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Materials Presented at the MU-SPIN Ninth Annual Users' Conference

**Sponsored by NASA's Office of Equal Opportunity Programs
Minority University Research and Education Division**

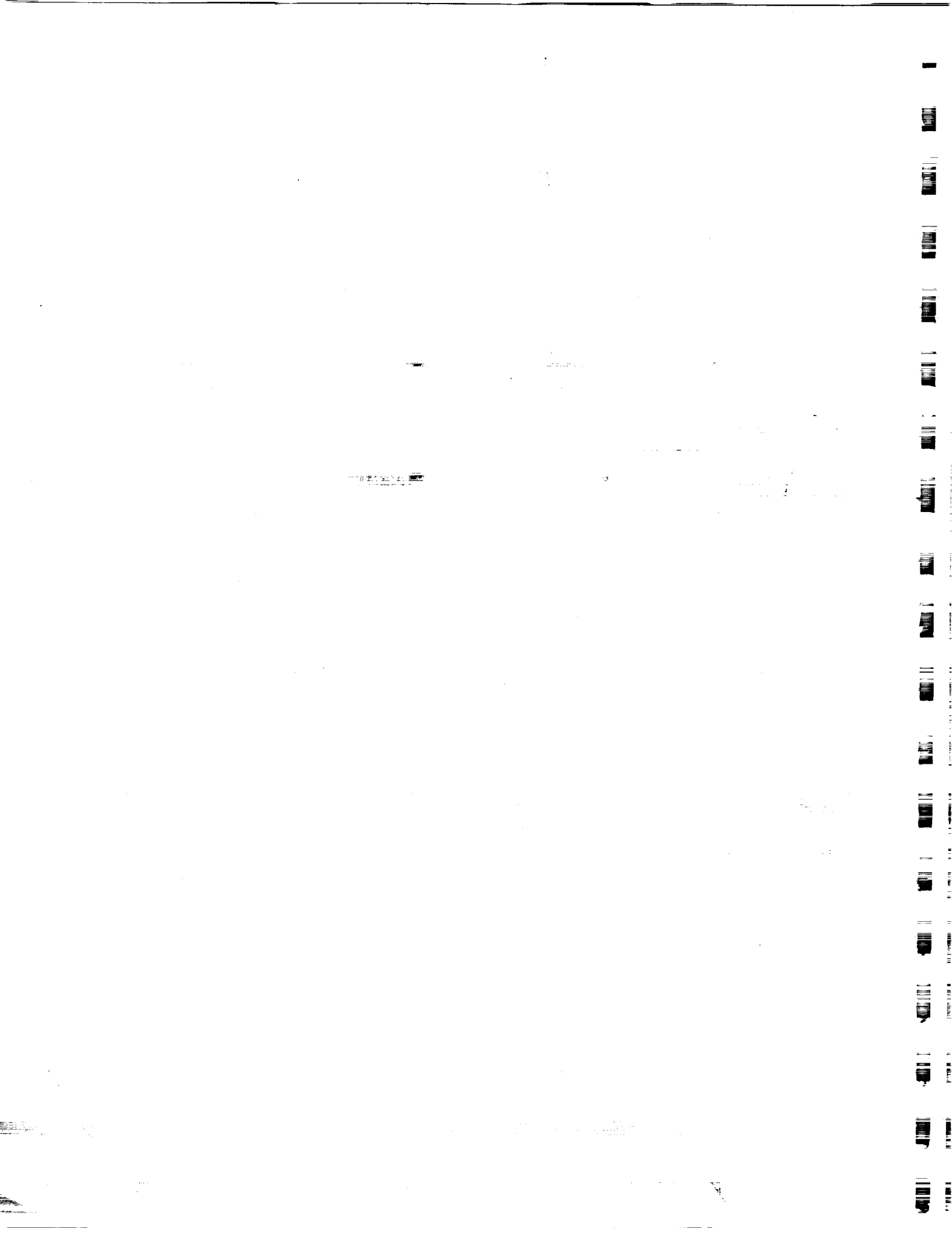
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*Proceedings of a Conference Held at
Florida International University
and the Wyndham Airport Hotel
Miami, Florida
September 21–25, 1999*



"Preparing for MU-SPIN 2000: A New MU-SPIN for the New Millennium"

November 2000



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National Aeronautics and
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Conference Summary



MU-SPIN Ninth Annual Users' Conference Conference Summary

James Harrington, MU-SPIN Project Manager and Valerie Thomas, LaVal Corporation

MU-SPIN's Ninth Annual Users Conference was held from September 21-25, 1999 and hosted by Florida International University, a predominantly Hispanic-serving institution located in Miami, FL. Its theme was *A New MU-SPIN for the New Millennium*. The MU-SPIN conference focused on showcasing successful experiences with information technology to enhance faculty and student development in areas of scientific and technical research and education. And it provided a forum for discussing increased participation of MU-SPIN schools in NASA Flight Missions and NASA Educational and Public Outreach activities.

The Conference opened on Tuesday September 21, 1999 with a Poster Session that featured 35 posters on a variety of topics. They included posters on:

- Space Science (Planetary Nebula M57, Longslit Spectra of Galaxy NGC 1569, Blackholes, Lagoon Nebula, and Cosmology for Non-Science Majors)
- Earth System Science (Learning Earth Science Through Visualization)
- Databases (Implementing a Database Management System, and Network Configuration and Database Programming)
- Computer Science (Interactive Pre-College Computational Science, Real-Time Constraints, PC Operating Systems, UML and RAS, Code Generation, Automatic Online Tests Generation, and Event-Driven Programming in Visual J++)
- Meteorology (Standards-Based Activities for all Students, Air Ocean and Climate Modeling, and Total Optical Depth Analysis for NO_2 , O_3 , and Aerosols)
- Education (Miami PREP/Projects Access, Student Assessment Research and Its Application to Curriculum Development, Preparing for the Computer Literate 21st Century, and Bringing the Internet to the Inner City)
- Other (Calculus With Mathematica, Testing of Commercial CCD Camera, Students: MU-SPIN at UTEP's Production Model for Y2K, and IP Telephony)

There also were posters for the MU-SPIN NASA Resources and Training Sites (NRTS), highlighting their accomplishments.

The opening plenary session was held on Wednesday, September 22, 1999. Dr. Mark Rossenberg, Florida International University Provost; Mr. George Reese, NASA Headquarters; and Dr. M.A. Ebadian, Florida International each gave welcome remarks. Mr. Orlando Figuero, NASA Goddard Space Flight Center was the keynote speaker. Ms. Bettie White and Ms. Milagros Mateu, both from NASA Headquarters, also made opening remarks. Mr. James Harrington, MU-SPIN Project Manager, set the overall tone for the conference in his remarks. The rest of the conference was a full schedule of activities, which included Opportunities for Involvement, Calls for Presentations, Break-out (i.e., follow-up to the Opportunities for Involvement sessions), and Wrap-up sessions.

Opportunities for Involvement sessions focused on Space Science, Earth Science, Education, and Aeronautics. These sessions provided insight into the missions of NASA's enterprises and NASA's Education program. Presentations by NASA scientists, university Principal Investigators, and other affiliates addressed key issues for increased minority involvement.

Space Science Opportunities for Involvement

This session provided a general overview of space science and the associated research opportunities; an overview of the Explorer Project; information on MESSENGER, a new NASA mission; Education Public Outreach, associated with space science missions; and MU-SPIN's Space Mission Involvement Initiative. These presentations gave the attendees some insight on the various ways of becoming involved in mission oriented space science research and the associated education outreach. In addition, plans for the upcoming MU-SPIN Space Mission Involvement Workshop videoconference was discussed.

Earth Science Opportunities for Involvement

Presentations in this session provided information on Earth science data available electronically, Education and Public Outreach strategies, MU-SPIN universities' projects, and the application of technology for management of Native American's tribal resources. The discussions focused on Norfolk State University's Atmospheric Research and Faculty Awards Research Experience; Howard University's Center for the Study of Terrestrial Atmospheres (CSTEA) Collaboration with the Goddard Space Flight Center; and the Geographic Information Systems Training on Tribal Lands in Northern California. It also included the Global Change Data and Information System (GCDIS), which provides access to data from multiple government agencies.

Aeronautics Opportunities for Involvement

The Aeronautics Opportunities for Involvement presentation addressed the types of aeronautics research conducted by NASA (including commercial needs), how universities can gain entry (summer faculty fellowships, contacting researchers at NASA Centers, and collaborating with NASA researchers), and the importance of knowing about the NASA Space Grant/EPSCoR Affiliates. Another important resource is the NASA University Affairs Officer; each NASA Center has one.

Education Opportunities for Involvement

The presenters in this session covered the Earth and space science education programs and projects, available for educators; professional development (NOVA workshops); a classroom of the future; and software tools for building and nurturing virtual learning communities. Handouts were distributed and the following web page urls were given out as sources for additional information:

- Earth Science Education Strategies
- <http://www.strategies.org/>
- <http://eospsso.gsfc.nasa.gov/>
- Echo the Bat - <http://imagers.gsfc.nasa.gov/>
- Tools for working with a virtual community
- <http://www.anlon.com/learn/>
- <http://www.webct.com/>
- The NOVA Project - <http://www.eng.ua.edu/~nova/>
- Explorers of the Universe - <http://explorers.tsuniv.edu/>

Calls for Participation

The Calls for Presentation session had presentations on the Next Generation Web Servers and topics related to minority universities (i.e., The Digital Divide and Computer-Mediated Networks for increasing participation of minority institutions in NASA science and technology programs.)

Break-out Sessions

There was a break-out session for the Aeronautics, Earth Science and Space Science Opportunities for Involvement sessions. This allowed for interested attendees to participate in further discussions and the presenters to address specific issues related to the topic area. A report on the proceedings of each of these sessions was made at the plenary wrap-up session.

Conference Agenda



Tuesday, September 21, 1999

5:30 - 8:00 p.m. Registration
Wyndham Hotel, Gateway Ballroom/Foyer Area

5:30 - 8:00 p.m. Welcome Reception
Wyndham Hotel, Gateway Ballroom

5:30 - 8:00 p.m. Poster Session
Wyndham Hotel, Gateway Ballroom

Implementing a Database Management System (DBMS) - Mr. Jibril Abdurrashid, Medgar Evers College

A Study of the Planetary Nebula M57 - Ms. Deithra Archie, New Mexico State University and Mr. Brian Moore, Tennessee State University

City College of New York NRTS - Dr. Shermane Austin, City College of New York

A Study of HII Regions and M8 - Ms. Tamara Battle, Medgar Evers College

Specifying a Software System Using UML and RAS - Ms. Christy Chatmon, Florida A&M University

Learning Earth System Science Through Visualization - Dr. Raj Chaudhury, Norfolk State University

Network Configuration of Oracle and Database Programming Using SQL - Mr. Melton Davis, Medgar Evers College

Systems Programming: The Network Configuration of an Object Relational Database Management System - Mr. Philip Diaz II, Medgar Evers College

Longslit Spectra of the Galaxy NGC 1569 - Ms. Ely Duenas, City College of New York

Standards-Based Meteorological Activities for All Students - Mr. Barry Fried and Mr. Ian Harding, Canarsie High School

Development of Interactive Pre-College Computational Science Enrichment - Mr. Yash Gad, University of Houston - Downtown

Real-Time Constraints - Ms. Carmen Gillette, Florida A&M University

Elizabeth City State University NRTS - Dr. Linda Hayden, Elizabeth City State University

Function Comparisons for PC Operating Systems - Dr. Jim Holloway and Mr. Charlie Wrenn, Tennessee State University

Air Ocean and Climate Monitoring Enhancing Undergraduate Training in Physical Environmental and Computer Science - Mr. W. W. Hope, Medgar Evers College

Do Blackholes Really Exist? - Miss Audrey Jularbal, F. M. Black Middle School

Tuesday, September 21, 1999 - continued

5:30 - 8:00 p.m.

Poster Session - continued

Bringing the Internet to the Inner City: Morgan State University NRTS -
Dr. William Lupton, Morgan State University

Calculus with Mathematica - Mr. Sam N. McDonald, South Carolina State
University

*Preparing for the Computer Literate 21st Century: Are HBCU and OMU
Libraries Ready?* - Ms. Patricia Morris and Ms. Eliana Norlin, University
of Arizona

Miami PREP/Proyecto Access: A Three-Year History of Achievement - Dr.
Gustavo Roig and Mr. Frank Fins, Florida International University

Formalization of UML - Mr. Glenn L. Ray, Florida A&M University

Code Generation - Mr. Aubrey Rembert and Mr. Eric Palmer, Florida A&M
University

University of Texas at El Paso NRTS - Mr. Harry Schulte, University of
Texas at El Paso

Tennessee State University NRTS - Dr. Willard Smith, Tennessee State
University

Cosmology for Non-Science Majors - Dr. Daniel Smith Jr., South Carolina
State University

The Dust and Gas Distribution of the Lagoon Nebula - Mr. Ben Teasdel
and Ms. Erica Lamar, South Carolina State University

*Student Assessment Research and It's Application to Curriculum
Development* - Dr. Enoch Temple, Alabama A&M University

Testing of a Commercial CCD Camera - Mr. Taran Tulsee, Queens College

Automatic Online Tests Generation - Mr. Michael Vulis, City College of
New York

South Carolina State University NRTS - Dr. Donald Walter, South Carolina
State University

Prairie View A&M University NRTS - Dr. John Williams, Prairie View A&M
University

*Total Optical Depth Analysis for NO₂, O₃ and Aerosols by Shadow Band
Radiometry* - Mr. Lorenzo Williamson, Medgar Evers College

Extending UML - Ms. Melinda Wylie, Florida A&M University

*"Students: MU-SPIN at UTEP's Production Model for Y2K." The
determinant role of student support for the development and
production of new media resources for research and education* - Ms.
Iliana Zuniga, University of Texas at El Paso

Wednesday, September 22, 1999

- 7:00 - 8:00 a.m. Breakfast
Wyndham Hotel, Las Americas
- 8:00 a.m. Buses leave for FIU
- 9:00 - 9:15 a.m. Welcome
Dr. Mark Rossenberg, Florida International University Provost
Graham Center, Ballroom
- 9:15 - 9:25 a.m. Welcome
Ms. Milagros Mateu, NASA Headquarters
- 9:25 - 9:30 a.m. Welcome
Dr. James Jackson, NASA Goddard Space Flight Center
- 9:30 - 9:45 a.m. Welcome
Dr. M. A. Ebadian, Florida International University
- 9:45 - 10:30 a.m. Keynote Address
Mr. Orlando Figueroa, NASA Goddard Space Flight Center
- 10:30 - 10:45 a.m. Break
- 10:45 - 11:00 a.m. Minority University Research & Education Division
Mr. John Malone, NASA Headquarters
- 11:00 - 11:15 a.m. Hispanic Institutions Program
Ms. Milagros Mateu, NASA Headquarters
- 11:15 - 11:45 a.m. MU-SPIN Update
Mr. James Harrington, MU-SPIN Project Manager
- 11:45 a.m. - 1:30 p.m. Lunch & Tour of FIU
- 1:30 - 3:30 p.m. Space Science Opportunities for Involvement
- Overview of Space Science* - Dr. James Green, NASA Goddard Space Flight Center
- Explorer Project* - Mr. Jim Barrowman, NASA Goddard Space Flight Center
- Messenger Project* - Mr. Stanton J. Peale, University of California
- Education Public Outreach* - Ms. Stephanie Stockman, NASA Goddard Space Flight Center
- EPO Opportunities Associated with Space Science Research Grants* - Mr. Leonard Strachan, Smithsonian Astrophysical Observatory
- Positioning MU-SPIN Institutions* - Dr. Valerie Thomas, LaVal Corporation
- 3:30 - 3:45 p.m. Wrap-up & Announcements
- 3:45 p.m. Buses leave for hotel

Wednesday, September 22, 1999 - continued

- 5:00 - 6:30 p.m. Calls for Participation & Reception
Wyndham Hotel, Gateway Ballroom
- Ms. Jolanta Lisowska, Ms. Sonia Marin and Mr. Francisco Muniz, LaGuardia Community College
- Problems, Prospects and Promise of Implementing Computer-Mediated Networks: The Case for Effective Participation of Minority Institutions in NASA Science and Technology Programs* - Dr. Adeyemi Adekoya, Virginia State University
- The "Digital Divide", African-Americans and HBCUs: The problem, the impact, and the solution, respectively* - Dr. Eugene Jones, TRACTELL Inc.
- Next Generation Web Servers* - Dr. Mou Liang Kung, Norfolk State University
- 7:00 - 9:00 p.m. Awards Dinner
Wyndham Hotel, Las Americas

Thursday, September 23, 1999

- 7:00 - 8:00 a.m. Breakfast
Wyndham Hotel, Las Americas
- 8:00 a.m. Buses leave for FIU
- 9:00 - 9:15 a.m. Welcome
Mr. Reggie Eason, Deputy Project Manager
Graham Center, Ballroom
- 9:15 - 10:00 a.m. Earth Science Opportunities for Involvement
- "Global Change DIS"* - Ms. Lola Olsen, NASA Goddard Space Flight Center
- Education and Public Outreach Strategies for Earth Science* - Mr. Allen Baker, Vital Strategies
- 10:00 - 10:15 a.m. Break
- 10:15 a.m. - 12:00 p.m. Earth Science Opportunities for Involvement - continued
- "Atmospheric Research" and "Faculty Awards Research Experience"* - Dr. Waldo Rodriguez, Norfolk State University
- Center for the Study of Terrestrial and Extraterrestrial Atmospheres (CSTEAs) Collaboration with Goddard Space Flight Center* - Dr. Arthur Thorpe, Howard University
- 12:00 - 1:00 p.m. Lunch
- 1:00 - 1:30 p.m. Earth Science Opportunities for Involvement - continued
- "Geographic Information Systems Training on Tribal Lands in Northern California"* - Dr. Ali Moddares, California State University at Los Angeles, Ms. Kim Colgrove, Ms. Tammie Grant, Mr. Derrick Lente and Mr. Tony O'Rourke, Native American GIS

Thursday, September 23, 1999 - continued

- 1:30 - 2:00 p.m. Aeronautics Opportunities for Involvement
Dr. Roger Hathaway, NASA Langley Research Center
- 2:00 - 2:15 p.m. Break
- 2:15 - 3:15 p.m. Break-out Sessions
- Aeronautics Break-out Session I
 Graham Center, Panther Suite, Room 325
- Earth Science Break-out Session III
 Graham Center, Ballroom
- Space Science Break-out Session IV
 Graham Center, Room 241B
- 3:15 - 4:15 p.m. Report of Break-out Sessions & Announcements
- 4:30 p.m. Buses leave for hotel
- 6:00 p.m. Group Dinner
 Penrod's at South Beach
- 9:30 p.m. Buses leave for hotel - 1st pick-up
- 10:30 p.m. Buses leave for hotel - 2nd pick-up

Friday, September 24, 1999

- 7:00 - 8:00 a.m. Breakfast
 Wyndham Hotel, Las Americas
- 8:00 a.m. Buses leave for FIU
- 9:00 - 10:20 a.m. Education Opportunities for Involvement
 Graham Center, Ballroom
- Space Science Ecosystems* - Ms. Carolyn Ng, NASA Goddard Space Flight
 Center
- Earth Science Education Strategies* - Ms. Theresa Schwerin, Institute for
 Global Environmental Strategies (IGES)
- 10:20 - 10:35 a.m. Break
- 10:35 a.m. - 12:00 p.m. Education Opportunities - continued
- Explorers of the Universe* - Dr. Marino Alvarez, Mr. Michael R. Busby, Mr.
 Goli Sotoohi, Ms. Tiffani Cannon and Mr. Montanez A. Wade, Tennessee
 State University
- "Echo the Bat"* and *"The Pigeon Adventure"* - Ms. Ginger Butcher, NASA
 Goddard Space Flight Center
- 12:00 - 1:00 p.m. Lunch

Friday, September 24, 1999- continued

- 1:00 - 3:00 p.m. Education Opportunities - continued
- The NOVA Project* - Dr. Leo Edwards, Fayetteville State University
- Classroom of the Future* - Mr. Bob Myers, Wheeling Jesuit University
- Software Tools for Building and Nurturing Virtual Learning Communities-*
 Dr. Gloria Melara-Vides, California State University - Northridge
- 3:15 p.m. Buses leave for hotel
- 5:30 - 10:00 p.m. Group Activity I: Bayside Market (\$5)

Saturday, September 25, 1999

- 9:00 - 10:00 a.m. Breakfast
 Wyndham Hotel, Las Americas
- 10:00 - 11:00 a.m. Conference Wrap-up
 Mr. James Harrington, MU-SPIN Project Manager
 Gateway Ballroom
- 11:00 a.m. - 12:00 p.m. Giveaway
 (Winners must be present!)
- 2:00 - 7:00 p.m. Group Activity II: National Everglades Park (\$10)

Attendee List

MU-SPIN Ninth Annual Users' Conference
Miami, FL
September 21-25, 1999

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Poster Session

Hand-Held Sunphotometers for High School Student Construction and Measuring Aerosol Optical Thickness

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Abstract

Science education is taking the teaching of science from a traditional (lecture) approach to a multi-dimensional sense-making approach which allows teachers to support students by providing exploratory experiences. Using projects is one way of providing students with opportunities to observe and participate in sense-making activity. We created a learning environment that fostered inquiry-based learning. Students were engaged in a variety of inquiry activities that enabled them to work in cooperative planning teams where respect for each other was encouraged and their ability to grasp, transform and transfer information was enhanced.

- Summer, 1998: An air pollution workshop was conducted for high school students in the Medgar Evers College/Middle College High School Liberty Partnership Summer Program. Students learned the basics of meteorology: structure and composition of the atmosphere and the processes that cause weather. The highlight of this workshop was the building of hand-held sunphotometers, which measure the intensity of the sunlight striking the Earth.*
- Summer, 1999: high school students conducted a research project which measured the mass and size of ambient particulates and enhanced our ability to observe through land based measurements changes in the optical depth of ambient aerosols over Brooklyn. Students used hand held Sunphotometers to collect data over a two week period and entered it into the NASA GISS database by way of the Internet.*

Introduction

The project-based science method is one of the new approaches to teaching science. What is the project based-science method? How do we apply it? These questions and many more along with how this approach was applied to our workshop will be addressed. No longer are we in a time when inert knowledge, the understanding that is stored in the mind but cannot be retrieved or used in appropriate situations, is accepted (Perkins 1986). With inert knowledge the learners lack connections and relationships between ideas, thereby hindering them from developing complete understanding, and as a result they cannot apply what they have learned to give a scientific explanation of scientific phenomena (Eylon & Lynn, 1988; Osborne & Freyberg, 1986).

We are now in an exciting and challenging time in the history of science education. The concern of many parents, educators, scientists and public officials is that students be unable to cope with the tremendous changes that science and technology is bringing (Krajcik, Czerniak & Berger 1999). In the past, the traditional or "back to basics" educational approaches focused on teaching students basic facts. Now the focus is now on the students' ability to develop an understanding of science that they can apply to real life. Because educators realize that the understanding students develop in school will impact what they are able to do throughout their lives regardless of their careers, they have made the development of a scientifically literate society a national goal of science education (National Research Council, 1996). The need to develop a scientifically literate society has educators grappling with appropriate goals for science education. As we think of the future success of our nation we realize that the success of our national goals strongly depends on the individual goals we set in our classes.

A successful nation begins with a successful home, school, community, city, state, and finally nation. It was with the objective that we put this workshop together.

Teaching Philosophy

The Project-based Science Method, which seeks to engage students in finding solutions to meaningful real world questions through collaboration and the use of learning techniques, is our teaching philosophy. The approach to this style of teaching is to utilize a driving question which is the central organizing feature of the project-based science. Because it organizes content and drives activities that take place in a science class, the driving question is the first step in meeting all the other key features of the project-based science. It explicitly links different subject areas and sets the stage for planning and carrying out investigations.

Teaching Method

A driving question is a well designed question used in the project based science that is elaborated, explored, and answered by students and the teacher. For a driving question to be effective however, it must be made up of five key features. It must be feasible, worthwhile, contextualized, meaningful and sustainable, thus bringing us to the constructivist model of learning; the model places greater emphasis on understanding, forming relationships between concepts, relating new learning to schema already present in the brain, and developing applications of new knowledge to events and problems that the students encounter. This puts the focus on the student as an active builder of knowledge in a community of learners. This learning model suggests that learning cannot be separated from the social context in which it takes place (Lorsbach, A., and K. Tobin).

Summer 1998: Workshop

Student Profile -

There were eight students whose ages ranged from 14 to 17. There were three females and five males; six were just entering high school while two were already in high school and were scheduled to graduate January, 1999. Thus their academic levels in science and mathematics as well as their maturity levels varied considerably.

Curriculum -

The driving question for this workshop was: How do we explain the conclusion by statisticians that if you and your friends were living in the South Bronx, there is a strong possibility that you would contract asthma? This question led to other questions such as: What happens in your body when you contract asthma? What are some of the external contributing factors that cause asthma? What can be done to lessen the number of people who contract asthma? These and more questions led to the planning and carrying out of investigations. This is a good driving question because it explicitly linked different subject areas, such as human physiology which includes the study of the respiratory system, and environmental studies in particular, air pollution. It was feasible; students were able to design and perform investigations to answer the questions. It was worthwhile; the questions has a rich science content. It was contextualized; the questions were anchored in the lives of the learners and addressed important, real world questions. It was meaningful; the questions were interesting and exciting to the learners. And finally, it was sustainable; the driving question sustained the students' interest for weeks.

Workshop Content -

These investigations began with the students learning about the composition of the atmosphere. The atmosphere is made up of permanent and variable gases, of which aerosols are a part. They also learned the basics of meteorology, the science that studies the atmosphere and the processes (such as cloud formation, lightning and wind speed) that cause weather. The students began to realize is that we spend our entire lives surrounded by the atmosphere and are greatly affected by its activities. We focused on the environment, by addressing the effects air pollution on human health. Is it natural or anthropogenic? We learned about the counter offensive on air pollution which deals with regulations designed to improve air quality and the substantial impact they have made on the lives of people in the United States. We also learned the principles of the

Sunphotometer which measures the intensity of light, giving us a means to calculate aerosol optical thickness (AOT), the expression of haze measurement. The project that culminated this workshop was the building of the hand-held sunphotometers.

1999 Summer Research Project

The hand-held sunphotometers were used in the Summer of 1999 to take readings of the intensity of the sunlight striking the earth in order to calculate aerosol optical thickness (AOT). A four member team of high school students performed the measurements.

Student Profile -

There were four students: Niclaos Almonor from Science Skills Center High School; Donesia Hepburn from Middle College High School at Medgar Evers College, Ruramai Hope from Ethel Walker High School, and Lloyd Mebane from Stuyvesant High School. Their ages ranged from 14 to 17. There were two females and two males; two were entering the 12th grade, one the eleventh grade and one the tenth grade. Their academic levels in science and mathematics were very high as well as their maturity levels.

Methodology -

The TERC VHS-1 sunphotometers used this Summer have an improved performance over those used last year. The new sunphotometers utilize two resistors as opposed to one, neutralizing the dark voltage readings. In addition, a yellow Light Emitting Diode (LED) has replaced the green LED, thus providing a diode that senses a higher frequency of light. The yellow LED has a frequency range of 530 to 570 nm. The team, working in half hour shifts from 10:30 a.m. to 7:30 p.m. Monday through Thursday and 8:00 a.m. to 6:00 p.m. Friday and Saturday, collected data using the hand held sunphotometers. Data were collected from July 21, 1999 to July 30, 1999. Reading were taken at Medgar Evers College on Rogers Avenue between Carroll and Crown Streets.

The collected data were put into the Goddard Institute for Space Science (GISS) database by way of the Internet. In addition, the TERC VHS-1 spread sheet was developed to compute the AOT at a given time. The spreadsheet program automatically determines the air mass for each data point. The variables on the spread sheet include: hour angle, date, time of measurement, dark voltage, sunlight and voltage. The spreadsheet calculations include the natural log of the sunlight voltage minus the dark voltage, air mass, AOT at 530 nm, percent transmission, sun angle and zenith angle.

Environmental Factors -

Global and regional climatic conditions are effected by ambient particulate matter or aerosols. Particulates suspended in the troposphere bounce light into new angles which have the effect of degrading visibility. Particulates also interfere with light coming into the earth from the sun, creating in some regions an aerosol cooling or parasol effect which appears to neutralize the greenhouse effect. Other indirect effects of aerosol cooling can be caused by sulfates which have an affinity for water. Sulfates pull free-floating moisture into droplets of liquid and acid, called acid rain. The droplets condense making clouds more numerous and brighter, thus further shading the planet.

Results -

The variable weather conditions during the two weeks made it a challenge to calibrate our instrument. However, they were able to obtain data and enter into the NASA GISS data base via the Internet. The graphs represent the time variation of the AOT at 530nm for Tuesday, July 20, Monday, July 26, and Friday, July 30, 1999. However, the graph must be recalibrated using appropriate air mass values. The spreadsheets corresponding to these days are also presented.

Future Activities

Three of the students will continue the project during the academic year. Their activities will include:

1. Collecting data on a continuing basis;
2. Using the spreadsheet provided by GISS Institute on Climate and Planets (ICP) to analyze the data;
3. Calibrating the instruments to find the Extraterrestrial Constant (ET) which is the signal that the instrument measures in the absence of the atmosphere; and
4. Quantitatively comparing the hand-held results with those of the Multi-filter Rotating Shadowband Radiometer (MFRSR).

Conclusion

This was a very rich and rewarding experience for me. This approach has proven to be, in my opinion, very effective and efficient. The students' knowledge of air pollution and its effects on people right here in New York has been greatly enhanced. I would like to see this approach implemented in all schools throughout the New York City education system. It will be one way of insuring that our students and our society become more scientifically literate at a much faster pace.

Acknowledgement

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A Study of the Planetary Nebula M57

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Abstract

We present an overview of the objects known as planetary nebulae. These emission nebulae are the end-product of the evolution of a dying star. Our ground-based imagery is of the most famous of these objects, M57, also known as the Ring Nebula. Taken with the 2.12-meter telescope at San Pedro Matir in Baja, Mexico, these seeing-limited images show variations in ionization, density and temperature as a function of position in the nebula. Our ground-based imagery is compared to similar HST archival images.

Introduction

The authors were part of an eight week summer astrophysical research program for undergraduates at the MUSPIN-funded NRTS site at South Carolina State University (SCSU). A portion of our studies was devoted to the topic of planetary nebulae in general and M57 (the Ring Nebula) specifically.

Previously collected imagery of M57 was examined using the Image Reduction Analysis Facility (IRAF) software. Various noise sources were removed from the images and the resultant images are presented herein. The reduced images will be used as part of a larger, ongoing project at SCSU that examines the physical and chemical diagnostics of galactic emission nebulae.

Our paper begins with an examination of planetary nebulae in general. This is followed with a specific discussion of the M57 data set used. Finally, our results are shown and a brief comparison is made with an archival image of M57 taken with the Hubble Space Telescope.

Planetary Nebulae

When first viewed by astronomers over 150 years ago, these objects looked like Uranus & Neptune and were thought to be other planets, hence the name. In actuality they have nothing to do with planets. Planetary nebulae are the dying stage of a star.

The life of a star is a series of stages from birth to death and the life sequence of a star depends on its mass. Stars with mass approximately equal to the Sun go through the sequence in Table 1 and become a planetary nebula. After a red giant ejects its outer layers, what is left is a large cloud of gas (the nebula) and a small dense core known as a white dwarf.

The temperature of the nebula is around 15,000 K while the surface temperature of the white dwarf is 100,000 K. The ring or shell is gas expanding from the central star and it glows by means of atomic processes such as ionization and recombination, with the white dwarf as the source of the ionizing UV photons. These atomic processes in the shell are the same as in HII regions (see paper by T. Battle this conference for details).

M57 Data Analysis

The Object M57: The nebula M57, commonly called the Ring Nebula, is the most widely studied planetary nebula. Details about M57 can be found in Table 2.

The Data Set: The data used for this study was collected at the San Pedro Matir observatory in Baja, Mexico in June 1994. The 2.12-meter telescope and a set of narrow-band interference filters were used to capture the CCD images. The specific images used by us are listed in Table 3.

Data Reduction: The IRAF software package was used on a SUN workstation to reduce the images from their raw form to a state in which the noise sources were removed. These corrections and the relevant IRAF tasks used are listed in Table 4. Information about CCD noise sources can be found at this conference in the paper by Taran Tulsee.

Purpose of the Data Reduction: The goal of this analysis is to produce images which are free of noise and which can then be used by other investigators to derive important physical characteristics about the nebula. Table 3 lists the images and the corresponding physical characteristics that can be derived from the images (e.g. gas temperature and dust distribution).

Results

The different ions in the gas of the nebula are approximately evenly distributed throughout the object. However, images taken which let in light of only a particular ion show that there is a stronger emission from some regions. This has to do with the level of ionization in the nebula at that point and the particular atomic process that is strongest at that location in the nebula.

O⁺⁺ Image: Figure 1 is a false-color image taken through a filter centered on the emission line of doubly ionized oxygen at 5007 angstroms. This emission is strongest where the gas is highly ionized. Note that the strongest emission comes from a smaller region of the nebula than with the hydrogen alpha image.

H_α Image: Figure 2 was taken through a filter centered on the emission line of hydrogen alpha at 6563 angstroms. The photons are emitted when an electron recombines with a single proton to recreate a neutral hydrogen atom. Since this occurs throughout the nebula, the distribution of light is smoother and less localized than with the O⁺⁺ image.

Continuum Image: Figure 3 shows the emission from M57 taken through a filter centered on the wavelength 5348 angstroms. This is in a part of the spectrum where the stars and nebula emit continuum photons and not the emission photons of a specific ion. The gas in an emission nebula like M57 does not emit a great deal of light in the continuum, as a comparison of Figure 5 with 3 and 4 shows. The temperature and pressure conditions in the nebula are not high enough for strong emission. Note, however, that the stars are strong in the continuum. This is due to the higher gas pressure in the star compared to the nebula.

Comparison with Hubble: Figure 4 is an image of M57 taken from the archives of the Hubble Space Telescope. Notice that the details which are barely visible in Figures 2-4 are clearly visible in the Hubble image. This is due to the fact that the Hubble images can resolve features as small as 0.1 arcseconds while the ones from our data are about 6-8 times less sharp because of blurring due to the Earth's atmosphere. Further comparison is difficult because the Hubble picture is the sum of several images taken through filters different than our own. However, much of the overall detail is the same.

Summary

Our study of the planetary nebulae has resulted in the following:

1. An overview of planetary nebulae has been completed with special emphasis on M57
2. New ground-based imagery has been reduced such that noise sources are removed.
3. Imagery is ready for calibration and use by future investigators.
4. Comparison of Hubble and ground-based imagery shows higher spatial resolution (as expected) from Hubble; however, no significant deviations are found from lower resolution ground-based data

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Table 1
Evolution of a Solar Type Star

Stage 1: Gas cloud collapses to form star

- Gravity pulls dust and gas particles together.
- Dust and gas condense
- Gravitational collapse is initiated, yielding a dense core.

Stage 2: Thermonuclear burning

- The dense core collapses to form a protostar.
- Protostar converts gravitational contraction to heat.
- When conditions such as density, temperature, and pressure are high, nuclear fusion begins.
- Yielding a star.

Stage 3: Main sequence

- Star spends 90% of life at this stage.
- In the core of the star, hydrogen is being converted into helium.
- As a result of the conversion, contraction takes place.
- The rate of fusion and temperature increase.

Stage 4: Swell to red giant

- Fusion energy reduces as a result of hydrogen reduction.
- There is less fusion energy to counteract gravity.
- The core contracts, helium fuses in core.
- There is an increase in heat emitted from core.
- Hydrogen fusion begins in the shell around core.
- Shell expands, increasing star diameter.

Stage 5: Throws off outer shell and star left behind.

- Red giant is unstable.
- Star sheds outer material.
- Planetary nebulae is born as an expanding gas cloud.
- In the center of the planetary nebulae a white dwarf stars remains.

