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Goddard Space Flight Center

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Goddard leadership shares vision of Center's future

"The American people are calling for dramatic changes in the way their Government works. They want a smaller, less expensive Government that delivers more for less—one that does the right things, with the right people, at the right cost. NASA is in the vanguard of Government reinvention. We are revolutionizing the Agency, and the NASA that emerges will be better than ever. Responding to the needs of the American people and other Government agencies, we are returning NASA to a research and development Agency with a renewed focus on the development and application of new cutting-edge technologies, giving up-front consideration to the potential commercial use of our technologies," so writes NASA Administrator Daniel Goldin in the 1996 NASA Strategic Plan.

On April 8 in Goddard's Building 3 Auditorium, Center Director Joseph Rothenberg, Deputy Center Director Al Diaz and Dr. Dorothy Zukor, leader of Goddard's Strategic Planning Team, addressed the Agency's Strategic Plan and spoke to employees about the Center's future. A future they say will be filled with the challenge of change.

The Agency is changing and that change impacts Goddard. Rothenberg and senior Center management told employees that the Center is responding to the challenges of the changing environment in the NASA Strategic Plan.

NASA is learning to do more with a smaller budget and a shrinking workforce. In his March 19, 1996, Agency-wide budget report Mr. Goldin said, "There is a new attitude out at NASA/Goddard. I think Joe Rothenberg and Al Diaz are to be commended. They are committed to getting costs cut and this is important."

To carry out this responsibility, Goddard needs to develop itself as a national resource that in collaboration with academia and industry carries out its mission in the future in more innovative ways. GSFC needs to refocus the workforce to a more hands-on technical organization. Goddard must increase partnerships with industry by looking for technology commercialization opportunities and increase our inreach and outreach activities to ensure a wide community involvement and benefit from NASA/Goddard programs.

GSFC 2005

According to Diaz, all Center planning efforts will consider that the future does not hold the promise of necessary resources to provide the scientific community with the kind of product Goddard has provided in the past. This means changes in the way GSFC works to get things accomplished.

"We have an opportunity at Goddard to re-engage our dreams. The challenge is that we have is to do it in the context of a new budget reality. We have an opportunity to transform our flight program activity into a program that is consistent with the budget through investments in technology and through new ways of doing business," Diaz said.

The challenge for Goddard is to find new and innovative ways to do more science, technology, and research and development, as well as less routine operations while establishing initiatives that enable lower costs and technology advances.

Senior management has accepted the challenge and is by example exploring ways to reduce the cost of the Mission to Planet Earth missions by introducing new technology as early as the CHEM 1 mission and to follow that up with the incorporation of lessons learned from the first series of Earth Observing System (EOS) missions. Diaz says "Reducing the cost of the overall run-out allows us to achieve what the Administrator has committed to, which is the full capture of the 24 measurements that are defined for the EOS program."

Strategic Planning Activities

The Center's Strategic Plan is being developed by a team led by Dr. Zukor. According to Zukor, the plan will help GSFC get its bearing in these times of change. "Our hope is to have a plan that we can use. It may not even be a document. It may just come out on the internet and may just be a series of bullets. Hopefully it will be something that you can look at, refer to and use for guidance in making decisions for an extremely successful future."

The new approach to planning is proactive and flexible. The goal is to have the plan drive the Center resource allocations, and not the other way around. "We want to be proactive and come up with a plan that says this is what we want to do, and work to get the resources to carry out the plan. We must have alternatives in place so that we can do a portion of the plan, or have different ways of doing it so that we achieve our strategic goals." Zukor said.

The Strategic Plan also will provide the framework with its programmatic and technology goals, to re-engineer the Center processes and organization. The re-engineering process is expected to get underway in the next several months.

Goddard's Vision

Goddard's future vision includes a new way of doing business with increased collaborative efforts with academia and industry while working within the con-

Continued on page 8

Director's Update

by Joe Rothenberg

By now you are aware that it is again the season when the NASA budget is under scrutiny. As Administrator Dan Goldin and various Associate Administrators defend NASA's budget to Congress, they are continually asked not only to revalidate NASA's programs but also the very relevance of our agency. I believe Goddards' mission is both relevant to the nation and critical to increasing the knowledge of Earth systems and the universe.

Our NOAA and GOES spacecraft are important tools for forecasting and tracking global weather. These spacecraft provide a vital resource that enable the tracking of severe weather activity that saves lives and property. Our Mission to Planet Earth program will provide the data which will enable humans to preserve the Earth's environment for future generations, and, in the final analysis, help preserve the planet.

We all feel the excitement of new discoveries that are generated from our ongoing space science investigations into the mysteries of the universe.

At Goddard, we have leadership roles in answering several questions that are motivating the Agency's space science community. Through education and outreach we are communicating this excitement to the youth of our nation.

I believe that Goddard's leadership in answering these questions will continue to motivate youth to enter the technical and scientific career fields, enabling the U.S. to maintain our technological leadership.

If the relevance of NASA or the importance of your contribution to the Goddard mission ever comes into question just ask yourself will the nation and planet survive without NASA?

Communication Tips

LETTERS & MEMOS

No way they can be avoided. Written communications-up, down, and across -are woven into the fabric of American enterprise. These helpful hints can make your letters and memos more effective.

