestimate the
potential for severe weather from GOES infrared imagery. With this in
mind, Dr. Robert Adler's group at GSFC has undertaken the development of a
technique to adjust GOES T_{min} values to yield colder and more realistic
temperatures. After applying a lag correction, this technique utilizes an
axially symmetric Gaussian shape assumption to calculate an adjusted
temperature T_c as follows:

$$T_o' = [T_{back} - T_s][\frac{cr_s^2}{1-e^{-cr_s^2}}]$$

and:

$$T_c = T_{back} - T_o'$$

where T_{back} is a background temperature computed from an array of pixels
surrounding the coldest point, T_s is the GOES T_{min}, r_s is the radius of the

satellite instantaneous field of view, c is a slope or shape parameter and T_o' is $T_{back} - T_s$ at r = 0. This technique was evaluated by this author using high resolution (1km) brightness temperature data from a low orbiting satellite (TIROS-N).

The first step in the investigation involved finding severe weather cases in which TIROS-N data was collected concurrently with GOES data. Three different days of data were obtained and analyzed. They were 10 April, 20 May and 30 May, 1979, when severe weather occured in the Texas-Oklahoma region. On the basis of the analysis, several characteristics of the technique were noted. First, the technique works best for large mature storms most of which are imbedded in the anvil cirrus of organized complexes. Second, the technique yields less desirable results for growing storms which are commonly isolated and somewhat smaller in areal extent. An examination of the term C in the equation found that it was not an independent parameter depicting slope but was rather a shape parameter highly dependent on the difference $(T_{back} - T_s)$.

A second research area incolved the behavior of cloud parcels and their relationship to T_{min} above the tropopause. Stereo heights were determined and matched with TIROS-N T_{min} values in an attempt to establish a temperature-height relationship for overshooting thunderstorm tops in the severe weather case of 20 May 1979. This investigation is still in the initial stages and further research within the Severe Storms Branch is planned on this problem and the aforementioned temperature adjustment algorithm.

USER-PROGRAMMER DIALOGUE:
Guidelines for Designing Menus and
Help Files for Interactive Computer Systems

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This project studies the user-programmer interface for the Transportable Applications Executive (TAE), a collection of "executive" programs which interact with a user to manage the execution of application programs. Successful use of the TAE depends upon effective human-machine communication. Since machines are only a vehicle for the exchange, this classic statement boils down to a need to ensure a meaningful dialogue between the programmer and the user.

As we know from everyday experience, sending a message involves a series of choices: not only about the content, but also about such things as organization, sentence structure, word choice, and tone. To make things complicated, in most cases these choices must be made concurrently. To make things even more complex, these decisions are seldom clear-cut; usually they are trade-offs which require the "sender" to exercise judgment.

The product of my ten-week fellowship is a set of guidelines to aid the programmer in making the various decisions necessary for a clear user-programmer dialogue. These guidelines are divided into four sections: (1) Format, (2) Sequence, (3) Audience, and (4) Aim.

Format, in terms of this study, means the spatial and structural presentation of information. In short, this section deals with formal aspects of organization. Its goal is to promote an effective and efficient transfer of information between programmer and user. This section examines the issues of eye span and information processing, routine placement of information on the CRT screen, and meaningful use of blank space in panel displays.

While the first section covers the formal qualities of a panel display, in practice--except for menus--panels appear most often in series. Sequence deals with the procedural aspects of multiple panel displays. This section looks at the issues of timeliness of presentation, modularization of information, and patterns of user behavior.

The persons to whom a message is addressed--the audience--are not passive receivers. When they decode the message, they create meaning. Audience looks at the relationship among "programmer," "user," and "message." It covers the issues of analyzing the audience's knowledge, attitudes, and needs, anticipating the audience's inferences, and identifying textual ambiguities.

The person who sends the message determines many more things about the communication than just the content. The programmer's aim or intention shows up in everything from tone to format. Aim considers the programmer's purpose and covers issues of persona/voice, tone/style, and reader-based prose.

SUMMARY REPORT OF WORK PERFORMED AT GODDARD SPACE FLIGHT CENTER
FOR
NASA/ASEE SUMMER FACULTY FELLOWSHIP
SUMMER 1982

DETERMINATION OF POINT SPREAD FUNCTION AND STUDY OF RESTORATION
FILTER TECHNIQUES FOR LANDSAT-D THEMATIC MAPPER IMAGING SYSTEM

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ABSTRACT

Typically the optical sensing, electronic detection, digitization and
transmission of image intensity, as well as environmental factors, result
in an image that is geometrically distorted, radiometrically degraded and
contaminated with noise to a significant degree. In order to correct for
this deterioration of image quality, a variety of algorithms are used to
effect image restoration. Central to these efforts at image restoration
are imaging system identification and noise modeling.

Image system identification requires the determination of the system's
point spread function. The psf represents the manner in which the system
smears out in the image plane an intense point source in the object plane.
The system psf can be determined analytically based on the theoretical
responses of the various system components. Using information supplied by
Hughes' Aircraft Company, who designed and built the Thematic Mapper
instrument assembly for Landsat IV, the system psf for TM was determined.

If a Weiner-type restoration technique is used, then a model of the
noise-to-signal ratio is required. Design information on the noise-to-
signal characteristics of TM were unavailable. Lacking this design
information, another approach to determining this noise-to-signal ratio is
from an analysis of scene data obtained from early pictures returned by
TM. This is an area for further investigation.

Another area to be investigated is the possibility of "superresolution."
The ability to extract information from the image beyond the diffraction
limit of the optical system can be achieved using the theory of analytic
continuation, provided the system psf is represented with sufficient
accuracy.

Modeling of Switching Power Regulators

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The project was undertaken in the Space Power Applications branch in collaboration with Dr. Gaddy and Mr. Rodriguez. The computing facilities available were a HP-9845 desktop computer and a CRT terminal connected to a DEC VAX computer. They proved to be very adequate.

The successful design of switching power regulators is normally based on the solid foundation of long experience of the designers. Difficulties as they arise are remedied usually by intuition; but their source often remains a mystery. The purpose of modelling switching power regulators is to shed light on the operation of the various parts of those circuits, and to explore quantitatively their stability and audiosusceptibility. A computer then becomes a valuable design tool. That was the goal of the project.

The first task was to explore the workings of a computer program SPICE available in the VAX system. It was tested on a regulator problem that was analyzed by the Norden Co. which published the results. Convergence of the dc solution was found to be slow sometimes.

The second task was to study the reports of research efforts conducted by TRW and, separately, by Duke University under contract with NASA; a tedious task. Various analytical methods were propounded in these reports. It was important to compare them and estimate the nature of the approximations involved. All of them were only capable of predicting small-signal stability. Besides, they required extensive manipulation of the state equations of the circuit prior to the stability study. The discrete-time domain simulation, modified appropriately, seemed to be the most suitable to use in connection with SPICE.

Back to SPICE to attempt the method, considerable difficulty was experienced in setting the initial conditions. It was later discovered that initial conditions were a serious weakness of SPICE. It was decided to test the proposed method on a small scale in the future, independently of any particular general-purpose program, and at the same time search for a better program on a better version of SPICE itself.