Table 2
Description of M57

Constellation	Lyra
Right ascension	18 hours and 54 minutes
Declination	33 degrees North
Distance	5,000 light years or 28 million billion miles
Core Size	70 arcsecs
Halo Size	150 arcsecs
Magnitude of Central Star	15
Shell Temperature	15,000 K
Star Temperature	100,000 K
Rate of expansion	19 kilometers per second

Table 3
San Pedro Matir Data Set

<u>Image Name</u>	<u>Exp. Time</u>	<u>Filter *</u>	<u>Ion</u>	<u>Diagnostic</u>
n4m57003	100 sec	6563*	H ⁺ (Ha)	Dust
n4m57004	100 sec	6450*	Continuum	N/A
n4m57009	200 sec	5348*	Continuum	N/A
n4m57010	400 sec	4770*	Continuum	N/A
n4m57011	300 sec	4861*	H ⁺ (Hb)	Dust
n4m57012	200 sec	5007*	O ⁺⁺	Temperature

* Central wavelength of filter bandpass in angstroms

Table 4
Data Reduction Steps

<u>Step #</u>	<u>Correction</u>	<u>IRAF Task</u>
1	Cosmic Ray Removal	Cosmicrays
2	Bad Pixel Removal	Fixpix
3	Bias Subtraction	Imarith
4	Flat Field Correction	Imarith
5	Alignment of images	Imalign
6	Exposure Time Division	Imarith
7	Continuum Subtraction	Imarith

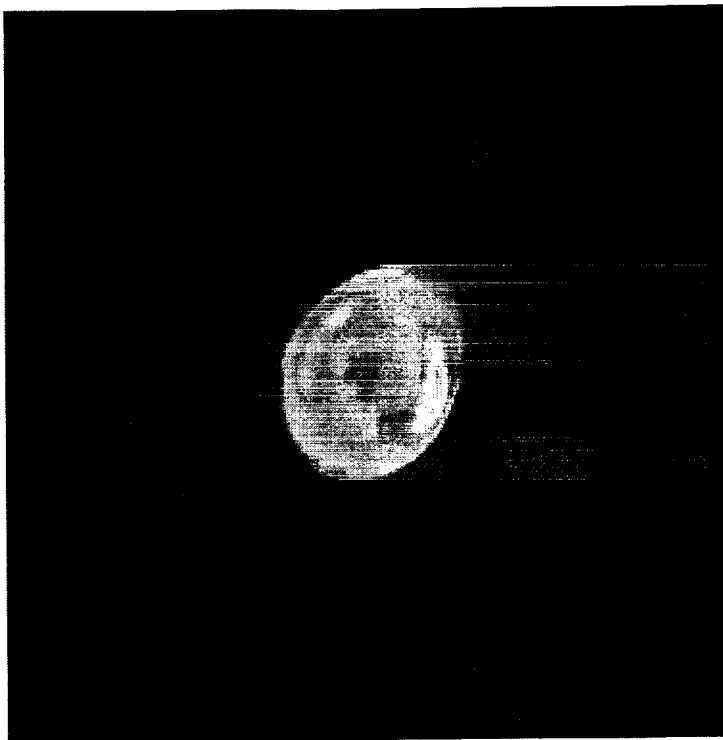


Figure 1
OIII image of M57 from SPM data set. See text for details.

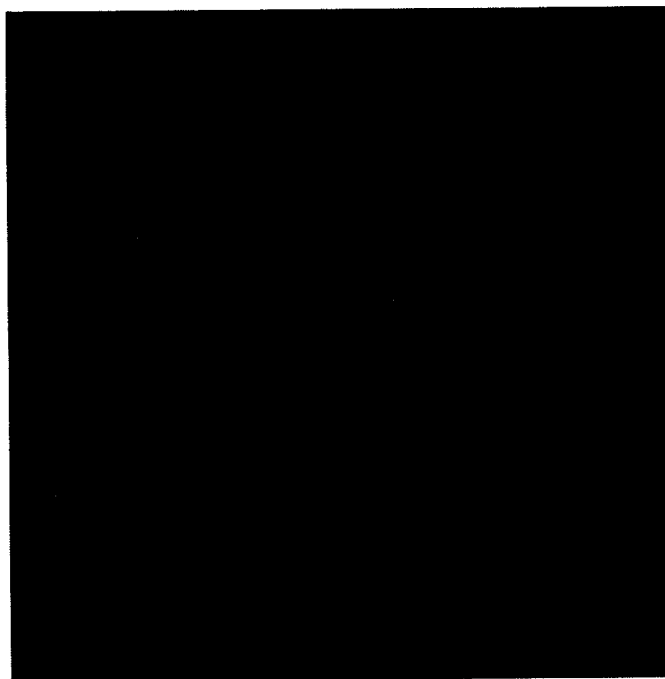


Figure 2
H? image of M57 from SPM data set. See text for details

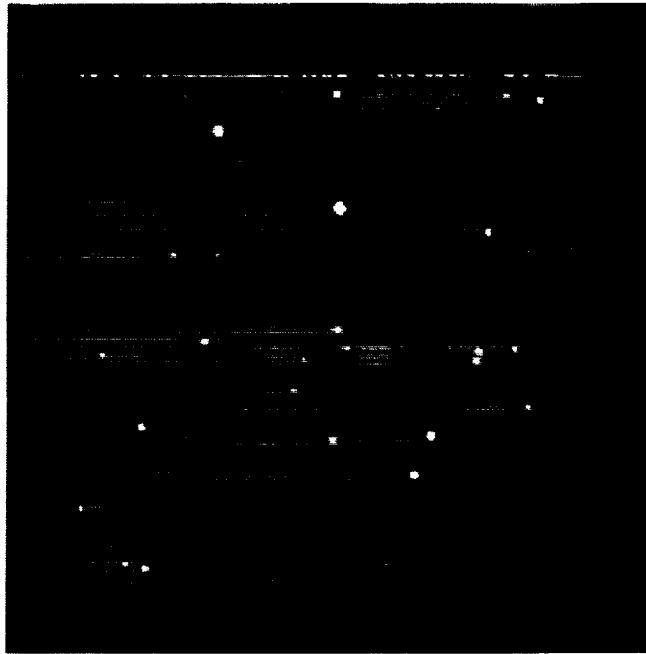


Figure 3
Continuum image of M57 from SPM data set. See text for details.

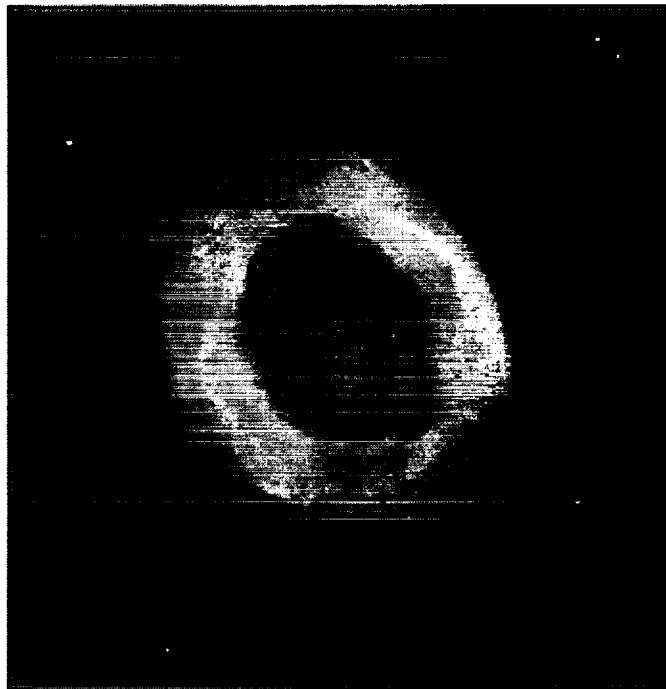


Figure 4
HST archival image of M57. See text for details.

A Study of HII Regions and M8

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Abstract

We present an overview of the objects in the interstellar medium known as H II regions. These clouds of dust and gas are detected in emission throughout the plane of the galaxy, and are the site of ongoing star formation. We present imagery of one of the more famous H II regions; M8, the Lagoon Nebula. The ionization structure of the nebula is examined and our ground-based imagery is compared to HST (Hubble Space Telescope) archival images of this object.

Introduction

The results of a study of the HII region, M8, are given. We have spent the months of June and July 1999 as part of an undergraduate research program in astrophysics at South Carolina State University (SCSU). NASA/MUSPIN funded this project through the Network Resource and Training Sites (NRTS) at SCSU and at City College of New York.

We used data taken in June 1994 at the San Pedro Matir (SPM) observatory in Baja, Mexico. More information on the data set used in our study can be found in Table 1. Information on SPM can be found in the paper at this conference by B. Teasdel and E. Lamar. Our summer program included an overview of astronomy and the physics of gaseous, emission nebulae. We used UNIX workstations and astrophysical image processing software to reduce the images from SPM.

This paper begins with a discussion of the basic atomic processes which occur in such nebulae, including M8 shown in Figure 1. Then what follows is a discussion of HII regions in general, what they are and how they form and evolve. Finally, we talk about the Lagoon Nebula and our own data analysis and results which will be used by future investigators.

The Atomic Processes

Within the depths of interstellar space lie clouds of gas and dust. When a hot, energetic star is embedded in such a cloud, one or more of the following occurs:

- **Ionization** - Ultraviolet radiation from the star ionizes the hydrogen in the gas, converting it into a plasma of positive hydrogen ions (protons) and free electrons. These detached protons and electrons then become part of the gas, each of them moving around as free particles.
- **Recombination** - The protons in the gas are continually colliding with electrons and recapturing them, becoming neutral hydrogen again. The electron falls through the various energy levels of the hydrogen atom on its way to the ground state, emitting a photon for each jump to a lower energy level closer to the nucleus of the atom.
- **Excitation** - An electron is not captured but, instead, collides with an ion. In doing so, the electron gives up some of its kinetic energy to the ion, thereby exciting it to a higher state of energy.
- **Deexcitation** - This can occur in one of two ways:

As an ion collisionally deexcites, the original electron that caused the collision takes away energy from the ion and moves freely about, in which case a photon is emitted. The second method of deexcitation is the case of spontaneous decay. The ion itself drops to a lower energy level and, in this process, emits a photon.

H II Regions: An Overview

H II regions are zones of gas that is mostly ionized. The "II" in HII refers to the second state of hydrogen, the ionized state. The gas temperature in an HII region is typically around 10,000 K, with a range from 7,000 to 12,000 K. Gas densities range from 100 to 10,000 particles/cm³. Characteristically, these regions include several bright, hot stars responsible for ionizing the surrounding gas.

An HII region typically appears red as it glows with the photons emitted when the electrons within the region recombine with hydrogen protons. The red color is largely due to the H α photon at 6563 angstroms (see Figure 1). Emission by H II regions is maintained by the continuous cycle of ionization of H I atoms (neutral hydrogen) followed by recombination of the HII ion. The central star of the nebula supplies the ultraviolet photons which start the cycle.

Formation & Evolution

The Danish astronomer B. Strömgren developed the theory of H II regions, in 1939. In this theory, the life of an H II region can be divided into three stages:

- **Formation Phase** - This begins with the main sequence turn on of a type O or early type B star emitting a sufficient amount of ultraviolet radiation. The outflow of radiation from the star forms an ionization front (IF), which heats and ionizes the gas as it progresses outward. The formation phase comes to an end when the ionization front reaches the end of the Strömgren sphere, the point where the radiation field runs out of hydrogen-ionizing photons.
- **Expansion Phase** - Here the nebula and surrounding neutral material divide into distinct regions. These are identified as: the ionized gas inside the Strömgren radius; the ionization front; a shell of neutral material which has already been shocked but not yet ionized; the shock front; and the neutral molecular cloud. The expansion of the ionized zone continues because of a pressure differential between the compressed neutral zone and the ionized gas. The higher pressure in the ionized zone is due to the higher temperature and the larger particle density, since every ionization doubles the number of particles in the H⁺ zone.
- **Recombination Phase** - In this phase, equal pressure is attained on both sides of the ionized front. This occurs when either the Strömgren radius is so large that the radiation field is depleted of ionizing photons or the central star of the H II region evolves off the main sequence and the number of ionizing photons produced drops significantly. An equilibrium Strömgren sphere results.

The Lagoon Nebula

The Lagoon Nebula is one of the most spectacular examples of an emission nebula discovered to date. Located in the summer's night sky, the Lagoon Nebula can be viewed through binoculars in the constellation of Sagittarius. Named "Lagoon" for the band of dust seeming to cut through its center (see Figure 1), giving the appearance that the nebula is split in two, this nebula is home to a diverse array of astronomical objects including a bright open cluster of stars and several energetic star-forming regions. The nebula itself is a large bubble of gas and dust set against the backdrop of an immense, ill-defined molecular cloud. Its general red glow is caused by luminous hydrogen gas, while the dark filaments are caused by absorption by dense lanes of dust. Also known as M8 and NGC 6523, the Lagoon Nebula lies approximately 4500 light-years away with a diameter of 120 light-years.

The large, majestic Lagoon Nebula is home for many young stars and hot gas, and is commonly referred to as a star factory. This star factory continues to eat away at the gas, all the while adding young, hot stars to the cluster. You can plainly see one of the factory's byproducts in NGC 6530, a visible group of stars on the eastern edge of the nebula.

At the heart of the Lagoon Nebula in Sagittarius is located the distinctive feature of the dumbbell-shaped, bright knot of gas and dust known as the Hourglass Nebula (see Figures 3-5). The nearby star

Herschel 36 powers this intense region, the 9th magnitude O7 star located in a small dark cloud just west of the Hourglass. The brightest star in the field of the Hourglass is the 6th magnitude 9 Sagittarii, a hot O5 star that appears to be the main illuminating source within the nebula.

Results

Table 1 lists the images from San Pedro Matir which were available. Only the OIII, Ha and the two continuum images were used in this study. A great deal of time was spent removing the CCD noise sources from the images. However, in the interest of space, the description of the noise removal and data reduction procedures are not described here; but, the reader is referred to the paper by B. Teasdel and E. Lamar elsewhere in this conference. Once the noise sources were removed, the images were ready for examination.

- OIII image - Figure 2: As shown in Table 1, this ion has a high ionization potential (35.1 eV). The yellow regions in Figure 2 are the regions where the OIII emission is strongest, with pink the next strongest and green the weakest. As expected, the Hourglass feature is the region of highest ionization level in the nebula since it lies closest to the ultraviolet radiation from the star. The further one moves away from the ionizing stars in the Hourglass, the lower the ionization (first pink then green).
- Ha Image - Figure 3: This is an inverted or negative image. What appears dark in the figure is actually bright on the sky. The darker the region, the stronger the Ha emission. Note that in comparison to the OIII image, the emission in this figure is less concentrated and more evenly spread out. This is because the recombination of hydrogen protons occurs equally throughout the HII region regardless of how close to the star.
- Continuum Image - Figure 4: This image was taken through the filter centered on the continuum at 6450 angstroms. The lighter the color (white and yellow) the stronger the emission at this wavelength.

The temperature and pressure of an HII region is not high enough for the continuum emission to be strong. Therefore, the nebular gas has only a weak emission in the continuum. The temperature and pressure of a star is great enough so that it will appear bright in the continuum image. Note that the Hourglass feature and surrounding region appear bright not because the gas in the nebula is emitting many photons at 6450 angstroms. Instead, they appear bright because the light from those regions is really light from the stars which reflects off of dust grains in the nebula and into the field-of-view of the CCD.

- Hubble Image - Figure 5: An portion of an image of M8 from the archives of the Hubble Space Telescope is presented in Figure 5. Direct comparison with our images is not easy since the Hubble image is a composite of several images taken through filters which do not all coincide with our own filters. Nonetheless, one can see the extraordinary detail of the inner region of M8, near the Hourglass. Our ground-based images show only a bright feature while the Hubble image, unaffected by the blurring of the atmosphere, shows the Hourglass to be a complex region of bright gas and dark clouds of dust.

Summary

Our study of HII regions and the Lagoon Nebula included a better understanding of the following:

1. The four major atomic processes which occur in gaseous nebulae have been studied and understood.
2. The formation and evolution of HII regions is explained and represented figuratively.
3. New ground-based imagery of M8 has been reduced and a preliminary analysis was made.

4. A comparison was made between our ground-based images and one archival image of M8 taken by the Hubble Space Telescope.

Acknowledgments

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Table 1
Observation Log for M8, the Lagoon Nebula

Image Name	Exp. Time (s)	Filter Central λ	Ion	Ionization Potential	Diagnostic
N3m8025	150	5007 \AA	O III	35.1 eV	Te*
N4m8003	60	6450 \AA	Continuum	N/A	N/A
N4m8009	200	4861 \AA	H II	13.6 eV	Dust
N4m8012	400	4770 \AA	Continuum	N/A	N/A
N4m8013	300	6731 \AA	S II	10.4 eV	Ne*
N4m8014	300	6717 \AA	S II	10.4 eV	Ne
N4m8017	60	6563 \AA	H II	13.6 eV	Dust

* Where T_e represents electron temperature and N_e represents electron density

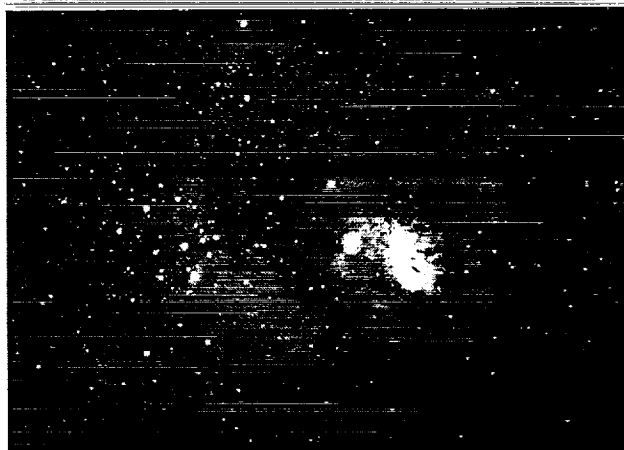


Figure 1
Wide angle view of the Lagoon Nebula, M8.

Figure 2
Not available for publication.



Figure 3
Ha image of M8 from SPM data set.

Figure 4
Not available for publication.



Figure 5
HST archival image of the hourglass region of M8.

Network Configuration of Oracle and Database Programming Using SQL

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Abstract

A database can be defined as a collection of information organized in such a way that it can be retrieved and used. A database management system (DBMS) can further be defined as the tool that enables us to manage and interact with the database. The Oracle 8 Server is a state-of-the-art information management environment. It is a repository for very large amounts of data, and gives users rapid access to that data. The Oracle 8 Server allows for sharing of data between applications; the information is stored in one place and used by many systems. My research will focus primarily on SQL (Structured Query Language) programming. SQL is the way you define and manipulate data in Oracle's relational database. SQL is the industry standard adopted by all database vendors. When programming with SQL, you work on sets of data (i.e., information is not processed one record at a time).

Background

A little background on the evolution of databases and database theory will help you understand the workings of SQL. Database systems store information in every conceivable business environment. From large tracking databases such as airline reservation systems to a child's baseball card collection, database systems store and distribute the data that we depend on. Until the last few years, large database systems could be run only on large mainframe computers. These machines have traditionally been expensive to design, purchase, and maintain. However, today's generation of powerful, inexpensive workstation computers enables programmers to design software that maintains and distributes data quickly and inexpensively.

The most popular data storage model is the relational database, which grew from the paper "A Relational Model of Data for Large Shared Data Banks," written by Dr. E.F.Codd in 1970. SQL evolved to service the concepts of the relational database model. Most databases have had a "parent/child" relationship; that is, a parent node would contain pointers to its children. This method has several advantages and many disadvantages. In its favor is the fact that the physical structure of data on a disk becomes unimportant. The programmer simply stores pointers to the next location, so data can be accessed in this manner. Also, data can be added and deleted easily. However, different groups of information could not be easily joined to form new information. The format of the data on the disk could not be arbitrarily changed after the database was created. Doing so would require the creation of a new database structure.

Codd's idea for an RDBMS uses mathematical concepts of relational algebra to break down data into sets and related common subsets.

Because information can naturally be grouped into distinct sets, Dr. Codd organized his database system around this concept. Under the relational model, data is separated into sets that resemble a table structure. This table structure consists of individual data elements called columns or fields. A single set of a group of fields is known as a record or row.

When programming, you can embed SQL statements into your source code using an editor of your choice. This source code is then used as input for the precompiler, which in turn translates all the embedded SQL statements into native code. Finally, you can compile and link this code to create an executable after including some Oracle calls.

SQL, SQL*PLUS, PL/SQL:

SQL, SQL*Plus, PL/SQL: What's the difference? This is the most often asked question for people new to Oracle. There are several products with the letters "SQL" in the title, and these three, SQL*Plus, SQL, and PL/SQL, are often used together. Because of this, it's easy to become confused as to which product is doing the work and where the work is being done. I will now briefly describe each of these three products.

SQL stands for Structured Query Language. This has become the lingua franca of database access languages. It has been adopted by the International Standards Organization (ISO) and has also been adopted by the American National Standards Institute (ANSI). When you code statements such as SELECT, INSERT, UPDATE, and DELETE, SQL is the language you are using. It is a declarative language and is always executed on the database server. Often you will find yourself coding SQL statements in a development tool, such as PowerBuilder or Visual Basic, but at runtime those statements are sent to the server for execution.

PL/SQL is Oracle's Procedural Language extension to SQL. It too, usually runs on the database server, but some Oracle products such as Developer/2000 also contains a PL/SQL engine that resides on the client. Thus, you can run your PL/SQL code on either the client or the server depending on which is more appropriate for the task at hand. Unlike SQL, PL/SQL is procedural, not declarative. This means that your code specifies exactly how things get done. As in SQL, however, you need some way to send your PL/SQL code up to the server for execution. PL/SQL also enables you to embed SQL statements within its procedural code.

SQL*Plus is an interactive program that allows you to type in and execute SQL statements. It also enables you to type in and execute PL/SQL code and is one of the most common front ends used to develop and create stored PL/SQL procedures and functions.

This tight-knit relationship between PL/SQL, SQL, and SQL*Plus is the cause for some of the confusions between the products. What happens when you run SQL*Plus and type in a SQL statement? Where does the processing take place? What exactly does SQL*Plus do, and what does the database do? If you are in a Windows environment and you have a database server somewhere on the network, the following things happen:

- SQL*Plus transmits your SQL query over the network to the database server.
- SQL*Plus waits for a reply from the database server.
- The database server executes the query and transmits the results back to SQL*Plus.
- SQL*Plus displays the query results on you computer screen.

Even if you're not running in a networked Windows environment, the same things happen. The only difference might be that the database server and SQL*Plus are running on the same physical machine. This would be true, for example, if you were running Personal Oracle on a single PC.

PL/SQL is executed in much the same manner. Type a PL/SQL block into SQL*Plus, and it is transmitted to the database server for execution. If there are any SQL statements in the PL/SQL code, they are sent to the server's SQL engine for execution, and the results are returned back to the PL/SQL program.

The important thing is that SQL*Plus does not execute your SQL queries. SQL*Plus also does not execute your PL/SQL code. SQL*Plus simply serves as your window into the Oracle database, which is where the real action takes place.

One last comment, a special type of index supported by many database systems allows the database manager or developer to cluster data. When a clustered index is used, the physical arrangement of the data within a table is modified. Using a clustered index usually results in faster data retrieval than using a traditional, nonclustered index.

Future Work

I have created tables using SQL on the Physical, Environmental and Computer Science Department's Database Management System. The goal of this research will be to implement database applications that will be utilized by the department. The applications will range from information about the department to storing scientific data.

Acknowledgements

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The Network Configuration of an Object Relational Database Management System

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Abstract

The networking and implementation of the Oracle Database Management System (ODBMS) requires developers to have knowledge of the UNIX operating system as well as all the features of the Oracle Server. The server is an object relational database management system (DBMS). By using distributed processing, processes are split up between the database server and client application programs. The DBMS handles all the responsibilities of the server. The workstations running the database application concentrate on the interpretation and display of data.

Introduction

Database management systems have evolved from hierarchical to network to relational models. Oracle extends the relational model to an object-relational model. The Internal Level, Conceptual Level, and External Level form the architecture of a DBMS.

Architecture of a Database Management System:

- Internal Level: The internal level describes the physical storage structure of database.
- Conceptual Level: The conceptual level describes the entire database for a community of users. It hides the details of physical storage structures and concentrates on describing entities, data types, relationships, user operations, and constraints.
- External Level: The external level describes how users view the data of the database.

The relational model has three major aspects:

- Structures are well-defined objects (such as tables views, indexes) that store or access the data of a database. Structures and the data contained within them can be manipulated by operations.
- Operations are clearly defined actions that allow users to manipulate the data and structures of a database. The operations on a database must comply to a predefined set of integrity rules.
- Integrity rules are the laws that govern which operations are allowed on the data and structures of a database. Integrity rules protect the data and the structures of a database.

Benefits of Relational Database Management:

- Independence of physical data storage and logical database structure;
- Easy access to all data;
- Flexibility in database design;
- Reduced data storage and redundancy;

The Object-Relational model allows users to define object-types. Object types specify the structure of the data and the methods of operating on the data.

An object type has three features:

- A name, which serves to identify the object type uniquely.
- Attributes, which are built-in data-types or other user-defined types.
- Methods, which implement specific operations that an application can perform on the data. Every object type has a constructor method that makes a new object according to the data-type's specification.

Client/Server Architecture and SQL

The DBMS is divided into two parts: a front-end (client) and a back-end (server) portion. The advantage of this division is the distribution of processes over multiple processors. This reduces the processing load and improves the system as a whole. The client supports database applications; its focus is making requests and viewing data managed by the server. SQL (Structured Query Language) is the standard language for a DBMS. The server portion receives and processes the SQL statements that originate from client applications. SQL statements execute all operations on the information in an Oracle database. SQL statements are divided into the following categories:

- Data Definition Language (DDL): DDL commands set up the data. They allow the programmer to create and alter databases and tables.
- Data Manipulation Language (DML): The DML consists of those executable statements that transfer information to and from the database. You can update, insert, delete, and retrieve data in a table with these commands.
- Data Sub Language (DSL): The end user uses a query language such as SQL or some application program. These languages include a data sub-language (DSL). A DSL is a subset of the total language that specifically deals with database objects and operations. The DSL is a combination of the DDL and the DML.

The database server must reliably manage large amounts of data in a multi-user environment so that users can collectively access the same data. The server instance is a combination of background process and memory buffers. The Oracle Server consists of a database and server instance. The purpose of the database is to store and retrieve related information. The System Global Area (SGA) is an area of memory used for database information shared by database users. When a database starts up, a SGA is allocated and background processes are started. Net8 is the mechanism the DBMS uses for interfacing with the communication protocols used by the networks that utilize distributed processing. Communication protocols define the way that data is transmitted and received on a network. In a network environment, the database server communicates with the client workstations using the Net8 software.

Overview of Network Connection

To successfully connect the Oracle Server to a Local Area Network (LAN) it must meet the standards of the Optimal Flexible Architecture (OFA). The OFA is the recommended scheme for configuring Oracle. A node is any computer that provides a service on a network. The node is configured so it can be identified on the network. The OFA employs a directory and configuration structure that can support the multiple components of the Server on a single node. Connecting the Oracle Server involves the following steps:

Layout of Operating System:

I configured the operating system to satisfy the hardware, software, memory, and disk space requirements. I created four mount points to comply with the OFA standard. These mount points are created for the installation of the Oracle Server. The first mount point is for where the software is to be downloaded. The second through the fourth mount points are for database files. I used File Transfer Protocol (FTP) commands to connect to Netscape's web-site. I transferred files from their web sight to the local system. Once these files were transferred to the local system, I was able to install a web-browser on the local system, thus enabling it with access to the Internet. Through the web-browser, I downloaded JAVA and C compilers onto the local system. These compilers will be used to develop Oracle applications.

Set UNIX Environment:

- I configured the Kernel parameters to accommodate the SGA structure of the Oracle Server. They control the allocation of shared memory and enable the database to startup.
- I created environment variables to the local system's `.profile` (pronounced dot profile) file. Directory paths are assigned to these variables. The Oracle Installer program downloads its files to these paths.
- I created UNIX accounts for a Database Administration (DBA) group and a database user group. Users assigned to the DBA group have access to all components of the Server. Only the DBA can startup the database instance. The DBA creates user accounts to the Server and sets the permissions for the individual users. The DBA also can create programs. Users assigned to the database user account can create programs and view the tables that the DBA grants permission.

Installation:

All the previous steps must be completed successfully in order for the Oracle Server to be correctly installed. The Installer program downloads the software into the paths defined in the local system's `.profile` file. The Oracle Server has been successfully connected to the LAN. An Internet Protocol (IP) address has been assigned to the local system. The IP address affords users the ability to Telnet to the local system.

Client Configuration:

Clients for the DBMS network were configured on Windows NT, 95, and 98 operating systems. Service names are aliases for the database server. The service name file contains the IP address of the server; the protocol to be used for client connection, in this case TCP/IP, and the name of the database instance the client will connect to. The Net8 software allows clients to communicate with the server through service names. Using FTP, a copy of the service name file is sent to the workstations running the client applications.

The Client/Server Architecture Process:

1. The DBA starts up the database instance.
2. A client workstation runs an application. A user process is initiated through the application. The client connects to the server using the proper Net8 driver.
3. The server detects the connection request from the application and creates a server process on behalf of the user process.
4. The user executes an SQL statement and commits the transaction.
5. The server process receives the statement and checks the shared pool for any shared SQL area that contains an identical SQL statement. If the area is found, the server process checks

the users' access privileges to the requested data and the previously existing shared SQL area is used to process the statement.

6. The server process retrieves any necessary data values from the actual data file.
7. The server process modifies data in the SGA. The Database Writer (DBWn) writes modified blocks from the database buffer cache to the data files. The Log Writer writes redo log entries to disk (LGWR).
8. If the transaction is successful, the server process sends a message across the network to the application. If it is not successful, an error message is transmitted.
9. Throughout this entire procedure, the other background processes run. The server manages other users and transactions.

Results

The DBMS server and a Windows 98 client is located in the Physical Science, Environmental Science and Computer Science Advanced Computer Research Laboratory. Windows 95 clients are located in the Physical Science, Environmental Science and Computer Science LSAMP/ Learning Center Computer Laboratory and the Medgar Evers College Computer Laboratory. The successful network configuration of the DBMS has allowed the Introduction to Database Systems course to take place in a professional environment. I created user accounts for the students and implemented a backup and recovery system for the database.

Conclusion

The object approach in relation to a DBMS is a way to frame solutions to problems. It is an approach of abstraction that allows developers to represent entities with particular states and behaviors. Objects are manipulated according to specific protocol: this process is known as the object's interface. The result of this allows developers to reuse code in different applications or databases. It models the application or database as a set of objects collaborating with one another to fulfill their responsibilities.

The DBMS supports multi-users executing a variety of database applications operating on the same data and do not suffer from slow processing performance. The DBA can selectively control the availability of data. The DBA has the ability to provide fail-safe security features to limit and monitor data access. These features enforce rules of data integrity. The result of this eliminates the need of coding and managing checks in developing database applications.

Oracle combines the data physically located on different computers into one logical database that can be accessed by all network users. The software is developed to work under different operating systems. The applications developed for Oracle can be transferred to any operating system with little or no modification. This feature allows different types of computers to share information across networks.

Acknowledgements

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Longslit Spectra of the Galaxy NGC 1569

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Abstract

Longslit spectra of the starburst galaxy NGC 1569 are displayed. This ground-based data was acquired at the 90-inch telescope of the Steward Observatory (Kitt Peak, Arizona) in September 1998. Results for the red region of the spectrum are presented. The variation of ionization and gas density as a function of position in the galaxy are shown. The background stellar component of the galaxy is separated from the nebular emission spectrum. These ground-based results will be used with space-based data to be acquired by astronomers at South Carolina State University, the University of Maryland and Rice University as part of an approved Cycle 8 Hubble Space Telescope program.

Background

A galaxy is a massive system of stars, gas and dust bound together by its own gravity. The inward pull of gravity is balanced by the orbital energy of stars, gas and dust found within itself. The nearest galaxy, the Large Magellanic Cloud, is more than 150 thousand light years away. Distances to galaxies are so great that Megaparsecs are the preferred distance unit; where:

1 light-year	=	5.9 trillion miles
1 parsec	=	3.26 light years
1 Megaparsec	=	1 million parsecs

Comparisons between observations and models of evolving galaxies help understand the star formation process, triggering mechanisms, influence of the environment, the chemical history, and processes in the interstellar gas.

The three (3) basic galaxy types are elliptical, spiral and irregular. See Figure 1 for examples. Starburst galaxies are those which belong to one of the three basic types and which have undergone one or more episodes of rapid star formation on a large scale. The intent of this study was to better understand galaxies in general and the starburst galaxy NGC 1569 in particular. Figure 2 shows positive and negative images of NGC 1569. NGC 1569 is the subject of a Cycle 8 Hubble observing program and the ground-based data examined herein will be used in support of the HST data.

Types of Galaxies

Spiral Galaxies: With spiral shapes, this type consists of a nucleus, disk, halo and spiral arms. The interstellar material in spiral galaxies is usually spread throughout their disks. Bright emission nebulae and light-absorption by dust can be observed in spiral galaxies. The arms contain young stars. Open clusters can usually be seen in the spiral arms, while globular clusters are often visible in their halos. The diameter of spiral galaxies range from ~20,000 to ~100,000 light-years (l-y). Their masses range from 10^9 to 10^{12} solar masses.

Elliptical Galaxies: This galaxy type has relatively low luminosity and are spherical or ellipsoidal in shape. They are thought to be composed of mainly old stars. They have a nucleus and halo with no spiral arms. Most of them have narrow lanes of light-absorbing dust. Stars are mainly concentrated in the center. The size, mass and luminosity range is considerable. Giant ellipticals, the largest galaxies of this type, are more luminous than any known spiral and have masses of at least 10^{12} times that of the sun. Dwarfs, which are the smallest ellipticals, are the most common size of such galaxies. In dwarfs only a few bright stars can be found. The central region of a dwarf elliptical is transparent.

Irregular Galaxies: Irregulars have asymmetrical structures. A large amount of dust and gas is present. Star formation is more common than in the other types.

Starburst Galaxies: Recent starburst subtypes are mostly irregular galaxies. Star formation rate in a typical spiral is 1-10 solar masses per year. Star formation rate during a burst is 10-300 solar masses per year. During a starburst, there is a driven galactic wind, the kinetic energy supplied by supernovae and stellar winds 'inflates' an expanding 'super-bubble' in the surrounding interstellar medium (ISM) of such a galaxy. The outflow of such a galactic wind may have a devastating effect on a dwarf galaxy because it facilitates the removal of substantial amounts of interstellar matter. Such metal-rich mass loss of starburst galaxies can account for a substantial fraction of the metals currently found in the intergalactic medium.

NGC 1569: A Starburst Galaxy

NGC 1569, is a dwarf, irregular galaxy. It is located 2.2 Mpc from the sun and has a mass of 3.4×10^8 solar masses. Dwarfs like NGC 1569 can be used as laboratories for testing various ideas about galaxy evolution and the interstellar medium. By studying NGC 1569 we gain knowledge about starburst galaxies, the evolution of dwarf galaxies, and about the physics of starburst-driven outflows. Its blue color, luminous Ha emission, strong infrared emission, two super-star clusters, and other observations, imply that NGC 1569 is dominated by a large population of young, high-mass stars. Images of NGC 1569 in the Ha revealed that it is immersed in a bright, complex system of emission-line filaments and loops that extend out several kpc along the minor axis of the galaxy. Spectroscopic studies of NGC 1569 show evidence of several expanding bubble-like structures. Typical sizes of such structures are of a few hundred pc and their expansion velocities go up to 50 km/s. NGC 1569 is also a moderately strong X-ray source.

Spectrum of NGC 1569

Longslit, two-dimensional (2-D) spectra were obtained of NGC 1569 using the 90-inch telescope at the Steward Observatory in September 1998. Only the red spectrum was analyzed in this study. Details regarding the observatory and the data set can be found in Tables 1 and 2. Location of the longslit projected onto the galaxy can be seen in Figure 2 as position #3. A reproduction of the 2-D, red spectrum can be see in Figure 3. The usual CCD noise sources were removed from the spectrum. Additional image processing is required for 2-D spectra and the appropriate IRAF tasks are listed in Table 3.

Table 1
Steward Observatory Bok Telescope & Site

Location:	Kitt Peak, Arizona
Elevation:	2071 m (6795 ft.)
Latitude:	+31° 57' 46.5"
Longitude:	111° 36' 01.6"W
Bok Telescope Aperture:	90"(2.3 m)
Spectrograph Gratings Used:	600 lines/mm blazed in red 600 lines/mm blazed in blue
Dates when data were taken:	September 17 - 19, 1998
CCD Chip Size:	1200 x 800 pixels (dispersion x spatial direction)
Data binned by 2 at the telescope (in the spatial direction):	1200 x 400 pixels
Trimmed data:	1190 x 152 pixels

Table 2
Observing Log

Image Name	Image Type	Exposure Time (sec)
dome0065.fits	dome flat	30
dome0066.fits	dome flat	30
dome0067.fits	dome flat	30
hear0050.fits	HeAr calibration lamp	1
n15690049.fits	object	600
twil0113.fits	twilight flat	2
twil0114.fits	twilight flat	2

Table 3
IRAF tasks used in data processing & analysis

<u>Task</u>	<u>Description</u>
cosmicrays	Found in the noao.imred.ccdred package, it removes most cosmic rays from images.
fixpix	Removes bad columns of pixels or cosmic rays that were not removed by cosmicrays. Uses a pixel coordinate file with the location of the bad pixels to be removed or smoothed.
illumination	Found in the twodspec.longslit package, it generates a function which shows how light varies with location in the spatial direction.
imsurfit	Found in the images.imfit package, it generates a response function in the dispersion/wavelength direction. The input data was our dome-average.
linebias	Subtracts the bias mean value of data images, and also trims out the unused portion of the CCD image.
identify/reidentify/transform	Series of tasks which correlate the wavelength scale with pixel location.