A conversational tone is best

Whether you're writing to subordinates, peers, or higher-ups, a conversational tone will draw people to your point of view. For example:

Formal: I would suggest that you remit the balance in full within 10 days of receipt of this notice. Conversational: Please send us a check for the balance of the payment by March 15.

Formal: Please be advised that we are processing your claims for monthly benefits. Conversational: We're processing your claims for monthly benefits.

By writing this way, you'll be seen as a person, not a bureaucrat who doesn't understand the lives of others.

Advertising techniques bring success to memos

Don't be afraid to use the techniques of advertising in your communications. Even the most routine memos can benefit:

• When referencing a Goddard organization, refer to it by name rather than by code. This will lend personality to the organization and remind us that our center is made up of people, not organization charts. Of course, when referring to a center mailing address, it is acceptable to use the organization code.

• Break up the size of type blocks. For instance, move in the margins of a particularly important paragraph two or more inches on both sides.

• Use boldfaced, action-oriented headlines and subheads.

• Underline key phrases.

• Use bulleted lists rather than lines of narrative.

• Be aggressive in your use of white space. For instance, a memo of one or two paragraphs typically occupies the top few lines of the page. If you center those lines in the middle of the page, and surround it dramatically by white space, you will draw your readers into the story.

Avoid ending letters with clichés

Do you end your letters with a formulaic tag line that is devoid of meaning?

• A typical ending: "Please feel free to contact me if you have any questions." Instead, end letters by spelling out the next steps you expect.

• Your closing lines could be: I will look for your response in the next few days, I will be glad to answer any questions, and I will call you to discuss further.

Be concise when writing

Wordy writing is weak writing. To write more powerfully, follow these rules:

1. Remove unnecessary modifiers. We absolutely guarantee all our products. Her contribution was very crucial to our success.

2. Don't identify places, books, or objects that are self-evident. *Not:* He is from the city of Houston. But: He is from Houston.

3. Avoid beginning your sentences with empty words such as "frankly", "essentially", and "basically".

4. Whenever possible, remove phrases such as "at the rate of" and "in the time of". *Not:* He types at the rate of 55 words per minute. But: He types 55 words per minute.

5. Avoid the expression "serve as a". Rephrase the sentence or try substituting is or are. *Not:* She serves as our proofreader. But: She is our proofreader.

6. Avoid the phrase "the reason is because". You can often trim it down by rewording the sentence. *Not:* The reason he finishes early is because he is organized. But: He finishes early because he is organized.

(*Style, Darn Ya, Style,* F&W Publications, and cited in Writer's Digest, 1507 Dana Ave., Cincinnati, OH 45207)

Compton Gamma Ray Observatory on orbit five years

by Donna Drelick

The Goddard-managed Compton Gamma Ray Observatory marked its fifth year on orbit April 5. Launched in 1991 from the Space Shuttle Atlantis, the Compton observatory is the second in a series of Great Observatories and is the heaviest spacecraft ever deployed by a shuttle.

The Compton Observatory, named for American Nobel Prize-winning physicist Arthur Holly Compton, is the first satellite dedicated to making gamma ray observations across a broad spectrum of energies. Scientists believe that gamma rays, which are an invisible, highly energetic form of radiation, are emitted during violent cosmic events such as supernovae, quasars, pulsars and black holes.

NASA scientists used CGRO to create a comprehensive map of celestial gamma ray sources. "The spacecraft and instruments have been remarkably reliable, and all four instruments are performing near their design specification" said Dr. Neil Gehrels, CGRO Project Manager at Goddard. "Thus far CGRO has made extraordinary discoveries, and the science team is looking forward to more discoveries as the observatory begins its sixth year in space."

Although tape recorders on the observatory failed early in the mission, that turned out to be an unexpected scientific bonus. Instead of storing data on the spacecraft and retrieving it every four hours, scientists can now receive a 24-hour-a-day stream of data in real time. This allows scientists to quickly begin monitoring outbursts of energy, such as on Jan. 31, 1993, when the satellite detected the highest energy gamma rays ever seen in a burst, an event dubbed the "Super Bowl Burst." In December 1995, CGRO detected the sudden appearance of a never-before-seen type of object which bursts and pulses at the same time. This bursting pulsar is currently the brightest source of gamma rays and X-rays in the sky.

Among CGRO's most significant discoveries:

- The discovery that gamma ray bursts are evenly distributed across the sky, which suggests that gamma rays are coming from farthest reaches of space and not just from our own Milky Way galaxy, as astronomers once believed.
- The discovery of gamma ray quasars, a new class of high-energy gamma ray sources, in Active Galactic Nuclei (AGN), the bright and active central cores of some galaxies.
- The discovery in December 1995 of a source of gamma rays and X-rays that exhibits the behavior of both a pulsar and a burster. During the first day it was observed, it produced more than 140 powerful bursts of gamma rays. It is currently the brightest source of gamma rays and X-rays in the sky.
- The discovery that gamma ray bursts and solar flares are accompanied not only by a release of low-energy gamma rays over a relatively short period of time (tenths of seconds to seconds) but also by a release of high energy gamma rays over a longer period of time.
- The discovery that a second class of gamma-ray emitting AGN, known as Seyfert galaxies, emit most of their gamma-rays at lower energies than previously thought. This is important evidence that such objects may be the source of diffuse gamma rays.
- A threefold increase, from two to six, in the number of pulsars known to emit gamma rays (pulsars are rotating neutron stars that spin very rapidly and produce beams of radio energy that appear to flash on and off), among more than 500 known radio pulsars. This gives astronomers a greater opportunity to understand why some pulsars emit gamma rays and others do not.
- The first detection of the presence and nuclear decay of cobalt 57, an isotope of cobalt thought to have been created during the explosion of a star known as Supernova 1987A. This detection helps confirm the nucleosynthesis theory of how elements heavier than hydrogen and helium are formed and distributed in our galaxy via the evolution of stars.
- The discovery that the energy (photons of light) created by the mutual destruction of electrons and positrons ("anti particles") in our galaxy is concentrated in a bulge around the center of the galaxy, with a second component extending out along the plane of our galaxy.
- The first mapping of the distribution of a radioactive isotope called Aluminum 26 within the Milky Way Galaxy. The instruments on CGRO detect the isotope by measuring gamma ray energy associated with its radioactive decay. Scientists believe that this energy distribution, which has proven to be "patchy" rather than smooth, holds clues to understanding nucleosynthesis in our galaxy.
- The detection of the gamma ray energy given off by interactions between cosmic rays and carbon 12 and oxygen 16 nuclei. The energy "signature" associated with the excitation of these molecules and subsequent emission of gamma rays help scientists identify the types of matter and nuclear processes occurring within the region of the Milky Way galaxy known as the Orion Arm.

The Compton observatory currently is in a circular, 240-mile-high orbit inclined 28.5 degrees to the equator. NASA is considering reboosting the 17-ton, low-Earth-orbiting satellite to a higher orbit that would allow the spacecraft to continue to track the gamma ray universe well into the next century.

The Compton Observatory has vastly increased our understanding of some of the most violent events in the universe," said NASA Program Manager Dr. Alan Bunner. "TRW should be congratulated for designing and building such a robust spacecraft which has given us five years of spectacular scientific achievement. We have every reason to believe we will continue to be amazed by its discoveries in the future."

The Compton Observatory is managed for NASA's Office of Space Science, Washington, D.C., by Goddard. CGRO was built by TRW Space & Electronics Group, Redondo Beach, Calif.

Information on the Compton Gamma Ray Observatory is available on the Internet at: http://enemy.gsfc.nasa.gov/cossc/cgro.html

Several NASA spacecraft observe Comet Hyakutake

During March, NASA conducted a variety of activities designed to study the Comet C/1996 B2 Hyakutake and will share this information with the general public.

Discovered on Jan. 30 by Japanese amateur comet hunter Yuji Hyakutake using powerful binoculars, the comet was as bright or brighter than the stars of the Big Dipper. The comet made its closest approach to Earth on March 25 at a distance of about 9.3 million miles. According to the Harvard-Smithsonian Center for Astrophysics, Cambridge, Mass, Comet Hyakutake made the nearest passage to Earth of any comet since 1983, and the fifth closest this century.

A comet is a small, icy body that orbits the Sun in an elongated orbit that can be disturbed by the on-going orbits of the planets. Resembling a "dirty snowball," a comet typically has a relatively tiny nucleus, often less than six miles across. When radiation from the sun warms a comet, ice particles from its nucleus tend to "steam" outwards, creating a large coma or surrounding atmosphere and a tail of material that streams away from the Sun. In some cases, the coma and tail can be thousands or even millions of miles across, offering dramatic viewing opportunities. Comet Hyakutake has the potential to provide just such a spectacle.

Goddard-managed spacecraft including the International Ultraviolet Explorer and the Hubble Space Telescope headed NASA's efforts to take images of Comet Hyakutake.

Since Hubble is not actively controlled from the ground and the comet's position was not precisely known, viewing the speeding visitor was especially tricky. Hubble was preprogrammed to point at a selected spot in the sky where the comet was to be at a specific time.