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

DATA ACQUISITION SOFTWARE WITH LSI-11

Donald F. Collins
Warren Wilson COLLEGE
Swannanoa, N. C.
Aug. 1982

Data acquisition software was developed on an LSI-11 system for the purpose of bench-check experiments for the calibration of a Digital Processing Unit (DPU). The DPU is part of the Solar Wind Ion Charge Spectrometer (SWICS) system developed for the Solar Polar spacecraft mission.

The data acquisition software reads the DPU data (8-bit bytes) from a parallel input port to the microcomputer, checks for sync bytes, and, after sync is found, "stuffs" the sync bytes and successive bytes into a buffer of two-byte words for writing to disk. Because the parallel data come in a rapid sequence (a burst of eleven bytes every second, at the rate of one byte per seven milliseconds within each burst) the data acquisition software employs double buffering for the input and output. One input buffer is processed while the other input buffer is used for input. A similar double-buffered situation is employed for the output of the processed bytes onto disk: one output buffer to receive the processed bytes and the other output buffer for storage to floppy disk.

In order to process one buffer while the other is filling, the input is interrupt driven in order that the main program need not spend time polling the device for data. This is also referred to as "event driven" I/O.

Structured programming techniques were employed using Warnier-Orr diagrams - both in the design stage and in the final documentation stage. A recursive algorithm, written in LSI-11 assembly code, detects the sync-bytes which occur at four successive levels. The procedure to check for sync for one byte calls itself to check the next level of sync at the next byte.

The development of this software, at this point, requires a routine to send the output buffer to disk and a routine to initiate a direct-memory-access handler.

MODELS OF A NON-GLACIAL EARTH

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Models of the present atmospheric circulation are usually evaluated with meteorological observations gathered during the last century. It is of considerable interest to climate modelers to determine how well their models perform under radically different boundary conditions. This summer's work has involved my co-operation as a geologist with a group of climate modelers at the Goddard Laboratory for the Atmospheric Sciences. I developed a new set of boundary conditions -- the positions of the continents during a time when the Earth had little or no ice -- and determined whether the model could explain the data. It could not. I then examined possible causes for the discrepancy, and am presently working on a theory that the Earth may have been warmer at that time due a higher concentration of CO_2 in the atmosphere. I am now testing that theory with an independent set of geological data.

Work Summary of the 1982 Summer Faculty Fellowship Program
Performed at Goddard Space Flight Center

Magnetic Pair Production and Pulsar Gamma-Ray Emission

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The radio objects known as pulsars, which are generally accepted to be rotating magnetic neutron stars, are in at least two cases (PSR 0531 + 21, PSR 0833-45) also strong emitters of pulsed energetic gamma radiation. An understanding of the processes responsible for this gamma emission appears to require investigations of fundamental electromagnetic interactions in superstrong magnetic fields (of order 10^{12} Gauss). The work reported here has been concerned with one such process, whereby energetic photons may be converted directly to electron-positron pairs in the presence of the external field. This effect, known as magnetic pair production, is in fact thought to be responsible for the development of electromagnetic cascade showers in pulsar magnetospheres.

One major goal of this work has been to extend the range of validity of the currently available asymptotic results for this process, which yield photon mean free paths in the limits of high energies ($\hbar\omega \gg 2mc^2$) and low field strengths ($B \ll B_{cr} = 4.4 \times 10^{13}$ Gauss). Extensions both to lower energies and higher field strengths are necessary to cover the regimes of greatest interest in pulsar cascade theory. In addition, the energy distributions of the emergent e^+/e^- pairs are required for detailed modeling of the cascade process. Both of these goals have largely been met during this summer, and a report of this work is currently being prepared for journal publication.

ABSTRACT of summer research of Ely A. Dorsey, NASA-ASEE Faculty Fellow, University of the District of Columbia
1982

This research consisted of synthesizing earth models of the geomagnetic field. After this initial procedure, we related in a statistical way, our estimates form the MAGSAT mission, of the magnetic anomaly or magnetic field due to the crust, to equally distributed dipoles on the surface of the earth. This procedure is called equivalent source. Built in to our process was the statistical method of least squares. That is, our fundamental equation for the geomagnetic potential or total magnetic anomaly is

$$\Delta T = \left[-\vec{u}^2 \cdot \vec{\nabla} \left\{ \vec{u_1} \cdot \vec{\nabla_1} \left(\tfrac{1}{R} \right) \right\} \right] * \Delta \dot{j}$$

The Δj is the magnetic contrast or susceptibility of the source point. And the expression within the square brackets is simply a geometric source function expanded in spherical harmonics. The Δj is found by least squares. We also need to invert an $n \times m$, $n \gg m$ matrix. In addition we use statistical weights to effect our results. The technique employed is that of Lanczos. Our resolution methodology is primarily experiential.

It was also found curious that there existed a bi-modal distribution of correlation coefficients between gravitational and magnetic anomalies. The negative skew over the continent, the positive over the ocean.

It was also found that the statistical methods used to smooth data were giving too much smoothness.

It was also determined that optimal algorithim design for programs was not present. Instead concern was over storage capacity captured in the DIMENSION statement of the programs. APL was recommended as an additional language.

PR Tracking System

Reginald S. Heyward
Math and Computer Science
Hampton Institute
Hampton, Va.

Despite the fact that there is an old cliche' that says "the only thing that remains the same in change," we often resist change furiously even if it is in our best interest. There is a rumor circulated throughout most of NASA centers saying that Goddard has the worst Purchasing request (PR) system. Every one out of two PRs gets lost or delays in Goddard obsolete PR system. This problem has to be seriously addressed and solved. Dr. Kurzhals was given the cumbersome task a solving this mammoth problem. He assigned me the project of deciphering the current PR system, interfacing and updating it with our computer technological knowledge, in addition to writing a flow chart for the life cycle of a PR. Consequently, I will explain in detail the ramification of the life span of an arbitrary PR, the current PR system problems and how we will determine to solve these problems by interfacing the PRs with the computer.