Results

- Figure 4: (Ionization Structure)

Figure 4 shows two red spectra from two separate locations in the galaxy. These were taken from pixel rows 60 (top tracing) and 49 (bottom tracing) along the slit. The coordinates along the Y axis are flux units ($\text{ergs cm}^{-2} \text{s}^{-1}$). Close examination shows that the top spectrum comes from a region of the galaxy which is both higher in the amount of emission and also higher in ionization. Note that the ratio of the 5007 line (OIII) to the 4861 line (H β) is about 6 in the top tracing but only about 4 in the bottom one. The top location corresponds to a region in the galaxy closer to highly ionizing stars such as O stars and Wolf-Rayet stars.

- Figure 5: (Ionization Structure)

The same two regions of the galaxy are shown, but with a restricted region of the spectrum, in the vicinity of H α at 6563 angstroms. The SII doublet at 6717 and 6731 angstroms is clearly

visible. Note, that in the top (high ionization) location, the He I line at 6678 is present, but not in the lower ionization, bottom spectrum. The explanation for this is the same as in Figure 4.

· Figure 6: (Gas Density Variation)

The top part of Figure 6 shows a tracing *along the slit*. In other words, across the face of the galaxy for a given wavelength. The solid line shows how the SII emission line at 6717 angstroms varies with position; while the dashed line shows how the SII line at 6731 angstroms varies with position. Note there are clearly places in the galaxy where the SII emission gets stronger. These correspond to regions of higher gas density.

The bottom part of the figure is simply the ratio of the intensities of 6717 angstroms to 6731 angstroms for the same positions across the galaxy as in the top figure. This ratio is related to the electron density in the gas as follows:

Ratio = 1.4 is for an electron density = 80 cm^{-3}

Ratio = 1.2 is for an electron density = 200 cm^{-3}

Ratio = 1.0 is for an electron density = 800 cm^{-3}

Ratios greater than 1.4 are not considered accurate indicators.

Summary

A study of galaxies in general as well as starbursters has been completed with the following results:

1. The irregular, starburst galaxy NGC 1569 had been studied.
2. A red, longslit spectrum of NGC 1569 has been reduced and analyzed
3. Variations in ionization and gas density as a function of position in the galaxy have been found.
4. These ground-based results will be used with WFPC2 imagery from the Hubble Space Telescope to be taken on September 23, 1999. Astronomers at South Carolina State University (SCSU), the University of Maryland and Rice University will carry out the analysis of the Hubble data.

Acknowledgements

We are pleased to acknowledge the assistance of NASA through the MUSPIN Project in providing a stipend and travel funds. This was made possible by cooperative agreements between NASA and SCSU (NCC5-116), the City College of New York NRTS (NCC5-98) and two agreements with Tennessee State University (NCC5-96 and NCC5-228).

Note: Figures 4, 5 and 6 are not available for publication at this time.

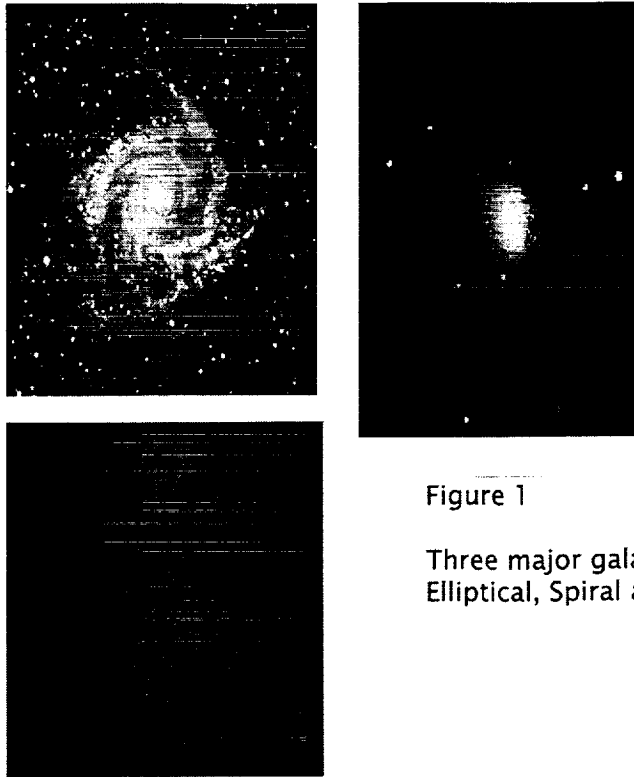


Figure 1

Three major galaxy types:
Elliptical, Spiral and Irregular

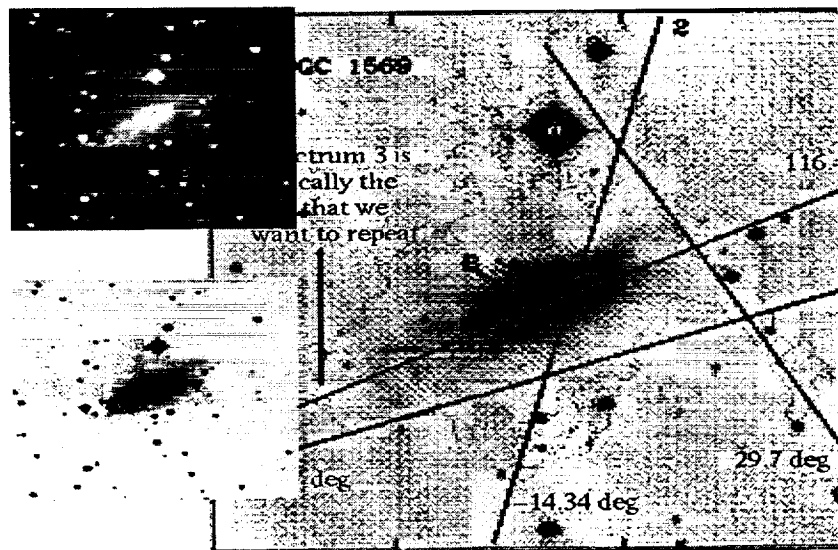


Figure 2

Positive and negative images of NGC 1569 (left) and slitposition #3 (right used in this study).

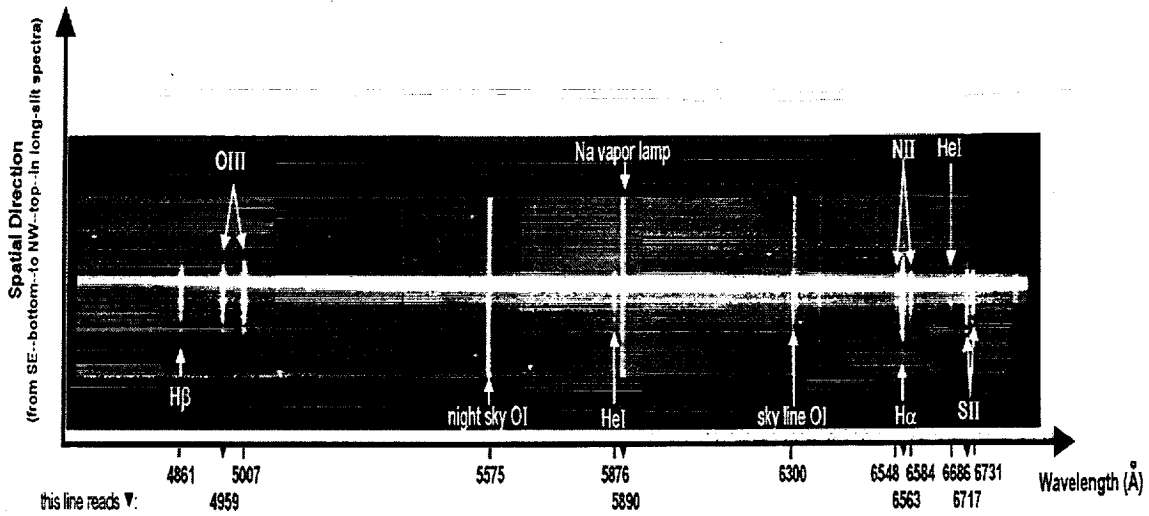


Figure 3

Two-dimensional, longslit spectrum of NGC 1569 used in this study. Important emission lines from the galaxy are indicated along with sky lines from the Earth's atmosphere, including light from man-made Na-vapor lamps. Wavelength space is left to right and spatial coverage across the galaxy is top to bottom.

A Standards-Based Meteorological Activities for All Students@

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Canarsie High School is typical urban high school in Brooklyn, New York. We have been involved in a District Initiative in collaboration with the City College of New York (CCNY) to initiate and incorporate relevant technologies into the science content areas and classrooms. Through changes in teaching strategies consistent with science education reform movements for mainstream, gifted and special education students; we have been able to effectively motivate student interest and to enhance and enrich the learning potential of all students. Our lessons involve extensive computer and Internet applications, concentrating our efforts in developing high-ordered reasoning skills to address the required concepts covered in Earth Science and Environmental Science curricula. This is a crucial aspect of applied learning approaches as related science concepts are integrated and clearly demonstrated in our daily lives.

Our task was to infuse 'live' weather data into Earth Science and Environmental Science classrooms. Student-centered learning activities, laboratory experiences and long-term investigations were designed, written and included into classroom lessons and laboratory sections. This component is aligned with the *New Learning and Performance Standards*, and makes use of investigative and inquiry-based studies through technological resources. These were accomplished through data readings taken from our school weather station and various World Wide Web sites. Weather data from area >cluster' schools were also used to compare micro-climates within our local region. This fostered peer communication skills among students and staff throughout the Brooklyn High School District.

Our presentation session allowed us to share and disseminate these ideas and strategies described above, that have made for successful science courses in a typical New York City high school addressing mainstream, gifted and special education students. The following items were discussed and imparted at this presentation:

- described specific classroom and laboratory activities using weather station data and Internet resources
- demonstrated particular >mindson' strategies in adapting curricula to meet the needs of at-risk populations
- characterized collaborative efforts by high schools and colleges to enrich the learning experience for both students and teachers
- exhibited the *Canarsie High School home page* and specific linkage sites that are used in the Earth Science and Environmental Science classrooms

Weather Data Analysis Activity Sheet

Name _____ Teacher _____ Date _____

Date of Analysis _____

Examine the weather data (*tables and graphs*) downloaded from the Canarsie High School Weather Station.

- 1) For each of the variables indicated, describe any noticeable pattern that exists during the 24-hour period.

outside temperature: _____

barometric pressure: _____

humidity: _____

rain fall: _____

wind speed: _____

wind direction: _____

- 2) During this 24-hour period, describe the relationship of each weather variable as the barometric pressure falls (or rises).

- 3) Specify the approximate time when the barometric pressure has reached its minimum (or maximum).

Time of day (am or pm): _____

- 4) Identify the Outside Temperature, Outside Humidity and Dewpoint values at this time.

Outside Temperature: _____

Outside Humidity: _____

Dewpoint: _____

- 5) From the information you have examined and listed, describe the weather conditions that existed for the time interval outlined in #3 and #4, above.

- 6) Explain how changes in barometric pressure relate to the potential of precipitation?

- 7) State how your data reflects these inter-dependent weather concepts.



C.O.N.E.Y. PROJECT

Introduction

The **C.O.N.E.Y.** (Combined Oceanic and Nautical Environmental Effect on You) Project is an observational project that encourages students to analyze and explain the effect of the ocean on the New York City vicinity. This project is a Brooklyn High School local project that will be used as a Regents Earth Science (Program Modification) long-term investigation.

This project will include:

- collection of weather data (archived and current)
- analysis of weather data
- field trips to Prospect Park and Jamaica Bay
- observations of various ecosystems
- creation of a technique to predict the ocean-land interaction

New York City's proximity to the ocean allows us to witness the dynamic interaction of the ocean and land areas. This interaction has a pronounced effect on the local climate of the five boroughs and is an important factor in forecasting the weather for the New York City area.

We will use National Weather Service stations across the New York City area and local school-based weather stations. These networks of weather data recording sites allow us to observe, analyze and understand the complex ocean-land climate interaction. The collection of real time data, and the analysis of that data invites students to examine the local climate in a way which enhances concept understanding of climate and weather patterns.

This project relies heavily on the use of Internet resources to collect our data, examine and analyze images of the New York City area, and to "*connect*" local schools in this active learning process. This combination of data, images and collaboration provides our students the opportunity to serve as true participants in this educational environment.

The following lesson represents an introductory-level Internet activity in the **C.O.N.E.Y.** Project that allows you to obtain weather data in several New York City locations, analyze maps and graphs and to interpret the effect of the ocean-land interaction.

Procedure

- Students or the teacher will connect to the **C.O.N.E.Y. Project Home Page**, located at *URL* address <http://maestro.com/~canarsie> (Canarsie High School Science Home Page).
- Ideally, each student should have access to a computer terminal. However, this project can be conducted in the classroom using a computer/TV connection or a computer/overhead or LCD panel connection. The teacher should make copies of the project to be distributed to each student.
- Once the **C.O.N.E.Y. Home Page** has been loaded, students should use the on-line images to answer the questions at the end of each section.

1. Image # 1 is an image of *New York City* taken from the Space Shuttle. The map is a satellite depiction of the New York City area. On this map, *North* is located at the top of the map. Answer the 2 questions that follow the map.

a) _____

b) _____

2. Image # 2 is a graph of the *average high temperature* at Central Park (*blue*) and JFK (*red*), for the month of April, 1996. Answer the 2 questions below the graph.

a) _____

b) _____

3. Image # 3 is a graph of the *average wind speed* at Central Park (*blue*) and JFK (*red*), for the month of April, 1996. Answer the 2 questions below the graph.

a) _____

b) _____

4. Image # 4 is an image of the borough of *Brooklyn*. The weather stations in this project are indicated by blackened in circles. Answer the 2 questions below the graph.

a) _____

b) _____

5. Image # 5 represents the daily maximum and daily minimum temperatures of New York State on a typical date in April. Analyze the data in the map image. In a brief essay, answer the following:

- describe the area reflecting the warmest and of the coolest daytime temperatures in the region
- describe the area that is identified as displaying the most varied temperatures during the nighttime hours.
- describe the presence of how the ocean influences the distribution of temperatures across New York State on this day.

How Can We Plot the Movement of a Hurricane Using Latitude and Longitude?

Teacher Reference Sheet

Instructional Objectives

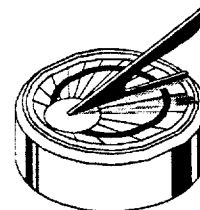
Students will be able to . . .

- define *latitude, longitude, hurricane, and tropical storm*
- analyze past and present locations of hurricanes and tropical storms and plot predicted movement
- construct a plotted map of the storms past and future movement
- predict the future movement of the hurricane

Materials and Set-up

This lab activity is designed for classroom use or in lieu of a standard latitude/longitude mapping exercise. If a computer room is available for individual student use, the teacher should make provisions for each computer station to be able to access the necessary files.

- 1) Access the Canarsie High School Home Page (<http://maestro.com/~canarsie>), find the title of the laboratory activity and click on the corresponding link site for weather maps. This activity will make use of downloaded *.gif image files from The National Hurricane Service.
- 2) The first map you will need to download is a latitude/longitude map of the East Coast of the United States. This map can be found on the *Tropical Weather Section* link site of the Canarsie High School Home Page.
- 3) If a hurricane is currently in the Atlantic Ocean, then it is highly recommended that teachers use this data to plot the tracking map.
- 4) If a hurricane is NOT presently found in the Atlantic, then it is expected that teachers will use the data that comes with the lab activity.
- 5) Due to the timing of hurricanes, it is expected that teachers use this lab activity during the months of September/October, during the teaching of latitude/longitude (Unit 1).
- 6) These files may also be stored and accessed through a compatible-format viewer or the Paintbrush Accessories program in Windows. The images should be converted to *.bmp file format.
- 7) You must then retrieve the latitude/longitude data to plot. If you are using a current storm, access the following address: (<http://cirrus.sprl.umich.edu/wxnet/tropical.html>) and get the latitude pairs for the current storm. If you are using the sample data, it is provided with the lab.
- 8) Obtain the official hurricane forecast positions from the National Hurricane Center. If you are using a current storm, go to (<http://cirrus.sprl.umich.edu/wxnet/tropical.html>) and download the current marine advisory for the storm. If you are using the sample data, it is provided with this lab.



Pre-Lab Worksheet

Aim: How Can We Plot the Movement of a Hurricane Using Latitude and Longitude?

Directions:

Soon, you will be carrying on this activity using technology in the Earth Science Laboratory. In order to make your laboratory work more meaningful and enjoyable, you are asked to define the following terms and answer the following questions. Use your textbook and class notes to help you. The index of your book can be very useful.

1) Define:

- a) latitude - _____

- b) longitude - _____

- c) hurricane - _____

- d) tropical storm - _____

2) Using the *Earth Science Reference Tables*, find the latitude and longitude of the following places in New York State.

- a) Binghamton latitude: _____ longitude: _____
- b) Utica latitude: _____ longitude: _____
- c) Albany latitude: _____ longitude: _____
- d) Buffalo latitude: _____ longitude: _____
- e) Mt. Marcy latitude: _____ longitude: _____

How Can We Plot the Movement of a Hurricane Using Latitude and Longitude?

Introduction

Hurricanes are probably the most powerful weather event that can affect the environment. Since the times of Columbus, hurricanes have terrified and amazed us with their power, fickleness and even grace. Today, the job of forecasting hurricane movement is that of the National Hurricane Center. They use the latest in technology to plot where a hurricane is presently located, and where it will be in 24 to 48 hours. One of the basic tools that a meteorologist must master is the use of latitude and longitude.

Student Objectives

You will be able to ...

- define *latitude, longitude, hurricane, and tropical storm*
- analyze past and present locations of hurricanes and tropical storms and plot predicted movement
- construct a plotted map of the storms past and future movement
- predict the future movement of the hurricane

Materials & Resources

- PC computer w/ Windows and TV/video monitor
- peripheral PC/TV converter box
- modem line (optional)
- *.bmp image of hurricane plotting map
- black-line master of map

Procedure

Task # 1 - Plotting Past Hurricane & Tropical Storm Positions

- 1) Using Paintbrush in Windows Accessories, open file (*hurrchrt.bmp*). Use the mouse to draw points for every position on your plotting table. For each point on your map, write down the time and date that you find on your table. Connect the points to form a line.

Task #2 - Predicting Future Hurricane Positions

- 1) Using the forecast positions for the hurricane provided by the National Hurricane Center, plot the predicted path of the storm for the next 72 hours using a different colored pen or pencil.
- 2) Connect all the points on one line and answer the following questions.

TOPIC: METEOROLOGY

Analysis

Answer these questions based upon your completed hurricane plotting chart, your Earth Science Reference Tables and your knowledge of Earth Science.

- 1) Why are latitude and longitude important in the plotting of hurricanes and tropical storms?

- 2) Describe the general direction of the hurricane movement in the early part of your chart, what about at the end?

- 3) Using the scale on the map, determine how close the hurricane gets to New York City.

- 4) Determine the distance that the hurricane is from each of the cities below. Use the hurricane closest approach to each city as your guide.

Miami: _____ Cape Hatteras: _____

Savannah: _____ Philadelphia: _____

Follow-Up Activity

If the storm that you plotted is one that is actually happening at this time, watch the local news or Weather Channel to see if the storm follows the predicted path given by the National Hurricane Center. Describe hurricanes that have affected New York City in the past and discuss the possibility of future hurricanes.

Sample Data for Lab

Data for Hurricane Felix 1995

<u>DATE</u>	<u>TIME</u>	<u>LATITUDE (EN)</u>	<u>LONGITUDE (EW)</u>
8/11/95	12:00	20.9	-56.2
8/12/95	00:00	22.5	-58.6
8/12/95	12:00	24.0	-61.0
8/13/95	00:00	25.5	-62.1
8/13/95	12:00	27.4	-62.4
8/14/95	00:00	28.2	-62.4
8/14/95	12:00	30.5	-63.7
8/15/95	00:00	31.2	-65.3
8/15/95	12:00	32.4	-67.5
8/16/95	00:00	33.8	-70.9
8/16/95	12:00	34.6	-72.5

TOPIC: METEOROLOGY

Forecast Data from the National Hurricane Center

	<u>LATITUDE (EN)</u>	<u>LONGITUDE (EW)</u>
12 HOURS <i>08/17/95 (00:00)</i>	35.3	-73.1
24 HOURS <i>08/17/95 (12:00)</i>	35.9	-73.0
36 HOURS <i>08/18/95 (00:00)</i>	37.0	-71.4
48 HOURS <i>08/18/95 (12:00)</i>	37.2	-69.6

Note: The time 00:00 refers to midnight GMT. This is about 7:00 pm New York time. The negative sign in front of the longitude is just a shorthand way of signifying that it is degrees west.

IP Telephony: Architecture and Growth Factor

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Abstract

IP telephony is used to send service like voice, facsimile, and /or voice-message applications between two or more computers in real time. It combines voice and data that are transported via the Internet, rather than the Public Switching Telephone Network(PSTN). IP telephony became a reality because of the H.323 specification. H.323 establishes standards for compression for audio and video data stream.

Introduction

Internet can provide business with a world-wide audience, what about the phone bill you will incur for communication for long distance and international calls? Fortunately, the Internet promises even bigger communication savings by drastically lowering long distance phone bills. Internet Protocol, one of the fastest -growing uses for the Internet, cuts long-distance phone charges down to a bare minimum by using existing data lines and gateways, which translate analog calls into digital information and back again.

Regular phone calls travel through several circuit switches, while Internet calls need to travel through gateway only twice: once to turn it to digital form and once to change it back. Dedicated lines are not needed. Internet telephony is estimated to grow rapidly. Many analysts estimated that by the year 2010, half of the long-distance traffic will go over IP. Instead of paying between 10 and 30 cents per minutes for domestic long-distance calls, most IP telephony services charge an average of 8 cents per call. Cost savings on international call via the Internet can be even greater.

The major drawback of using IP telephony is that it doesn't give the stable quality that many people expect during a phone call. If the lines are jammed with other Internet traffic, calls can break up and bits of the conversation will get delayed or lost. Since it uses IP/UDP, calls may be unreliable. IP telephony call can be made three ways: computer-to-computer, computer-to-phone, or directly phone-to-phone.

Discussion

Computer Telephone Integration(CTI) provides an environment for application creating that gives access to the function of both telephone system and the computer system. IP telephony is an implementation of CTI. Telephony basically covers the telephone system itself: the way in which telephone networks carry calls, and the way that those telephone calls get to the right person. The Public Switched Telephone Network(PSTN) uses an entire telephone channel for every phone call, fax, or data connections, and route the call from the sender to receiver as if establishing a single end to end circuits. That is why they are called "circuit-switched" networks. Circuits are reserved between the origination switch and the terminating switch based on the called party number(Walter, 1993).

The combination of IP and telephone gives IP telephony. IP telephony sends services like voice, facsimile, and/or voice-message applications between two or more computer users in real time thereby combining voice and data that is transported via the Internet, rather than the PSTN(Siemens). How does IP telephone works? The services starts from the Personal Computer(PC) that has special software to convert the sound into digital codes, which are then passed on to the Internet Service Provider(ISP). The ISP breaks

the digital messages up into packets. Packets piece of message each encoded with a destination address. The packets go to the the Internet Telephone Service Provider(ITSP) who reassembles the packets as they arrive and converts them to speech. It then goes to the traditional PSTN, which direct the call to the right phone number. ITSP charges for the local call and a handling fee (Armstrong, Sandler, Elstrom, 97).

H. 323 Standard

H.323 establishes standards for compression and decompression of audio and video data streams, ensuring that equipment from different vendors will have area of common support. H. 323 is not tied to any hardware or operating system. It addresses the core Internet-telephony application by defining how delay-sensitive traffic gets priority transport to ensure real-time communications service over the Internet. Video and voice traffic are bandwidth-intensive that could clog the corporate network. H.323 address this issue by providing bandwidth management. Network managers can limit the number of simultaneous H.323 connections within the network or the amount of bandwidth available to H.323 applications. These limits ensure that critical traffic will not be disrupted. H.323 allows customers to use multimedia applications without changing their network infrastructures since it is designed to compensate for effect of highly variable LAN latency(Siemens).

Customers make conference without worrying about compatibility at the receiving point. The H.323 ensures that the receiver can decompress the information without any problem. H.323 allows customers products to inter operate with other H.323 compliant products by providing device-to device, application to-application , and vendor-to -vendor interoperability.

Gateway server allows a full-duplex conversion. A gateway consists of several parts. One is a switched-circuit network interface, incorporating T1 of ISDN PRI interface cards. Gateway usually also contains NICs for communication with devices on H.323 network. Other components include digital signal processors, which take care of voice compression and echo cancellation, and a control processor that oversees all other gateway functions(Ong, 1999).

Gatekeepers are required to perform four functions. First, they must translate terminal and gateway LAN aliases to IP or IPX addresses. Second, gatekeepers perform bandwidth control, which involves allocating bandwidth out of the telephone. Gateways have overcome an IP telephone problem of addressing.

EMBED Unknown * MERGEFORMAT

Another important piece of any H.323 network is the gatekeeper, which acts as the central point for all calls within its zone. A gatekeeper's zone is defined as H.323 terminals, translation gateways, and multipoint units over which it has control during a call; they can refuse to create more connections once a pre-established upper limit for a number of simultaneous conversations has been reached. A third gatekeeper function is admission control, which use Remote Access Service(RAS) messages to authorize network access. The fourth required function is zone management, which involves performing the previous three tasks for all terminals, gateways, and MUCs within its zone(DataBeam, 199998).

Gatekeepers can also perform several optional functions. One is call-control signaling, which permits the gatekeeper to process Q.931 signal messages. Q.931 is a signal protocol which sets up and terminates a connection between two H.323 devices. A gatekeeper may also perform bandwidth management, an extension of bandwidth control, which means it can determine when there is no available bandwidth for a call, or if there is no more available bandwidth when a call in progress request more. Other optional gatekeeper services include call authorization, which involves the acceptance or rejection of calls based on certain criteria such as time of day, type of services, and lack of bandwidth. Gatekeepers also may perform call management, which involves keeping track of H.323 calls in progress to determine which terminals are busy. This helps gatekeepers redirect calls or save call-setup time by not trying to reach a terminal already in use.

Although H.323 is geared toward audio and video conferencing, it does support data conferencing. ITU incorporates the T-120 standard, which defines point-to-point and multipoint data conferencing

sessions with ease. The T-120 data conferencing standard contains a series of communication and application protocols and services that provide support for real-time. This provides exceptional benefits to end user, vendors, and developers tasked with implementing real-time applications. T.120 error-corrected data delivery ensures that all endpoints will receive each data transmission. In multicast enable works, T.120 can employ reliable and unreliable delivery services. Unreliable data delivery is also available without multicast. The T.120 standard supports a broad range of transport options, including PSTN, ISDN, Packet Switched Digital Networks(PSDN), Circuit Switched Digital Network, and popular local area network protocols(DataBeam, 1998).

Architecture Overview

The H.323 Recommendation covers the technical requirements for audio and video communications services in LANs that do not provide a guaranteed Quality of Service(QoS). H.323 references the T.120 specifications for data conferencing and enables conferences which include a data capability. The scope of H.323 does not include the LAN itself or the transport layer that may be used to connect various LANs. Only elements needed for interaction with the Switched Circuit Network are within the scope of H.323. H.323 defines four major components for network-based communications system: Terminal, Gateways, Gatekeepers, and Multipoint Control Units.

Terminals are the client endpoints on the LAN that provides real-time, two-way communications. All terminals must support voice communications, video, and data. H.323 specifies the modes of operation required for different audio, video, and/or data terminals to work together. All H.323 terminals must support H.245, which is used to negotiate channel usage and capabilities.

Gateway is an optional element in an H.323 conference. Gateways provide many services, the most common being a translation function between H.323 conferencing endpoints and other terminal types. In addition, the Gateway also translates between audio and video codecs and performs call setup and clearing on both the LAN side and switched-circuit network side. In general, the purpose of Gateway is to establish links with analog PSTN terminals, create links with remote H.320-compliant terminals over ISDN-based switched-circuit networks, and establish links with remote H.324-compliant terminals over PSTN network.

Gatekeeper is most important component of an H.323 enabled network. It acts as the central point for all calls within its zone and provides call control services to registered endpoints. In many ways, H.323 gatekeeper acts as a virtual switch.

The Multipoint Control Units(MCU) supports conferences between three or more endpoints. Under H.323, an MCU consists of a multipoint controller, which is required to have one or more multipoint processor. The multipoint processor handles H.245 negotiates between all terminals to determine common capabilities for audio, and video processing.

Key Benefits of H.323

H.323 establishes standards for compression and decompression of audio and video data streams, ensuring that equipment from different vendors will have some area of common support.

Interoperability

Users want to conference without worrying about compatibility at the receiving end. Besides ensuring that the receiver can decompress the information. H.323 establishes methods for receiving clients to communicate capabilities to the sender.

Network Independence

H.323 is designed to run on top of common network architectures. As network technology evolves, and as bandwidth-management techniques improves, H.323-based solutions will be able to take advantage of those enhanced capabilities.

Platform and Application Independence

H.323 is not tied up to any hardware or operating system. H.323-compliant platforms will be available in many sizes and shapes. Including video-enabled personal computers, dedicated platforms, IP-enabled telephone handsets, cable TV set-top boxes and turnkey boxes. Other key benefits of H.323 includes: Multipoint Support, Bandwidth Management, Multicast support, Flexibility and Inter-Network Conferencing.

Quality of Service Challenge in IP Telephony

The Public Switched Telephone Network(PSTN) was designed for real-time voice transport, providing low latency, guaranteed bandwidth, and lossless transmission. On the contrary, IP networks were designed to transport data, they introduces latency, packet jittering, and packet loss.

QoS Challenge: Latency

For toll quality voice conversation, end to end delay must be under 250ms, requiring 100ms gateway delay and less than 150ms IP network delay. IP telephony uses Real TimePAGE Protocol(RTP) embedded in IP/UDP. It contains time stamp and sequence number. It has no built-in latency guarantee.

QoS Challenge: Packet Jitter

IP packet arrives time is not deterministic, this creates inter-arrival time jitter. Jitter contributes to latency. Jitter buffer management is needed in gateway.

$$\text{Latency(total)} = \text{Latency(avg)} + \text{Jitter(max)}$$

QoS Challenge: Packet Loss

IP packets may be lost during transmission. It may be discarded by routers. It arrives out-of-order beyond allowable latency. Many gateways have processing to address mitigate packet loss. Some of the techniques used are: packet redundancy, forward error correction, and lost packet interpolation schemes. The goal is to keep packet loss below 5-10%.

Potential QoS Solutions

The following suggestions are provided to improve quality of service: over -provisioning, buy grade of service guarantees, and utilize new IP-related protocols. The over-provisioning allows to build excess capacity in LAN or private WAN and continual capacity planning as needed.

With IP telephony technology being relatively new there are some advantages and disadvantages. Many corporations wanted proof of cost savings, quality and reliability, endorsements by others in the field, and maturity in the technology. The ultimate objective, of course, is reliable, high-quality voice service, the kind that users expect from the PSTN. Internet's limited bandwidth often results in congestion, which, in turn can cause delays in packet transmission. Packet loss, overhead, latency and jitter are additional disadvantages with IP Telephony technology.

A characteristic that determines the quality of an Internet telephony connection is simply how well the transmitted voice quality matches the speaker's natural voice. If certain voice packets are delayed beyond a specific threshold, Internet telephony software will "guess" at the contents of the lost packets by analyzing the surrounding packets and interpolating. The more interpolation than necessary, the more the voice quality is distorted.

Because the Internet is a packet-switched or connectionless network, the individual packets of each voice signal travel over separate network paths for reassembly in the proper sequence at their ultimate destination. While this makes for a more efficient use of network resources than the circuit-switched PSTN, which routes a call over a single path, it also increases the chances for packet loss. In voice communications, packet loss shows up in the form of gaps or periods of silence in the conversation, leading to a "clipped-speech" effect that is unsatisfactory for most users and unacceptable in business communications.

Packetizing voice codes are becoming better at reducing sensitivity to packet loss. The main approaches are smaller packet sizes, interpolation (algorithmic regeneration of lost sound), and a technique where a low-bit-rate sample of each voice packet is appended to the subsequent packet. Through these techniques, and at some cost of bandwidth efficiency, good sound quality can be maintained even in relatively high packet loss scenarios.

As techniques for reducing sensitivity to packet loss improve, so a new opportunity emerges for the achievement of even greater efficiencies by suppressing the transmission of voice packets whose loss is determined by the encoder to be below a threshold of tolerability at the decoder. This is particularly attractive in the emerging packet-based networking world where random packet loss is being controlled through complex protocols and through server control and where statistical multiplexing favors the reuse of recovered bandwidth.

In IP Telephony each voice packet carries a header with identification and routing information that contributes 'overhead' not present with circuit switching techniques. Real-time traffic (including voice) is very sensitive to delay and packet loss. Transmitting the real-time traffic in very small packets offsets this sensitivity. The use of very small packets has the unfortunate effect of increasing the ratio of overhead to revenue-bearing traffic reducing the effective capacity of a given transmission medium.

A typical encoded voice payload size is 20 to 40 bytes, while overhead in packet-based networks varies between 10 and 40 bytes. Thus, packet overhead consumes an average of 20% to 50% of the occupied capacity when packet networks carry encoded voice traffic. IP networks, in particular the Internet, are among the worst offenders in this area. Evolving methodologies are reducing this overhead through session multiplexing within packets, header compression and other techniques that replace the header with session or local channel identifiers similar to Frame Relay's Data Link Connection Identifier (DLCI). Thus, it is likely that packet-based networks will soon exceed the efficiency of circuit-based networks for the transmission of high-quality voice traffic.

Header overhead in packet-based networks does however provide a significant advantage over its circuit-based counterpart, delivering the statistical multiplexing capability so valuable for mixing multiple traffic types over a single network (Couch, 1999).

Latency is another challenge to consider with IP Telephony technology. Latency is the time required for data to travel from point A to point B. During a telephone call end-to-end delay much above 300 milliseconds is perceptible. Though many acceptable voice services exceed this level, offerings must operate below it. Advanced packet-based voice solutions keep total delay below the 300ms threshold, but most networks experience higher delay, impeding support for toll-grade voice solutions. This is particularly true for Internet and international traffic. Thus, limiting delay while improving other quality factors is the focus of much of the current research and development in packet-voice technology.

With the advent of IPV6 (RSVP) and Winsock 2.0, many of the issues associated with this delay problem (namely routing, topology, traffic profile and protocol factors) are significantly reduced. Jitter is the variability in latency. Jitter is caused by the cumulative effects of queuing delays at the various transmission and switching points along the path of a given session through a network. Jitter will tend to have a maximum value for a given network path loosely defined by the congestion thresholds

set for the nodes and trunks along that path. In general increasing jitter will give way to packet loss as link load values exceed 50%-70% or node load values exceed 70%-90%, depending on the traffic profiles for the network(Rahalho, 1999).

In any case jitter buffers are required whenever real-time traffic egresses a packet network in order that the potential for under-run conditions is minimized. In a voice application "underrun" describes the situation where analogue output is starved of digital input and "clipping" occurs. These jitter buffers contribute to the end-to-end delay for the call.

Network routers help reduce jitter by flushing their transmission buffers before significant queues accumulate. And, since interframe times are typically 30 to 100 milliseconds on a single VoIP session, it is highly two consecutive packet from a single session will end up simultaneously in the same transmission queue. In well-engineered networks enough packets will usually be transmitted for maintenance of reasonable voice quality even during normal transient congestion conditions. Jitter buffer values suitable for the current public Internet should be expected to exceed 200 milliseconds. While this still allows the provisioning of services with reasonable quality, IPV6 and Winsock 2 will also help to reduce the required jitter buffer values to around 100 milliseconds.