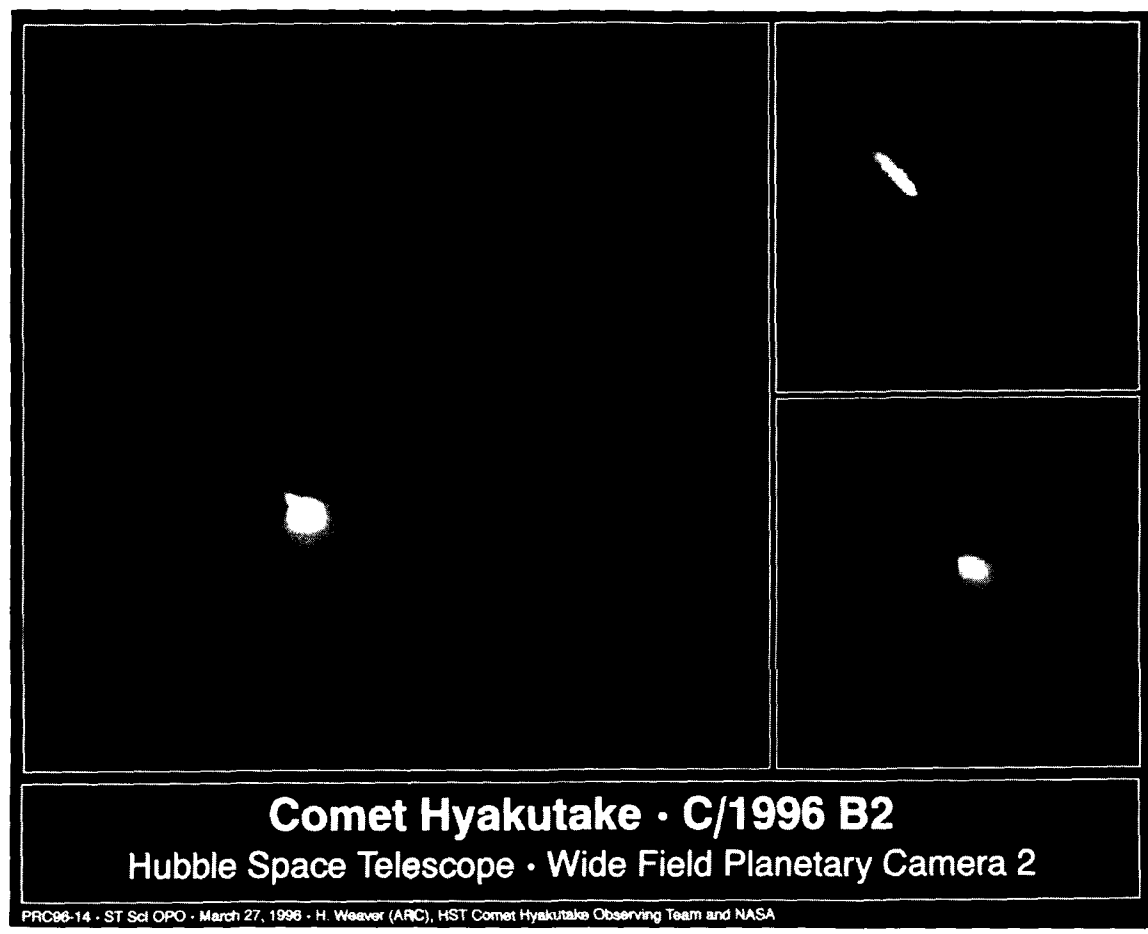
NASA's recently launched Near Earth Asteroid Rendezvous (NEAR) spacecraft took images of the comet as a calibration exercise. Although NEAR offers a different vantage point from Hubble, its camera was not designed to image objects at such large distances.

Several NASA-supported ground-based observatories began studying the comet during late March and will continue in April as the comet approaches perihelion (its closest distance from the Sun.)

NASA's Infrared Telescope Facility (IRTF) on Mauna Kea, Hawaii, also dedicated several days of observing time to study the release of dust and ice grains from the nucleus of the comet. These ices are composed primarily of water. Spectral observations of the molecules vaporized from the nucleus should provide samples of molecular abundances that were present at the time of the formation of the solar system. The Goddard-managed Extreme Ultraviolet Explorer spacecraft made observations of neon and helium for comparison with the water production rates measured by the IRTF.

Images from IRTF and many other sources are posted to a "virtual star party" on the Internet called the "Night of the Comet," sponsored by NASA's Ames Research Center, Mountain View, Calif., NASA's Stratospheric Observatory For Infrared Astronomy program, and its K-12 Internet Initiative. This home page allows anyone with access to a computer and a modem to post and observe Hyakutake images, track the progress of the comet, converse with NASA experts, learn about astronomy and participate in experiments.

"Night of the Comet" can be accessed via the Internet at URL:http://www.comet.arc.nasa.gov/comet/



NASA

These Hubble Space Telescope images of Comet Hyakutake were taken at 8:30 pm. EST on March 25 when the comet passed at a distance of only 9.3 million miles from Earth.

First X-rays from a comet discovered

by Jim Sahli

A team of U.S. and German astrophysicists have made the first ever detection of X-rays coming from a comet.

The discovery of a strong radiation signal — about 100 times brighter than even the most optimistic predictions — was made March 27, 1996, during observations of comet Hyakutake using Germany's orbiting ROSAT satellite.

"It was a thrilling moment when the X-rays from the comet appeared on our screen at the ROSAT ground station," said Dr. Konrad Dennerl of the Max Planck Institute for Extraterrestrial Physics (MPE), Garching, Germany. Following the initial detection, the team reported repeated X-ray emissions from the comet over the next 24 hours. The comet was near its closest approach to the Earth at a distance of less than 10 million miles when it was first detected by ROSAT.

The strength and rapid changes in intensity of the comet's X-ray emission both surprised and puzzled astronomers.

"We had no clear expectation that comets shine in X-rays," said Dr. Michael J. Mumma of Goddard. "Now we have our work cut out for us in explaining these data, but that's the kind of problem you love to have."

The comet was examined repeatedly during March 26-27 as it swept across the sky. In fact the German scientists used a computer to correct for the comet's motion to produce accurate images during each observation. Satellite attitude was not changed during these observations.