PR TRACKING SYSTEM
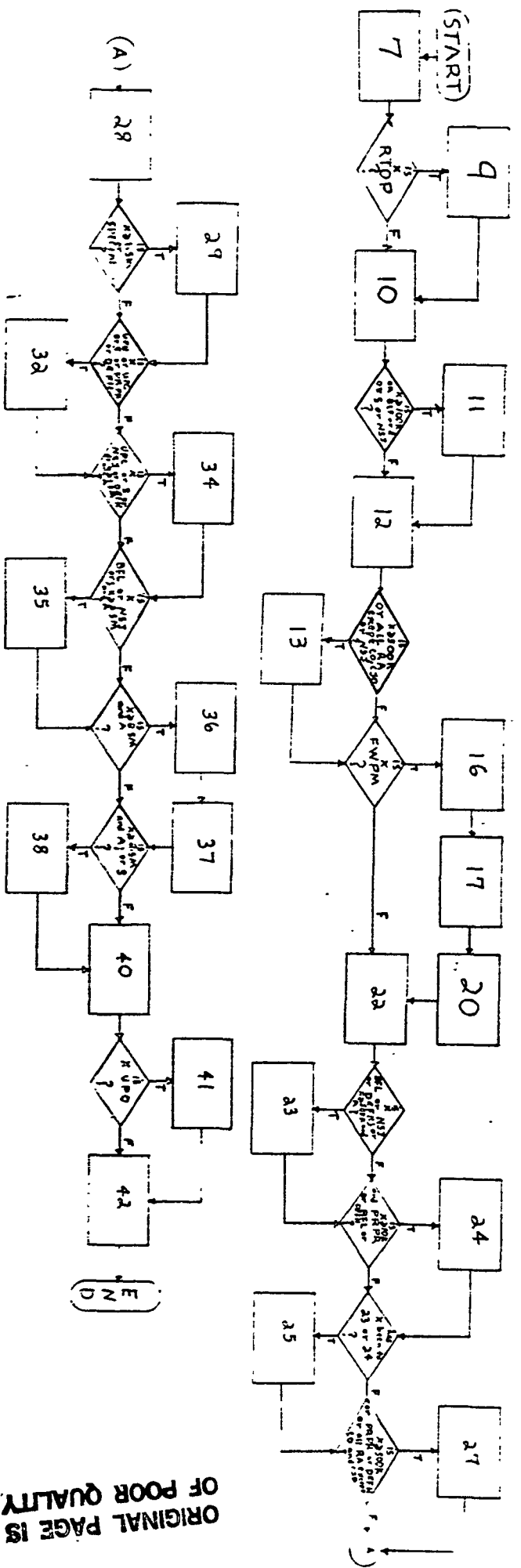
ACRONYMS

A-	Attachments
BFL-	Building Facility Lease
CO-	Charge Order
CJO-	Co-op Job order
D&FH-	Determination And Findings To Headquarters
E-	Emergency
FWPM-	Funded With Project Money
JNP-	Justification For Noncompetitive Procurement
NSS-	Nonpersonal Service Justification
PRPR-	PR Package Requirements
RA-	Required Addition PR Approvals
S-	Sensitive
UPC-	Unsolicited Proposal Commercials
UPO-	University Programs Officer
UPU-	Unsolicited Proposal Universities
X-	PR

SPECIAL- Financial Management Division notifies All fund
under special conditions.

7-Resources Representative
9-RTOP Manager
10-Branch Head
11-Division Chief
12-Directorate Financial Manager
13-Directorate Resources Manager
16-Project Financial Manager
17-Directorate Project Manager
20-Project Manager
22-Procurement Manager
23-Policy and Review Office
24-Office of Chief Counsel (Legal)
25-Procurement Manager
27-Director of Technical Directorate
28-Logistics Management Division
29-Financial Management Division
32-Project Procurement Division
34-Procurement Division

35-Director of Management Operation
36-Program Analysis Office
37-Comptroller
38-Office of Director
40-Accounting
41-University Program Office
42-Industry Assistance

A STUDY OF ATMOSPHERIC OZONE VARIATIONS
IN THE VICNITY OF PALESTINE, TEXAS

Anthony Jusick
Department of Physics
Stetson University
DeLand, Florida

Ozone mixing ratio height profiles and total ozone values measured by the SBUV spectrometer carried aboard the Nimbus 7 satellite have been analyzed in a latitude-longitude window of width 10 and 60 degrees centered about Palestine, Texas. Orbital data averaged over this window have been studied on a daily basis in order to ascertain whether significant fluctuations occur on this short a time scale. Deviations of the daily mean profile from the monthly mean profile varying with a regular period of from 3 to 4 weeks have been observed in the months of November and December, 1978. These regular fluctuations may be due to the presence of planetary waves in the stratosphere.

The remainder of the year's data is being studied for similar effects. Temperature height profiles in the same window will then be searched for similar deviations possessing an inverse correlation. This study will be continued at the home institution. A possible global analysis of the SBUV data may then be undertaken to search for similar effects. As the study of localized variations of this variety has not been reported in the literature it is hoped that the results will be of a publishable nature.

A COMPUTER STUDY AT GODDARD SPACE FLIGHT CENTER

BY T. N. Lee ,   1982 Summer Fellow
Electrical Engineering and Computer Science Dept.
The George Washington University

Issues of Computer Performance Evaluation cannot be answered absolutely. They must be addressed relative to many other diverse factors, such as economic issues, human factor, political considerations, and many more. In this summer, we are dealing with PACNET, POCC AUTOMATED COMPUTER NETWORK.

Due to the availability of the hardware procurment and the Blue Print of the future networks, we are able to build a Queueing Model for the future PACNET. PACNET is basically a HYPERchannel base network, a high speed, heterrogeneous devices, two 50 megabit/sec passive coaxial cable trunks network. Devices are connected to trunks through Hyperchannel bus interface units called Adapters. An adapter is divided into three logical components: trunk interfaces, a microprocessor with control and data buffering, and device interface. The data buffer provides two 2K byte logical buffers that may be fill/emptied in parallel, allowing a 50 megabit/sec transfer with an attached device. The Protocol of the Channel is Carrier Sense Multiple Access Staggered Delays scheme. The Queueing Model we built to analyze PACNET this summer is a continuation one for the last summer. Theory behind is M/G/1 Queueing Model based on Renewal Theorem.

Nice results were obtained which include a closed form expression for the statistics of the Network, a simulation model outlines. Throughput and time-delay investigation show the PACNET performs well above the required specifications.

REPORT ON SUMMER 1982 FELLOWSHIP:

Preamplifiers for the Infrared Heterodyne Spectrometer
John B. Newman*
Goddard Space Flight Center

The signal degradation in infrared heterodyne spectrometers operating with an intermediate frequency range from zero to 1.6 GHz is from two to six times poorer than the ideal value. An improvement by a factor of approximately 1.8 would result if the noise reduction now obtainable with narrow band amplifiers using gallium arsenide field effect transistors (GaAs FET's) could be realized in the spectrometer preamplifier following the optical mixer. Using narrow band GaAs FET amplifiers, greater sensitivity has been obtained in other instruments, notably in moonbounce signal receivers, nuclear magnetic resonance spectrometers and in superconducting magnetometers. Increasing the sensitivity and broadening the bandwidth of the infrared heterodyne spectrometer are continuing objectives of the Infrared and Radio Astronomy Branch of the Goddard Space Flight Center. During the summer of 1982 I have assisted in the pursuit of these objectives:

Gallium arsenide has a great advantage over many other semiconductors in that its performance improves as its temperature is lowered. GaAs FET amplifiers can be made to operate, showing a gain increase and a noise reduction down to liquid helium temperatures, ($\sim 4^{\circ}$ Kelvin). Examples of application exist with these devices operated at spot frequencies from 130 MHz to 12 GHz, from ambient to cryogenic temperatures. Design details may be found in the literature for amplifiers with noise factors from 1.07 to 1.2 (noise temperatures (T_N) from 20°K to 60°K) compared to a factor of 2 ($T_N \sim 290^{\circ}$K) for bipolar transistors. However, a major problem in their use in the IR heterodyne spectrometer is the difficulty of impedance matching over a broad band, in this case, from zero to two GHz.