IP Telephone Growth Factor

The rapid growth is being driven by a powerful combination of factors. Currently, IP telephony gives new operators an easy and cost-efficient way to compete with incumbent companies by undercutting their pricing regimes, while avoiding many of the regulatory barriers to standard voice provision. However, unlike other low-price telecom services such as callback, the success of IP telephony is not merely dependent on exploiting the artificial price differentials which will fade away once the prices of standard services are set on a more rational economic basis. It also offers a platform for the integration of voice and data communications for easier development of value-added services such as video conferencing, unified messaging and increased call center functionality. More generally, the switch to IP as the main delivery mechanism for telecom services in the future is looking increasingly likely. The most recent harbingers of this change are the new entrant operators such as Qwest and Level3. Their extensive deployment of high-bandwidth IP networks is likely to encourage a wholesale switch to IP, as the economies of scale they attain drive down IP provisioning costs even further and force traditional operators to abandon their legacy system. The technological goal of the IP telephony industry is the establishment of a single IP pipeline carrying all of a corporate's voice, video, and data traffic. The benefits are numerous and compelling. First, consolidation will bring both cost savings and possible simplified ease of use via centralized network management software(Essex, '99)

Conclusion

The telecommunications industry is changing at an astounding rate. IP telephony offers potential to provide a richer service experience through the use of Internet-based server technology and the combination of video and data services with basic voice services. The use of the Internet as a distribution channel, coupled with the low start-up costs will dramatically alter the voice service rate. The H.323 is comprehensive, yet flexible, and can be applied to voice and full multimedia video conferencing stations. H.323 applications are set to grow into the main stream market.

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Function Comparisons for PC Operating Systems

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Abstract

Many personal computer users as well as those who must support PC users must deal with multiple operating systems. This poster, along with the handout, serves as a single reference for looking up how to complete a task in a particular operating system. This poster illustrates how to perform some basic functions when using the various Microsoft operating systems. The name of the function, such as "deleting a file", is listed, and the procedure for completing the function described for each of the operating systems. The poster serves as a reference and a copy of the poster is included with a handout that will be given to each visitor to the poster site. The handout gives details for the procedures outlined by the reference poster.

The poster and handout contents are available over the web at <http://coe.tsuniv.edu>.

Air, Ocean and Climate Monitoring Enhancing Undergraduate Training in the Physical, Environmental and Computer Sciences

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Abstract

Faculty in the Department of Physical, Environmental and Computer Sciences strongly believe in the concept that undergraduate research and research-related activities must be integrated into the fabric of our undergraduate Science and Technology curricula. High level skills, such as problem solving, reasoning, collaboration and the ability to engage in research, are learned for advanced study in graduate school or for competing for well paying positions in the scientific community. One goal of our academic programs is to have a pipeline of research activities from high school to four year college, to graduate school, based on the GISS Institute on Climate and Planets model.

- An information infrastructure has been developed in the Advanced Computing Research Laboratory.*
- A new Bachelor of Science degree program in Environmental Science has inspired changes in the approach to teaching Quantitative Analysis and Environmental Measurements and Instrumentation. Project-based activities are incorporated into the laboratory section of these courses.*
- Students pursuing degrees in Computer Science, Physical Science and Environmental Science, are encouraged to enroll in Independent Research early in their academic careers. Research Projects include; Ocean Modeling, Remote Sensing, Aerosol Optical Depth, and Meteorological.*

Introduction

The Department of Physical, Environmental and Computer Science (PECS) is integrating research and research-related activities into the fabric of undergraduate Science and Technology curriculum. Research provide those high level skills, such as problem solving, data analysis, reasoning, collaboration and appropriate work ethics, that students will need for advanced study in graduate school or for competing for well paying positions in the scientific community. It also makes them better teachers.

A strong relationship with NASA Goddard Institute for Space Studies (GISS) has provided opportunities for students to have hands-on experience in Air, Ocean and Climate studies. An information infrastructure for PECS has been developed, centered at the Advanced Computing Research Laboratory (ACRL), to provide access to NASA GISS facilities and resources from our home campus. This access is contributing to the enhancement of teaching and learning in our class room.

MEC offers both associate and baccalaureate degree programs. The three goals of our academic program are:

- to have a pipeline of research activities from high school to pre-college, to four year college, to graduate school which is based on the GISS Institute on Climate and Planets (ICP) model;
- to integrate research and research related activities into the fabric of our undergraduate degree programs as part of the restructuring of Science, Mathematics, Engineering and Technology (SMET) education; and
- to increase the number of under-represented students in the SMET pipeline who will either further their studies and research in graduate school, research institutions or industry or enter teaching.

Our degree programs are:

- The Bachelor of Science (BS.) Degree Program in Environmental Science focuses on the urban environment and include topics dealing with ethics, responsibility, law and business. Areas of study include: Toxic Sites, Waste Disposal and Management, Air and Water Pollution, Global Warming and Ocean and Atmospheric Studies. Students are required to complete a research project or participate in an internship during their senior year.
- The Associate of Science (A.S.) Degree in Computer Science is concerned with computers, their organization, the theory which underlies their existence, and their application; the program lays the foundation for advanced computing and provides opportunity for hands-on experience. The program follows the guidelines of the ACM and the Computer Society of The IEEE Joint Curriculum Task Force.
- The Associate of Science (A.S.) Degree in Physical Science is essentially a transfer program and has three options: Chemistry, Physics and Engineering. A.S. degree students are encouraged to enroll in Independent Research during their sophomore year.

Curriculum Development

The NASA Earth Science enterprise has an educational component; its emphasis is the integration of research into curricula, and this is the primary motivation for modifying old courses, developing new ones and creating new options for our Environmental Science program. A new degree program in Earth Systems Science is also in the developmental stage. New Courses include: Atmospheric Science (Meteorology), Special Topics in Climate and Planets, Remote Sensing - Computer Methods for Satellite Data Analysis, Hydrology (cross listed between Medgar Evers College and the City College of New York), Oceanography, Dynamic Earth (Geology), Internet and Web Technologies and Astrophysics.

University Physics I, II and III, Quantitative Analysis, Environmental Measurement and Instrumentation are modified to include up-to-date information and technology. For example, a Sunphotometer, multi-filter rotating shadowband radiometer, placed on the roof the Science Building, will be used for optical depth measurements, effective particle size and aerosol size distribution, and experiments are being developed for use in University Physics II & III.

New approaches in the teaching of analytical chemistry have been developed; project-based activities are incorporated into the laboratory section of Quantitative Analysis and Environmental Measurements and Instrumentation. Students are required to analyze ambient air for volatile organic compounds and particulate matter.

The proposed Baccalaureate Degree Program in Earth Systems Science will prepare students to become highly skilled in theoretical and applied research in the areas of study in the NASA Earth Science Enterprise. Through the use of NASA data from satellites, all the components of the Earth System: air, water, land, biota and their interaction will be studied. Student will be required to begin a research project during their junior year and complete a senior thesis.

Information Infrastructure and Computer Facilities

An information infrastructure for the Department of Physical Sciences and Computer Science has been developed. The local Area Network is designed for easy expansion and a student team under the supervision of the computer science faculty and an external consultant (NEED TITLE FOR DON), assembled the LAN and is currently assisting in network administration activities on a continual bases and is providing technical assistance/support. The network is connected via a Hub concentrator going through the Sun Ultra 1 Server, through a "CISCO" Router, through a "Timplex" Multiplexer with a T1 line to the CUNY Internet Server. Advanced Computing Research Laboratory (ACRL) is the core of the LAN and includes 4 Sun Ultra 1's, Netra J Web Server, Power Macintosh, PC, color laser printer, laser printer, scanner, 4 mm and 8 mm tape drives; software includes the Solaris Operating System

(2.5.1), the network file system, a full repertoire of compilers, mathematics software (MathLab, Maple) and image processing (IDL, MIRA Pro). Student also networked 6 faculty offices for 12 faculty, Environmental Science Laboratory, the AMP Learning Center for science students.

Freshman and sophomore students in the new course, Internet and Web Technologies, are obtaining hands-on experience for the development of web pages. For their class projects, students are finalizing our Departmental web site and are making their own web pages. Four teams are responsible for a major component of the PECS site. For their research project, a team of computer science majors are developing a database management system for the Department. Activities completed include:

- Network client/server configuration of Oracle 8.0.5;
- Server configuration implemented on the Sun Solaris 2.5.1 operating system;
- Clients configured in the Windows NT 98 and 95 operating systems; and
- User accounts and user profiles created for computer science courses.

Undergraduate Research Program

Students pursuing degrees in Environmental Science, Computer Science and Physical Science transfer are encouraged to enroll in independent research early their academic career. Most of the research projects are located in PECS. A state of the arts Environmental Science Laboratory, The Analytical Chemistry Laboratory and Advanced Computing Research Laboratory are the main facilities. Equipment include: Rotating Shadowband Radiometer, Gas Chromatography (GC), High Performance Liquid Chromatography (HPLC), Gas Chromatography/Mass Spectrometer (GC/MS), Fourier Transform Infrared Spectrophotometer (FTIR), UV-Visible Spectrophotometer, Atomic Absorption Spectrophotometer, Total Organic Carbon Unit, Mercury Vapor Analyzer, Non-viable Ambient Particle Sizing Sampler (8 Stage), Portable Indoor Air Quality Monitor, Universal Personal Samplers. Our faculty and students also have access to other special facilities, such as the Physics (EPR and NMR) Laboratory of Hunter College, the Remote Sensing Laboratory of the City College of New York and the Astrophysical Observatory of the College of Staten Island. Over two dozen Students have given Presentations at National and Local Conferences. Activities for independent research include the follow:

- Atmospheric Remote Sensing: Multifilter Rotating Shadow-band Radiometer
- Studies on Indoor and Ambient Airborne Particles in the New York City Environment.
- Ocean and General Circulation Model (OGCM) Studies of Turbulent Mixing Mechanisms and the Significance of Ocean Turbulence on Global Climate
- Determination of Trihalomethanes in Drinking Water by Micro Liquid-Liquid Extraction and Gas Chromatography
- Indoor Measurements of Elemental Mercury and Lead
- Water Purification System: A Bench-top Model
- Synthesis of Organotin Compounds
- Artificial Intelligence and Knowledge Representation
- Network Configuration of Object Relational Database Management System
- Studies of H II regions of M8, the Lagoon Nebula (South Carolina State University)
- Studying Hurricanes Using Data from Quick Scat and TRMM (City College of NY)
- Magnetic Resonance Studies of Materials for Advanced Batteries and Fuel Cells (Hunter College)

- Photometry of Binary and Variable Stars (College of Staten Island - Astrophysical Observatory)
- Maximum and Minimum Temperature Frequency as a Primary Measure of Global Change (GISS)

Examples of Student Results

Air Monitoring in the Neighborhood Environment

For laboratory projects and or research, students monitor ambient and indoor air in their neighborhoods. The focus of these activities is determined by current issues and neighborhood concerns. For example, when concern was raised about the use of mercury in religious practices by a segment of the inner-city population, a related project was, "In Search of Mercury in the Brooklyn Environment". The students compared the mercury levels in the homes of suspected users of mercury, with the levels in the home of non-users. Students' results from one such study for a small group-project, indicated that the mercury levels were all below the OSHA limit. However, the level in the home of the suspected user, was twice that of the non-user. The following questions were raise during discussions on the results:

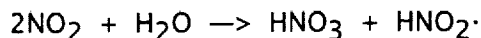
- Is the concern about the religious use of mercury unjustified, since levels in the homes of user and non-user are all below OSHA limit?
- Does the elevated level in the home of the suspected user of mercury present any health risk?

Sometimes, unexpected teaching/learning opportunities are presented as students involve themselves in their project. From one study on "Aldehydes and Ketones in Printing and Photocopying Rooms", as expected, formaldehyde, acetone, acetaldehyde, and benzaldehyde were identified and found to be below the OSHA limit. What captured the students' interest however, was the fact that the two sampling trains which were running simultaneously at two different locations in the same room, produced markedly different results; a significant amount of an unidentified compound (unknown peak at 5.76 min., from chromatogram) was found in sampling position 2 while no such compound was found in sampling position 1. This result encouraged students to have a closer look at the different types of chemicals used in printing and examined the way the chemical were handled and stored in room under investigation.

Air-Borne Particulate Matter a Focus of an Instrumentation Course

Particulate matter (PM) constitute complex a mixtures of air-borne pollutants. They are emitted from natural and anthropogenic sources. Anthropogenic sources are mainly through fossil fuel burning by electrical utilities, industries and motor vehicles. In the urban atmosphere, concentration of particles are more than 50% greater than that for rural or so called clean suburban atmosphere. Inhalation of fine particles (PM10), has shown to worsen asthma and increase bronchial hyperactivity . A large portion of outdoor aerosols penetrate indoor and are trapped, causing indoor air pollution levels to be greater than outdoor. Global and regional climatic conditions are also affected by atmospheric aerosols. Particles in the troposphere scatter solar radiation, trap greenhouse thermal radiation, alter the amount of light reflected by the earth, and increase the stability and brightness of the clouds. In addition, atmospheric aerosols also contribute to acid rains, and visibility impairment .

Students used a number of analytical equipment to conduct various analyses on particulate matter collected from ambient and indoor air; air-borne particles were analyzed for lead by flame AAS, pesticide (aldrin) by GC-ECD, volatile organic compounds by GC-MSD, and water extractable nitrite by HPLC. The determination nitrite washed off from air-borne particles, presented an opportunity for the students to discuss extensively, the chemistry of nitrogen dioxide interacting with air-borne particles. The following reaction is well known:



The possibility of nitrogen dioxide reacting with surface water on the particulate was established through the students investigations and discussions.

To introduce students to remote sensing, a the multi-filter shadow band radiometer (MFSBR), a sunphotometer, is studied as an instrument for ground-based remote sensing. The sun photometer which is installed the on the roof of Medgar Evers College, enables students to observe changes in the optical depth of ambient aerosols over Brooklyn.

Establishment of an Oracle Database Management System

Computer Science students are establishing an Oracle Database Management System (ODBMS) for the PECS Department. This database system is an object-oriented relational system. They networked and implemented the Oracle Server to the Local Area Network. Clients were configured in various operating systems and the students perform administrative duties. The students are in an applications development phase, which include importing previously developed database systems (urban environmental research groups) into the Oracle environment, and setting up user accounts and user profiles for the Introduction to Database Management Systems course.

Conclusion

Faculty in the Department of Physical, Environmental and Computer Sciences strongly believe in the concept that undergraduate research and research related activities must be integrated into the fabric of our undergraduate Science and Technology curricula. Thus far, these activities have excited our students through this hands on approach, and it has given many confidence that they can become a research scientist. In addition it has allowed faculty to have more interesting classes, applied some the results to their research and created a more meaningful mentor-student relationship for many students. We will be developing modules that involve ocean, climate and remote sensing research and we expect to rely heavily on NASA data and educational products for group projects and research for undergraduates (e.g. ocean modeling, remote sensing, climate change, ocean/atmosphere/land mass interaction).

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Do Black Holes Really Exist

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Do black holes really exist or is it all just imagination. "Black Holes"...that word is a mystery to all astronomers in the world. How do we know they exist? And if they do...how do we prove that they really do?

Black holes form when a star that burns out of fuel starts to collapse on its own mass for a period of time. Once this process is over, the star has squeezed all its mass into one point. This one point is called a *singularity*. People might not believe it but at this point both time and space stop.

Black holes have been known to pull stars and other heavenly bodies into its center by its gravity. There is a limit to where nothing can escape and where nothing can get away. This invisible circle around a black hole is called the *event horizon*. Anything that goes past the event horizon will no doubt get sucked into the black hole. Anything beyond the event horizon will not get sucked in, but will orbit the black hole.

My project centered around black holes and whether they could exist. My research concluded that very large galaxies such as NGC 3379 must contain a black hole because the stars orbiting its center are moving faster than they should and they have shifted their spectral lines to the red. The only conclusion would be that a very massive object is causing this. The only known object in the universe that would cause this would be a black hole.

Morgan State University Network Resources & Training Sites

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Abstract

The Morgan State University NRTS is an innovative NASA MU-SPIN sponsored program, for developing and sustaining infrastructure and connectivity at under-represented institutions. The program is designed to stimulate the use of the Internet via computer networks. As an integral part of minority institutions' interdisciplinary research and education experience. Administered by the Morgan Network Resource Training Site (NRTS), participating schools have come from no access (in many cases) to completely functioning multimedia laboratories enhancing SEM studies and participating in nationwide NASA programs. A vigorous training component to ensure both its continuance and growth is included for all partnership schools and satellites.

The Morgan NRTS is responsible for building and maintaining internet connectivity to minority institutions and predominately minority attended elementary and secondary schools, in the Baltimore City public school system, and providing training in network implementation, operation and usage to faculty, staff and students at these institutions.

As we advance through the fourth year, the NRTS initiative thrust is to incorporate the use of the infrastructure to embrace other NASA interest programs. To utilize the capability that now exists in the participating schools to best advantage in as many outreach programs as practical in support of science, engineering and math. The collaboration with ACE program, Al J. Bra interactive educational tool, 3-t mentor program and the Earth cam project are such examples. The fourth year will see the completion phase of all participating school laboratories, increase training on site and expanded outreach involvement. Examples of these are as follows:

Facilitated and participated in workshops and conferences

- 8th Annual MU-SPIN Users Conference Albuquerque, New Mexico
- University of Maryland Eastern Shore Spring Workshop
- Central State University Fall Workshop
- Morgan State University Summer Workshop
- Matthew Henson Elementary School Technical Workshops
- Adventures in Supercomputer Workshop in Baton Rouge, Louisiana (the following schools attended):
 - Matthew Henson Elementary School
 - Gwynns Falls Elementary School
 - Sinclair Lane Elementary School
 - Northern Senior High School
 - Harlem Park Middle School
 - Morgan State University
- Explores of the Universe
- Globe
- EarthCam at Morgan State University (NASA Sponsored)

The following labs have been completed:

- Harlem Park Middle School
- Matthew Henson Elementary School
- Southern Senior High School

- Coppin State College
- Sojourner Douglass College

The following labs have been added to the program and are being scheduled for completion:

- Sinclair Lane Elementary
- Northern Senior High School

Cosmology for Non-Science Majors

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Introduction

Observational advances have considerably broadened the experimental base for cosmology (the scientific study of the formation of the universe) in recent years. NASA's Cosmic Background Explorer (COBE), the Hubble Space Telescope (HST), and very recent supernova data have given scientists glimpses of the hot universe as early as 300,000 years after the big-bang, and evidence of the galaxy formation thereafter. In spite of these dramatic observational advances, there is a perception in the lay population that study of the early universe is largely based on speculation. To help counter this notion, a new course is being developed, to be taught at South Carolina State University (SCSU), whose aim is to present the scientific evidence for the big-bang universe at a level suitable for non-science majors who have at least completed a course in pre-calculus.

Course materials under development will require hands-on, active learning on the part of the student, reducing the amount of lecturing, and improving the likelihood of an effective course. Materials already available from other universities are being adapted for the SCSU course.

Course Structure

Scientific evidence in support of the big-bang picture of the early universe is quite abundant, so there is a need for some organizing scheme which is simple and comprehensible to a lay person. Evidence presented in this course is organized under three categories which constitute the major evidence supporting the big-bang: (1) the expanding universe, (2) the Cosmic Microwave Background, and (3) the abundance of helium. Each of these topics has deepened and broadened over the years to the point where there is now considerable overlap among them, but they are solid anchors for the novice. Necessary basic physics background will be taught to students so that each topic is built upon a strong foundation.

Scientific data within each category are usually presented in graphical form, and it is the aim of the course to give the student an understanding of these data, both by computer simulation, and by lab activities. In addition, a course web-site is being developed where the student (and anyone else) will have access to virtually all of the activity-based course materials, and access to links to other cosmology-related web-sites.

Summary

A course is being developed to present to non-science students the scientific evidence supporting the hot big bang model of the early universe. Hands-on activities and computer simulations are to be used to establish the necessary background for students to understand scientific data. These activities are being documented on a web-site so that they are always available for students, as well as others who are interested in such a course. An incomplete version of the web-site, including activities, references, and other links, can be found at <http://physics.scsu.edu/~dms/cosmology/home2.html>.

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Executive Summary

The Milestones and Deliverables for the Fourth Year and the previous three years of the NASA/Tennessee State University Network Resources and Training Site (NASA/TSU NRTS) have or will be accomplished by August 14, 1999 with one exception. The goal of a T3 (45 Mbps) connection for the campus was not reached. These lines were cost prohibitive. This is being replaced by Tennessee State University's participation in the development of the State of Tennessee ATM (or faster) System. This project is currently being bid. The network resources study and plans jointly developed by NASA/TSU NRTS in collaboration with the TSU Office of Information and Communication and the Network Support Services at Goddard Space Flight Center have resulted in the implementation of an ATM Backbone for Tennessee State University. Several of the original goals for this and previous years have been exceeded. Specific discussions of these accomplishments are as follows:

- Upgraded and additional application servers were placed at Lane College, LeMoyne-Owen College, Pearl Cohn High School, Kentucky State University and a 63-gig file server at Tennessee State University. Many of these were planned with NASA/TSU NRTS and fully or partially funded by the institutions. This is creating the independence and continuation proposed in the CAN.
- Tennessee State University has three rooms equipped for high speed distance learning and teleconferencing. Several classes and video conferences have been successfully conducted in these facilities.
- "Explorers of the Universe" was a NASA/TSU NRTS program this year. Seventeen High School students and four faculty members presented research findings at three national on one international conference. The "Explorers of the Universe," added to the NASA/TSU NRTS program on the urging of NASA, has expanded to include two additional projects that are affiliated with NASA Goddard Space Flight Center. These projects will include teachers and students who are part of MU-SPIN and NRTS. In these two projects grant requests through MURED Partnership Grants, will involve teachers and students in the "Explorers of the Universe" in the Mars Orbital Laser Altimeter (MOLA) and the Vegetation Canopy Lidar (VCL) Missions. A second grant request will involve like efforts with Landsat 7 and Terra. Students in the middle and secondary grades will be investigating self-directed cases relating to these two projects. The MOLA project has students mapping topography data received from the Mars Global Surveyor and developing analogies to their respective terrain locations. Stephanie Stockman, NASA Goddard Space Flight Center, will be the bridge between the middle, secondary students and their teachers with the scientists. She is also responsible for taking part in the development of study cases. Teachers and their students in middle and secondary schools affiliated with MU-SPIN and NRTS are being identified to participate in Explorers of the Universe Scientific/Literacy Project
- Dr. Geoffery Burks and astronomy educator will join the NASA/TSU NRTS staff on June 1, 1999. This will further our efforts in the pursuit, of the Center of Excellence in astronomy education. This will allow for expansion of "Explorers of the Universe."

- MAN connectivity to the Internet is in place at all sites. T1 lines are installed at all of the Colleges and Universities. The Metro Schools are all connected with at least one ISDN line and plans for expansion of the bandwidth as use indicates are in place. As a part the above mentioned "Explorers of the Universe" program, Hunters Lane High School was networked this fall and computers placed in the Physics lab.
- The LAN plans, as they existed for this year, have been implemented for the MSET departments at the NRTS campus and satellite sites.
- User Support and Network Operations Offices are functioning at the NRTS sites. The Universities have dedicated on site staff at all institutions. The elementary and secondary schools have limited on site staff, but a central support staff through the technical and library services group is available. All schools have direct phone support from the NASA/TSU NRTS Help desk. On site training has proven to be effective in making more of these sites' self sufficient.
- Lane College received funding to upgrade the 24-station lab in the Math and Science Building Planning and designs were provided by NRTS. This lab, in the New Library building, is available many more hours than the other campus labs. The Lilly Foundation UNCF grant will be used to place computers on all faculty desks.
- LeMoyne-Owen College is using its UNCF Lilly Foundation grant to add 70+ computers for faculty and staff. This will create a 3.5 to 1 students to computers ratio at the College. The College is also adopting a nearby school as a partner through the Memphis Public Schools Community Involvement Program.
- Knoxville College with partnership assistance and funds from St. Mary's Hospital and The Knoxville Utility Board (KUB) has rewired the campus electrical feeds. KUB provided the materials and installation at no cost to Knoxville College. St. Mary's Hospital has provided planning and technical assistance and will provide computers when the above mentioned LAN network bid is completed.
- The Marshall Space Flight Center has been very helpful in analysis and planning for improvement of performance of the TSU Network. They are assisting in the study mentioned above and with advice on development of ATM systems on Campus.
- Tennessee State University Department of Computer Science has received a third Grant from Microsoft to install and test software. This \$70,000+ grant helped to leverage the cost and instillation of NT Networks in the Academic Computing facilities.

The funds for the NASA/TSU NRTS Project continue to be leveraged to a considerable degree. The continued funding of the Metropolitan Nashville/Davidson County Schools, the work and funding at Knoxville College, Lane College, LeMoyne-Owen and the departments of Math, Biology, Chemistry, and Computer Science at TSU has totaled more than \$1,200,000. In addition the funds at Jackson State used in planning and development have resulted in a Leveraging in excess of \$6,000,000 toward engineering and installation of campus networking infrastructure and facilities. These will be completed by the fall of 1999. Other funding with leveraging efforts are still pending as of this date.

Student Performance Assessment Research and It's Application to Curriculum Development

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Abstract

This presentation will briefly describe a current statistical study and student performance assessment methodologies that are under development at Alabama A&M University. The presentation will focus on two research objectives: (1) Develop a set of statistical models that will connect university curriculum variables to outputs such as student performance in a particular mathematics class or on post-graduate standardized examinations. (2) Use statistical models to assess the performance effectiveness of a variety of teaching and tutoring methodologies. A brief description of activities and technology infrastructure that supports objectives 1 and 2 are provided. Specific example applications of the proposed statistical model and mathematics course exit-tests will be presented. Closing comments will be related to how the above, NASA supported, research provides a statistical infrastructure which may be used to make decisions regarding curriculum adjustments.

Student Performance Assessment Research and It's Application to Curriculum Development

The author of this paper spent summers of 1994-95 as a National Aeronautics and Space Administration (NASA) Summer Faculty Research Fellow. While in this program, he researched statistical methodologies that may be used to enhance the flaw detection performance of space-age nondestructive evaluation (NDE) equipment. Flaw detection performance research naturally led to a study of statistical models which may be used to classify the type of flaws detected. Flaw detection and classification are important because they provide information that may be used by an engineer to predict the life and reliability of a system in which a flaw has (or has not) been detected. Statistical tools such as regression discriminant analysis and neural network analysis were applied in the model construction process.

In the fall of 1997, NASA awarded the Mathematics Department of Alabama A&M University (AAMU) a grant which is being used to apply modeling technology in an educational setting. Specifically, the type of statistical models used to study NDE equipment performance are being applied to model student performance. Strategies used to maximize performance in both systems are similar. Hence, the main focus of this research is to apply the above mentioned statistical tools to enhance AAMU's student performance in science and engineering. The enhancement process includes (1) the detection of student deficiencies (diagnosis), (2) classification (placement) and (3) curriculum adjustments (experimentation). The four major objectives of this research are (1) to identify a set of control and noise variables that are most likely to influence student performance, (2) to define a set of models that connect student performance to control and noise variables, (3) to determine how all variables and their interactions influence performance, (4) to identify the setting for variables that will maximize student performance.

Section 3 will discuss the need for this type of research and section 2 briefly describes the statistical model and gives an example. Computer equipment used for data collection and testing is described in section 4 and section 5 mentions benefits and recommendations.

A General Model -

This section contains a few equations which may not be of interest to the general audience for the this publication. However, the equations serve to identify what is meant by input and output variables and how I plan to connect them. For a simple variable connection equation, readers may wish to restrict their focus to equation (2.1).

Assume that y is the output of a student evaluation system (say, a course exit test) with a normal probability distribution of mean μ . Further assume that input (control) variables x_1, x_2, \dots, x_k and noncontrollable noise variables z_1, z_2, \dots, z_m have influence on output y . For compactness, let control vector $\underline{x} = (x_1, x_2, \dots, x_k)'$ and noise vector $\underline{Z} = (z_1, z_2, \dots, z_m)$. A general equation that connects output y to \underline{x} and \underline{z} is

$$Y = \beta_0 + \underline{X}' \underline{\beta} + \underline{Z}' \underline{\delta} + \underline{X}' \Lambda \underline{Z} + \varepsilon \quad (2.1)$$

where β_0 is a general parameter of vector coefficients of control variables, $\underline{\delta}$ is a coefficient vector of noise variables, Λ is a matrix which contains the coefficients of the interactions between noise and control variables, and ε is a random lack of fit component.

Model system (2.1) generates two response surfaces that are of benefit to student performance evaluation. They are system output mean which is given by

$$E[y] = \mu = \beta_0 + \underline{x}' \underline{\beta} \quad (2.2)$$

and system output variance

$$\text{Var}[y] = \sigma^2 = [\underline{\delta} + \underline{X}' \underline{v}] v [\underline{\delta} + \underline{X}' \underline{v}]', \quad (2.3)$$

where V is the variance-covariance matrix for noise variables in \underline{Z} . Observed data on y , \underline{x} , and \underline{Z} may be used to estimate parameter values β_0 , $\underline{\beta}$, $\underline{\delta}$, and Λ . Once the parameters are estimated and substituted into equation (2.1), the model is ready to be used. The reader should be reminded that a single model may have several uses: (1) prediction of output variable when inputs are known, (2) adjustment of input variables so that some desired control is imposed on the output, (3) hypotheses testing. At various stages in this research I will use all of the above applications.

Need for Research and an Application

Need for Research -

In an effort to assist government agencies, major universities, and historically black colleges and universities (HBCU) in their decision making process regarding the strengthening of HBCU's, several studies have been done. For example, Brazziel and Brazziel (1994), in an extensive data analysis project, evaluated the influence of educational and demographic variables on the graduation rate of minority doctorates in science and engineering Program. Solorzano (1995) examines the baccalaureate origin of African-Americans who earned doctorates during the 1980-1990 time period. Rotberg (1990) studied trends in financial support and institutional priorities with respect to minority participation in science and engineering programs. All of these studies have been very useful. However, I have been unable to locate a comprehensive study of the effectiveness of science and engineering programs at an HBCU. No study at any HBCU has developed a statistical model that connects university environmental and academic variables to student performance on, say, the GRE or other post graduate examinations. Models of this type are unique to a particular university. Therefore, the absence of such HBCU studies, combined with recent emphasis on college student performance assessment by funding and accreditation agencies, has left some HBCU faculty and administrators uncertain about what to assess and how to use assessment results. This research will develop a set of models that will connect input variables on academic background, university curricula and university environment to various measurements for academic output. A single example of academic output is given in the next paragraph.

An Application at AAMU - (Now under development because data collection process requires four years.)

Let us suppose that the output variable is a student's on the GRE or one of its subtests. The input variables may be GPA, scores on standard exit-examinations for mathematics courses, practice GRE tests administered at various periods during the student's under graduate study, academic class load, tutoring for GRE, etc. Once the model is developed, the GRE score may be predicted at, say, the sophomore level of study. If the predicted score does not meet desired level, student is counseled with regard to specific adjustments that must be made within the next two years to achieve a desired score.

Technology Infrastructure and Other Activities

Computer Support -

During the 1997-98 academic year, the computer committee of the AAMU Mathematics Department provided several significant enhancements to the departmental computer facilities. This includes configuring faculty computers to interface with an NT server, installation of MAPLE V, EXP, Internet Explorer, etc. All of these enhancements improved student and faculty accesses to the math lab network.

Software for Testing and Research -

We have recently acquired a computer adaptive testing package (COMPASS) and a statistical computer package (SAS). We have also acquired the Gateway Computer Administered Calculus tests, which are marketed by the Wiley Book Company. We will use the Wiley tests as calculus exit-tests for calculus I, II and III. A commercially provided computer adaptive GRE package from the ETS company has been installed. Data collected by COMPASS, the Wiley tests and the GRE package will be merged and uploaded into SAS where statistical analyses will be performed.

GRE Requirement for Graduation -

As specified on page 174 of the 1998 AAMU undergraduate bulletin, all seniors who are enrolled in the School of Arts and Sciences must take the GRE before they graduate. The advantage of this requirement has been discussed with the School of Engineering administration and they are now considering the GRE requirement.

Testing -

An extensive review of commercially available tests for research purposes has been conducted. These reviews combined with our technology infrastructure described in this section influenced us to adopt computer administrated placement/exit exams for college algebra through calculus III. Computer tests were administered to a sample of 350 algebra and calculus students in August 1998. Exit-tests were administered to this sample at the end of Fall semester, 1998. Data summary analyses are in progress.

Benefits -

This research project has already provided a statistical infrastructure upon which the effectiveness of old and new curriculum programs may be evaluated. The decision process of curriculum personnel, administrators and researchers in science and education have already been influenced by its results. For example, the Computer Science Program recently submitted a \$1.5 million proposal to NSF. It used data collected by this project and the evaluation segment of that proposal is heavily based on models being developed by this research.

MU-SPIN -

The poster presentation at The 1999 MU-SPIN Ninth Annual User's Conference shows descriptive statistics through charts and graphs that have been collected by this project.

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Testing of a Commercial CCD Camera

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Abstract

The results are presented of the examination and testing of a commercial CCD camera designed for use by amateur astronomers and university astronomy laboratory courses. The characteristics of the CCD chip are presented in graphical and tabular form. Individual and averaged bias frames are discussed. Dark frames were taken and counts are presented as a function of time. Flat field and other images were used to identify and locate bad pixel columns as well as pixels which vary significantly from the mean pixel sensitivity.

Introduction

The results are presented of an investigation of the use of Charge Coupled Devices (CCDs). This work was carried out at South Carolina State University (SCSU) during June and July 1999 using available computers, software, a telescope and a commercial CCD from the Santa Barbara Instrument Group (SBIG) known as the SBIG-7.

The objectives of this investigation were:

1. To better understand CCDs and their use in astronomy.
2. Obtain hands-on experience in setting up and operating a CCD camera in conjunction with a telescope.
3. To study in detail a commercially available CCD camera and characterize its noise and stability.
4. To use this same CCD camera to obtain images of astrophysical objects; and, to compare these images to those taken using research-grade CCDs at ground observatories and onboard the Hubble Space Telescope.

Objectives 1-3 were achieved. Objective 4 was not achieved due to poor weather conditions at the end of the eight week session.

We will begin our discussion with an overview of CCDs, their operation and the sources of noise which must be removed in order for their data to be scientifically useful. We will then move on to describe our testing of the SCSU SBIG-7 and conclude with a characterization of its properties.

CCDs

A Charge-Coupled Device (CCD) is an array of semiconductors which respond to select wavelengths of electromagnetic radiation. The array consists of a "checker board" of picture elements or pixels arranged in columns and rows. A large CCD is one with 2048 rows and 2048 columns or 4,194,304 total pixels; yet it is only 2.5 inches on each edge.

When a photon strikes a pixel, it frees up an electron which stays in the pixel and is numerically recorded as a count. There is a direct and usually linear relationship between the brightness of the object and the number of counts recorded. After an exposure, the chip is emptied and the counts recorded for each pixel. These counts are stored on a computer as an array or table of numbers. This array of numbers can be displayed on a computer screen as an image or picture.

In astrophysics, the CCD chip is placed in a camera attached to a telescope. The telescope collects the photons emitted by the celestial object and focuses them onto the CCD. Commercial, hand-held

digital cameras are in common use. They work on the same principal as the ones used in astronomy; except, the astronomical CCD is very sensitive to low levels of light. Hence, it can record faint objects which would not be detected by a regular digital camera.

CCD Noise

When an image is recorded by a CCD, there are various unwanted effects (noise) which must be removed in order for the information to be scientifically useful.

- **Cosmic Rays:** Energetic particles from space which strike the CCD during the exposure and release electrons into one or more pixels. They are seen as bright streaks or dots in the image.
- **Bias counts:** The chip and accompanying electronics introduce false counts into each pixel. The bias counts are random and fairly uniform across the chip, introducing a shift in the zero point or base level of the noise.
- **Dark current:** Vibrational and kinetic energy of electrons due to heat from the chip and its surroundings will cause some electrons to break free and fall into the pixels where they will be included with true counts. Astrophysical CCDs are usually chilled to liquid nitrogen temperatures to minimize this effect.
- **Flat Field Variations:** Each pixel is a separate detector. It is impossible to make all of the pixels equally sensitive to photons of a given wavelength. These variations across the chip are generally no more than 5-10% from the median sensitivity.
- **Bad Pixels:** Cosmetic imperfections are introduced during the chip manufacturing process. This leads to some pixels being far over or under sensitive, more so than the minor variations discussed under flat field variations.