X-rays have never been found from a comet before, and scientists had optimistically predicted an intensity that turned out to be about 100 times weaker than the radiation actually detected by ROSAT. Strong changes in the brightness of the X-rays were another surprise. There were pronounced increases and decreases in the X-ray brightness from one ROSAT observation to another, typically over a time difference of a few hours.

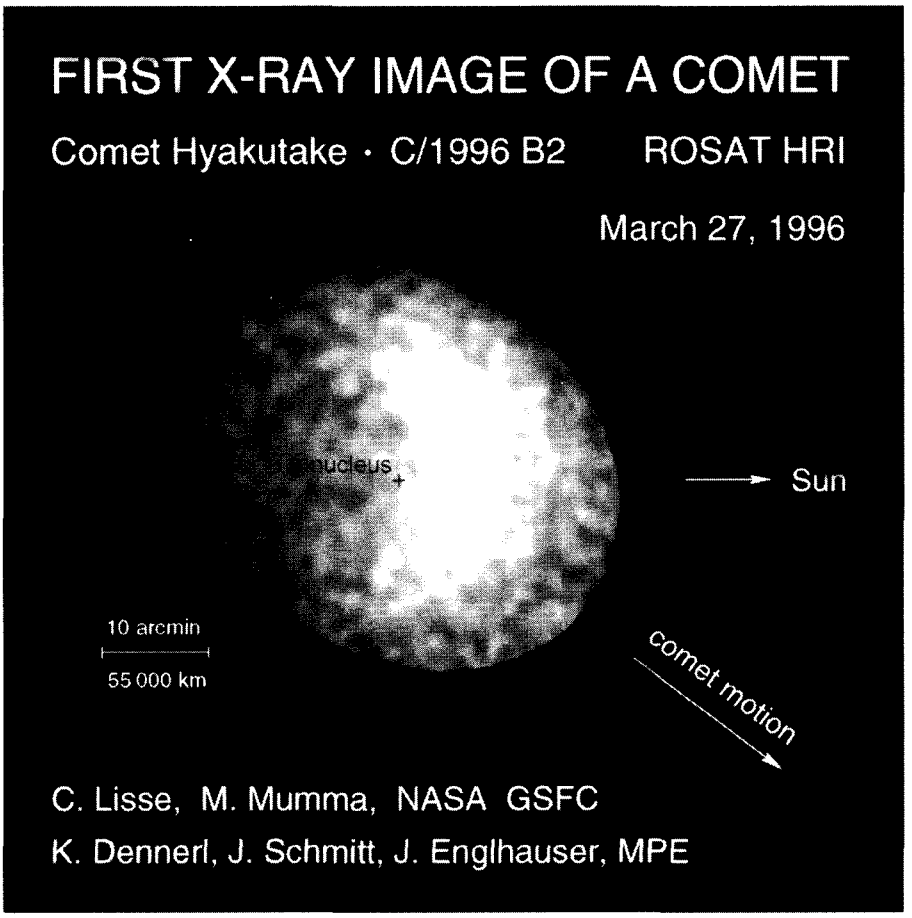
Still another puzzle is the nature of the physical process that generates the X-rays, but the ROSAT image may contain clues to this process. In the image, the X-rays from the comet seem to come from a crescent-shaped region on the sunward side of Comet Hyakutake.

Explaining the unexpected bright X-ray emission is the next major task for the science team. One preliminary theory is that X-ray emission from the Sun was absorbed by a cloud of gaseous water molecules surrounding the nucleus of the comet, and then were re-emitted by the molecules in a process physicists call fluorescence."

According to this idea, the cloud is so thick that its sunward side absorbs nearly all the incoming solar X-rays, so that none reach the remainder of the cloud. This could explain why the cometary X-ray emission has the form of a crescent, rather than that of a sphere around the nucleus.

A second possible explanation is that the X-rays are produced from the violent collision between the comet material and the supersonic "wind" of plasma and particles streaming away from the Sun.

We always learn something new when we study an object at different wavelengths," commented Dr. Carey M. Lisse of Goddard, the leader of the X-ray investigation. "Now we have to determine why the comet is so bright in X-rays, and see what we can learn about its structure and composition from these unique images."



An X-ray image of Comet Hyakutake, as observed by the High Resolution Imager on the ROSAT X-ray observatory. The X-rays arise primarily from a crescent-shaped region with a diameter of about 50,000 km, on the sunlit side of the comet. The directions toward the sun and of the comet motion are indicated by the arrows. No X-ray emission is detected from the nucleus, marked by the "+" sign. The ellipse represents the instrument field of view, not the extent of the X-ray emission.

Goddard development named invention of the year

by Donna Drelick

NASA has selected a technique for encoding and compressing digital data as the winner of the Government Invention of the Year Award for 1995. The "Method for Coding Low Entropy Data," a creation of Dr. Pen-Shu Yeh of Goddard, has been selected by the NASA Office of General Counsel for the honor.

As scientific instruments grow increasingly more precise and sophisticated, the amount of data generated by them also increases. The data compression technology reduces redundancy in the data representation while guaranteeing its full and accurate reconstruction. Using data compression technology on a spacecraft reduces the requirements for onboard memory and ground station contact time, which often translates into saving millions of dollars for a single space mission.