Objectives for the summer's work include (1) assistance in the completion of an automated instrument for measuring the gain, noise temperature and noise figure of typical amplifiers, (2) making measurements on both commercially available and laboratory built amplifiers, (3) building some possibly useful devices and measuring them, and (4) setting out some possibilities for future work on this problem. The first two objectives have been met; measurements have been made on ten preamplifiers over the 0.5 to 2 GHz frequency range, six at both 290° and 100°K. Objective (3) is still in progress; a good deal of information has been gathered and there appear to be several concrete suggestions for future work. An investigation of the performance of monolithic GaAs FET amplifiers at cryogenic temperatures is anticipated before the summer's end. It is also anticipated that the performance of some locally built preamplifiers will be measured.

Finally, it ought to be clear that the progress made by one person in the summer on this project would not be possible without a very considerable prior effort by colleagues in the IR Branch at Goddard, notably David Buhl, John Hillman, Michael Mumma, and others. I happily salute and acknowledge their ongoing efforts!

*A NASA-ASEE Summer Faculty Fellow
Colleague: Michael J. Mumma. Infrared and Radio Astronomy Branch, Code 693, Goddard Space Flight Center, Greenbelt, Maryland 20771.
Permanent Address: Department of Physics, Towson State University, Baltimore, MD 21204.

Work Summary of the Summer
Faculty Fellowship Program
Performed At
Goddard Spcae Flight Center
1982

MAINE LANDSAT DEMONSTRATION PROGRAM

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College of Forest Resources
University of Maine
Orono, Maine

Over 90% of the state of Maine is covered with forest land. For this reason, it was appropriate to select a heavily forested area around Morrishead Lake as a Landsat study site. In this area, a forest vegetation classification system was developed and field tested. In addition, other aspects of this program included disturbance and change studies. This is a cooperative project between ERRSAC, NASA, Maine Dept. of Conservation, Maine Fish & Game Dept., Maine Department of Environmental Protection, and the University of Maine, Orono. The demonstration aspect of this program is almost completed. The next step is to develope and to implement an application plan. This application plan will provide a framework by which the Landsat technology can be transferred to field foresters, and also to small wood lot owners, throughout the state.

In addition to the Maine Project, several other programs were also conducted this summer with ERRSAC. On a pilot basis, some work has been accomplished on a Landsat tropical ecosystem demonstration program. In this project, a limited amount of work has been done to date with the mangrove forest type. This work would be aimed at not only mangroves, but also savannah and dry-high forest. A proposal has been written and submitted for funding that would allow vegetation classification, and change detection. If funding is obtained, the project will use MSS, Landsat-D, & TM to obtain the necessary data. This project will provide hard copy products useful to forest land managers and land planners. The project will require several weeks of field work that is scheduled to start about August 1, 1982.

Another project developed with ERRSAC in the SEM Basswood Program. This program is designed to test the use of the Landsat/IDIMS system to enhance the image quality on a SEM micrograph. A portion of an SEM micrograph of a basswood (Tilia americans) stem was used as the study material. Work thus far on this project indicates that the enhanced micrograph can be very much more useful, and provide more detailed information than the enhanced micrograph.

A STRATOSPHERIC ODD NITROGEN STUDY

Nicola Orsini
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Photochemical models have consistently overestimated the amount of nitric oxide (NO) in the stratosphere. There are many uncertainties associated with the input parameters that go into NO calculations. The major effort this summer has been to run a photochemical model to define the sensitivity of NO to the various uncertainties, and to compare model results with selected measurements.

The reason for the NO overestimation was found to be nitrous oxide (N_2O). At 50 km the N_2O calculations were about a factor of 13 larger than the measurements. The major process for the production of NO is

$$N_2O + O(^1D) \xrightarrow{k} 2\ NO$$
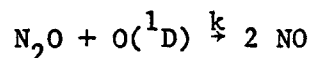
$O(^1D)$ are oxygen atoms in the ^1D state and k is the rate at which the process proceeds. Thus, an overestimation in N_2O leads to an excess in NO.

After careful analyses it was concluded that a smaller diffusion coefficient (K_z) had to be used to eliminate the discrepancy between measured and calculated N_2O. A diffusion coefficient is a measure of the vertical transport of minor gases through the earth's atmosphere. It is obtained mainly by modeling gases with well known production and loss processes. In particular, methane (CH_4) and N_2O are used.

Is a smaller K_z justified? Recent chemistry suggests that the destruction of CH_4 has been overestimated. CH_4 is produced at the earth's surface and transported to higher altitudes. Thus, one concludes that, K_z must be smaller to compensate for the smaller CH_4 loss. With a smaller K_z, the model predicts NO, N_2O, NO_2, and HNO_3 very well. These results will be submitted for publication in the coming fall.

ATTITUDE DYNAMICS AND CONTROL

Dennis Pence
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Burlington, Vermont   05405

Most of this summer has been spent learning about the mathematical theory of attitude determination and control. This has included the various parametrizations of the attitude of a spacecraft, the kinematic and dynamic equations of rotational motion, the types of sensor information, and the various control devices used to maintain a desired orientation as a satellite moves in its orbit.

My research interests are in approximation theory. I was particularly interested in the application of Kalman filtering techniques to the optimal estimation of the true attitude based upon sensor observations as they are obtained. Later in a batch process, a best least-square approximation for the attitude is sometimes calculated, either to find sensor biases or to provide accurate attitude information during the time of a scientific or image sensing activity. It is my personal opinion that some form of smoothing and approximation by polynomial splines would provide computationally advantageous alternatives for certain attitude data applications.

To gain a more practical understanding of this area, I have helped in the mathematical design of a simulator for the attitude control system proposed for ERBS (Earth Radiation Budget Satellite) which is scheduled for shuttle launch in the summer of 1984. The simulator is still in the early design stage with a target date of January 1983 for completion.

Finally, information has been collected describing the process for initial orbit acquisition, particularly the changes that will be required as NASA moves primarily to shuttle launches in the near future. This information as well as perhaps a module on attitude dynamics will be incorporated in an existing University of Vermont course on the Mathematics of Space Flight.

Work Summary
NASA-ASEE Summer Faculty Fellowship Program
Goddard Space Flight Center
June--August, 1982

LOW ENERGY GAMMA-RAY ASTRONOMY

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SUNY/Geneseo
Geneseo, NY 14454

The low energy gamma-ray astronomy group is a part of the Laboratory for High Energy Astrophysics. For the past 6 years the main thrust of the group has been to make high resolution gamma-ray measurements of various celestial gamma-ray sources. The spectra are taken using three high purity Germanium detectors which are flown approximately 20 miles above the Earth's surface using high altitude balloons.

Essentially, my work can be broken down into three projects:

1. interface a pulse height analyzer system to a PDP11/70 computer;
2. 'debug' and calibrate a Sun sensor detection system; and,
3. measure the efficiency of the three Germanium detectors.