The SBIG-7 CCD

The SBIG-7 is described in Table 1. Figure 1 shows the SBIG-7 from the side. Figure 2 shows a view looking down, into the CCD camera, the path photons travel to the chip. Figure 2 shows two (2) CCD chips inside the SBIG-7. We examined the properties of the larger of the two chips. Note the scale of the picture in Figure 2 and the small size of the CCD chips. Figure 3 shows the author next to a 12-inch, reflecting telescope. The CCD is mounted in the eyepiece holder. Power and computer cables plug into the CCD camera. The cable in Figure 3 provides communication between the CCD and a PC. Software on the computer is used to control the camera and to acquire images. However, it has only rudimentary image analysis software. Once images are recorded, they are stored on the PC and later transferred to a UNIX workstation which uses IRAF (Image Reduction Analysis Facility) software, a professional, astronomical image processing package.

Testing of the SBIG-7

- **Cosmic Rays:** The number of cosmic rays detected is largely a function of elevation. The higher the elevation, the less atmospheric protection and the greater the number of hits. Our tests were conducted at sea level and these hits are visually obvious, so no attempt was made to parameterize this noise source.
- **Bad Pixels:** The SCSU CCD was, cosmetically, very "clean". Only one column of bad pixels was detected: Column 631, Rows 57 through 510
- **Bias Counts:** A series of bias frames were taken in groups of 10. That is 1-10 were taken one after another, then there was a pause of 10 minutes before 11-20 were taken. The statistics of the 39 bias frames is given in Table 2, which shows the minimum, maximum, mean and standard deviation from the mean count values for the 390,150 pixels in each frame.

Note that except for the first four frames taken, the statistics of the bias frames is fairly constant. The first four bias frames have counts which are systematically higher than all the other frames. Figure 4 shows this as well. The top frame is the histogram of the first bias frame taken. The bottom frame is the histogram of the 10th bias frame taken. Since the bias noise is random, one expects a gaussian distribution. The early frames show a double gaussian while later frames show only a single gaussian, which is to be expected.

The conclusion reached is that a number of the pixels on the chip are "noisy" for the first few minutes after the CCD is activated. This is an important discovery and is useful for future users. Therefore, one should give the CCD about 10 minutes of warm up time and then discard the first few bias frames before saving any data.

- **Dark Counts:** A dark frame is one in which the CCD integrates counts over time, but where the chip is not exposed to any light. In this case, bias counts, cosmic rays and dark counts will collect but no counts due to a celestial object. The dark count should increase with time, but in what mathematical fashion? A series of darks were taken at increasing exposure times. The results were:

Exposure Time (seconds)	Mean Dark Counts	Uncertainty in Counts
100	30	± 1
300	94	± 1
900	279	± 1
1800	555	± 65

The conclusion is that the SCSU CCD has a nicely defined *linear* relationship between exposure time and dark counts and an accumulation rate of 0.3 counts per second per pixel.

- **Flat Field Variations:** In theory all pixels should be equally sensitive. In practice, some are more or less sensitive than others. Furthermore, dust and other imperfections can cast shadows on certain pixels and decrease their sensitivity.

In order to correct for this effect, one exposes the CCD camera to a uniform light source, a so called "flat" source. One in which white light evenly illuminates the entire surface. In our case, the telescope-CCD pointed at a white board toward which a white light was directed.

Our flat field exposure is shown in Figure 5. The top frame is an actual flat field image. The large circular feature is a bright spot from the light. Despite our efforts, we did not uniformly illuminate the white board. This is also reflected in the histogram of this image, the lower frame in Figure 5. One would expect a gaussian distribution, and that appears to form with a peak around 2300. However, the number of pixels with high counts is distorted by the bright spot, so the right hand side of the histogram is higher than we would have with a uniformly illuminated surface. Nonetheless, one can conclude that a variation of 20000 to 25000 or 22500 ± 2500 , is an 11% effect, even with non-uniform illumination.

Conclusions

A study of CCDs in general and the SBIG ST-7 specifically has been completed with the following results:

1. A study of CCDs has been completed and their operation is understood.
2. The SCSU SBIG-7 is cosmetically clean with only one known bad pixel column.
3. One should allow the SCSU chip at least 10 minutes of warm up time before taking any exposures. This will allow the electronics to stabilize and not produce unusually high bias counts.

4. The dark counts are linear as a function of time and accumulate at the rate of 0.3 counts per pixel per second.
5. The flat-field response of the SCSU chip is uniform to within $\pm 11\%$. If one is careful to use a uniform source, the uniformity is likely even better than this amount.

Acknowledgements

The support of NASA and the MUSPIN Project Office is recognized and appreciated. Stipend and travel funds for this research were provided by NASA through cooperative agreements with the City College of New York (NCC5-98), SCSU (NCC5-116) and Tennessee State University (NCC5-228).

Table 1
SBIG-7 Camera Specifications

<u>Specification</u>	<u>Value</u>
Camera/Manufacturer	SBIG7 Santa Barbara Instrument Group
1482 East Valley Road, Suite 33	PO Box 50437 Santa Barbara CA 93150
CCD chip/ manufacturer	KAF 0400/ KODAK
Array Dimensions	6.89mm x 4.59mm = 31.63 mm ²
Number of Pixels	765 x 510 = 390150
Pixel Size	9 μ m x 9 μ m = 81 μ m ²
Electronic Shutter	None
Saturation (resolution)	High : 16,383 counts Low / Medium : 65536 counts

Table 2
Statistics of Bias Frames Taken Sequentially

IMAGE Name	# Pixels	MEAN	STDDEV Counts	MIN Counts	MAX Counts
bias1001.fits	390150	159.9	26.35	93.	4287.
bias1002.fits	390150	156.8	25.72	90.	4288.
bias1003.fits	390150	139.1	16.62	91.	3565.
bias1004.fits	390150	110.3	6.193	86.	1150.
bias1005.fits	390150	105.2	4.569	84.	448.
bias1006.fits	390150	104.9	4.502	84.	403.
bias1007.fits	390150	104.1	4.507	83.	393.
bias1008.fits	390150	104.2	4.534	84.	413.
bias1009.fits	390150	104.3	4.511	85.	399.
bias1010.fits	390150	105.2	4.518	85.	418.
bias1011.fits	390150	106.4	4.551	85.	407.
bias1012.fits	390150	104.5	4.555	84.	403.
bias1013.fits	390150	104.5	4.531	84.	402.
bias1014.fits	390150	105.4	4.528	84.	415.
bias1015.fits	390150	105.4	4.536	85.	416.
bias1016.fits	390150	106.5	4.552	86.	401.
bias1017.fits	390150	103.4	4.54	81.	405.
bias1018.fits	390150	105.4	4.509	84.	406.
bias1019.fits	390150	104.5	4.52	83.	396.
bias1020.fits	390150	105.3	4.528	78.	399.
bias1021.fits	390150	105.4	4.485	83.	419.
bias1022.fits	390150	104.4	4.508	84.	418.
bias1023.fits	390150	104.2	4.48	83.	396.
bias1024.fits	390150	104.3	4.506	83.	392.
bias1025.fits	390150	104.2	4.533	85.	401.
bias1026.fits	390150	103.2	4.479	82.	395.
bias1027.fits	390150	105.3	4.509	84.	410.
bias1028.fits	390150	104.1	4.461	80.	417.
bias1029.fits	390150	104.0	4.482	85.	401.
bias1030.fits	390150	105.1	4.477	86.	421.
bias1031.fits	390150	104.2	4.417	83.	399.
bias1032.fits	390150	102.9	4.436	82.	404.
bias1033.fits	390150	104.8	4.435	86.	417.
bias1034.fits	390150	103.8	4.443	83.	411.
bias1035.fits	390150	104.8	4.446	83.	405.
bias1036.fits	390150	106.8	4.459	86.	419.
bias1037.fits	390150	103.8	4.457	84.	404.
bias1038.fits	390150	104.8	4.441	85.	418.
bias1039.fits	390150	104.7	4.446	83.	394.

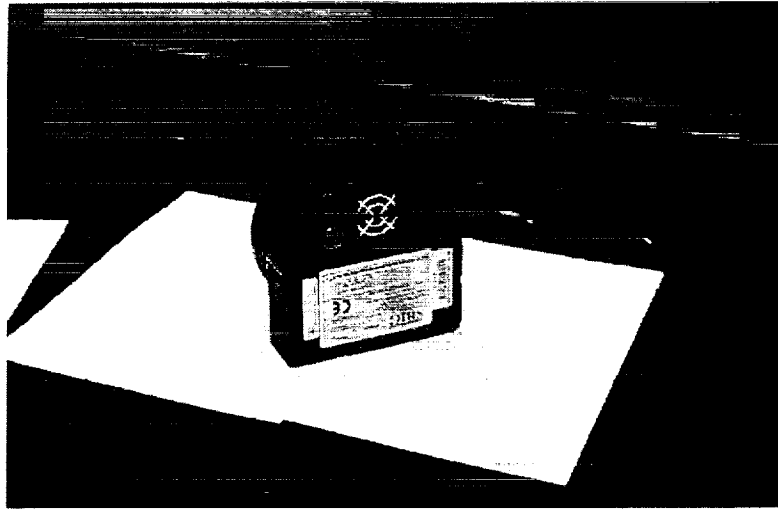


Figure 1
SBIG-7 CCD Camera viewed from the side.



Figure 2
Two CCD chips visible inside the SBIG-7 camera.

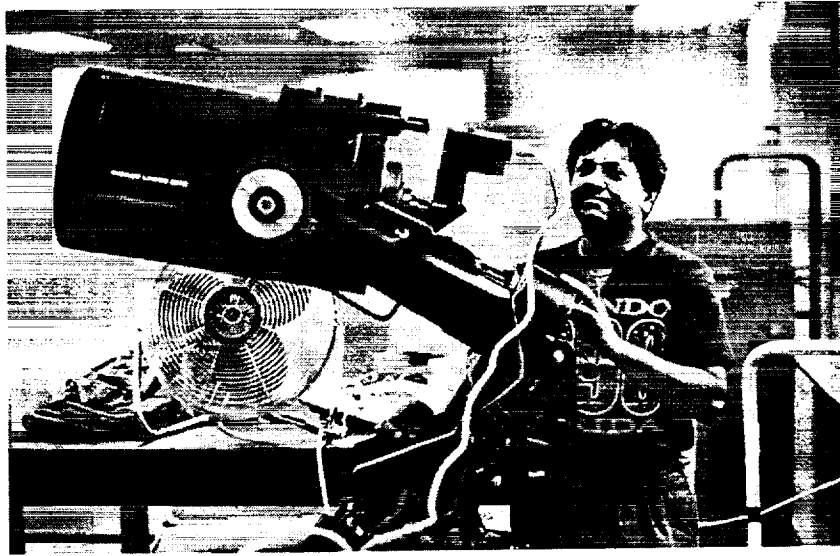


Figure 3

The author with the SBIG-7 CCD camera attached to a 12-inch telescope.

Note: Figures 4 and 5 are not available for publication.

Total Optical Depth Analysis for NO₂, O₃ and Aerosols by a Multi-Filter Shadowband Radiometer

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Abstract

The main focus of this research is the retrieval of tropospheric aerosol information using a Multi-filter Rotating Shadowband Radiometer, Model MFR-7, placed on the roof of the Science Building at Medgar Evers College. This instrument makes precise measurements of atmospheric extinction of the direct solar beam simultaneously at six wavelengths (415, 500, 615, 670, 840 and 940 nm) at one minute intervals throughout the day. We are interested in measuring the changes in the optical depth of ambient aerosols, mass, effective particle size, aerosol size distribution, and chemical composition of ambient particulate matter the Greater New York City Area. Results will be compared with data obtained by A. Lacis, B. Carlson and B. Cairns at the NASA Goddard Institute for Space Studies.

Introduction

Interest in climate/human health relationships has increased during the late 1980s and 1990s, partly because of the availability of more complete databases and because of a human-induced global warming, which is predicted to increase the mean global temperature by 2-5 degrees Celsius over the next century. The measurements of the optical depth indirectly measures the concentration various greenhouse gases such as water vapor, aerosols, nitrogen dioxide and ozone. Subsequently, aerosol concentrations change over time; this is due to precipitation, wind speed and anthropogenic sources. This research will examine the effects of man-made pollution over a period of time over the Greater New York Region.

The MFRSR Spectrometer

The multi-filter rotating shadow band radiometer (MFRSR) is a ground based instrument that uses independent interference-filter-photodiode detectors and the computer controlled automated rotating shadow-band technique to make spectrally resolved measurements at seven wavelengths of direct-normal, total-horizontal, and diffused-horizontal irradiances. The three irradiance components are measured with the same detector for a given wavelength. The measurement sequence starts with a measurement made while the band is at nadir; this is the total horizontal irradiance. The band is then rotated so that the three measurements are made in sequence. The middle one blocks the sun, to give the diffuse horizontal irradiance, and the other two block strips of the sky 90° to either side.

These side measurements allow for a first order correction for the excess sky blocked by the band when the sun-blocking measurement is made. Finally the diffused component is subtracted from the total horizontal component to give the direct horizontal component; the direct beam flux.

$$\text{Direct Normal} = \text{Global} - \text{Diffused}$$

The entire measurement sequence is completed for all wavelengths simultaneously in less than ten seconds and measurement sequences are performed every minute.

One can use the direct-normal component observations for Langley analysis to obtain depths and to provide an ongoing calibration against the solar constant by extrapolation to zero air mass. The long-term stability of all three measured components can be tied to the solar constant by an analysis of the routinely collected data. The MFRSR provides atmospheric (column) extinction of the direct solar

beam simultaneously at six wavelengths (nominally: 415, 500, 615, 670, 840 and 940 nm) at one minute intervals throughout the day. The choice of wavelength allows for the calculation of the optical depths for water vapor, aerosols, nitrogen dioxide and ozone.

Wavelength (nm)	Trace Species
415	aerosols
500	aerosols, ozone
610	aerosols, ozone
665	aerosols, ozone
862	aerosols
940	water vapor

The results of Multi-spectral Atmospheric Column Extinction (MACE) analysis then yield detailed time series information on the variations of the column amounts of atmospheric NO₂ and Ozone, and aerosol size distribution.

The MFRSR records the changes in atmospheric column extinction. I_{in} , measures atmospheric extinction using the six spectral intensities and is given by

$$I_{in} = C_n I_n^0 \exp(-T_{in}/m_i),$$

where m_i is the solar zenith angle, T_{in} is the atmospheric column extinction optical depth, I_n^0 are the total optical atmosphere (TOA) solar radiation intensities at MFRSR wavelengths, and C_n are the respective calibration coefficients. From the above equation, we can solve for the optical depth

$$T_{in} = m_i \log(-I_n^0/I_{in}) + m_i \log(C_n)$$

Electromagnetic Radiation

All the information that we obtain about the world around us (universe) comes to us by electromagnetic radiation. There is a Particle-Wave duality of light. Sometimes light behaves as a wave (e.g. interference, diffraction) and sometimes it behaves like a particle, called a photon (e.g. photoelectric effect, Compton effect). The relationship between velocity, frequency and wavelength (wave) of electromagnetic radiation is given by

$$c = \lambda \nu$$

The energy of a photon (particle) is given by

$$E = h\nu$$

where $h = 6.6 \times 10^{-34}$ J/s is Planck's constant. This also indicates that energy is quantized.

Electromagnetic radiation interacts with matter; physical properties that can be observed and measured are transmission, absorption, reflection, refraction, polarization and scattering. The scattering property is of special interest. There are two forms of scattering which are applicable to the principles of remote sensing: Rayleigh Scattering and Mie Scattering.

Rayleigh Scattering: The molecules are many times smaller than the electromagnetic radiation wavelength. The amount of scattering, I_s , is given by

$$I_{scat} \propto \frac{1}{\lambda^4}$$

The advantages of Rayleigh scattering are that it is strongly wavelength dependent and often only in the direction of energy propagation; and it does not depend on atmospheric conditions.

MIE Scattering: This occurs in conditions where the electromagnetic radiation wavelength and the particle size are the same. The larger particles in the atmosphere such as dust and water vapor are

responsible for Mei Scattering. The long wavelengths in the red region are effected by Mei scattering.

Remote Sensing

Remote Sensing describes any method by which data can be measured over a large area without making any physical connection with the object being measured. There are two classifications of Remote Sensing Systems: Active or Passive; and Imaging or Nonimaging.

Active Remote Sensing: An active system transmits an electromagnetic radiation signal and receives the back scattered reflected signal (e.g., radar).

Passive Remote Sensing: A passive system only receives electromagnetic radiation (e.g. cameras, thermal scanners, multispectra scanners - Landsat Satellite).

Most remotely sensed data are collected using passive remote sensing systems. Nonimaging are quantitative/digital and can be presented as line plots or serial data. Imaging formats are spatial and utilize shades, patterns or colors to visually represent qualitative or quantitative data.

Preliminary Results

The data collected thus far are uncalibrated, in units of mW and are then converted to $W/m^2\text{-nm}$. The collected data (spectral lines) has been separated using Excel 4.0. We have collected 20 days (June, July) of data to be used in a time based MACE. At this time, the MFRSR is not calibrated; we are obtaining milliwatt values which need to be corrected to watts/meter²-nanometer ($mW/m^2\text{-nm}$). The collected data (spectra lines) has been separated using Excel 4.0. We have collected 20 days of data to be used in the time-based MACE analysis. The graphs show a one day sample of data at six different wavelengths measured simultaneously. In addition, a sequence of graphs show global, diffuse and direct normal components.

Future Work

1. Make analytical comparison of our preliminary data with data obtain by the radiometer at the Goddard Institute for Space Studies.
2. Calibration of MFRSR with mercury arc lamp spectral lines.
3. Analyze calibrated or uncalibrated data by the Langley Analysis.
4. Sweeping off data from MFRSR to the Dell PC to the Sun Solaris workstation using the rrsplit file.
5. Compilation of Hierarchy Data Format (HDF) read software for satellite data formats in C++ on to Sun Solaris workstation.
6. Provide access to a range of satellite data on Sun workstations for possible use in the project. We will compare MFRSR results to EPA, TOMS data from the NIMBUS-7 satellite spectroscopic profiles for our longitude and latitude.
7. Use IDL 5.2 software to compose global model correlations from all sources.

Acknowledgement

This research is supported by NASA GISS/MEC Partnership, NASA CCNY/CUNY NRTS, NASA PAIR at CCNY and the NSF NYC-LSAMP.

References

- L. Harrison, J. Michalsky and J. Berndt, "Automated multifilter shadow-band radiometer: an instrument for optical depth and radiation measurements", *Appl. Opt.* 33, 5118-5125.
- L. Harrison and J. Michalsky, "Objective algorithms for the retrieval of optical depths from ground based measurements", *Appl. Opt.* 33, 5126-5132.
- A. A. Lacis, B. E. Carlson and B. Cairns, "MACE Analysis of MFRSR Measurements, unpublished.

Minority University Research & Education Division (MURED) Update

Mr. John Malone
NASA Headquarters

MURED into the New Millennium

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Overview of Presentation

- FY 2000 Funding Priorities for MI's
- FY 2000 Investment Opportunities
 - IRA
 - FAR
 - PAIR
 - MASTAP
 - PACE

FY 2000 Program Priorities for MI's

- Expand and advance NASA's scientific and technological base by building on prior year's efforts in research and academic infrastructure
- Increase exposure to NASA's unique mission and facilities by developing closer relationships with NASA Strategic Enterprises
- Increase involvement in competitive peer review and merit selection processes
- Contribute significantly to the Agency's strategic goals and objectives
- Create systemic and sustainable change through partnerships and programs that enhance research and education programs
- Prepare faculty and students at HBCU's for NASA-related fields and increase number of students that enter and successfully complete degrees in NASA-related fields
- Establish measurable program goals and objectives
- Improve financial management performance

Program Focus

Institutional Focus:

- Historically Black Colleges and Universities (HBCU's)
- Other Minority Universities (OMU's)
 - Hispanic Serving Institutions
 - Tribal Colleges and Universities (TCU's)
- Non-Profit Organizations

Programmatic Focus on Competitive, Peer Review, and Merit Selected Awards:

- University Research Centers (URC's)
- Institutional Research Awards (IRA's)
- Individual Principal Investigators (FAR)
- Mathematics and Science Awards (MSET) (PACE & MASTAP)
- Partnership Awards (PAIR)

Institutional Research Awards (IRA)

Program Objectives:

- Establish significant, multi-disciplinary scientific, engineering, and/or commercial research capability at the HBCU or OMU that contribute substantially to the programs of one or more of the four Strategic Enterprises (Earth Science, Aero-Space Technology, Space Science, and the Human Exploration and Development of Space) described in NASA's Strategic Plan.
- Improve the number and the percentage at which U.S. citizens who historically have been underrepresented in NASA-related fields are awarded advanced degrees in such fields at their own university, and/or rates at which their undergraduate degree recipients go on to earn advanced degrees in such fields at other institutions.
- Gain more support from sources outside NASA Minority University Research and Education Programs (MUREP) by aggressively pursuing additional funding opportunities offered by NASA Strategic Enterprises, industry, and other funding agencies.

Awards

May be up to \$500,000 for each of four (4) years

NRA Release Date: September, 1999

Proposals Due: in approximately 90 days

Web Address: <http://mured.alliedtech.com>

Faculty Awards for Research (FAR)

Program Objectives:

- Identify outstanding and promising engineering, physical and life science tenure-track faculty early in their academic careers as principal investigators who are cable of contributing to the Agency's research objectives and who have limited past NASA research grant experience.
- Provide such faculty members with sufficient research support and exposure to the NASA peer review process to enable them to demonstrate creativity, productivity, and future promise in the transition toward achieving competitive awards in the Agency's mainstream research processes.
- Support these investigators with resources to provide research experience in NASA-related fields to graduate and undergraduate students, who are U. S. citizens, thereby increasing the pool from which NASA and the aerospace industry can draw.

Awards

May be up to \$100,000 for each of three (3) years

NRA Release Date:

Proposals are in review. Selections will be made in December 1999

Partnership Awards for the Integration of Research into Undergraduate Education (PAIR)

Program Objectives:

- The purpose of the PAIR Award is to enhance undergraduate faculty teaching and the student's education by integrating the NASA research investment at the HBCU or OMU into the undergraduate MSET courses and curricula specifically related to NASA Strategic Enterprise missions and human resource requirements.

Awards

It is anticipated that at least two-million dollars will be allocated for PAIR Awards. NASA expects to provide first-year funds of up to \$200,000 and up to \$300,000 for the funding of second and third year efforts. Funding for three years may not exceed \$800,000.

NRA Release Date: September 15, 1999
Proposal Due Date: December 1, 1999
Web Address: <http://mured.alliedtech.com>

Minority University Mathematics, Science, and Technology Awards for Teacher Education Program (MASTAP)

Program Objectives:

The purpose of the MASTAP Award is to strengthen HBCU's and OMU's teacher education programs and thereby increase the number and percentage of certified mathematics, science, and technology teachers who are employed and retained in hard to staff schools. As a result of this award, the institution will graduate more certified mathematics, science and technology teachers with knowledge of national and state MSET standards. The teachers will also be encouraged to use NASA's educational resources to enhance their knowledge and to foster the effective implementation of the program's goals and objectives.

Awards

It is anticipated that at least 1.5 million dollars will be allocated for MASTAP Awards. Each award will consist of annual grant not to exceed \$200,000 per year for a maximum of 3 years.

NRA Release Date: September 15, 1999
Proposal Due Date: December 8, 1999
Web Address: <http://mured.alliedtech.com>

Precollege Awards for Excellence in Mathematics, Science, Engineering, and Technology (PACE/MSET)

Program Objectives:

The purpose of the PACE/MSET Award is to enhance the capabilities of disadvantaged students in college preparatory courses in mathematics, science, engineering, and technology through outreach projects that are a collaborative effort between the minority university, nonprofit education organization, or school district.

Awards

It is anticipated that \$1.2 million will be allocated for PACE/MSET Awards. Each award will consist of a grant not to exceed \$100,000 per year for a maximum of 3 years.

NRA Release Date: September 15, 1999
Proposal Due Date: December 15, 1999
Web Address: <http://mured.alliedtech.com>

MU-SPIN Update

Mr. James Harrington
MU-SPIN Project Manager

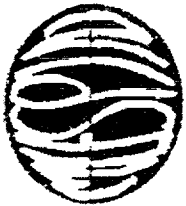


Minority University - Space Interdisciplinary Network [MU-SPIN]

Project Manager: James Harrington Jr.

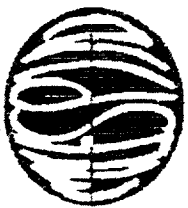
Deputy Project Manager: Reginald D. Eason

<http://muspin.gsfc.nasa.gov>



MU-SPIN Goals

- Strengthen the science and engineering capabilities of MU-SPIN institutions in research and education via computer networks;
- Involve and prepare minority institutions and principal investigators to successfully participate in competitive research and education processes via computer networks;
- Develop training and education mechanisms to support, sustain and evolve the institutional network infrastructure, thereby generating a better prepared pool of candidates to contribute to NASA's missions.



Current Situation

- Project and NRTS Third Year Review Team Findings have recognized that MU-SPIN and NRTS should give highest priority to the development of capacity to assist NRTS partners in the usage of their networks for research and/or education. This activity should have priority over the addition of new partners.
- One third of Tribal Colleges **do not** have Internet connectivity. (Preliminary results from AIHEC Technology Survey)
- The amount of technology on HBCU and Hispanic serving campuses varies widely, but many have lagged behind larger and wealthier colleges and universities. (Cronicle for Higher Education, March 26, 1999)



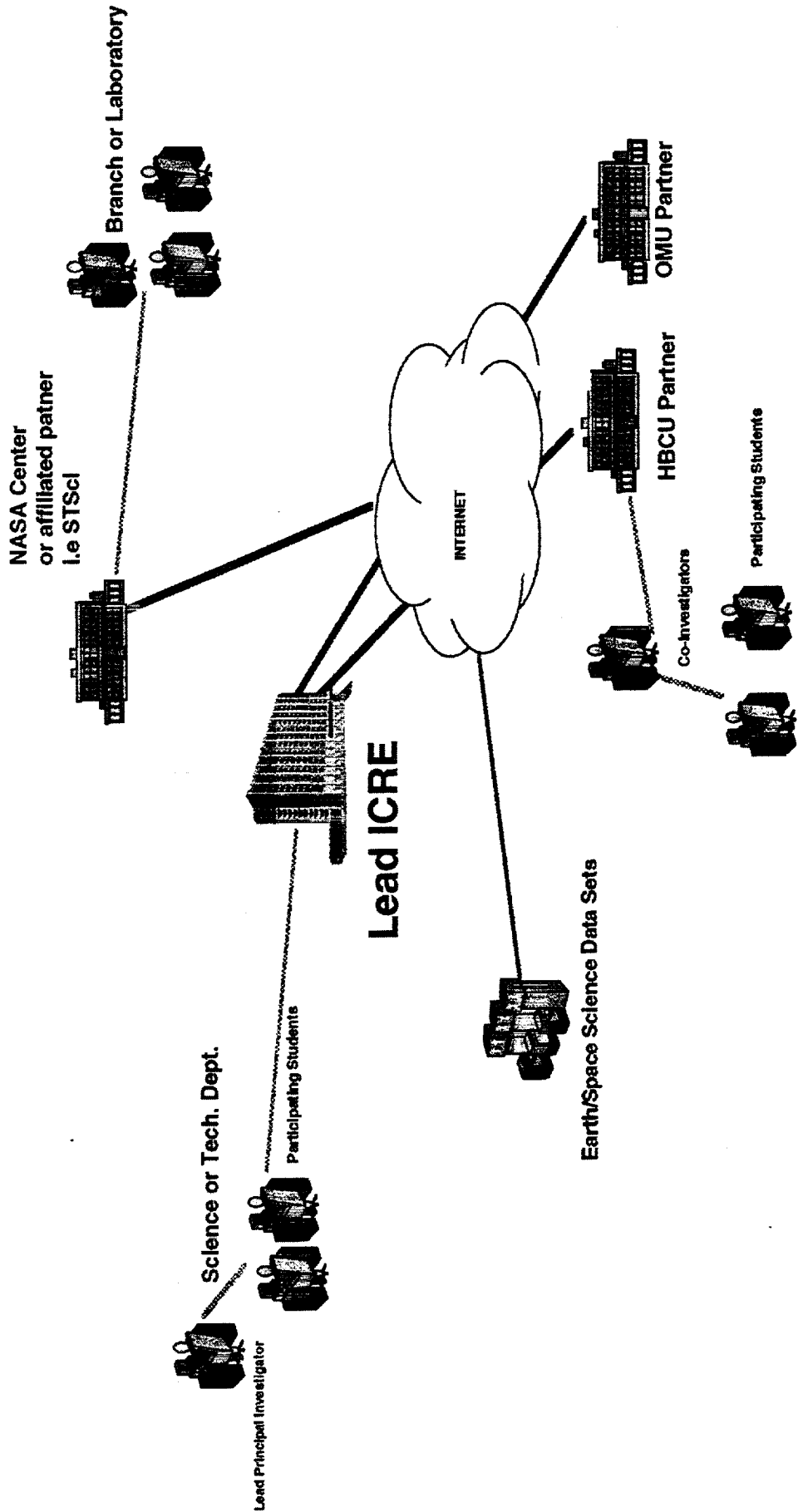
Activity Platforms



- Collaborative Research and Education
 - SCSU Astronomy Institute
 - TSU Astronomy/Planetary Geography Education
 - PVAMU Solar Research
- Science Curriculum Reform
 - Code FE NOVA/MU-SPIN workshops
- Flight Research Support/Team Building
 - Understanding the OSS Strategic Plan and Themes
 - Mentoring flight alternatives and competitive science
 - Promoting diverse team building
- Collaborating E/PO for Messenger

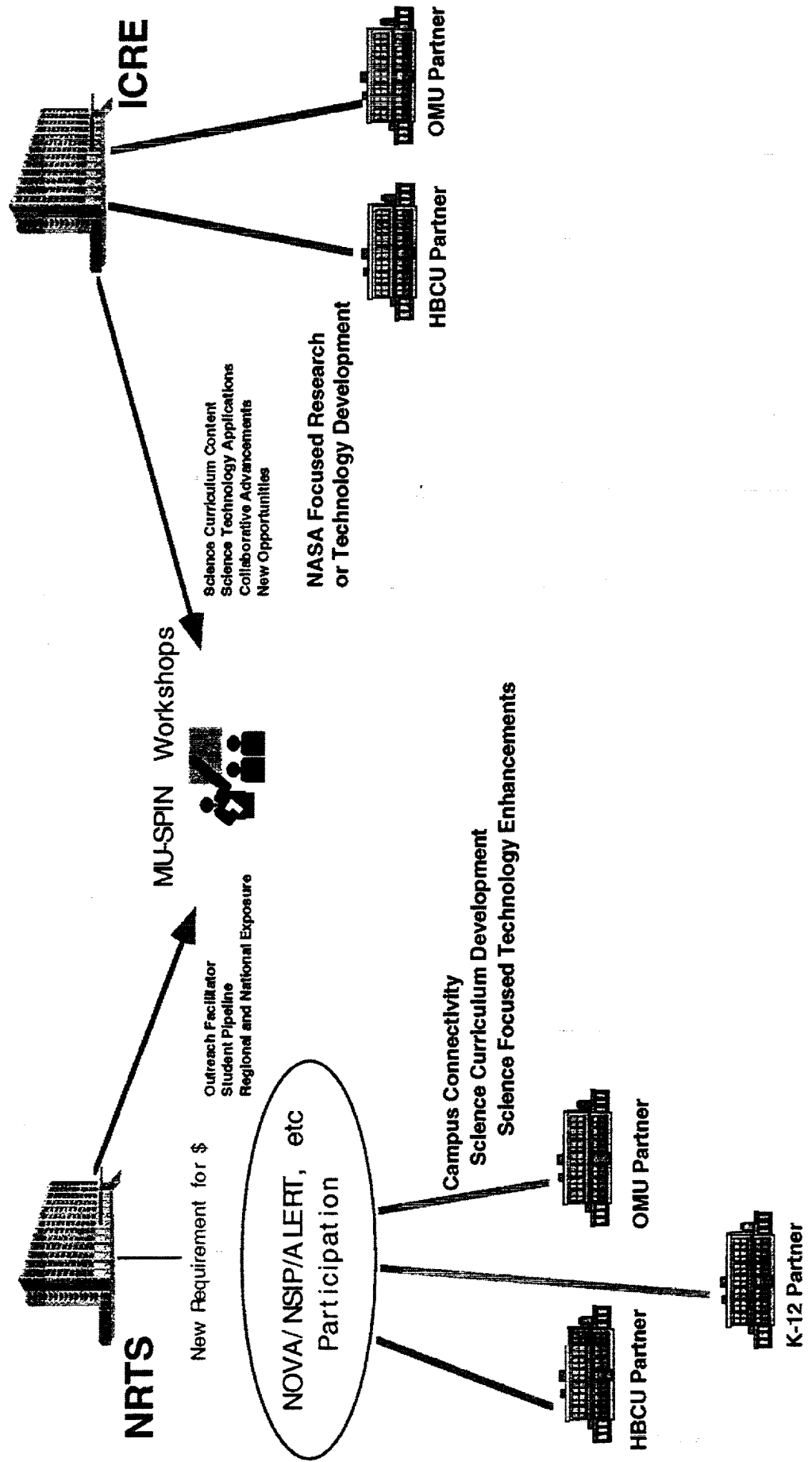
Institute for Collaborative Research and Education

- o Perform collaborative research in a NASA related activity as a virtual institute;
- o Outreach to a minimum of two HBCUs or OMUs ; and
- o Assist in coordination and provide content to a minimum of two NRTS academic year workshops on NASA collaborative science and technology.



NRTS/ICRE Partnership for Increasing Minority Participation in NASA Programs

- o Continue telecommunications technology support to the underserved;
- o Increase participation by requiring new NASA affiliations;
- o Improve curriculum content and delivery through new activities with NASA partners;
- o Improved project relevancy driven by new NRTS and ICRE activities.



Space Science Opportunities for Involvement

Mr. Jim Barrowman
NASA Goddard Space Flight Center

Dr. James Green
NASA Goddard Space Flight Center

Mr. Stanton J. Peale
University of California

Ms. Stephanie Stockman
NASA Goddard Space Flight Center

Mr. Leonard Strachan
Smithsonian Astrophysical Observatory

Dr. Valerie Thomas
LaVal Corporation

MU-SPIN Conference Explorers Program Perspective

Mr. Jim Barrowman
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Explorer Program Mission Statement:

The mission of the Explorer Program is to provide frequent flight opportunities for world-class scientific investigations from space within the following space science themes:

- Astronomical Search for Origins and Planetary Systems
- Structure and Evolution of the Universe
- The Sun-Earth Connection

America's space exploration started with Explorer 1

- Launched February 1, 1958
- Discovered the Van Allen Radiation Belts
- Over 75 Explorer missions have flown.

A Brief History of Explorers

See Picture 1.