The new coding method also will benefit industry, particularly the medical community. Studies at Goddard indicate the new coding method offers superior performance for medical imaging data systems such as magnetic resonance, ultrasound and nuclear medicine. "The needs of space imaging systems and medical imaging systems are similar in many ways," said Yeh. "Doctors, like scientists, always demand full fidelity of their data.

This encoding method for improving digital data is just one part of the advanced data compression technology developed at Goddard. Several years ago, we realized the need to initiate this technology development because our science community has demanded more and more data from their instruments," Yeh continued. The Method for Coding Low Entropy Data extends performance beyond the bounds set by traditionals codes, making this technology more adaptive to various kinds of instruments and applications.

Implementing data compression on spacecraft requires a technique that adapts easily to changes in data while using little power and memory.

Yeh and her colleagues at Goddard found that the Rice algorithm, developed at the Jet Propulsion Laboratory, Pasadena, Calif., in the early 1970s, adapted to their needs for lossless data compression. Yeh showed that the Rice algorithm was actually a derivative of a widely accepted code, and extended it to increase the efficiency of her method. The extended Rice algorithm has since been designed in silicon circuits suitable for space flights. These circuits have been integrated in several space missions, including the Small Satellite Technology Initiative Lewis spacecraft, and for software onboard the Mars Observer and Goddard's Submillimeter Wave Astronomy Satellite.

Yeh's data compression technology is under consideration to become an international standard for space data systems.

"Dr. Yeh has extended a method for data compression which will benefit NASA and industry as well," said Warner Miller, Panel Chairman of the Consultative Committee for Space Data Systems. "The data compression method already has been endorsed by industry and universities."

Yeh was honored for her advancements in encoding digital data at a NASA Headquarters ceremony this month.

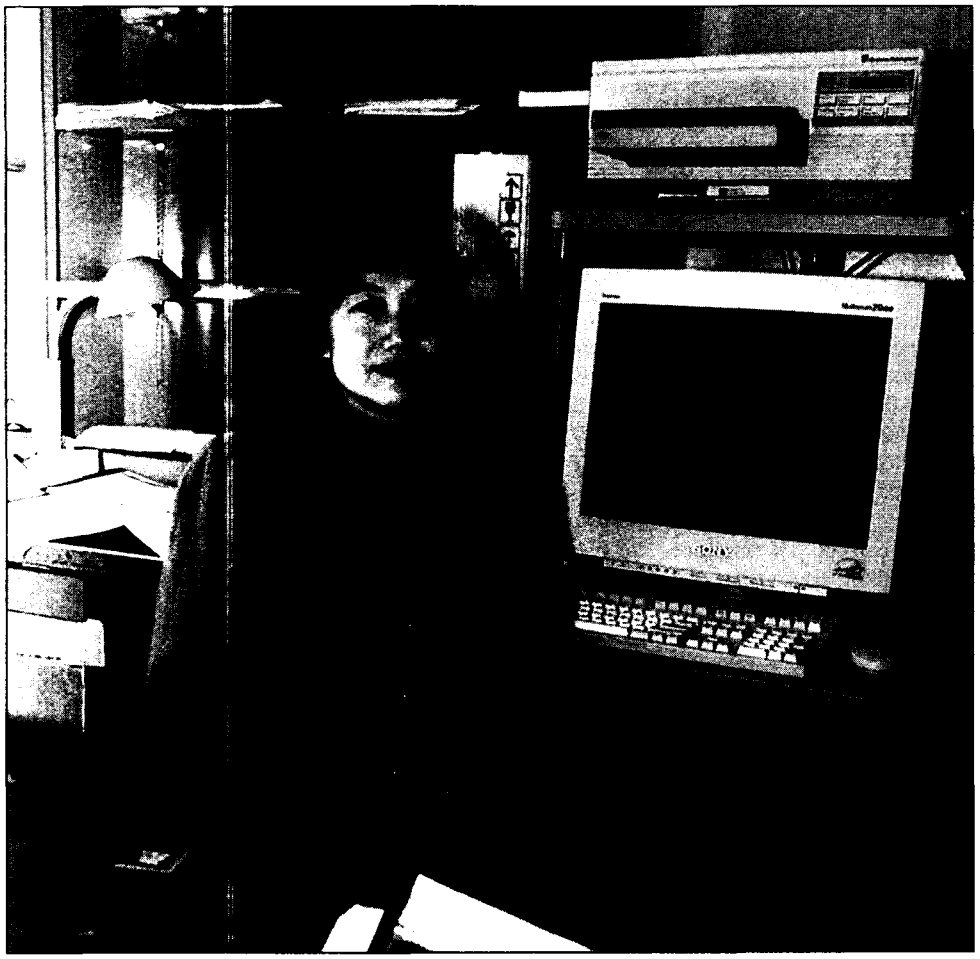
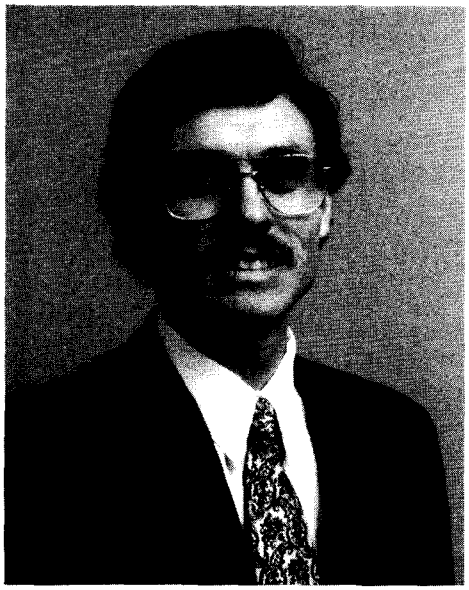