Project 1 was completed in 3 weeks, project 2 is not completed, and project 3 took 6 weeks.

Project 1 was straightforward and amounted to converting information being output by the analyzer using 20 bits and converting it to 32 bits for compatibility with the PDP11/70. Also, the bits had to be swapped end around.

Project 3 involved taking gamma ray spectra for various calibrated sources in a fixed geometry. The efficiency is defined as the fraction of incident gamma rays that are detected in the full energy peak. Corrections have to be made for the age of the source, attenuation of gamma rays by the source holder, attenuation by air, attenuation by the beryllium window of the detector, emission probability of individual gamma-ray lines, and the κ escape peak (Ge κ_{α} X-ray production). The efficiency curve was measured between 7-1000 keV. It was flat from 7 to 100 keV and then decreased logarithmicly between 100 and 1000 keV.

THERMAL TESTING OF PUMPED TWO-PHASE BREADBOARD HARDWARE

Rogers, D. B.*: Prairie View A & M University
May 17, 1982 - July 23, 1982

OBJECTIVES

1. Experimentally determine heat transfer coefficients and pressure drops for two-phase flow of R-11 through copper tube evaporators heated from the top and fitted with heat transfer enhancement devices.

2. Analyze the thermo-hydrodynamics effects on system performance of series connected and parallel connected condensers and evaporators.

PERTINENT WORK PERFORMED

1. Redesigned original breadboard hardware to better model a heat rejection system, by installing the heaters on top of the tubes, and integrating condensers and evaporators in series and in parallel, in the fluid circuit.

2. Added heat transfer enhancement devices to the evaporator tubes, twisted tape in one evaporator and twisted tape with roughened tube wall in a second evaporator.

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* Formerly of Tennessee State University

3. Obtained heat transfer coefficients for internally
    smooth tubes and for tubes fitted with the heat
    transfer enhancement devices.

MAJOR RESULTS

1. Heat transfer coefficient for tubes fitted with
    twisted insert are 20% higher than tubes without
    inserts.

2. Evaporators up-stream of series connected evaporator
    have a detrimental effect on heat transfer
    coefficients of down-stream evaporators.

3. Down-stream evaporators and condenser have no effect
    on heat transfer coefficients of up-stream evaporators.

Work Summary
Summer Faculty Fellowship Program 1982
Goddard Space Flight Center

OFFICE AUTOMATION PILOT SYSTEM

Roberta Evans Sabin
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Coppin State College
Baltimore, Maryland

The Mission and Data Operations Directorate (Code 500) has planned an office automation pilot system which will include electronic mail and calendar, graphics generation, and a data base support for managerial recordkeeping. The system will be fully operational by Summer 1983. After a test phase, it could be adopted as an operational system if desired. My work this summer has been involved with user interface in this system.

I began a study of already existing and possible menus for the various components of the system as well as a general menu which would be available to a user at their initial contact with the system. As the final system will result from the efforts of several different contractors and staff members, cohesion among the components was sought as was a "user-friendly" interface which would encourage frequent use. The menu system is intended for use on newly purchased IBM personal computers which will interface with the host, an onsite IBM 4341, via a phone modem.

A hardware inventory was conducted, the results of which led to recommendations for purchase and placement of equipment within the Directorate. The effort here was to locate a terminal within 60 feet of the office space of every Code 500 employee. This effort has led to the establishment of lines of communication with many members of the Directorate and the informal publicizing of the office automation project.

Finally, in an effort to make recommendations regarding user education for the coming system, users of a mail/calendar system already in use at GSFC were polled. Their suggestions have prompted the initiation of dialogue with contractors who will deliver onsite user education during the coming 12 months.

Certainly, this work has acquainted me with some of the complexities of the hardware and software involved as well as, perhaps more importantly, the human factors involved. Automating communication and office procedures will require tact, patience, and long-range planning.

QUASI-PROJECTION-OPERATOR CALCULATION OF INELASTIC
RESONANCES IN LITHIUM-LIKE SYSTEMS

James S. Sims
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Mont Alto Campus-Penn State University
Mont Alto, Pennsylvania

The most clean-cut technique for calculating resonances in electron
collisions with atomic systems arises from the projection-operator
formalism of Feshbach. The effectiveness of the method stems from the
fact that "Feshbach" resonance energies emerge automatically from the
eigenvalues of a projected Schrödinger-like equation whose spectrum is
discrete and which can be solved as an ordinary bound state problem.
The Goddard Atomic Physics group has been interested in "Feshbach"
resonances in He$^-$ and Li for many years. They have developed a
quasi-projection-operator technique which relaxes the idempotency
requirement of the projection-operator formalism and has been used by
them in many fruitful two- and three-electron resonance calculations.
However, their computer program for three-electron systems was confined
to resonances below the first excited ($2\,^3$S) threshold.

My summer's work has been to extend the Goddard quasi-projection-
operator program so that resonances below any discrete threshold can be
calculated. Calculations are underway to clear up questions the
Goddard group has had concerning Li ^{2}P and ^{2}D resonances, and new research
is underway on He$^-$ resonances of interest to the Goddard group.

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

User Services and Programming Environments

Barbara T. Straka
Department of Computer Science
Jackson State University
Jackson, MS 39217

User Service is the service provided by a computing center
for its users. A programming environment is a development
environment which provides tools for automating software
development.

This summer's work took two separate directions. The
primary effort was the evaluation of user services provided
by the Science and Applications Computing Center. The
second activity was a study of the feasibility of creating
an integrated tool programming environment from a production
environment that evolved over time.

The evaluation of User Services resulted in the publication
of a number of documents. Two major documents were a Guide
to User Services and User Communication. The former
document is intended to act as a reference guide for
coordinating and improving the user services provided by the
Science and Applications Computing Center. The second
document includes a proposed information flow, list of
communication mechanisms, discussion of user friendliness,
and document mock-ups.

Observation were made for the study of integrated tool
programming environment but no conclusions have been
developed. It is conjectured that the production
environments can be modified to form the more productive
integrated tool environments.

STUDIES IN FLUID DYNAMICS IN ASTROPHYSICS

W. C. Straka

Department of Physics

Jackson State University

Jackson MS

The interstellar medium is a fluid of low and widely varying density and widely variable temperature. Among the most interesting parts of the interstellar medium are supernova remnant nebulae and stellar winds. In both cases, strong shocks are formed. A major problem in astrophysics is the relation of theory in fluid dynamics and the observations of such objects.

This summer's project had three major parts. The first was the modelling of shock-cloud interactions and relating these models to observations of filaments in supernova remnants. The second was a preliminary examination of the interaction between a stellar wind and the interstellar medium. The third was the conducting of a series of seminars in basic fluid dynamics for persons on site at Goddard.

The filament studies included examination of direct photographs and spectra of several remnant nebulae, especially the Cygnus Loop, and participation in two runs on the IUE. A model of a complete cloud-shock encounter was developed which explains the observations better than previous models. This model has been written into a paper which is being submitted to the Astrophysical Journal.