Explorer Program thrives on new, innovative, research ideas

- HBCU/OMUs are a mostly untapped resource
- No Explorer PIs from HBCU/OMU - Yet
- Attempt to involve HBCU/OMU via UNEX partnerships was unsuccessful. We will try again!
- NASA wants to broaden the Space Science & Explorers research base

Frequent Explorer Space Flights

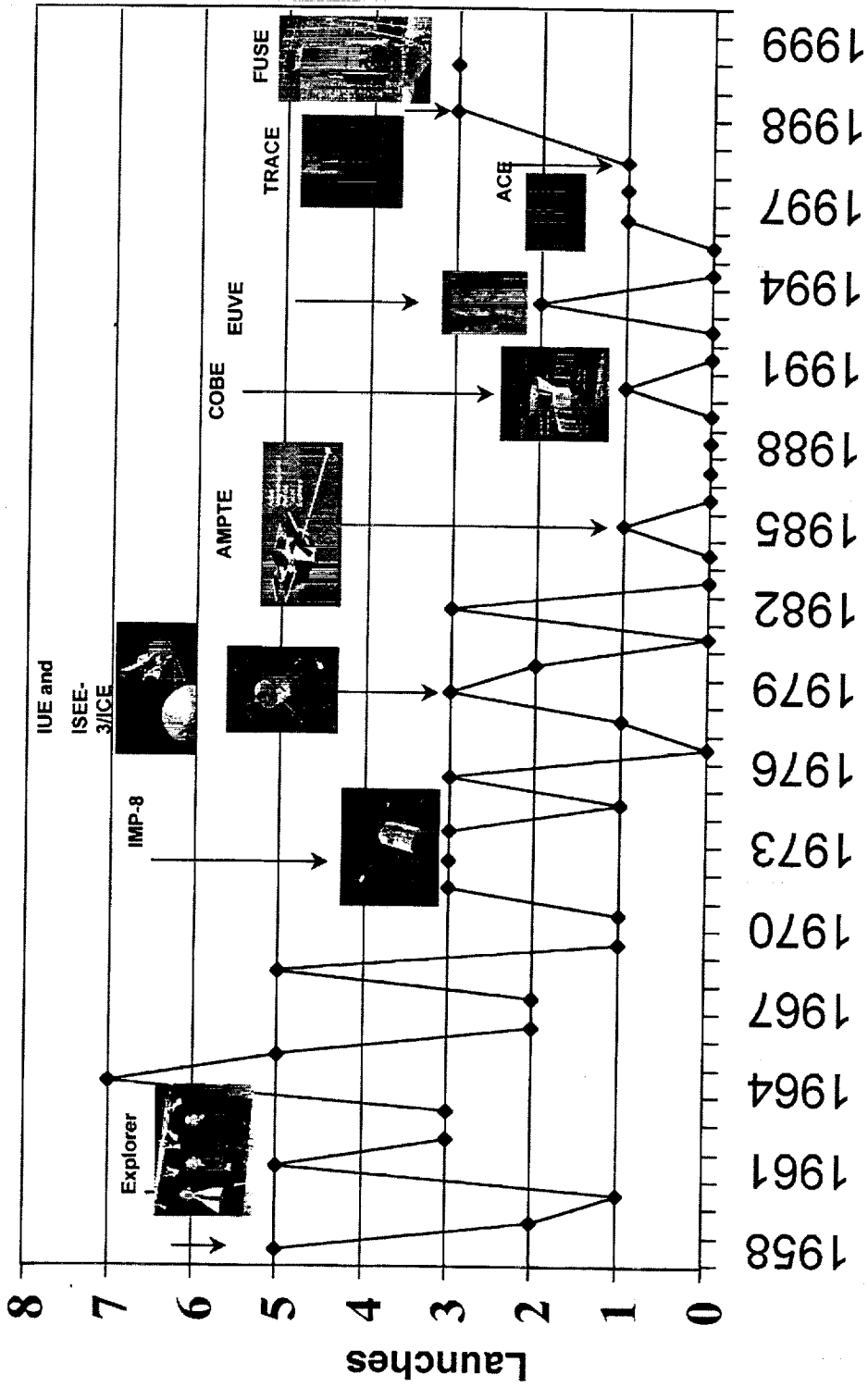
Four launches per year in four different sizes of missions

- MIDEX - Medium size Explorers - \$150M (1 per year)
- SMEX - Small Explorers - \$75M (1 per year)
- UNEX - University Explorers - \$15M (1 per year)
- MOpp - Missions of Opportunity - \$35M (flown on others' spacecraft)

Explorer Research Opportunities

- Three Announcements of Opportunity (AOs) every two years
 - Space Flight investigations
 - One each for MIDEX, SMEX, & UNEX
- One NASA Research Announcement (NRA) every two years
 - New technology development

A Brief History of Explorers



Picture 1



GODDARD SPACE FLIGHT CENTER



EXPLORERS SCHEDULE - POP 99-1

Announcements of Opportunity

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
MIDEX	▲ 3.4	▲ 5.6	▲ 7.8	▲ 9.10								
SMEX	▲ 8.9	▲ 10.11	▲ 12.13									
UNEX	▲ 1.2	▲ 3-6	▲ 7-10	▲ 11-14								
TECHNOLOGY NRAS	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲

▲ = Issued ▼ = Selected

Launch Schedule

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009					
MIDEX	▲ FUSE 6/89	▲ IMAGE 2/00	▲ MAP 11/00	▲ MIDEX-3 10/03	▲ MIDEX-4 10/04	▲ MIDEX-5 10/05	▲ MIDEX-6 10/06	▲ MIDEX-7 10/07	▲ MIDEX-8 10/08	▲ MIDEX-9 10/09							
SMEX	▲ TRACE 4/98	▲ SWAS 12/98	▲ WIRE 3/99	▲ HESS 7/00	▲ SMEX-8 7/03	▲ SMEX-9 7/04	▲ SMEX-10 7/05	▲ SMEX-11 7/06	▲ SMEX-12 7/07	▲ SMEX-13 7/08							
UNEX	▲ SNOE* 1/98	▲ TERRIERS* 5/99	▲ GALEX 9/01	▲ CHIPS 6/01	▲ IMEX 6/01	▲ UNEX-3 4/03	▲ UNEX-4 4/03	▲ UNEX-5 4/04	▲ UNEX-6 4/04	▲ UNEX-7 4/05	▲ UNEX-8 4/05	▲ UNEX-9 4/06	▲ UNEX-10 4/06	▲ UNEX-11 4/07	▲ UNEX-12 4/07	▲ UNEX-13 4/08	▲ UNEX-14 4/08
Missions of Opportunity		▲ HIETE II 1/00			▲ TWINS-A 1ST QTR		▲ TWINS-B 3RD QTR										

* - STEDJ Missions

6/14/99

On the web

Explorers

- <http://explorers.gsfc.nasa.gov/>

NASA Space Science

- <http://spacescience.nasa.gov/>

Overview of Space Science and Information Research Opportunities at NASA

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It is not possible to review all the opportunities that NASA provides to support the Space Science Enterprise, in the short amount of time allotted for this presentation. Therefore, only a few key programs will be discussed. The programs that I will discuss will concentrate on research opportunities for faculty, graduate and postdoctoral candidates in Space Science research and information technologies at NASA.

One of the most important programs for research opportunities is the NASA Research Announcement or NRA. NASA Headquarters issues NRA's on a regular basis and these cover space science and computer science activities relating to NASA missions and programs. In the Space Sciences, the most important NRA is called the "Research Opportunities in Space Science or the ROSS NRA. The ROSS NRA is composed of multiple announcements in the areas of structure and evolution of the Universe, Solar System exploration, Sun-Earth connections, and applied information systems.

Another important opportunity is the Graduate Student Research Program (GSRP). The GSRP is designed to cultivate research ties between a NASA Center and the academic community through the award of fellowships to promising students in science and engineering. This program is unique since it matches the student's area of research interest with existing work being carried out at NASA. This program is for U.S. citizens who are full-time graduate students. Students who are successful have made the match between their research and the NASA employee who will act as their NASA Advisor/Mentor. In this program, the student's research is primarily accomplished under the supervision of his faculty advisor with periodic or frequent interactions with the NASA Mentor. These interactions typically involve travel to the sponsoring NASA Center on a regular basis. The one-year fellowships are renewable for up to three years and over \$20,000 per year. These and other important opportunities will be discussed.

The MESSENGER Orbiter Mission to Mercury

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Abstract

MESSENGER is a Mercury Surface, Space Environment, Geochemistry and Ranging mission to orbit the planet Mercury for one Earth year following two flybys of that planet and two flybys of Venus. Here we point out the major science questions about Mercury that will be addressed by measurements from seven major instruments on the spacecraft along with the radio tracking. The Science Team for the mission is presented along with each team member's responsibilities showing the wide range of expertise necessary to accomplish the mission objectives. Methods of participation in the mission by members of the scientific community not on the Science Team and not otherwise associated with the mission are indicated.

Introduction

Mercury is one of the most interesting yet least explored planets in the solar system except for Pluto. It is the closest planet to the Sun and is therefore always seen in a twilight sky. The difficulty of observing the planet under these circumstances kept it shrouded in mystery until relatively recently. Its mass had been estimated from the gravitational perturbations of Venus's motion (Ash et al. 1967) and from this we deduced that Mercury has the highest uncompressed density of any body in the solar system (5.3 g/cm^3). The ratio of nickel-iron to silicate type material is the highest of any terrestrial type body. The nickel-iron core of Mercury has a radius of approximately 75% of the planetary radius and the metallic component comprises about 65% of the total mass (Siegfried and Solomon, 1974)—more than twice the ratio for Earth, Venus or Mars.

Because of its proximity to the Sun, it had been long assumed that tidal friction had reduced Mercury's rotation to a rate that is synchronous with its orbital motion—like that of the Moon, and observations of the repetitions of light and dark patterns on the surface seemed to verify this assumption (Dollfus, 1953). It came as quite a surprise then when radar observations revealed Mercury's rotation period relative to the stars to be close to 59 days (Pettengill and Dyce, 1965) instead of the 88 day period of the orbital motion. Theoretical arguments showing that Mercury should be rotating with a period precisely $2/3$ of its orbital period, stabilized against further tidal retardation because of its axial asymmetry and the high eccentricity of its orbit (Colombo, 1965; Goldreich and Peale, 1966), were confirmed by subsequent high resolution observations of the topography. Figure 1 pictures Mercury's rotation viewed from above the orbit. This was about the extent of our knowledge of Mercury until 1974.

Most of what is now known (Chapman, 1988; Vilas et al. 1988) comes from the three flybys of Mercury by Mariner 10 in 1974 and 1975. Mariner 10 imaged only about 45% of the surface at an average resolution of about 1 km and less than 1% of the surface at better than 500 m resolution. Further, Mariner 10 discovered the planet's internal magnetic field; measured the ultraviolet signatures of H, He, and O in Mercury's atmosphere; documented the time-variable nature of Mercury's magnetosphere; and determined some of the physical characteristics of the surface including distributions of plains and craters on the imaged parts and the discovery of scarps as long as 500 miles. Subsequent ground based discoveries include the Na and K components of the atmosphere (Potter and Morgan 1985, 1986). It was recognized that a spacecraft orbiting Mercury would greatly supplement this meager knowledge and provide answers to many of the scientific questions that we will discuss below.

The Rotation of Mercury

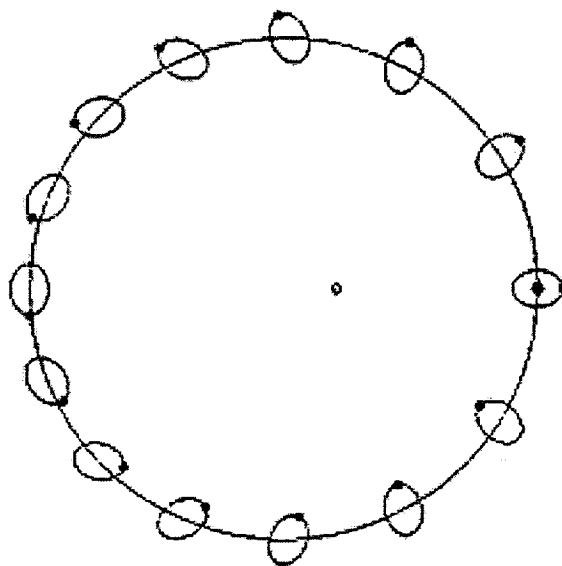


Figure 1

Mercury's rotation in the 3:2 spin-orbit resonance. The ellipses representing Mercury's orientation around the orbit are equally spaced in time.

But because of Mercury's close proximity to the Sun, it was thought that insertion of such a spacecraft into orbit about the planet could not be done with a conventional propulsion system, a view that drastically decreased the priority of further investigation of the planet. This difficulty in orbit insertion arises because of the high velocity a spacecraft would have relative to Mercury when it arrived from the vicinity of the Earth. For example, an elliptic spacecraft orbit with its aphelion (furthest point from the Sun) at the Earth's distance from the Sun (1 astronomical unit or AU) and its perihelion (closest point to the Sun) at Mercury's aphelion distance at about 0.46 AU is easy to attain and would be a natural trajectory to bring a spacecraft near Mercury. However, the spacecraft would arrive at Mercury with a velocity relative to the Sun of a little more than 51 km/sec and relative to Mercury of more than 12 km/sec. On board rockets would have to reduce the spacecraft velocity (Δv) by almost 9 km/sec for orbit insertion during the very brief time when the spacecraft is close to Mercury. A spacecraft designed to carry the large rocket and the large amount of fuel necessary for such a Δv would result in a prohibitively expensive mission, and it could deliver only a very small payload of instruments into orbit.

But just as encounters of spacecraft with a planet can increase the spacecraft velocity relative to the Sun for gravity assisted trajectories to the far outer solar system, such encounters can reduce the heliocentric spacecraft velocity. A spacecraft can be eased to smaller and smaller heliocentric orbits with a series of such encounters and arrive at Mercury with a slow enough velocity to allow insertion of a sizable payload into orbit *with current launch systems* (Yen, 1985, 1989). The MESSENGER spacecraft will use two gravity assists by Venus and two by Mercury itself before orbit insertion as it flies by Mercury the third time. Of course, one pays for this gradual approach to Mercury with relatively long missions, but we can now orbit Mercury and probe its secrets with unprecedented scrutiny. MESSENGER, launched in March 2004, will enter Mercury orbit in September 2009 and carry out comprehensive measurements for one Earth year. The orbit chosen to maximize the science return while minimizing the effects of the severe thermal environment for the MESSENGER spacecraft about Mercury is a polar orbit with a reasonably large eccentricity.

Science motivation for the MESSENGER mission

MESSENGER is focused on answering the following key scientific questions, which are motivated by and comprise natural extensions of our current knowledge. Together, answers to these questions will

substantially increase our understanding of how terrestrial planets formed and evolved.

1. What planetary formation processes led to the high metal/silicate ratio in Mercury?
2. What is the geological history of Mercury?
3. What is the nature and origin of Mercury's magnetic field?
4. What is the structure and state of Mercury's core?
5. What are the radar reflective materials at Mercury's poles?
6. What are the important volatile species and their sources and sinks on and near Mercury?

A global map of the surface composition and mineralogy will distinguish between the hypotheses for Mercury's high density in question 1 and thereby tell us which of several processes dominated during the formation of the terrestrial planets. The various processes during the formation stage predict different compositions of the surface. The global elemental abundances on Mercury's surface will be determined by the X-ray (XRS) and the γ -ray and neutron spectrometers (GRNS). Atoms in the top few mm of the surface have deep electronic levels vacated by solar X-rays, and subsequent decay back to the electronic ground state identifies the element with characteristic line emission. Energetic galactic cosmic rays excite nuclei in the top few cm of the surface, and decay back to the nuclear ground state with characteristic γ -ray line emission identifies the nucleus. Neutrons are also generated by cosmic ray collisions with surface elemental nuclei and slowed down by collisions with low mass elements such as hydrogen. They are also absorbed and scattered by other nuclei as they progress toward leakage from the surface above which they can be detected. The neutron spectrometer will be most useful in identifying the volatile content of the polar deposits discussed below. These elemental distributions will be supplemented by constraints on the distributions of minerals from the Visible and Infrared Spectrometer (VIRS) part of the Atmosphere and Surface Composition Spectrometer (ASCS) and the set of instruments will provide a self consistent determination of the surface composition and its variation over the surface.

The geological history of Mercury sought in question 2 is crucial to understanding how terrestrial planet evolution depends on planet size and initial conditions. The geological history developed from Mariner 10 images (Strom, 1979, 1997; Spudis and Guest, 1988) is uncertain because of the limited coverage and resolution. For example, volcanic lava flow fronts, such as those seen on the Moon, would not be visible at the Mariner 10 resolution. The geological history of Mercury will be deduced from the global imaging coverage at 250 m/pixel with the Mercury Dual Imaging System (MDIS), including stereo geometries supplemented with precise elevations from the Mercury Laser Altimeter (MLA). The goal is to understand the sequence of tectonic deformation, volcanism and cratering that shaped Mercury's surface. The distribution of the surface composition and mineralogy from the XRS, GRNS, and ASCS will constrain the interpretations of the geological sequences. The thermal history of the planet is also correlated with its geologic history. The strong temperature dependence of elastic and ductile strengths of rocky materials allows constraints to be placed on temperature gradients near the surface by comparing the gravitational field variations obtained from the radio tracking of the spacecraft with the topography obtained with the MLA. The ubiquitous lobate scarps seen by Mariner 10 are likely indications of thrust faults on a cooling and thereby shrinking planet.

Question 3 will be addressed by the magnetometer (MAG) and the Energetic Particle and Plasma Spectrometer (EPPS). MAG will map the configuration and time variability of the magnetic field, while the EPPS determination of the distribution of types, abundances, energetics and dynamical characteristics of the ions will help distinguish what part of the local field is internally generated in Mercury and what part is derived from external sources. This combination of measurements will distinguish Mercury's field from that carried by the solar wind. The true field configuration will constrain the nature of its source. Is the field really due to dynamo action in a liquid outer core?

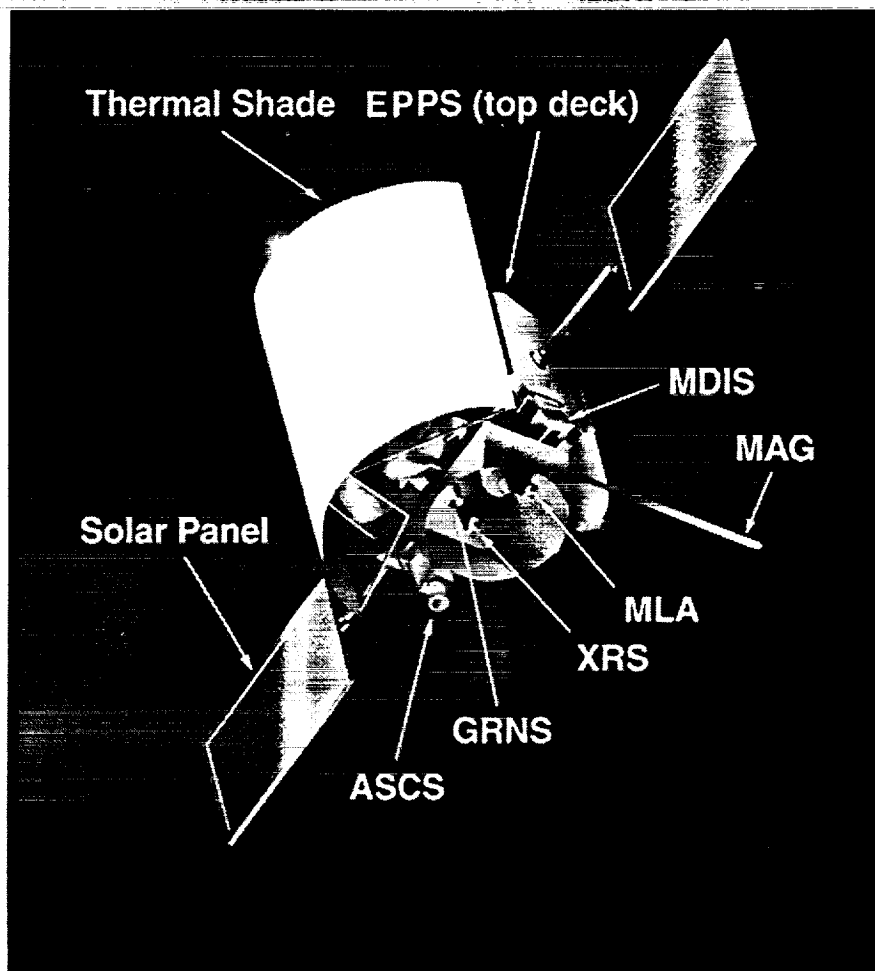


Figure 2

The MESSENGER spacecraft with Sun shield, solar arrays and seven instruments.

This last question is a prime motivation for question 4, which will be addressed by measuring the amplitude of the physical libration with the laser altimeter and radio tracking experiments. A metallic liquid outer core is necessary for a dynamo to work, but there is justified concern that such a liquid Ni-Fe core would have solidified over the age of the solar system in such a small planet (Siegfried and Solomon, 1974) unless sustained with a lower melting temperature by a sufficient contamination of another element such as sulfur (Schubert et al. 1988). The nature of the core is distinguished by the fact that the amplitude of the physical libration will be about twice as large as the solid planet value if the mantle is decoupled from the interior by a liquid layer. This libration is a periodic variation in Mercury's rotation rate around the mean spin angular velocity of 1.5 times the mean orbital angular velocity. It is induced from the gravitational torques on the non-axisymmetric shape of Mercury as it rotates relative to the Sun. Figure 1 shows the variation in Mercury's orientation around the orbit, where the solar gravitational torque always tries to align the long axis of Mercury with the Mercury-Sun line. In addition to the physical libration amplitude, the obliquity (angle between the equator and orbit planes) and the lowest order coefficients in the spherical harmonic expansion of Mercury's magnetic field, C_2^0 and C_2^1 must be determined (Peale, 1976, 1981, 1988, 1997). The first will be found along with the libration amplitude from the laser altimetry and radio science and the latter two numbers are part of the overall gravitational field determination from precise radio tracking of the spacecraft.

Question 5 is motivated by radar images that show regions of high radar reflectivity at the poles (Slade, et al., 1992; Harmon and Slade, 1992). These bright regions return a radio wave dominantly polarized in the same sense as that sent, whereas solid objects such as the Moon return mostly the opposite polarization. The anomalous polarization is a signature of relatively deep and clean water ice. The circular polarization of the radar wave can be thought of as an electric vector perpendicular

to the direction of propagation that rotates uniformly while advancing down the direction of propagation at the speed of light. The tip of the vector thereby describes a spiral along the propagation path. Normally most of the wave energy reflects from a solid body as in a mirror, such that the returning wave has mostly the opposite polarization. I.e., the observer sees the electric vector in the returning wave rotating the same direction as that in the wave he sent, but the wave is now propagating toward him instead of away, so the polarization is reversed. The Moon and the equatorial regions of Mars and Venus all demonstrate the dominance of the opposite polarization in the reflected radar waves.

It came somewhat as a surprise that the radar reflections from the icy satellites of Jupiter and from the ice caps of Mars came back with most of the radiation polarized in the *same* sense as that propagated (Ostro et al., 1988). This was explained by the realization that most of the radar energy is not reflected or absorbed at the surface of the ice as it was for rocky objects, but that it passed into the ice and was internally scattered off of inhomogeneities (buried craters?) to emerge from the interior with same polarization with which it entered—much like the reflection from a corner cube (Eshleman, 1986). The ice had to be deep relative to the wave length of the radar beam and not be very absorbing. Since the bright radar regions at Mercury's poles had the same anomalous polarization signature as the ice caps of Mars and as the icy Galilean satellites, water ice would seem to be in the dark shadows at Mercury's poles. A lower absolute radar reflectance than the Martian polar cap can be the result of incomplete areal coverage by ice units or a thin cover of dust or soil (Butler et al., 1993).

The permanently shadowed floors of impact craters near the poles are sufficiently cold (~60K) to preserve water ice for billions of years, assuming that Mercury has had its currently small obliquity for such a time (Paige et al., 1992; Ingersoll et al., 1992; Butler et al., 1993). Indeed, many of the areas of highest backscatter coincide with known impact structures imaged by Mariner 10 (Harmon et al., 1994). The source of the water ice is not known. It could be internally generated, or due to impact volatilization of cometary and meteoritic material followed by random-walk transport to the poles.

Sprague et al. (1995) proposed an alternative hypothesis that the polar deposits are composed of elemental sulfur, which can also be considered a volatile which could reach the cold traps at the poles in a manner similar to the transport of water vapor. A natural source of the sulfur vapors would be volcanic outgassing much as in terrestrial volcanos.

The GRNS will determine if Mercury's polar deposits contain hydrogen in water ice or sulfur. The neutron spectral signature of the hydrogen in water ice is unique, and that of sulfur will be compelling although not unique (Feldman et al., 1997). Coupling the neutron measurements with gamma ray spectra and UV spectral analysis of the volatile effluents will identify the volatiles comprising the polar deposits. Collisions of cosmic-ray-generated neutrons with hydrogen nuclei (protons) cause the neutrons to lose their initially high energies rapidly. This "moderation" of neutrons is often accomplished in nuclear reactors by surrounding the fuel rods with water. Neutrons lose energy slowly during scattering from heavy nuclei. This difference in the moderation properties of different polar deposits along with differences in the scattering and absorption cross sections of neutrons for various nuclei lead to the different energy distributions of those neutrons that leak from the surface. In addition, some of the neutrons will combine with protons to make deuterium with the emission of a γ -ray at 2.23 Mev. This will be seen by the gamma ray spectrometer if there is a lot of hydrogen (*i.e.*, water ice) in the deposits. Finally, the particle and plasma (EPPS) and UV (the Ultra Violet and Visual spectrometer (UVVS)) part of ASCS) spectrometers will identify the effluent from the frozen volatiles.

The ASCS/UVVS will address the sixth question concerning the volatile species in the atmosphere. The UV spectrometer will measure the composition, structure and time variability of Mercury's tenuous atmosphere. Correlations of the time variability with solar time, solar activity and the planet's distance from the Sun will constrain mechanisms of volatile release from the surface or volatile injection from the solar wind. Conjectures about the surface composition predict many more species in the atmosphere than the H, He, O, Na and K that have already been detected, and the spatial distribution of these species will be correlated with the distribution of surface composition and mineralogy thereby identifying the local source of the detected atmospheric species. The energetic particle part of EPPS will measure the exchange of species between the atmosphere and magnetosphere, and the plasma spectrometer part will identify and quantify those ions picked up by the solar wind. All of these measurements will be combined to identify the sources and sinks of the volatile species and the dynamics of their transport. We have already seen how this works in the identification of the volatile species in the polar deposits.

A great virtue of the MESSENGER mission is the way the instrumentation has been chosen to address all of the major science questions we have assembled about Mercury in a way that provides great redundancy and tests for self consistency. The cross correlations of the measurements will effectively constrain the answers to the major scientific questions. At the same time, we expect that many more, completely unanticipated puzzles will be disclosed such as happened during the spacecraft Galileo's scrutiny of the Jovian system. Figure 2 shows the spacecraft with its Sun shield and the instruments discussed above.

The Science Team

The variety of disciplines involved in understanding Mercury's current state, its history, the constraints it places on the theory of origin of the solar system and the variety of technologies employed in the measurements required the assembly of a science team with a range of expertise sufficiently wide to span these disciplines. The science team is shown in Table 1 along with their responsibilities during the mission development and execution and in interpreting the data that is returned.

Mission Implementation

To implement the mission, the Principal Investigator, Dr. Sean C. Solomon, Director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington (CIW), and The Johns Hopkins University Applied Physics Laboratory (JHU/APL) head a consortium of companies and universities to provide the spacecraft and instrumentation. The Applied Physics Laboratory is an organization with an unusually competent and experienced set of engineers and scientists. Their attention to detail and their management skills have produced a long series of successes associated with NASA missions. A recent example is their construction of the Near Earth Asteroid Rendezvous (NEAR) spacecraft which was delivered on time and under budget. Their NEAR mission management has continued successfully as the spacecraft nears orbit insertion about the asteroid Eros on Feb. 14, 2000. MESSENGER is in good hands.

To engage students and the public, the MESSENGER Education and Public Outreach (E/PO) Plan is coordinated by the American Association for the Advancement of Science. The extent and completeness of the E/PO Plan is indicated by the following partners in this undertaking: Messenger Science Team, Challenger Center for Space Science Education, Carnegie Academy for Science Education, Proxemy Research, Inc., Montana State University Center for Educational Resources (CERES), National Air and Space Museum, American Museum of Natural History, Minority University-Space Interdisciplinary Network (MU-SPIN), Space Explorers, Inc., Independent documentary film makers. Activities will include educational efforts at all pre-college levels, provision of curriculum support materials, student internships to work with science team members, teacher workshops and internet based courses. The disadvantaged public will be specifically sought out to receive MESSENGER information. Two major documentaries will be developed along with a series of programs during the mission. Minute radio segments will inform the public during the mission and materials for the media will be provided. Museum displays will be assembled and two general audience books will be put together. These activities will carry the excitement of the MESSENGER mission to students, teachers and the public perhaps more so than any previous NASA mission.

The returned data

Unlike many previous missions to the planets, there is no proprietary period of exclusive use of the Mercury data by the scientific personnel associated with the mission. The MESSENGER team is committed to providing all mission data to the scientific community as soon as processing and validation are completed. All validated mission data will be archived with the Planetary Data System (PDS). In parallel with this archiving, scientific results will be shared with the science community via scientific meetings and peer-reviewed publications. Public dissemination of images and data will start immediately following their receipt. Additional data products of scientific interest will be disseminated in electronic and printed formats. Optimal use will be made of the World Wide Web to provide results to the scientific community, to mission educational and outreach endeavors, and to the general public.

Given that the data will be available as received, scientific personnel outside the mission can use the data for their own analysis, and they can seek support for this analysis by submitting proposals to the appropriate discipline (e.g. Planetary Geology and Geophysics) in the NASA Research and Analysis Program or to similarly appropriate disciplines in NSF.

Table 1. The MESSENGER science team

Team Member	Role and Responsibility
Sean C. Solomon	Principle Investigator. Leads MESSENGER effort with responsibility for design, execution, and success of the mission, reports on project progress and status to NASA. Co-chairs all Science Team meetings. Ex-officio member of each Science Team group. Leads overall scientific analysis effort and participates in interpretation of imaging geochemical and geophysical measurements.
Mario H. Acuña	Shares in development of MAG. Participates in the analysis of magnetometer data.
Daniel N. Baker	Participates in the analysis of MAG, EPPS and UVVS data. Leads efforts to characterize magnetospheric processes.
William V. Boynton	Participates in the development of GRNS and XRS. Leads the analysis of γ -ray, neutron and X-ray measurements.
Clark R. Chapman	Participates in the analysis of imaging and IR spectral measurements. Leads interpretation of the impact cratering record.
Andrew F. Cheng	Leads the analysis of MAG, EPPS, and UVVS data for the study of interaction of the magnetosphere and the planetary surface.
George Gloeckler	Oversees development of Plasma Spectrometer subsystem of EPPS. Leads the interpretation of thermal plasma data.
Robert E. Gold	Implements science payload. Oversees the development of EPPS. Participates in analysis of energetic particle data.
James W. Head III	Leads the analysis of imaging data for the identification of volcanic features and the stratigraphic analysis of geologic units.
Stamatios M. Krimigis	Leads the analysis of EPPS data to characterize the magnetosphere and interplanetary medium.
William McClintock	Oversees development of ASCS. Leads the interpretation of UV spectra. Participates in the interpretation of IR spectra.
Ralph L. McNutt, Jr.	Project Scientist: assists PI. Oversees development of GRNS and XRS. Participates in analysis of surface composition.
Scott L. Murchie	Oversees MDIS development. Leads development of observing sequences and interpretation of imaging and spectral data.
Stanton J. Peale	Leads strategy for and interpretation of measurements of planetary orientation and physical liberation.
Roger J. Phillips	Leads the analysis of topography and gravity data for regional tectonics and interior dynamics.
Mark S. Robinson	Leads development of mosaicking and geometrical corrections for MDIS. Leads the analysis of imaging and spectral data.
James A. Slavin	Participates in development of MAG. Leads the analysis of magnetometer data for magnetic field structure.
David E. Smith	Participates in analysis of imaging and IR spectral measurements. Leads investigation of radio science. Participates in analysis of MLA data.
Robert C. Strom	Participates in analysis of imaging and IR spectral measurements. Leads the interpretation of volcanic and tectonic history.
Jacob I. Trombka	Oversees selection of GRNS and XRS detectors. Participates in the analysis of γ -ray, neutron, and X-ray measurements.
Maria T. Zubor	Leads analysis of MLA data. Participates in the analysis of occultation, radio science and gravity/topography data.

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EPO Opportunities Associated with Space Science Research Grants

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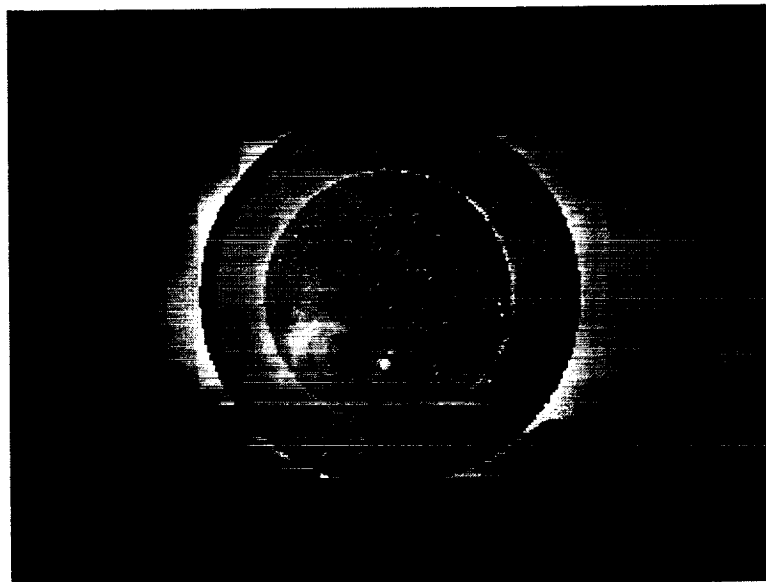
Overview

- Organization: Who we are
- Space Science Projects (at SAO and GSFC)
- Current EPO Activities
- Proposed Activities
- Useful Project Web Sites
- How to get Involved

Organization: Who we are

- We are a research group at SAO involved with the investigation of fundamental properties about the solar wind and solar corona using space-based solar instruments.
- The group is headed by Dr. John Kohl (PI) with 23 scientists and technical support staff at SAO in Cambridge and at NASA/Goddard Space Flight Center.
- The group has 20+ years of experience with flying solar coronagraphic instruments on rockets and spacecraft.
- Co-Investigators are from Italy, Switzerland, Belgium

EIT/UVCS Image of Corona

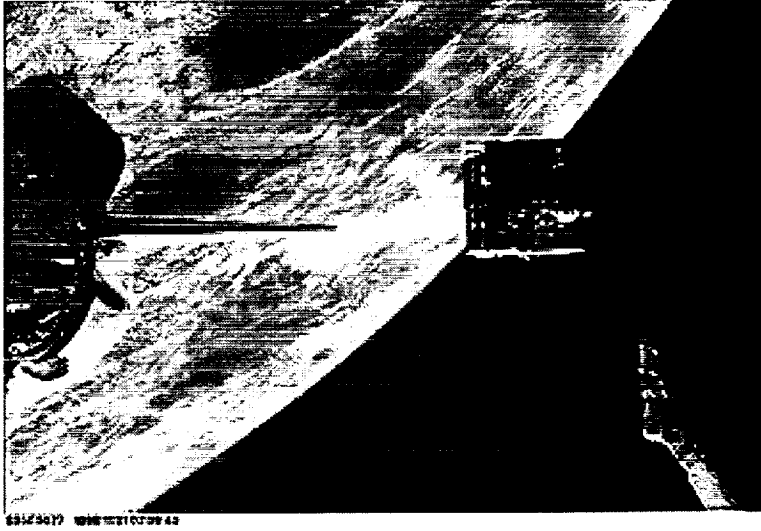


Space Science Projects at SAO & GSFC

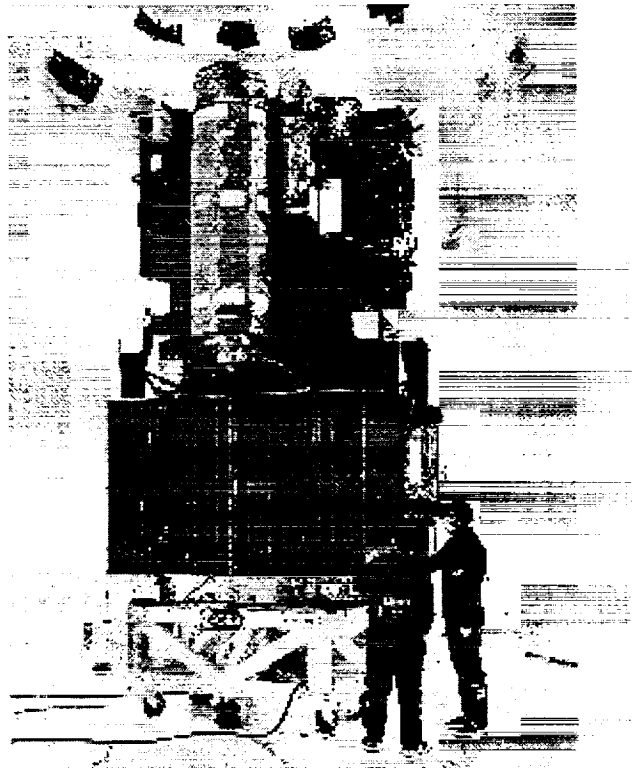
Present solar coronal/solar wind projects include:

- Spartan 201/Ultraviolet Coronal Spectrometer Experiment
 - Shuttle deployed and retrievable spacecraft
 - Five space shuttle flights from 1993 to 1998
- Ultraviolet Coronagraph Spectrometer (UVCS) on the Solar Heliospheric Observatory (SOHO)
 - In orbit at L1 Lagrange point 1.5 million km from earth
 - Near-continuous science operations since 1996

Pictures of Spartan and SOHO



1. UVCS/Spartan 201 in flight above the shuttle



2. UVCS/SOHO in the cleanroom

Current EPO Activities

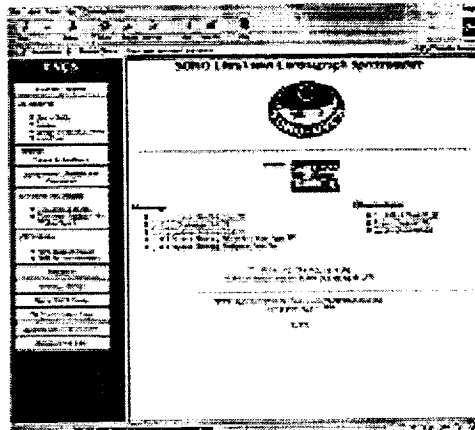
- HBCU student training in solar research topics at the SOHO Experiment Ops Facility at NASA/Goddard
- Internet based tutorials for analyzing UVCS/SOHO data
 - Includes UVCS/SOHO "Users Guide"
 - IDL data analysis software
 - Access to UVCS/SOHO solar coronal data
- "Ask an Astronomer" Web site
 - Provides answers to space related questions from students and teachers
- Students can participate on the UVCS/SOHO program, learning about all phases of research including:
 - Identifying a scientific objective for the observation
 - Planning observations to accomplish the objective, based on expected solar intensities and instrument sensitivities
 - Reducing UVCS/SOHO observations to remove instrumental effects and to produce physical parameters of the corona
 - Constructing empirical models for particular coronal feature or object being investigated

Proposed EPO Activities

Future EPO Activities will include the following:

- Strengthening partnerships with HBCUs to provide:
 - Student mentoring
 - Faculty collaborations
- Establishing a Sun-Earth Connection (SEC) Student Research program (aimed at high school students)
- Establishing a SEC Teacher/Scientist Forum
- Developing an EPO CD-ROM with Education guide

UVCS/SOHO Web Page



<http://cfa-www.harvard.edu/uvcs>

Project Web Sites

- UVCS/SOHO Web Sites:
<http://cfa-www.harvard.edu/uvcs>
<http://sohowww.nascom.nasa.gov>
- UVCS/Spartan Web Sites:
<http://cfa-www.harvard.edu/cfa/spartan>
<http://umbra.nascom.nasa.gov/spartan>
- ASCE Web Site (Proposed MIDEX):
<http://cfa-www.harvard.edu/asce>

Calls for Participation

Ms. Jolanta Lisowska
Ms. Sonia Marin
Mr. Francisco Muniz
LaGuardia Community College

Dr. Adeyemi Adekoya
Virginia State University

Dr. Eugene Jones
TRACTELL Inc.