Photo by Marc DeBord

Pen-Shu Yeh, creator of the Method for Coding Low Entropy Data, is shown in her office.

Recent key appointments at Goddard

Photo by Marc DeBord



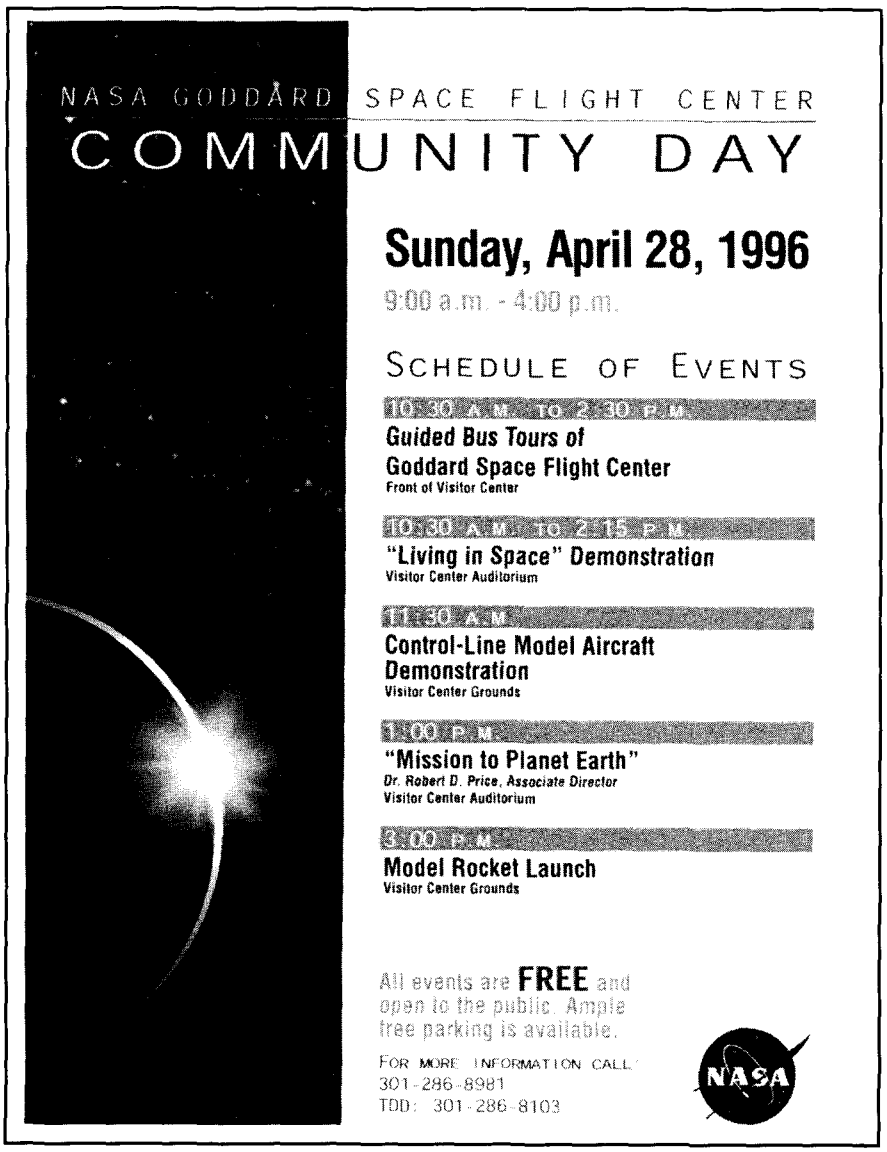
Philip Liebrecht

In March **Philip Liebrecht** became Chief of the Networks Division, replacing the retiring Daniel Spintman. Liebrecht formerly was the Associate Chief for Space Networks, a position he held since June 1993. He was responsible for the development, maintenance and operation of the Space Network and its components; the Tracking and Data Relay Satellites (TDRS), the White Sands Complex, the Network Control Center and the Compton Gamma Ray Observatory and the Remote Terminal System.

The Networks Division is responsible for planning, budgeting, management, development and operation of all ground support systems, ground stations and network facilities of NASA's space and ground networks including operation of the TDRS.

Jonathan Hartley was appointed Chief of the Data Systems Technology Division recently. He succeeds David Howell who took an assignment at NASA Headquarters. Hartley leads the Directorate efforts in applying and evaluating advanced technology in computer science and engineering to evolve the next generation of mission communications and data systems.