The stellar wind studies took a similar approach. An improved model is being developed for this phenomenon.

The seminar series conducted by me met 6 times for one hour each. The seminar started with the basic equations of fluid dynamics, continued with the development of the shock relations, and in the last few sessions developed several classic astrophysical problems. An average of 15 persons attended each session, or a total of 20 different persons attending one or more meetings. A number of the participants urged me to develop the notes written and handed out for the seminars into a book or a NASA monograph.

WORK SUMMARY OF THE SUMMER FACULTY
FELLOWSHIP PROGRAM PERFORMED AT
GODDARD SPACE FLIGHT CENTER

Analysis of Air Shower Data Looking
for Pulsar Resonant Time Structure

Hugh Tornabene
Department of Math, Science & Nursing
Bowie State College
Bowie, MD 20715

Pulsars emit wide band electromagnetic radiation containing a stable periodic pulsed component. Air showers are triggered by the impact of cosmic rays arriving at the earth's atmosphere. If some of the air showers are triggered by cosmic gamma rays orginating in pulsars then the periodicity of the pulsar might be reflected as an air shower arrival time periodicity.

The goal of this Summer's work was to scan a set of air shower arrival time data looking for such periodicity. A detected periodicity would be a clear indication of the existence of very high energy gamma rays coming from the pulsar. The candidate pulsar source is the Crab Nebula.

Following a discussion with Carl Fichtel at Goddard Space Flight Center the goal of the work was expanded to include a search for a similar 4.8 hour periodicity in gamma rays from Cygnus X3.

The Summer's work has consisted of:

(1) sifting the catalog of data looking for scans of Cygnus X3. Since Cygnus X3 happens to cross the Zenith daily at the site of the air shower array it was found that during the completion of other work, 2 scans of Cygnus X3 were made with an energy theshold of 10^{13} e.v. and 2 scans with an energy theshold of 10^{15} e.v.

(2) editing the raw data collected by the air shower array. Between July 72 and April 75, on 156 separate nights, a total of 6.5×10^{6} showers were detected by the 10 detector atmospheric Cerenkov light array. Data on most showers was recorded for each shower as a 32 byte 8 bit word. Most of this data is now blocked in a orderly form and absolute millisecond time calibration has been done for most nights.

(3) debuging the fortran routines to turn these 32 byte words into shower direction, arrival time and shower type, which work is still in progress.

9 JULY 1982

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

ELECTRON MICROPROBE STUDY OF OPAQUE OXIDE MINERALS

Richard D. Warner
Department of Chemistry & Geology
Clemson University
Clemson, South Carolina

Work during the first six weeks of the summer program concentrated on two principal areas: (1) microscopy of lower crust granulite and related samples and (2) making an automated MAC-400 electron microprobe fully operational. Among the problems encountered with the electron microprobe were the following: (1) vacuum leak on one of the three spectrometers; (2) drift in electron gun current; and (3) short filament lifetimes. The spectrometer was resealed, which alleviated but did not entirely eliminate the leak problem. Installation of a ceramic gun cable plus a special O-ring insert in the gun column greatly reduced gun current drift. Replacement of several O-rings in the top of the gun column and repair of a leak in the vacuum pump system improved the overall instrument vacuum, and thereby prolonged filament lifetimes to a workable 12-15 hours each. The two good spectrometers were aligned and peak and background positions determined for elements of interest. With the reference standards mounts prepared last summer, user files were created that permit routine quantitative analysis of the following minerals: olivines, pyroxenes, plagioclase feldspars, garnets, and opaque oxides. Analysis of additional minerals such as alkali feldspars, micas, and amphiboles will be possible once the third spectrometer is operational.

Sixty-five thin sections of rocks thought to sample portions of the earth's lower crust and upper mantle were examined with a petrographic microscope. The major minerals constituting each sample were identified and their relative abundance visually estimated. Photomicrographs were also taken to illustrate the rock textures.

During the last four weeks electron microprobe analyses were obtained of opaque oxide minerals in the above-mentioned samples. Microprobe analyses were also made of olivines, pyroxenes, and opaque oxides (mostly titanomagnetites and aluminian chromites, plus some ilmenites) in a suite of dolerite samples from South Carolina.

LABORATORY ASTROPHYSICAL INVESTIGATIONS

Thomas J. Wdowiak
Department of Physics
University of Alabama in Birmingham
Birmingham, Alabama

The investigations are a continuation of those pursued in the Astrophysics Laboratory at UAB and extend that work into the near and far infrared wavelengths. In addition densitometry of spectrograms taken in the investigators home laboratory, was carried out using GSFC facilities.

The summers work involved preparation of mixtures of CH_4 in argon and N_2, electrical discharge of the mixtures, and subsequent freezing out of the products at 10-15K. In certain cases H_2O and NH_3 were incorparated. Visible and near infrared (3500-26000A) spectral measurements in absorption were made with a Cary 14, and far infrared (3-50 microns) spectra were obtained with a Perkin-Elmer 621 operating in the reflectance mode.

The C_2^- ion was investigated in terms of its production in a discharge containing other constituents of astrophysical interest. The pricipài result was that C_2^- is not produced in a discharge in the presence of H_2O and NH_3 during argon matrix isolation, and was not produced during N_2 matrix isolation. This indicated that the investigators technique of producing large amounts of radicals in an argon discharge with subsequent matrix isolation is a highly efficient method and probably more efficient than photolysis.

Infrared studies with M. Moore and B. Donn have resulted in new understanding of some of the species trapped in the matrices studied at the shorter wavelengths. In particular interest was focused upon H_2O in the molecular and small cluster forms. Such a situation may be responsible for the 6.2 micron emmision observed in the "Red Rectangle" nebulosity.

Another important aspect of the summers work was densitometry of spectrograms of the formation of a 5800A emission feature in a matrix of $1CH_4:200Ar$ upon diffusion of reactive species with time and increasing temperature. The emission accompanied the formation of several absorption features that are candidates for for laboratory analogs of diffuse interstellar bands. Its import lies in the observation of 5800A emission by the "Red Rectangle" and a possible correlation of that phenomena with the diffuse interstellar band problem and cosmic organic chemistry in general.

An experiment to produce infrared emission features such as the 6.2 micron feature from the discharge products of CH_4 in argon, is under consideration. The summers experiance has also resulted in several avenues of future research to be carried out in the invesigators home instituion laboratory. These include the use of multiple diseharges of CH_4 and H_2O in argon impinging upon a common substrate to determine if a C_2^- : H_2O cluster system is possible. Such a system is of interest in terms of visible wavelength absorption, visible wavelengths fluorescence, and transfer of energy via phonon near resonance of a C_2^- energy level whose radiative transition is forbidden to an H_2O level capable of radiating at 6.2 microns.