Dr. Mou Liang Kung
Norfolk State University

Problems, Prospects and Promise of Implementing Computer-Mediated Networks: The Case for Effective Participation of Minority Institutions in NASA Science and Technology Programs

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Summary Slide

- Introduction
- Current Higher Education Issues
- 21st Century Colleges and Universities Key Performance Issues
- Peculiar Problems Encountered By Minority Colleges and Universities in Implementing Information Technology (IT)
- The need for Minority Colleges and Universities to Achieve Information Access
- Factors Challenging IT Applications
- Prospects of Implementing Computer-Mediated Networks
- Future Directions and Conclusion

Current Higher Education Issues

- Limited human and financial resources.
- Lack of adequate access to academic programs by regular and non-traditional students.
- Inadequate access to information, library and support services.
- Shifting student demographics.
- Explosive growth and advances of IT.

Peculiar Problems Encountered by Minority Colleges and Universities in Implementing Information IT

- Lack of Strategic IT plan.
- Lack of Awareness.
- Poorly Managed Implementations
- Lack of Management Involvement and Support.
- Lack of Necessary Technical Expertise.
- Lack of Purposeful IS Strategy.

The Need for Minority Colleges and Universities to Achieve Information Access

- Information Access = information resources and technology enabled process that extends the content of the curriculum, enriches classroom discourse, and enhances learning opportunities.
- New Paradigms for Teaching and Learning with Web and Distance-Learning Technologies.
- Student-centered Environment.
- Develop a logical transition or bridge to your next point.

The Next Generation Web Servers

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Presentation Narrative

Web servers traditionally were used for publishing documents on the Internet. Most web documents are coded in HTML (the HyperText Markup Language). HTML defines "tags" which mark the text format and rendering instruction instead of document structures (e.g. authors, version, abstract, chapters, sections, ... etc). Web browser vendors obligingly implement the rendition of the HTML tags by hard-coding them into their HTML browsers, making them very hard to add new tags without sacrificing interoperability. Vendor-added tags are typical problems for interoperability. There is simple no extensibility to HTML at all. Therefore, tricks and work-around have been conceived to enhance web pages by adding Java applets and client-side scripts (e.g. VBScript, JavaScript, ...etc.) making these web pages dependent upon specific programming languages.

At the same time, more and more businesses are opening accesses to their corporate databases via web servers to conduct e-commerce (e.g., Internet advertising, Internet purchases). When it comes to business to business data exchange, a major problem arises. Since HTML is only a presentation language, not a structural one, businesses who wish to conduct business data exchange must open two browser windows and manually transcribe or copy-and-paste data from one web page to another to achieve data exchange. Manual operations are time-consuming and prone to errors. They are totally unsuitable for financial transactions or database information exchange. Therefore, HTML is inadequate to foster process automation. Hence, new generations of web servers are needed to escape the shortcomings of HTML while remain backward compatible to legacy HTML documents.

Since the World Wide Web Consortium published the XML ([1], eXtensible Markup Language) specification in December of 1997, XML has been touted as the technology to anchor the next-generation Web. XML is a lean subset of SGML ([2], Standard Generalized Markup Language, ISO 8879) for network document delivery. While SGML is a system and software independent meta-language used to specify document types and structures, so is XML. Document components tagged with XML-based structural elements can be easily and consistently parsed for electronic processing. The instant fame of XML can be attributed to its powerful capabilities not found in HTML:

- allowing different content views of a document to different users on different rendering devices,
- providing a language-independent, platform-neutral, structured data exchange format for web applications or heterogeneous databases for process automation and integration,
- Configuring and representing distributed components (written in Java or other OO languages) in CORBA ([3], Common Object Request Broker Architecture) distributed environment.

On the Internet, two businesses can exchange data in XML format directly between two XML-enabled web servers which serve as front-ends to their individual corporate database servers without human intervention. Hence, XML is good for consumer to business as well as business to business applications. Therefore, the next generation of web servers must be able to handle XML.

Prior to the birth of XML, these capabilities might be found in more expensive and complicated SGML-based electronic publishing systems. However, due to the simplicity of XML, there is a plethora of low

can be created either by using plain text editors (e.g. Microsoft NotePad) or XML editors (e.g. XMetal, [4]) which simplify chores of following their document type definitions (DTD). The web servers must then be able to serve XML documents to XML browsers of the future as well as HTML browsers at present. There are at least two ways to deal with the XML to HTML conversion issue:

1. Use scripting language to offer CGI script hyperlinks. For example, one can use a Perl script to do the conversion.
2. Use Java servlet engine on web servers to implement Java servlets that will convert XML to HTML on the fly.

Currently, automated conversion can be done using the Cocoon servlet ([5]) on Apache JServ servlet engine ([6]), with an XML parser (e.g., IBM XML4J, [7]) and an XSL ([8], XML Stylesheet Language) processor (e.g., XSL:P Processor, [9]). XML parsers with DOM ([10], Document Object Model) support are essential since they parse the XML documents into document objects and validate them for further processing. The XSL processors with DOM support then attach styling information to these document objects to generate HTML output.

The experience of enabling web servers to serve XML documents to both traditional HTML browsers and browsers with some XML capabilities (e.g. Microsoft IE5, [11]) at Norfolk State University will be presented. A demo page can be found at <http://199.111.112.120/~randy>.

References

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- [2] Standard Generalized Markup Language, <http://www.oasis-open.org/cover>
- [3] Common Object Request Broker Architecture
- [4] XMetal, <http://www.softquad.com/products/xmetal/>
- [5] Cocoon, <http://java.apache.org/cocoon/>
- [6] Apache JServ servlet engine, <http://java.apache.org/>
- [7] IBM XML4J, <http://www.alphaworks.ibm.com/tech/xml4j>
- [8] Extensible Stylesheet Language, <http://www.w3.org/Style/XSL/>
- [9] XSL:P Processor, <http://www.clc-marketing.com/xslp/>
- [10] Document Object Model, <http://www.w3.org/DOM/>
- [11] Microsoft IE5, http://www.microsoft.com/msdownload/iebuild/ie5_win32/

Earth Science Opportunities for Involvement

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**NASA Education & Public Outreach Strategies for Minority Institutions:
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I. Introduction: Don't Assume

A. E/PO - Is it Education, or Science?

- E/PO is an educational opportunity for scientists and engineers - giving us the opportunity to translate NASA enterprise science into curricula throughout the K-14 spectrum, and for public science venues (planetaria, e.g.).

B. Why is E/PO significant to minority institutions?

- E/PO applications absolutely require minority participation -the announcement criteria, carefully read, will tell you about the level of participation or partnership with majority institutions.
- E/PO is, for NASA, increasingly important: in many cases, the E/PO segment of a mission related proposal is rated of equal importance with science and technical segments of the proposal.
- E/PO gives us an opportunity to interface with our education colleagues - and education is usually a powerful component of any minority college - to design curricular approaches to science we believe are in concert with the way we learn best, and to serve as a model for professional contribution back to our communities.

C. Doing your homework

- Get in the habit of consulting NASA's web-site - and especially the home pages for each enterprise
- The devil's in the details: search the enterprise home pages carefully for tab references to "Education", "Education/Public Outreach", or "E/PO". The criteria and definitions are revised continually in each NASA enterprise.

D. Different levels of participation

- Both AOs (Announcements of Opportunity) and NRAs (NASA Research Announcements) have E/PO segments -- but they represent very different kinds of opportunity. If you're not ready to apply as a Principal Investigator, learn more about partnering opportunities (see III. B., below).

E. Retroactive opportunity

- Don't be shy: in many cases, it's possible to submit an NRA application after a research grant has already been made. Determine whose professional work you most respect and would like to affiliate with, and contact that scientist or engineer to determine if their grant lacked an E/PO component which you might provide. Use your professional networks!

II. Earth Sciences Enterprise

A. What's unique about UNNESS?

- The UNNESS announcement offers a very unique E/PO opportunity, which may be repeated in future AOs in this and other enterprises. Consult the ESE home page, locate the UNNESS E/PO criteria in that announcement, and become familiar with it.

B. Getting help

- Currently, every NASA enterprise has its own unique way of approaching E/PO work, and an assistance office in that regard. Look for that office in the enterprise's home pages and talk with them -- even if you think the research announcement and the E/PO criteria are plain as day.

III. Space Sciences Enterprise

A. What's an Ecosystem?

- The Office of Space Science (OSS) has so evolved its approach to E/PO work, it has created a national "Ecosystem" of organizational entities - especially its national network of Forums and of Broker/Facilitators. These are key to your participation in NASA research opportunities. Identify them from the OSS web-site, and make contact.

B. Getting help

- Any OSS Ecosystem Broker/Facilitator can help you understand your best course of action regarding preparation of an AO or NRA response - and especially, helping you figure out partnering opportunities. Use them!

IV. Office of Education

A. Keeping an eye on LEARNERS

- LEARNERS is a periodic, entirely unique NASA grant announcement to do E/PO work through enterprise research already - and recently - performed. Consult the NASA Office of Education web-site, look for LEARNERS, and familiarize yourself with it.

B. CANs

- LEARNERS is just one example of a CAN - a Cooperative Announcement put together by two or more NASA offices or units. CANs are periodic, but always offer extraordinary opportunities to participate in NASA research via E/PO work. As you periodically roam NASA's key web-sites, be on the look-out for these CANs.

V. Getting Ready to Apply

A. Following rules

- NASA thinks through each AO and NRA extremely carefully before they're published, sometimes putting months of preparation into announcement construction. Follow the rules for submission and inclusion of material exactly - and realize that the pool of reviewers who will read your proposal are trained to follow the criteria without any deviation.
- The devil is in the details, again: make sure that the required information you provide in the Appendices of research proposals is fully, fairly and accurately descriptive of you and your institution. In most cases, this will be the only way for reviewers to estimate

your competency and capability - which is invariably one of the more important judging criteria.

VI. Just When You Thought It Was Over

A. What you wrote, and the reviewers read

- If, after submitting an E/PO or related proposal to NASA, you are not selected, make sure you know exactly what the reviewers read in your proposal: read their published comments carefully, and ask for a "debriefing" from the appropriate announcement officer, in which you should be able to get extended comments that amplify the reviewers' findings. That way, mistakes won't be repeated.

Awards for Research: An Opportunity for New Research Endeavors

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The Faculty Awards for Research (FAR) program from NASA's Code EU has proven an excellent venue for young investigators at Minority Institutions (MIs) to obtain the start-up funds to establish their research program. The FAR is a single investigator award for up to \$100,000 a year for a maximum of three years.

The Visualization of Atmospheric Water Vapor Data from SAGE (ViSAGE) project at Norfolk State University has been funded by a FAR award. These funds provided for the establishment of the Scientific Visualization Group at Norfolk State University and equipment for the Spartan Scientific Visualization Laboratory. Twelve students have been directly involved on atmospheric science research and scientific visualization. Seven publications with student co-authors have resulted from the research work. Although the FAR is a single investigator award, other faculty at Norfolk State University have developed an interest in Scientific Visualization and have participated in some aspects of the project. In addition, as a result of the FAR award the speaker has obtained a NASA Earth Science Enterprise grant for the Research Experience in Earth System Science programs at Norfolk State University and the prestigious NASA Administrator's Fellowship. Results of the research performed under these awards are briefly described below.

Scientific Visualization

The vast amounts of data obtained from remote sensing probes demands the development of user friendly data conditioning, analysis and visualization tools. To fully accomplish the goals of a mission, data conditioning, analysis and visualization tools that exploits the capabilities of the instrument are essential.

A scientific visualization software package (EzSAGE) has been created to easily extract, sort, condition and visualize data from the Stratospheric Aerosol and Gas Experiment II (SAGE II) instrument. SAGE II measures ozone, water vapor, nitric oxide, and aerosol as a function of latitude, longitude, and altitude. With EzSAGE the user can sort, condition and display the data in any choice of three-dimensional perspective by few clicks of the mouse. Figure 1. shows ozone concentrations vs. latitude-longitude, altitude-latitude, and altitude-longitude perspectives obtained from EzSAGE. These visualizations show relationships between atmospheric chemical species, effect of spatial dynamics, seasonal and annual trends, and provide an understanding of the atmospheric dynamics.

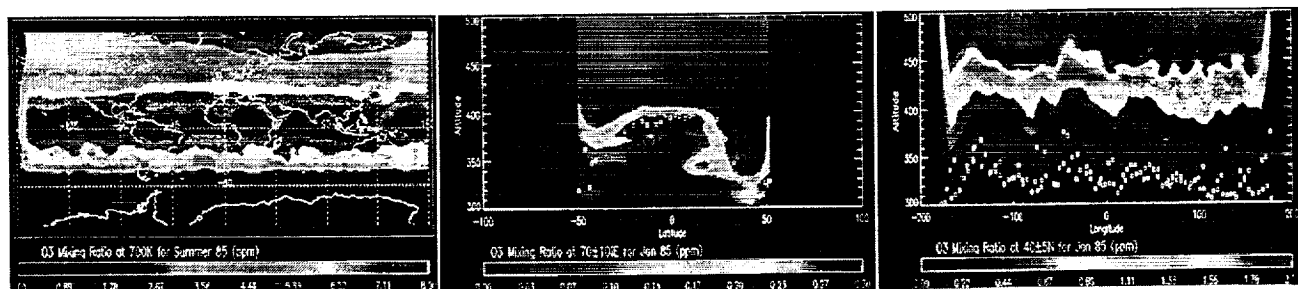


Figure 1. Ozone mixing ratio measured by the SAGE from various perspectives.

Atmospheric Science

Stratosphere-Troposphere Exchange (STE) is of significant importance to the chemistry and dynamics of the atmosphere. Monthly dependence of intrusions from tropospheric air into the stratosphere and stratospheric air into the troposphere (STE air masses) have been studied utilizing five years (1985-1990) of Stratospheric Aerosols and Gas Experiment II (SAGE II) water vapor and ozone measurements. Stratospheric air masses in the troposphere were identified by high ozone and low water vapor readings relative to isentropic tropospheric averages. Tropospheric air masses in the stratosphere were identified by high water vapor and low ozone measurements relative to the stratospheric averages. Frequency ratios of STE air masses to total measured occultations were calculated to determine zonal STE activity. Monthly climatologies of STE frequency ratios utilizing the five years of data were studied.

The results show a strong seasonal cycle. Higher frequency of tropospheric moist intrusions in to the stratosphere is observed during the summer hemisphere with the Northern Hemisphere exhibiting more activity than the Southern Hemisphere. This is attributed to the summer monsoons and high frequency of sub-tropic tropopause wave breaking events in the summer hemispheres [Chen, 1995; Postel and Hitchman, 1999]. These results are in good agreement with the model investigation by Chen [1995], the aircraft measurements by Ovarlez *et al.* [1999], and the results of the lower stratosphere water vapor investigation using SAGE II data by Pan *et al.* [1997].

High frequency of stratospheric intrusions in the troposphere is observed in the winter and spring hemisphere. These results are attributed to the higher frequency of tropopause folding events associated with middle latitude synoptic scale baroclinic disturbances in the mid-latitude tropopause during spring [Holton *et al.*, 1995].

Conclusion

The FAR award has provided the initial funds to establish the speaker's research program at Norfolk State University. Efforts in scientific visualization and atmospheric science are currently on going. Many students and some faculty members have been involved in the effort related to this award producing various publications. Other awards have been obtained as result of the FAR. Outcomes from the VISAGE FAR will continue for long after the funds have been utilized.

Programs such as the FAR are of significant importance to MIs. Unfortunately start-up funds for research are generally not available at Minority Institutions. The FAR funds provide the opportunity for young MI faculty to establish their research program, establish a research record, and compete for other sources of funding; undertakings that are nearly impossible without start-up funds.

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Education Opportunities for Involvement

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NASA Goddard Space Flight Center

Ms. Theresa Schwerin
Institute for Global Environmental Strategies (IGES)

Dr. Marino Alvarez
Mr. Michael R. Busby
Mr. Goli Sotoohi
Ms. Tiffani Cannon
Mr. Montanez A. Wade
Tennessee State University

Ms. Ginger Butcher
NASA Goddard Space Flight Center

Dr. Leo Edwards
Fayetteville State University

Mr. Bob Myers
Wheeling Jesuit University

Dr. Gloria Melara-Vides
California State University – Northridge

Explorers of the Universe: Interactive Electronic Network

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Abstract

This paper details how the Interactive Electronic Network is being utilized by secondary and postsecondary students, and their teachers and professors, to facilitate learning and understanding. The Interactive Electronic Network is couched within the Explorers of the Universe web site in a restricted portion entitled Gateway.

Introduction

The Explorers of the Universe (<http://explorers.tsuniv.edu>) is a scientific/literacy project designed for students to actively participate and learn science and literacy skills in a collaborative format with classroom teachers, university educators, community members, and practicing scientists (see Alvarez, 1998a, Alvarez, 1995; Alvarez & Busby, 1999; Alvarez & Rodriguez, 1995).

A unique aspect of the project presents students with authentic problem-oriented tasks that encourage the incorporation of related subject disciplines as they engage in self-directed case-based research. During their research students are guided by the Action Research Strategy and use the Interactive Electronic Network to communicate and keep records in their electronic notebook, develop concept maps and interactive vee diagrams, and store information on their individual electronic portfolio.

Interactive Electronic Network

The Explorers of the Universe Project is headquartered at the Center of Excellence in Information Systems, Tennessee State University. Dr. Marino Alvarez designed the web site for this project and the restricted Gateway portion is unique to this program. Goli Sotoohi manages the web site and is responsible for posting information, analyzing incoming data (e.g., concept maps, interactive vee diagrams, and notebook entries).

This management portion of the web site is divided into three consoles: Student, Teacher, and Researcher. Teachers at affiliated schools and professors at TSU manage their own respective students. They assign passwords and usernames, control incoming and outgoing communications between students, and have access to student concept maps, vee diagrams, electronic notebook entries, and portfolios. Students, once given a password and username by their teacher, are able to construct concept maps, vee diagrams, enter notations and thoughts into their electronic notebook, and enter video clips, photographs, journal articles, drawings, simulations, and any other relevant information (print or graphic) into their own portfolio. Any portion of a portfolio can be shared with other students within a given school or with students at another affiliated schools if their teacher gives permission.

When students want to submit their concept maps or vee diagrams for review by their teacher and researchers they submit them directly electronically via the Internet. Students also have a biographic file to enter any pertinent information about themselves including a photograph. The researcher console enables university educators, researchers, and scientists to access student entries, and respond by giving feedback to student maps, vee diagrams, notebook entry questions, and E-mails. When students log onto the Gateway portion of the web site, they are alerted to feedback responses. They click on concept map or interactive vee diagram and download the incoming information. When reviewing their vee, they simply highlight each epistemic element arrayed and a bubble appears with comments by their teacher and/or researcher.

Notebook entries and timed writings are analyzed using qualitative analyses. Once coded by the researchers and/or teachers, the information is entered into NU*DIST 4, a software program, for analysis. Likewise, concept maps and vee diagrams are analyzed and scored using protocols developed by Alvarez (1998b). This aids both the teacher and researcher to determine the degree of conceptual understanding being achieved by students as they pursue their respective case investigations.

Action Research Strategy

The Action Research Strategy (ARS) is displayed on the Library section of the Interactive Electronic Network. Students follow sequential stages of the Action Research Strategy: (1) problem/situation, (2) plan/strategy, (3) course of action, (4) resolution, and (5) action. Each stage corresponds to the epistemic elements arrayed on the vee diagram. The stages are designed for the learner to be the center of the learning process. The purpose of the ARS is to provide a conceptual framework for the student to think about, plan, implement, and reach closure with the case investigation.

Teacher and Student Investigations and Presentations

During the past academic year, 1998-1999, high school students and their teachers presented their case research at national, international, and state conferences. University of School of Nashville students and their teacher presented at the Satellites in Education Conference, West Chester, Pennsylvania. Seventeen students and three teachers from the University School of Nashville, Hunters Lane High School of Nashville, and George Washington High School Campus, in New York City (a MU-SPIN affiliated school) presented papers at the International Reading Association in San Diego, California. Two high school students and their teacher joined Stephanie Stockman and Marino Alvarez in making a research presentation at the American Educational Research Association Annual Meeting held in Montreal, Canada (Alvarez, Stockman, Rodriguez, Davidson, & Schwartz, 1999).

TSU Summer Institute

This past summer a high school and undergraduate summer institute was held at TSU's Center of Excellence in Information Systems. High school students participated in self-directed research projects using the Interactive Electronic Network. Likewise, undergraduate students, under the direction of Ms. Montanez Wade, became engaged in projects affiliated with the educational and research objectives of NASA's Center for Automated Space Science (CASS) and NSF's Center for Research Excellence in Science and Technology (CREST). The high school and undergraduate students continue with their case research during this academic school year.

The CASS and CREST programs are funded by NASA and NSF to encourage underrepresented minorities to pursue advance degrees in science and engineering. One of the goals is to expose the targeted population for research careers in science and engineering. The CASS and CREST programs provide students with activities during the school year and in a summer institute.

During the eight-week session, undergraduate students became involved in several research projects. Students selected a variety of topics that included: designing a computer accessible remote weather station for installation at TSU's robotic observatory, composing web designs, developing interactive data bases, crafting system identification of modal parameters of a flexible beam system, designing a controller for a slewing beam system, and constructing robotic designs. Students attended seminars

on various topics. These seminars included such topics as selecting a graduate school, developing critical thinking skills, C++ programming, enhancing oral and written communication skills and effective problem solving. The students used the Interactive Electronic Network to construct, communicate, and receive feedback on their vee diagrams and concept maps. These tools aided them in organizing and resolving their research topics. The Electronic Notebook was also used to record major milestones, and to develop a plan of attack to solve their particular problems.

Tiffani Cannon, a senior majoring in electrical and computer engineering, chose to design a C/C++ web site. Ms. Cannon used the metacognitive tools to plan and carry out her design of a web site for the C/C++ programming class. The program involved designing a tutorial for students enrolled in the C/C++ programming class to follow during their course of study.

Enhancing University Teaching and Learning Practices

The Explorers of the Universe Interactive Electronic Network is being used in the College of Education and the College of Arts and Sciences. Goli Sotoohi has assigned accounts for Dr. Alvarez's graduate students enrolled in "Strategies for Developing Reading/Study Skills in Secondary Schools," and for undergraduate students enrolled in Dr. Busby's "College Physics I" and Dr. Burks', "Introduction to Astronomy" classes. NU*DIST 4, a qualitative assessment, is being used to analyze notebook entries in these classes as well as high school student journal entries. The concept map and vee diagramming scoring protocols are used to analyze student constructions of these metacognitive tools.

The aim is to involve other faculty members to use innovative teaching strategies with their students beyond lecture. Simultaneously, using the Interactive Electronic Network as a tool so that students and professors may better negotiate the curriculum. We foresee this Interactive Electronic Network becoming a model for other colleges and universities, space installations, museums, and so forth, where interactive negotiations take place.

Conclusion

This interactivity between students (advanced, standard, and learning disabled), teachers, and researchers provide a forum for meaningful exchanges of ideas and a venue for these students to "show" what they can do in both visual displays and written form. Students with similar case topics have the option to share their ideas displayed on their respective maps and vee diagrams with others at remote locations. Even though the case topic may be the same, how they resolve their case is divergent. They collaborate with others, make entries, and notations, construct knowledge, and share this knowledge in ways that learning is meant to occur. The process is monitored and evaluated by their teachers and also by the researchers. This type of management approach lends itself to learning more about the learning process, and provides insight into ways that meaningful learning occurs with diverse learning and cultural populations.

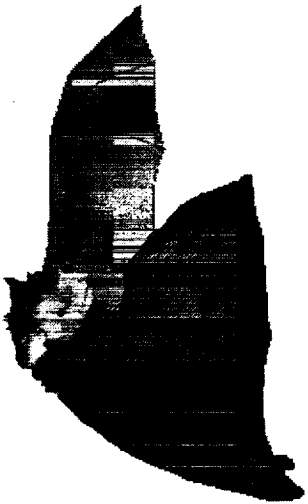
Acknowledgements

This paper is supported by the Center of Excellence in Information Systems at Tennessee State University, by NASA through the Tennessee Space Grant Consortium NGT 5-40054, and NASA Network Resources and Training Site (NRTS), NCC 5-96.

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Echo the Bat and the Pigeon Adventure

Ginger Butcher
GSFC Laboratory for Terrestrial Physics



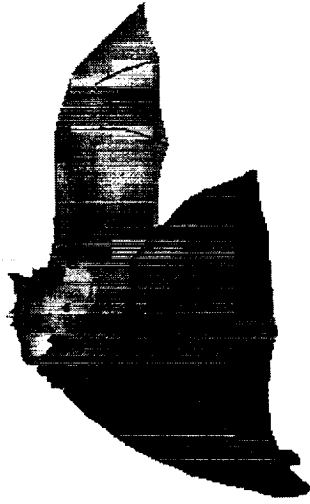
MU-SPIN Ninth Annual Users' Conference, Miami 1999



Agenda

- **IMAGERS concept**
- **The Adventure of Echo the Bat**
- **Successes of Echo the Bat**
- **The Sequel – Pigeon Adventure**
- **Opportunities**





In the Beginning

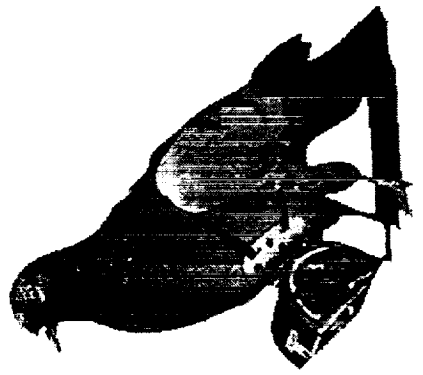
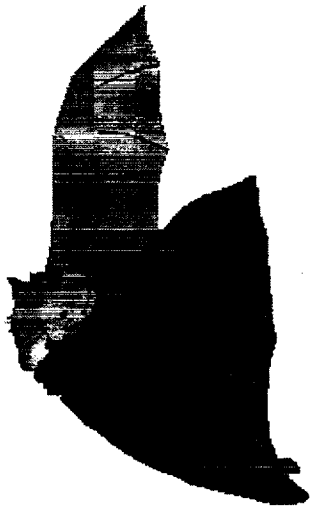
Multimedia, CD ROM to teach 2nd graders about Remote Sensing

Developed into Web Site

- **Staff was not available for CD ROM**
- **Enhanced distribution**
- **Expanded for Grades K-4 or 5-8**
- **2nd Grade was too narrow**
- **Consistent with Standards**



The Idea





The Adventure

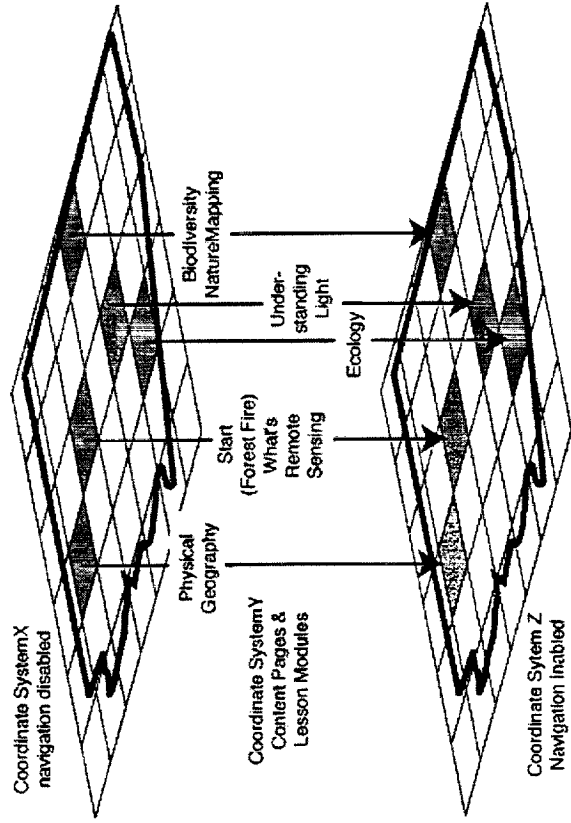


- Prototype of
Nine squares
- Content
based on
imagery
- 5 lessons at
key locations





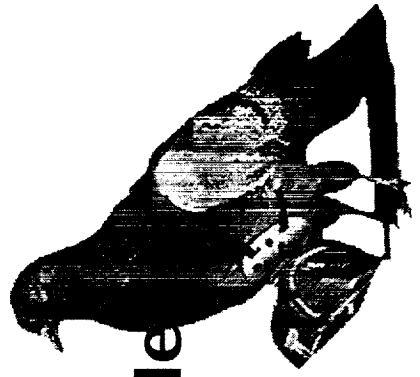
IMAGERS



- Adventure
- Methodology
- Template
- using Remote Sensing

I.M.A.G.E.R.S. was born

Interactive Multimedia Adventures in Grade School Education using Remote Sensing





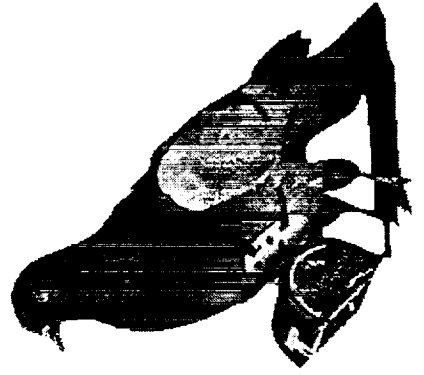
Echo the Bat

IMAGERS

Interactive Multimedia Adventures for Grade-school Education using Remote Sensing



Student's Site
Teacher's Guide



Student's Site

Netscape: IMAGERS - STUDENT'S SITE

Location: <http://imagers.gsfc.nasa.gov/student.html>

Back Forward Reload Home Search Images Guide Print Security

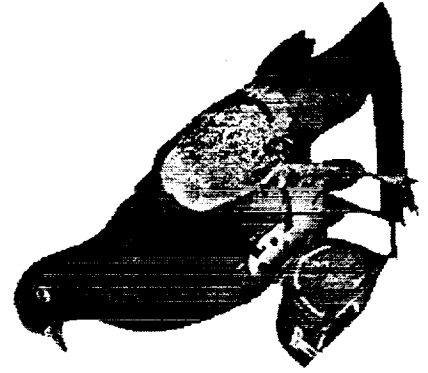
Student's Site

[SITE REQUIREMENTS | RETURN HOME](#)





Echo the Bat



Electromagnetic Spectrum Site

The Electromagnetic Spectrum

Visible Light Waves

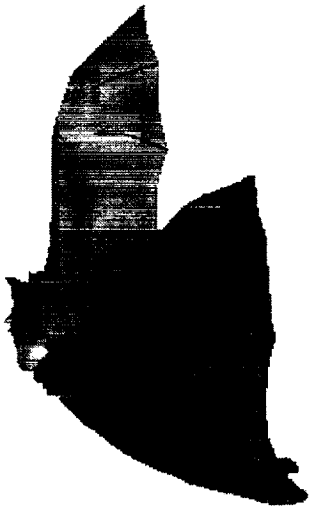
Visible Light Region of the Electromagnetic Spectrum

Waves are the only electromagnetic waves we can see. We see these waves as the rainbow. Each color has a different wavelength. All the colors together are called white light. When all the colors are mixed together, we see white light.

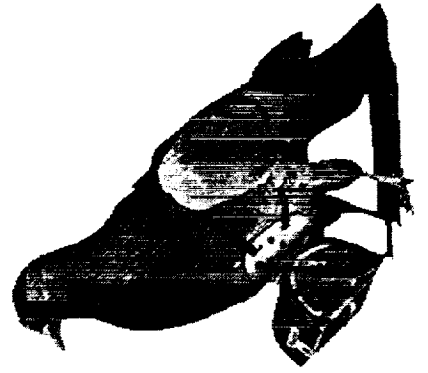
When white light shines through a prism or through water vapor in the air, the white light is broken apart into the colors of the visible light spectrum.

Wavestown Activity

Label the waves below that match the waves in the picture in the Electromagnetic Spectrum.



Echo the Bat



Activity on Primary Colors

Name: _____ Date: _____

Digital Pixels Activity

Color is how the pixels on the back of the wings work. The more pixels there are, the more the amount of red light, green light and blue light. These three colors of light make up the primary colors of light. You can mix these three colors to make other colors. Try to mix your computer monitor to an display thousands, even millions of colors.

0 = light off
 9 = light on
 5 = about 1/2 the amount of light

Red light

Green light

Blue light

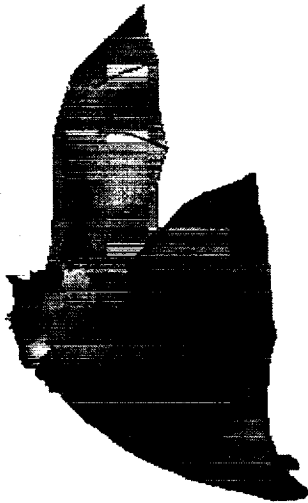
Example: red = green = blue = 9

0 red and light off
 9 red = green off or 9 blue = blue light on

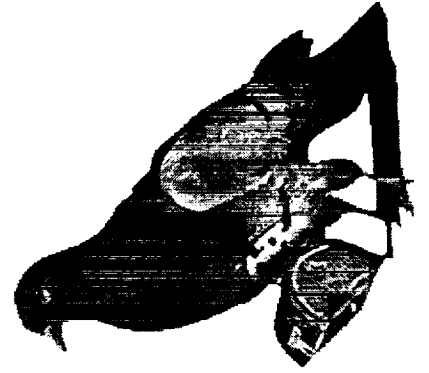
Content from the Adventure

Windows: Adventure of Echo the Bat (20)

One part of the sensor records only the amount of blue light reflected.