Hartley had been the Associate Chief of the Data System Technology Division since January 1993 and was responsible for planning and managing the development of advanced systems architectures and technology prototypes.



Goddard hosts Outreach Fair

Goddard hosts it's first Community Outreach Fair for Goddard employees May 21 from 10 a.m. to 1 p.m. in the Building 8 Auditorium. The purpose of the fair is to promote volunteerism and provide an opportunity for employees to talk to volunteer coordinators from public and private service organizations.

The Prince George's Voluntary Action Center, Montgomery County Volunteer and Community Service Center are participating along with Doctor's Community Hospital, Food & Friends, Jewish Council for the Aging, PG Memorial Library, Greenbelt Cares, Goddard's Visitor Center, Bowie SPCA and the Whitman-Walker Clinic of Suburban Maryland.

Many school systems require students to participate in community service. So you may find a volunteer organization where you and the 'student in your household' can take part in community service activities.

Goddard's Community Outreach Fair is sponsored by the Office of Public Affairs. For more information call Nina Desmond at 286-8141.

Goddard reaches out

Ten years ago, the word "outreach" never appeared in the NASA vocabulary. Today, the word is used so frequently as to diminish its meaning and potential impact of its message for the Agency.

Outreach, as envisioned by NASA Administrator Dan Goldin, and pursued by Goddard Space Flight Center Director Joe Rothenberg, means increasing the knowledge of NASA's impact on society. However, outreach is not accomplished by a special office. It is an important aspect of all we do.

"We are headed in the right directionhere at Goddard," said Kathy Nado, special assistant to Rothenberg for Outreach. "We are approaching it with three emphasis: education, technology transfer and public awareness. Our message, tailored to each individual audience, should extend the knowledge and understanding of Goddard's mission and goals. For successful implementation of a Goddard Outreach strategy, we must have wide ownership and clear implementation without stifling enthusiasm, initiative and creativity."

From an education standpoint, the Challenger Centers "did a wonderful job of getting us moving in the right direction through interactive curriculum developed in concert with educators and with the audience in mind," Nado said. "However, one of our roles at Goddard, with respect to education and outreach, is not necessarily to encourage students to enter into the science or technology fields, or even to become an astronaut. Through education, our goal is to develop effective implementations to make the results and the process of science available to both students and the public."

Nado said she is also encouraging more emphasis on technology transfer commercialization at Goddard. While the center generates a significant amount of technology available to transfer to private industry, getting the word is a challenge. "From a process standpoint, an invention disclosure is required before a patent application is processed, and an innovation disclosure is necessary for a process improvement." This step is a must before the next step, when an article appears in any publication, including the NASA Tech Briefs magazine.

The third aspect of outreach is communication with the public at-large. While the public affairs office is accomplishing much in this area, its numbers are limited and assistance from all organizations across the center is needed if the center is to generate the level of public awareness envisioned by NASA managers. A new committee, chaired by PAO and with membership from every Goddard directorate, is developing criteria and initiatives to enable greater public awareness.

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Cover Story

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straints of shrinking budgets. According to Rothenberg, "the Center will identify opportunities through a 'New Initiative Process' that establishes a cross-Center priority on initiatives and applies the resources to make them happen."

The New Millennium Mission illustrates Goddard's future in these changing times. Under Goddard project management, the focus of the first mission is the Advanced Land Imager which will enable first class science by validating breakthrough technology. The Advanced Land Imager will be developed from instrument technologies proposed by members of the existing New Millennium Integrated Product Develop-ment Teams which includes industry partners. The spacecraft support structure will be provided by Swales & Associates, Inc., and Litton Industries. The power and data subsystems will be provided through a Space Act cost-sharing agreement that calls for Litton to develop the hardware and integrate it into the New Millennium spacecraft, while providing the company with a two-year license to commercialize the technology. "This innovative arrangement, which includes a major commitment from Litton to integrate and deliver the hardware, represents an exciting new way of doing business for Goddard," said Rothenberg.

Other major new missions coming to Goddard are part of the Medium-class Explorer (MIDEX) program. NASA's Office of Space Science selected for definition studies leading to confirmation and development two Goddard proposals, The Microwave Anisotropy Probe (MAP) and the Imager for Magnetopause-to-Aurora Global Exploration (IMAGE). In addition to the two primary missions, two alternate missions also proposed by Goddard were chosen to receive minimal funding for study. The Explorer Project Office at Goddard will manage the MIDEX mission development for NASA's Office of Space Science. The MIDEX missions are a new component of the Explorer program, designed to complement the Small Explorer and the proposed University Explorer program. The Explorer program was restructured to permit more frequent, low-cost launch opportunities, with no more than three years from the design and development phase to launch. The MIDEX program is intended to provide research opportunities in the areas of astrophysics and space physics. Plans call for about one MIDEX mission to be launched per year, with development cost capped at no more than $70 million each.

New ways of doing business will create new opportunities and challenges for the GSFC workforce. "No matter how effective we think our programs are, we will continually be challenged to improve. The challenges will come from Congress, from the science community, from our customers," said Rothenberg. "In the future, we will have to continually be looking for ways to improve and to become even more effective and competitive."