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

TWO PROBLEMS IN MICROWAVE REMOTE SENSING

Herschel Weil
Department of Electrical and Computer Engineering
The University of Michigan
Ann Arbor, Michigan

A. Radar measurement of soil moisture content of foliage covered ground.

Professor Roger Lang of George Washington University and my Goddard
colleague, Dr. David M. Le Vine, have under development a computer model of
radar ground return in which it is assumed that the ground is covered by a
layer of small, electromagnetic scatterers simulating a leaf canopy. This
layer interferes with the desired deduction of soil moisture content from
the radar return. The present model is general in that it can be used
with any assumed scattering patterns for the individual leaves. So far
only the scattering patterns of disk-shaped scatterers, very small compared
to the wavelength of the radar signal or very much larger than the wavelength,
have been used for want of a method to compute the pattern for intermediate
sizes.

During my stay here, I have been supplying the needed patterns for
dieletric thin disk leaf models which do not have these size restrictions.
Specifically, I have transferred, to a NASA computer system, a program I had
previously developed at Michigan for computing the scattering and absorption
by thin disks of arbitrary size. There has not been time however, to
really use this program in Lang and Le Vine's model to explore the conse-
quences of having a cover of leaves whose size is of the order of the
wavelength.

B. High time resolution reception of 3-300 MHz radiation from lightning return strokes.

Accumulated measurements at GSFC and elsewhere have shown a frequency-dependent time delay for the onset of this radiation relative to the onset of lower frequency radiation. It is proposed that this lag is apparent; that the initial radiation has, in fact, simply been attenuated below the reception threshold of the receivers. Such attenuation would depend on the resistivity of the ground. The resistivity is frequency-dependent and negligible at the lower frequencies which do not exhibit the apparent time delay. The quantitative computation of the attenuation of signals radiated from sources near the ground (where the lightning return stroke starts) is quite involved. Although the basic theory was originally enunciated by Sommerfeld about 1909, it was not until recent years that accurate computationally efficient methods to apply the theory have been developed. Dr. Le Vine and I have worked out a procedure to incorporate this type of attenuation computation into an existing theory of lightning radiation due to Dr. Le Vine and which has successfully modeled a number of aspects of high resolution lightning observations but not the time delay effect.

I presented a lecture "When are spheroids good models for Rayleigh scatterers?" for the Climate and Radiations colloquium series.

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

CONSTRUCTION AND TESTING OF AN
INFRARED STAR TRACKER

David H. Zipoy
Astronomy Program
University of Maryland
College Park, Maryland

The Infrared group at the GSFC has an Infrared Heterodyne Spectrometer designed for observing astronomical objects. It has been used extensively to obtain high resolution spectra of the atmospheres of the sun, earth and other planets. It has also been used to a limited extent to observe stars. This requires very accurate guiding of the telescope which is difficult to impossible to do unassisted for very faint infrared stars. What is needed is a device that will automatically track these faint stars.

The first version of such a device was designed and built (by me) a few years ago but it only works well on fairly bright stars. A new version that should work on considerably dimmer stars is what is being completed under this Fellowship. The main novelty about this version is the implementation of computer-control rather than "hard-wired" devices such as lock-in amplifiers; this has proved to be less than half as expensive as the more conventional approach.

All of the parts have arrived and been assembled. Testing started on August 3 and will probably take a few more weeks to complete. I have collaborated closely with the Infrared group for about the last five years and so completing the testing will be no problem. It is hoped that it will be ready for our October observing run at the Kitt Peak National Observatory.

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 USA are visiting this area for a fellowship/research program from June 1 to August 6, 1982 (dates are flexible). If interested, call Mrs. Irving at 636-6600.

MECHANICAL ENGINEERING
Telephone (202) 636-6600

March 31, 1982

TO: Out of Town Faculty Fellows

FROM: Mrs. C. Irving, Secretary

RE: Housing for the 1982 Summer NASA-ASEE Faculty Program

Below you will find some listings of rooms and apartments to sub-let or rent for this summer. A brief description and 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!

3 Bedroom Apartment   1½ baths, air cond., living room, separate dining room, pool, dishwasher, furnished. Is on shuttle route to Univ. of Md. Want to sub-let for summer. $ 455 month & elec. Contact: Karen, Debbie or Pam 301-474-5534

2 Bedroom garden apt. furnished (optional), air cond., 3rd floor level, pool, shuttle to Univ. of Md. close-by. $ 390 month plus gas & elec. Contact: Dr. Rotheray, 301-454-7124 at work and 301-853-3073 at home.

1 Bedroom apartment, furnished, carpet, drapes, air cond., pool, tennis, basketball courts, on shuttle bus route to Univ. of Md., $400 month plus elect. & telephone. Contact: Nancy Eichhorn 301-439-8702 or Mr. & Mrs. Eichhorn at 301-974-4178. NOTE: Non-smokers only!

2 Bedroom furnished apartment, (only 1 large bedroom is vacant) - but it has 2 twin beds, 6th floor level in high-rise bldg., 1 bath, kitchen, telephone, prefer non-smokers. $ 157 each for two people; $250 for one person. Contact: Bill Bourne at 301-779-7337 (home).

2 Bedroom furnished apartment with air cond., pool, dishwasher, balcony, free parking. $400 month includes utilities. Contact: Bret at 301-345-5080.

2 Bedroom apartment, 2nd floor, air cond., pool, furn., $ 445 month plus elec. Contact John Crandell at 301-434-7786.

Basement apartment in house, 1 bedroom with own bath, kitchen, laundry privileges. Amateur radio ham. Contact: John Annen at Goddard - 301-344-8531 and 301-927-4015 at home. $ 100 month.

1 small bedroom apartment, no air cond., $250-300 month includes util. Contact Sam Selig at 301-344-5267 at work and 301-439-7581 daytime.

2 Bedrooms in a house, cooking and laundry privileges, car pooling possible. $ 125 month. Contact Mrs. Winifred Cameron at 301-344-8303 at work and 301-434-5129 at home.

1 Bedroom in a house, air cond., shared bath, cooking and laundry privileges, close to Goddard by car. $ 200 month. Contact: Gloria Cleveland at 301-577-3993.

1 Bedroom in a house (double bed), cooking and laundry privileges, dog and cat on premises, 2 miles from Goddard. $ 100 month - negotiable. Contact Grace Tamantini at 301-441-1947 at home, 301-344-7270 at Goddard, 301-750-2000 or 301-699-9066 to leave message.

Rent 1 large master Bedroom wing with full private bath in 3 bedroom apartment, air cond., 1st floor level, 2 large closets, furnished, cooking and laundry privileges, want non-smoker, 3 min. from Goddard. $ 175 month. Contact: Claire Serino at 301-794-8513.

1 Bedroom basement apartment in a house, separate entrance, separate bath and kitchen, large enough for 2 people. $ 300 month for 1 person, $250 each for 2 people, includes all utilities - negotiable. 7 minutes from Goddard. Ms. Narinder Ghaman at 301-344-5654 at work and 301-262-3038 at home.

1 bedroom in 2 bed. apartment, share bath, kitchen, air cond., pool, tennis, free parking. $ 250 month & $25 util. Prefer female. Contact Mrs. Wehr at 301-552-2861.

2 Bedroom apartment, furnished, 5 min. from Univ. of Md., air cond., sub-let, $145 month & elec. Contact Cathy or Jill at 301-927-6345 by May 15.