Echo the Bat

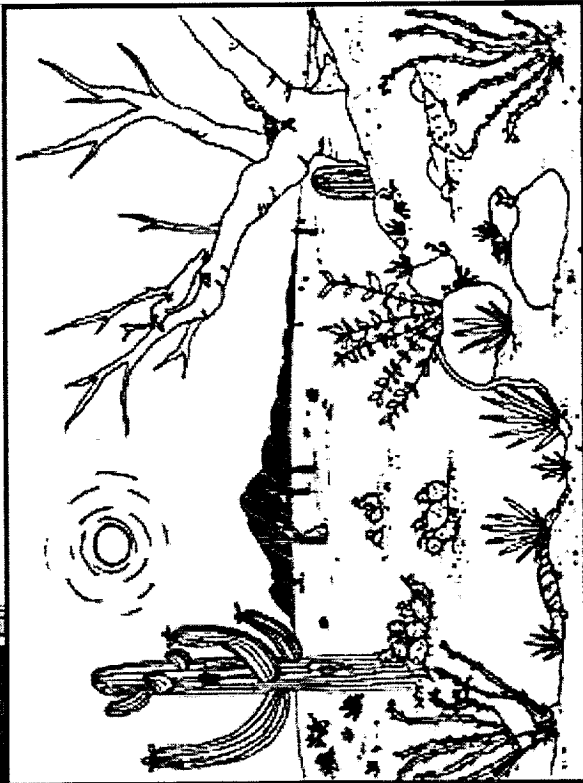


Hidden Animals Activity within Adventure

How many animals can you find in this desert picture?
 Folloy Echo

Name: Woodpecker
 Lives: Desert
 Habitat: in the South
 Insectivorous

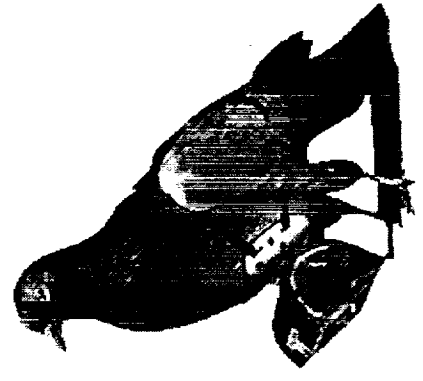
NatureMapping Classroom Activity

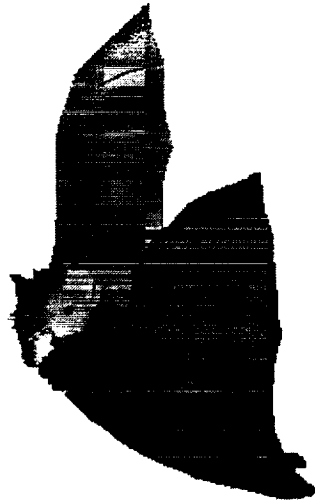


Echo & MU-SPIN



- Echo's Funding cut short
- Delivered project in Feb. 98
- MU-SPIN funding enabled us to pilot test, revise and prepare Echo for the NASA's Earth Science Enterprise Education Review

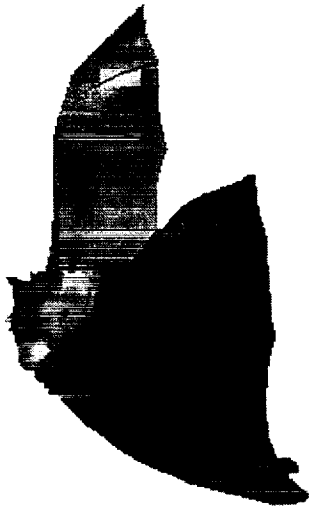




Successes

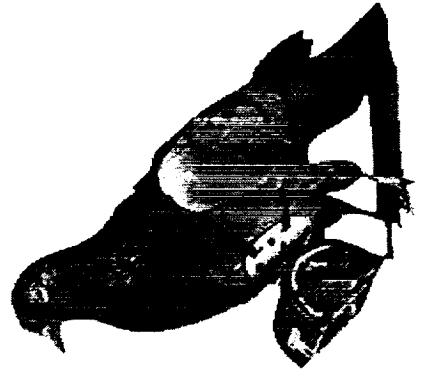
- **ESE Review – Broad Distribution**
- **Science Magazine**
- **Washington Times**
- **Net Mom – 4th edition of the “Internet Kids & Family Yellow Pages”**





Successes

- Echo the Bat Pop-up book was created in Spring 99
- Encouraging ESE review results



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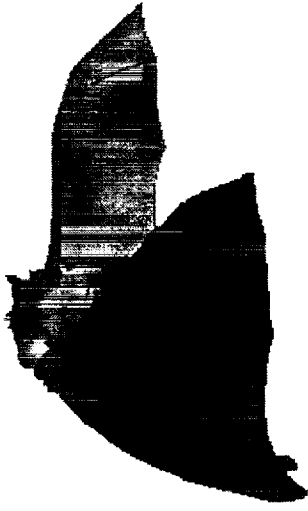
What we Learned

Focus on teacher resources

- Lessons easy to use
- Readily available materials
- Aligned with National Standards

Combine hands-on activities
with
interactive web site



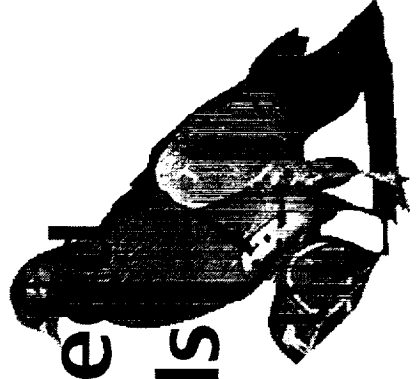


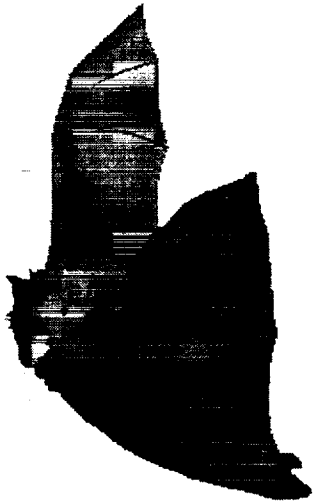
Pigeon Adventure

**Idea originated at 98 MU-SPIN
conference for an Urban Echo**

ECHO the BAT methodology

- **Adventure: Expand on the Echo
prototype through more
technology**
- **Teacher Materials: Meet the need
for K-4 Earth Science materials**





Adventure

- Based in NYC
- Maps, Aerial, and Landsat 7 images
- Story around a young girl and a pigeon



1969 Aerial Photo of NYC

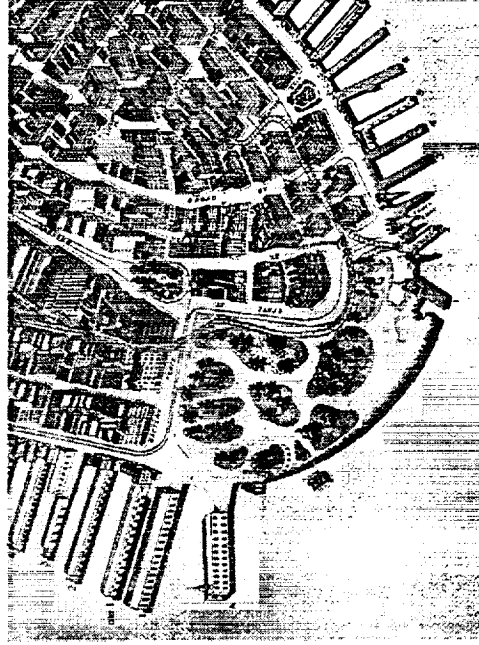


Source Material

Change over time



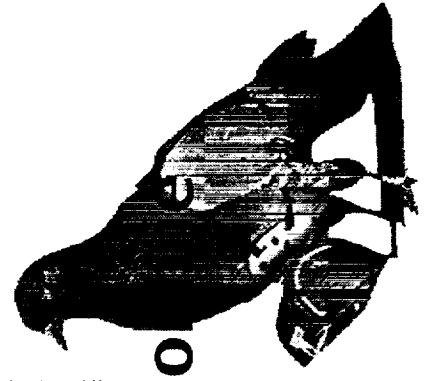
Battery Park, 1865

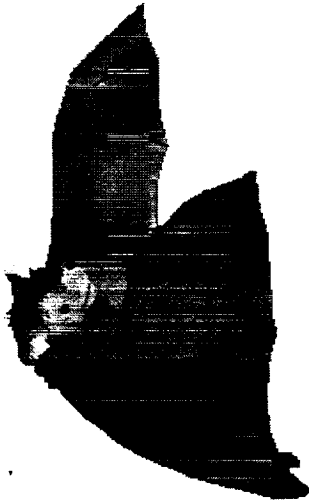


Battery Park, 1900

Historical “bird’s eye” views available
at the Library of Congress

MU-SPIN Ninth Annual Users’ Conference, Miami 1999





Context

- **Emphasize historical events**



Battery Park, 1865



Battery Park, 1969

**Comparing with aerial and satellite images
And identifying change in habitats**





Teacher Materials

Hands-on classroom activities on:

- **Identifying shapes, patterns and textures in R.S. imagery**
- **Identifying prominent features**
- **Describing change over time**
- **Identify changes in habitats**
- **Relating change to major historical events**





Opportunities

- **Teacher training workshops on Echo the Bat**
- **K-4 teachers to participate in the development of Pigeon classroom activities**
- **Pilot test Pigeon Adventure**





<http://imagers.gsfc.nasa.gov>

**For more information contact:
Ginger Butcher**

ginger@ltpmail.gsfc.nasa.gov



CREATING
CHANGE IN
HIGHER
EDUCATION



CONSTRUCTING,
CONNECTING
AND
COLLABORATING

*The University of Alabama
Fayetteville State University
University of Idaho*



NOVA

NASA Opportunities for Visionary Academics

Incipit Vita Nova (The new life begins)



NOVA – Who We Are

The University of Alabama

- Mike Freeman
 - Aerospace Engineering
- Kevin Whitaker
 - Aerospace Engineering
- Dennis Sunal
 - Science Education
- Jeanelle Hodges
NASA Headquarters
 - NOVA Fellow
 - Debbie Galloway
 - Education Division

Fayetteville State University

- Leo Edwards
 - Math/Science Education Center
- Ron Johnston
 - Natural Sciences

University of Idaho

- Mike Odell
 - Science Education
- Bob Kearney
 - Physics



Our Vision

**To prepare highly literate
pre-service teachers in
science, mathematics and
technology by creating
change in higher education**



NOVA Objectives

- Disseminate the NOVA higher education preservice change model nationally to a diverse population of institutions, addressing critical concerns for equity and geographic distribution.
- Sustain the change process by mentoring and partnering with workshop participants and NOVA grantees.
- Increase the interaction among members of the NOVA network by providing a forum for exchanging innovative ideas and leadership opportunities in higher education reform.

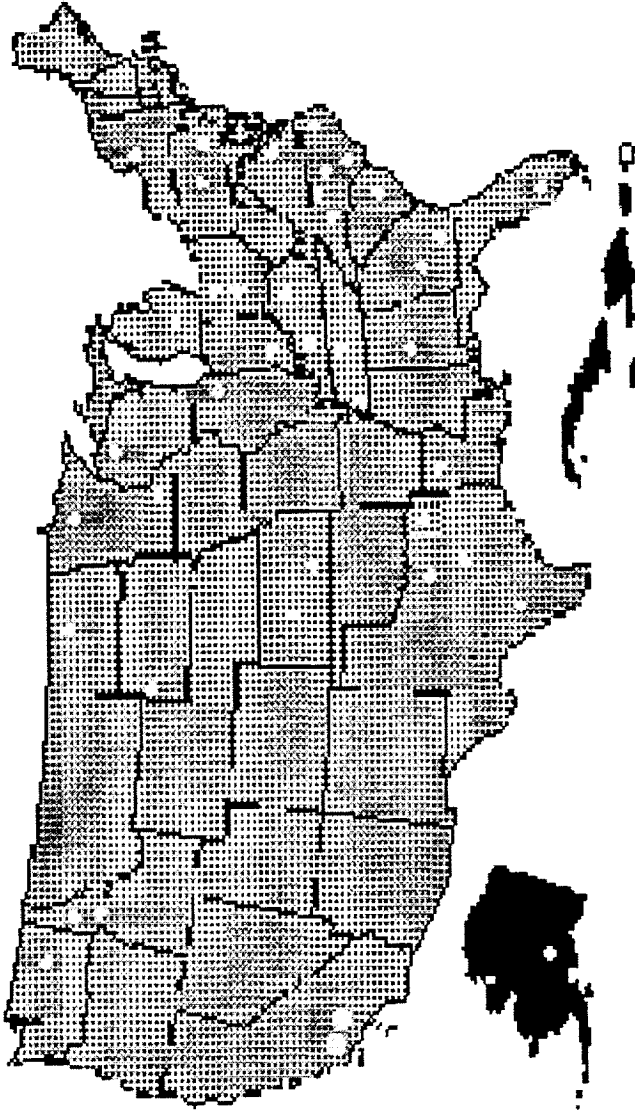


NOVA Objectives (continued)

- **Assess and evaluate all project activities to determine short- and long-term effectiveness and impact.**
- **Conduct and stimulate research on reform and change in higher education.**
- **Continue development of the NOVA higher education preservice change model whose foundation is based upon national standards and benchmarks for science, mathematics, and technology and NASA's strategic enterprises.**



NOVA Network Grant Recipients



Northwestern State Univ., LA
St. John Fisher College, NY
St. Mary's University, MN
Susquehanna University, PA
Texarkana College, TX
Texas A&M-Textarkana
Texas Women's University
Trinity Christian College, IL
University of Alabama
University of Dayton, OH
University of Idaho
University of the Incarnate
Word, TX
University of North Carolina-
Charlotte
University of South Florida
University of Virgin Islands
Univ. of Wisconsin-La Crosse
Univ. of Wisconsin-Superior
Valdosta State University, GA
Western Kentucky University
Whitworth College, WA

Alaska Pacific University
Austin Peay State University, TN
Baylor University, TX
Blackhills State University
Bowling Green State Univ., OH
Cedar Crest College, PA
Clemson University, SC
Columbus State University, GA
Crichton College, TN
CSU-Northridge, CA
CSU-Pomona, CA
Elizabeth City State University, NC
Elon College, NC
Emporia State University, KS
Fort Hayes State University, KS
Guilford College, NC
Hampton University, VA
Indiana University, IN
Lewis-Clark State College, ID
Michigan State University
Morehead State University, KY
North Carolina Central University



Example #1

University of Dayton

SCI 190: The Physical Universe

SCI 210: The Dynamic Earth

SCI 230: Organisms, Evolution, & Environment

Strategic Enterprises: Earth Science,

Space Science



Example #2

Cedar Crest College

MAT 103: Exploring Mathematics

*Strategic Enterprises: Earth Science,
Space Science,
& HEDS*



What is NOVA?

**NASA's preservice education program
which creates faculty change by:**

- National workshops
- National conferences
- Grants to other institutions
- Research on change in higher education
- Continuous mentoring



NOVA Workshops

Our primary dissemination vehicle is a university faculty development model with emphasis on:

- developing faculty expertise
- modeling and demonstrating
- practicing and applying
- developing an action plan

in the areas of pedagogy, curriculum, assessment and educational technology

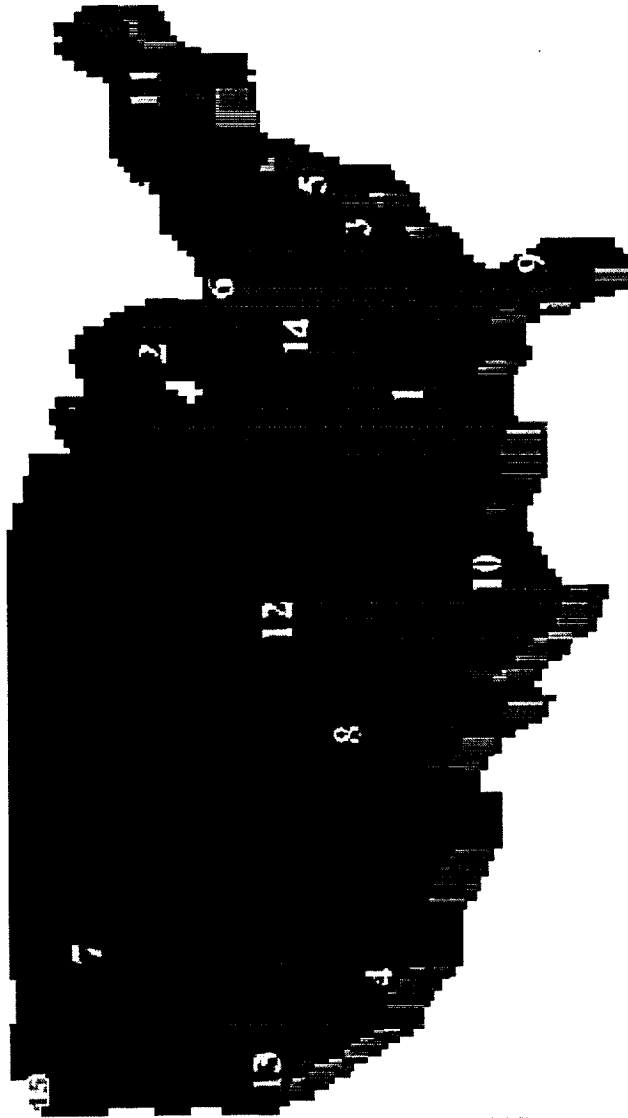


NOVA Workshops

- **Interdisciplinary teams ONLY**
 - **content faculty (science, math, engineering, etc.)**
 - **education faculty**
 - **administrator(s)**
- **NOVA consortium subsidizes travel expenses for participants**



Workshop Sites



- | | | |
|---------------------------|-------------------------------|----------------------------|
| 1) Univ. of Alabama | 7) Univ. of Idaho | 12) Kansas State Univ. |
| 2) Eastern Michigan Univ. | 8) New Mexico Highlands Univ. | 13) NASA / ARC , CA |
| 3) Fayetteville State, NC | 9) NASA / KSC, FL | 14) Western Kentucky Univ. |
| 4) NASA / JPL , CA | 10) NASA / JSC, TX | 15) Bellingham, WA |
| 5) NASA / LaRC, VA | 11) Univ. of New Hampshire | |
| 6) NASA / LeRC, OH | | |



NOVA Workshops

- 21 regional workshops scheduled
- 15 workshops held to date - 127 total institutions participating



Implementation Planning

Grants

- All workshop teams eligible to propose
 - proposals reviewed three times a year
 - quick review ~ 4 weeks after submission
- \$30,000 limit with a one-to-one cost sharing requirement
- One-year duration



Key Proposal Elements

- Present Course and Sequence
- New/Modified Course(s)
 - Innovative instruction & use of technology
 - Inclusion of standards
- Connection to NASA Strategic Enterprise(s)
- Collaborative Efforts
- Assessment & Evaluation
- Action Research



Details of Grant Recipients

NAME OF SCHOOL	AMOUNT AWARDED	MONTH/YEAR AWARDED
Alaska Pacific University	\$20,340	Jul 98
Austin Peay State University	\$23,504	Jun 97
Baylor University	\$29,356	Jun 97
Black Hills State University	\$27,885	Jul 98
Bowling Green State University	\$12,000	Jul 98
CSU - Pomona	\$30,000	Mar 97
CSU - Northridge	\$22,155	Jan 99
Cedar Crest College	\$27,120	Jan 97
Clemson University	\$22,000	Aug 96
Columbus State University	\$22,831	Aug 96
Crichton College	\$7,746	Jul 98
Elizabeth City State University	\$29,000	Jul 97
Elon College	\$15,000	Jun 97
Emporia State University	\$29,732	Nov 96



Details of Grant Recipients

NAME OF SCHOOL	AMOUNT AWARDED	MONTH/YEAR AWARDED
Fort Hays State University	\$30,000	Jul 97
Guilford College	\$30,000	Jan 97
Hampton University	\$29,995	Jul 97
Indiana University	\$23,668	Jan 98
Lewis-Clark State University	\$29,988	Apr 98
Michigan State University	\$30,000	Jul 97
Morehead State University	\$26,417	Jan 99
North Carolina Central University	\$22,952	Oct 97
Northwestern State University	\$15,178	Jan 98
St. John Fisher College	\$29,930	Apr 98
St. Mary's University	\$29,750	Jan 97
Susquehanna University	\$23,283	Jul 97
Texarkana College	\$23,000	Jan 99
Texas Women's University	\$29,824	Jun 97



Details of Grant Recipients

NAME OF SCHOOL	AMOUNT AWARDED	MONTH/YEAR AWARDED
Trinity College	\$22,000	Jan 99
University of Alabama	\$29,832	Sep 96
University of Dayton	\$29,615	Sep 96
University of the Incarnate Word	\$23,845	Jul 97
University of North Carolina-Charlotte	\$30,000	Jan 97/Oct
University of South Florida	\$30,000	Jul 98
University of the Virgin Islands	\$23,510	Jul 98
University of Wisconsin-La Crosse	\$27,851	Sep 98
University of Wisconsin-Superior	\$29,673	Sep 96
Valdosta State University	\$27,520	Jan 98
Western Kentucky University	\$25,669	Apr 98
Whitworth College	\$28,450	Jan 98



Electronic Dissemination

- **NOVA Web Site**
(www.eng.ua.edu/~nova)
 - consortium information
 - curriculum materials
 - electronic workshop application
 - additional relevant links
- **Grant Recipients' Web Sites**
 - local institution information
 - curriculum materials
 - points of contact



Assessment and Evaluation

- Pre- and post-evaluation of participants
- Post-workshop surveys and interviews
- Workshop evaluations
- Evaluation of NOVA Grant projects
- NOVA Network Institution site visits



Mentoring

ALL workshop participants are mentored after their workshop experience

- IP grant proposal preparation
- IP grant proposal revision(s)
- Implementation
- Institutional barriers
- Site visits



Follow-up Conference (Leadership Development Conference)

Grant recipients are brought back together to present their projects and research results

- Held each Fall
- Presentations along with focus groups to address key topics of concern
- 2 days



Phase II Grants

- Schools eligible after completion of initial NOVA grant
- Up to \$30,000 (with 1:1 match)
- Expansion of initial NOVA project to other faculty, other courses, other institutions (for example, feeder community colleges)



Closing Remarks

- Can NOVA help you create change on your campus?
- First step – put together an interdisciplinary team and come to a workshop



CREATING
CHANGE IN
HIGHER
EDUCATION



CONSTRUCTING,
CONNECTING
AND
COLLABORATING

The University of Alabama
Fayetteville State University
University of Idaho



The Earth System Science Education Alliance Program NASA Classroom of the Future

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Student Achievement and Teacher Preparation

There are favorable indicators concerning math and science education in our schools as reported in *The Learning Curve* (NSF, 1996). According to this report elementary schools in the United States are devoting more time to mathematics and science instruction. More college degrees are being awarded in the natural sciences and engineering, and many gains have been made by minorities in math and science achievement.

There are still many areas needing attention, however. In 1991, American 13-year olds were outperformed on an international science assessment by students in Hungary, Korea, Taiwan, and Switzerland (National Education Goals Panel, 1995). Teacher preparation still remains weak, with close to one-third of elementary teachers never having taken a three-credit hour course in biological, physical, or the earth systems sciences. In fact, less than 30 percent of elementary school teachers say they feel well qualified to teach life science (NSF, 1996). Research also suggests that students in science classes engage in tasks with low cognitive demand—emphasizing the memorization of facts and algorithms without understanding why the algorithms work (Tobin & Gallagher, 1987).

The role of the teacher is changing dramatically as we move toward the twenty-first century. A consensus of educators view teachers as key components in the development and implementation of any curricular reform. Teachers must be well-prepared for the critical role they will play, particularly if schools are to continuously improve and adopt strategies associated with inquiry and information-centered technology. The tradition of "teaching the way I was taught in graduate school" may be a notion of the past as educators poise for the continuous renewal and invigoration of their classroom methodologies in light of new, upcoming technologies.

Various organizations (the NRC, 1996; AAAS, 1993; BSCS, 1995; and the NSTA, 1992) have suggested that systemic change in classrooms may be achieved through the development of new standards. The new standards all emphasize student-centered classrooms, problem solving, critical thinking, the promotion of skills for life-long learning, collaborative learning, teachers as mentors, and the use of technology in the classroom. Reforming education will require substantive changes in how math and science are taught, which in turn will require equally substantive changes in professional development practices at all levels. On-line courses consisting of communities of learners are experiencing increasing use and credibility. This paper outlines the design, development and implementation of a middle school teachers' earth systems science graduate course. This 16-week course was developed at the Center for Educational Technologies, Wheeling Jesuit University, under the sponsorship of the National Aeronautics and Space Administration's Mission to Planet Earth. The themes of earth system science content and collaborative, inquiry-based science education prevailed within an electronic environment where teacher participants took responsibility for their learning within a structure of clear expectations.

Under a cooperative agreement with NASA's Earth Science Enterprise, the NASA Classroom of the Future (COTF) began developing online graduate courses for teachers at the K-4, middle school, and high school levels. The goals of the program were to (1) allow teachers to learn Earth System Science (2) provide external resources from NASA and other governmental agencies, (3) increase

teachers confidence in use of technology, (4) provide teachers with more classroom activities, and (5) model new teaching practices through design of the online courses. In the sections that follow, the design and delivery of the middle school course is discussed, followed by introduction of a NASA program to disseminate the online courses to colleges and universities engaged in teacher inservice.

Web Course Design

The course was delivered through the World Wide Web (WWW) and featured collaborative exercises and threaded discussion. This on-line asynchronous environment was chosen to accommodate teachers in remote locations and those whose schedules did not provide for on-campus attendance. Participants were chosen for the course based on access to the WWW and their stated interest in helping refine the course for future iterations. The course also addressed the US National Research Council's standard for using inquiry-based approaches in science teaching. This was accomplished by modeling a collaborative, student-centered environment in which teachers relied on each other to develop knowledge.

A primary concern during course design was to create an on-line learning environment where interdependence among participants provided the necessary glue for a successful community of learners. Davis's (1997) recipe for building a self-sustaining community included shared goals, challenges that cause relationships to form through exchanges of ideas, regular reflection for developing shared understanding, and an infrastructure or set of places that defined the way for the virtual community to form and interact. One means of following this recipe is to have participants focus on independent information collection, then enter "virtual space" to test ideas and ask questions of each other and the mentors. Rogers and Laws [2] addressed the challenge of building a community through extensive on-line discussions and providing opportunities for cooperative learning to support participation.

Cooperative learning is a successful teaching strategy in which small teams use a variety of learning activities to improve their understanding of a subject. Each team member is responsible not only for learning but also for helping others. This paradigm rejects the idea of competition in the classroom and promotes teamwork among learners by defining a variety of roles and by setting shared goals. It is important for each team member to take responsibility for the progress of the whole group — sharing ideas, materials and resources — and sharing equally in the rewards of a successfully completed assignment. A variant of cooperative learning is the jigsaw method in which participants are sent to new teams where each individual becomes an "expert" in a certain area. These experts then return to their original teams where information is shared with other team members in creating a product, in this case, an earth systems diagram.

Development Team and Participants

The development team included instructional designers, earth systems scientists, a graphic designer, and a web master. The inclusion of an expert in on-line collaborative environments and the web master proved to be crucial in the design and implementation. Two sections of participants (teachers) enrolled in the course (N=44). Each section had two mentors, a master teacher and an earth systems scientist. The mentors guided discussions by interjecting when necessary, responding to weekly discussions, and replying to students' journal entries.

Participants came from across the United States and had diverse backgrounds in earth systems science and on-line experience. All except two were practicing teachers; of the two, one is returning to the classroom; the other is a curriculum specialist.

Implementation

The on-line environment was seen as a place for collaboration and knowledge building, not as a repository for earth systems content. With this view in mind, participants were mailed necessary background reading materials, CD-ROMS, and other supporting materials. The on-line site was

limited to week by week instructions, information about grading, how to thrive in on-line communities, and the discussion area itself.

Design of the first three weeks allowed participants to become acclimated before plunging fully into collaborative activities. During this time most discussion occurred in "Course Space" (Figure 1). Starting slowly had several advantages. It allowed non-technical users to learn about cyberspace and for everyone to become accustomed to the site. During weeks two and three participants learned about the others assigned to their teams, and they were introduced to earth systems science.

During week two, the 1988 Yellowstone National Park fires were used as an event that impacted upon earth's interacting and interdependent spheres (i.e., atmosphere, biosphere, hydrosphere, and lithosphere.) Using a graphic depiction, participating teachers were presented with a tutorial on how to examine positive and negative feedback loops and dynamic equilibrium. During week three participants worked within their teams in designing a new earth systems diagram. The meteorite impact on the Yucatan Peninsula was used as the earth event for this diagram. Participants also reflected on their progress in content knowledge and posed questions in the "Journal Space." This was a weekly requirement and served as a space in which one-on-one discussions could be made with the course mentors.

Week four signaled the start of what would be four, three-week series, during which time deforestation, volcanoes, sea ice change, and hurricanes provided the events for group discussion and earth system diagram construction. This paper elaborates on the first, three-week series. To begin the deforestation discussion, each section of approximately 20 participants was broken into new "Sphere Space" teams. This meant, for example, that in a group of four, one person went to

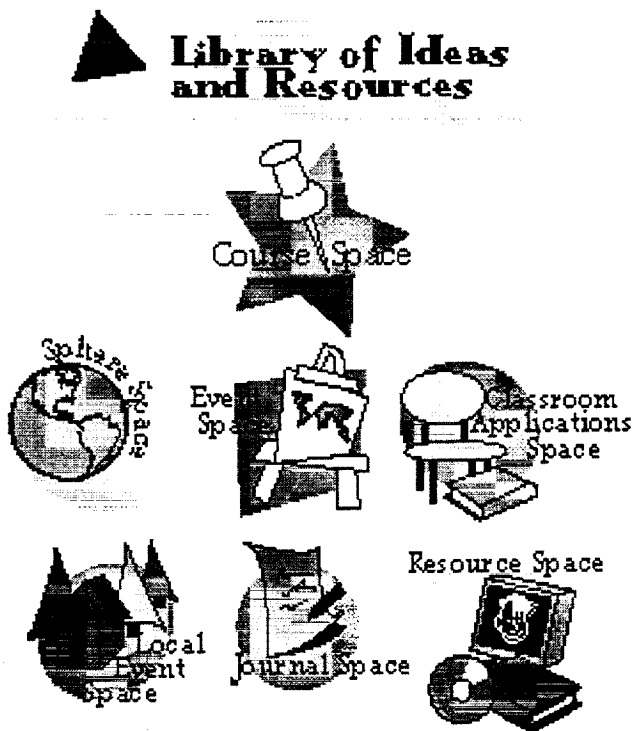


Fig. 1, Collaboration Space

the atmosphere sphere group discussion, one to the biosphere group discussion, and so on. The objective of the sphere group discussion was for each member to become as knowledgeable as possible about deforestation's impact on his or her sphere. At the end of the week, each participant had collected and discussed information concerning his or her sphere and then returned to the cooperative team to help with the construction of the earth systems diagram.

During week five the original cooperative teams reformed and work began on the earth systems diagram. This work was completed in "Event Space" (see Figure 1). Each member was counted on for knowledge developed during the previous week's sphere group discussion. Mentors watched the discussion, intervening only to ask thought-provoking questions or respond to requests. Week six provided teacher participants opportunities to think about and share classroom activities they would use with their middle school students. This information was recorded in "Classrooms Applications Space."

Requirements and Evaluation

Course developers provided participants rubrics as guides for course expectations and grading purposes. Participants were graded on their contributions to Sphere Space, Event Space, and Classroom Activities. Points were also awarded for journal entries and for the final project. For the final, participants could develop an earth systems diagram based on theories about geoengineering, or they could submit an article to Science Activities magazine.

Recommendations

Who succeeded in this course? Based on the low drop out rate (5 of 44), and the end-of-course surveys from participants, most succeeded. One participant noted in an email that she hoped the course would never end. Some individuals dominated discussion and some shied away, remaining aloof and laconic, much like face-to-face discussions would be. Rivers and Laws [6] suggest that students who succeed in asynchronous, distance learning courses tend to be more self-disciplined learners. McClure [7], in discussing development of the WELL, said developers thought the best participants would be intelligent people with diverse backgrounds and who were sufficiently outgoing and extroverted. The jigsaw design with well-defined spaces for public, private, large and small group activities was designed to mitigate against an "extroverts only" environment.

The course was extremely rigorous and time-consuming for teacher and mentors alike. It was designed to be this way, yet many teachers had not anticipated the heavy workload. Five quit. Two or three were talked into continuing through intervention by mentors or course developers. This is similar to the negotiations likely to ensue in on-campus, face-to-face courses.

Having a master teacher and an earth system scientist was a luxury that not many universities could afford. If this becomes too problematic, course developers could elect to spread the scientist's workload over multiple sections. A frequently asked questions (FAQ) area could also be developed to tap their content expertise.

Even with two mentors per approximately 20 students, the mentors' workload was huge. Developers would do well to keep the number of students in these classes at no more than 24. Based on what was observed in this course, raising the number of students is likely to detract from students' learning.

Developers envisioned all course coordination, communications, and discussions happening in asynchronous, virtual space. This proved to be overly optimistic; many phone calls and emails were used to provide scaffolding and support. One team of teachers formed their own synchronous, online chat sessions in order to facilitate timely construction of their earth system diagram. It is likely that in order to overcome the gap created in distance education, multiple means are not only likely, but necessary.

The groupware used for this course did not allow the participants to display graphics, pictures, or images, unless the web master assisted. The cooperative team mentioned above put their systems diagram on their own web site.

The web master's role was essential. The groupware used for the course needed a great deal of tweaking early in the course and he was called upon time after time to address users' technical problems. Many of these problems resulted from incompatibilities between browsers, versions of the browsers, and differences in users' platforms (Macintosh or Windows).

Giving teachers weekly tasks and deadlines paid off, especially in this asynchronous environment. The best weekly time frame was Monday morning through Sunday night; teachers liked to have the whole weekend to complete assignments.

Summary

An overriding objective in the development of this on-line course was to create "reasons" for individuals to engage in the material. The population consisted of very busy classroom teachers. Course developers purposely designed the structure to be student-centered so that participants relied on each other for input. As discussed above, this was accomplished through the jigsaw strategies that made participants depend on each other for essential information in creating the earth systems diagrams. There is always room for improvement and fine tuning, but developers have been pleased with the implementation of this course. After minor tuning, it will soon be offered again and will provide a model for development of other on-line courses.

The ESSEA Program

The COTF has developed and implemented online courses at the K-4, middle school, and high school levels. In an effort to disseminate these courses to have an impact on earth system science learning in the K-12 arena, the Earth System Science Education Alliance has been sponsored by the Earth Science Enterprise.

Universities, colleges, science institutions, and environmental education organizations involved in teacher pre-service, as well as in-service professional development, have been offered the opportunity to participate in this program (see <http://www.cet.edu/essea>). For example, we envision that groups such as the NASA Space Grant Consortium, the ESSE Program, the US Global Change State Education Teams, the NASA Minority University Space Information Network (MU-SPIN) Program, and other institutions involved in higher education, professional development, Earth System Science, and distance learning could all be potential providers of the K-12 Earth System Science on line courses for teachers.

It is the intent of the CET-IGES team to involve 22 training teams over a five-year period. Therefore, the program will commence during calendar year 1999 and continue through 2004. Participating institutions will be required to commit to a three-year period. During the first year they will receive support while learning the system. During the second year they will integrate the courses onto their host computers and then become independent, autonomous users in the third year. Because the entire program is five years in duration, new participating institutions can start in years two and three and still have time to finish within the five-year period. The extended time frame provides the CET and IGES an opportunity to improve the courses and program implementation through formative evaluation, to capture the very best of the program and display it on a central web site, and to increase program dissemination and participation to a wider audience.

Implementation

The objectives of this proposed program are to:

- promote on line professional development courses that will produce knowledgeable and well-equipped K-12 Earth System Science teachers;
- demonstrate the effectiveness of the World Wide Web in the promotion of a national professional development program for K-12 Earth System Science educators; and
- directly respond to the need to prepare more teachers to meet the demand of a growing US student population

This innovative program, with the NASA on line Earth System Science courses as its centerpiece, will not only include training teachers, but will also develop an active and long-term mechanism for delivering professional development on a national scale.

The general plan for developing this long-term mechanism for national delivery of the on line Earth System Science courses is to enlist the participation of universities, training organizations, and other institutions affiliated with professional development. These organizations would respond to an IGES-released solicitation requesting participation in this alliance.

The organizations would propose to:

- take part in this long-term educational project;
- recruit teachers to take the on line courses;
- provide the on line course(s) to teachers;
- agree to participate in training in order to provide the on line courses;
- commit to providing the technical capability to implement the courses; and
- provide feedback and evaluation information to the ESSEA team.

In the event that MU-SPIN organizations do not propose under the ESSEA program, organizations can still apply to participate by getting copies of the source code from the NASA COTF. Contact Dr. James Botti (jbotti@cet.edu) or Dr. Bob Myers (bmyers@cet.edu) for details.

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