1 Bedroom in a house, private bath, kitchen, laundry and cooking privileges, separate entrance. $ 190 month includes utilities. Contact: Mr. or Mrs. Leung at 301-249-2104 at home. Prefer male, car pooling possible, 15 minutes from Goddard.

PLEASE NOTE: All of these rooms and apartments are relatively close to Goddard, especially if you have a car. Many people listed work at Goddard — those whose numbers begin with 344, and possible car pooling could be worked out.

Also:

3 Bedroom, 1½ baths, furnished apartment. Walking distance from Goddard. Large walk-in closets, kitchen privileges, balcony, air cond. $387 month plus Electricity & telephone. Contact: Prof. Panos Ligomenides at 301-552-2244 at home or 301-454-6842 at work. No pets.

1 Bedroom in private home, double bed, closet, bath, prefer non-smoker, dog on premises, air cond., cooking and laundry facilities. $ 175 month. Contact Mrs. Vera Rollo at 301-577-2436 at home. Less than 1 mile from Goddard.

1 Bedroom basement apartment, air cond., prefer non-smoker. $320 plus gas & elec. Contact Laurie Levinson at 301-587-0634. 15-20 min. from Goddard.

Rent 3 Bedroom house - Rambler, fenced yard, den, available June 1, air cond., prefer adults (with teenaged children, not young children - lot of knick-knacks in house), 10 min. drive from Goddard, near subway stop. $700 & elec. & water. Contact Ms. Terre Bowman at 301-577-7371 at work on M,W,F and 301-459-4733 at home on T,Th, weekends.

1 Bedroom in a house, share cooking and laundry facilities, 2 single beds, air cond., non-smoker only, dog & cat on premises. $150-175 per month. Contact: Allen deSarran at 301-390-6598.

Rent 3 Bedroom house, 2 full baths, partially furnished, air cond., dishwasher, liv. room, dining room, kitchen, washer, no dryer, APF Home computer in the house for use, about 15 min. drive from Goddard. To rent the whole house $550 month & gas & elec. Contact: Mr. T.R. Miles at 301-490-4023 at home and 301-730-3700, ext. 701 at work.

2 Bedroom Apt. to rent, near Univ. of Md., air cond., semi-furnished. $450 month includes utilities. Contact: Jill or Laurie at 301-779-7935 or Stacy at 301-474-1948. Available May 17.
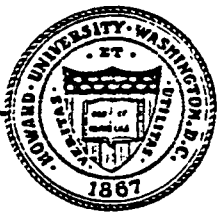
MECHANICAL ENGINEERING
Telephone (202) 636-6600

APPENDIX 4

Invitations to the Picnic

ORIGINAL PAGE IS OF POOR QUALITY

June 1, 1982

Dear Fellows:

As you will recall, the Annual Picnic of the NASA-ASEE SFFP at GSFC in honor of the 1982 Summer Faculty Fellows at GSFC and their families will be held on Thursday, June the tenth from 5:00 P.M. at the Rec Center (an all-weather facility), GSFC. The picnic is sponsored this year by the Department of Mechanical Engineering at Howard University.

The Co-directors urge you and your family to make every effort to participate in an evening of fun and friendship.

Sincerely yours,

Dan Fan

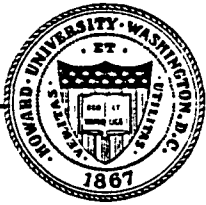- -

Please detach and return no later than Friday, June 5, 1982.

Check One

☐ I will attend the picnic supper on June 10, 1982. There will be _____ adult(s) and _____ child(ren) (11 years and younger) in my party.

☐ I will not be able to attend.

Fellow's Name _____

MECHANICAL ENGINEERING
Telephone (202) 636-6600

June 1, 1982

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 1982 Summer Faculty Fellows
at GSFC and their families on Thursday, June the tenth from 5:00 P.M. to
8:00 P.M. 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 10, 1982.

☐   I will not be able to attend.

_____   _____
        (Name)   Institutional Affiliation

-57-

APPENDIX 5

Tour of Bethlehem Steel

Reply to Attn of: .600

FILE 05747

Ms. Sharon Condon
Bethlehem Steel Corporation
Sparrows Point, MD 21219

FEB 0 9 1982

Dear Ms. Condon:

Per our telephone conversation of February 4, 1982, I am requesting a
tour of your plant facilities on June 24, 1982. At this time I would
estimate that 20-25 people will attend, however, I will be able to give
you a more accurate count in early June.

The group will consist of faculty members of engineering and science
departments from various universities around the country. These faculty
members are taking part in our Summer Faculty Fellowship Program sponsored
by NASA and the American Society for Engineering Education.

I will be in touch with you prior to the tour date to make last minute
arrangements.

Thank you for your consideration.

Sincerely,

ORIGINAL SIGNED BY

Jerry R. Hodge
Assistant to the Director of Sciences

cc: 600
     100
     251.2/Mailroom

600/JRH/csm:2/4/82

1982 NASA-ASEE Summer Faculty Fellowship Program

at

the Goddard Space Flight Center

TOUR OF THE BETHLEHEM STEEL PLANT

AT

SPARROWS POINT, MARYLAND

DATE: JUNE 24 (Thursday) 1982

TIME: TO BE ANNOUNCED

If you are interested in participating in the above scheduled tour of the Bethlehem Steel Plant, please complete and return the form below on or before June 15, 1982.

We are advised that a hard hat is required in the tour area and be sure to wear comfortable and safe shoes for climbing steps (maybe to the top of a blast furnace).

(Please detach along the dotted line)

I am interested in the tour of the Bethlehem Steel Plant at Sparrows Point, Maryland on June 24, 1982.

Number of people participating in my party including myself_____

Fellow's Name _____

EVALUATION QUESTIONNAIRE
(to be filled out by Faculty Fellows)

ORIGINAL PAGE IS
OF POOR QUALITY

1. Name _____

2. Home Institution _____

3. Research Colleague _____

4. Brief description of research topic _____

   _____

   _____

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

   _____

   _____

6. 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.

   _____

   _____

   _____

   _____

   _____

7. Principal benefits of Fellowship to NASA.

   _____

   _____

   _____

   _____

8. Principal benefits of Fellowship to yourself.

_____

_____

_____

_____

9a. 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.

_____

_____

_____

_____

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

_____

_____

_____

_____

10. Please give a summary evaluation of the seminar lectures.

_____

_____

_____

_____

11. How did you learn about the program?

_____

_____

12. (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?

_____

_____

_____

_____

_____

13. 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.

_____

_____

_____

14. 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.

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

	BELOW AVERAGE	AVERAGE	SOMEWHAT ABOVE AVERAGE	GOOD	UNUSUAL	OUT-STAND-ING	TRULY EXCEP-TIONAL
	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 the best ☐   Very Good ☐   Above Average ☐   Average ☐   Below 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 EXCEPTIONAL
Lowest 40	Middle 20	Next 15	Next Highest 15	Highest 10		

_____   _____
Signature of Colleague   Date