Season's Greetings

As we approach the holiday season, I extend to you and your families best wishes for a Merry Christmas and a Happy New Year.

During the past year the Goddard team made many contributions to our Nation's space efforts. With such satellites as OGO, IMP, the Ionosphere and Beacon Explorers, Ariel II and sounding rockets, we gathered much new scientific data. Nimbus enabled us to "look" at the earth and its weather patterns at night and day in a manner considered spectacular by many; our TIROS weather satellites were advanced to an operational system. Relay and Syncom provided reliable communications links across oceans and continents; and a second Echo satellite was sent aloft. Goddard launch teams contributed to the successful launchings of Ranger 7, Mars Mariner and Centaur. Also in 1964 manned space flight tracking stations throughout the world were readied to support Project Gemini; while the STADAN net was further improved to serve the even more complex scientific missions of the future. These are just some of the highlights which marked our efforts during the year now ending.

In the year to come, I know that the Goddard team can be counted upon to successfully meet the challenges which lie ahead for us all.

With Season's Greetings,

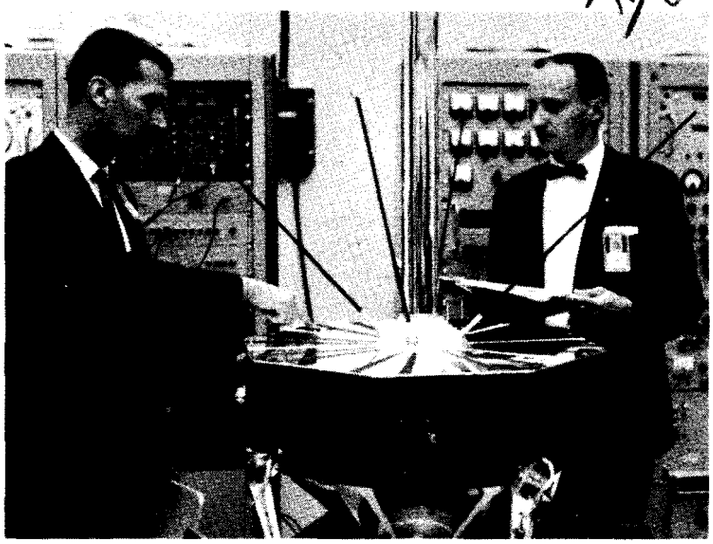
Harry J. Goett
Director

GODDARD NEWS

GODDARD SPACE FLIGHT CENTER / GREENBELT, MARYLAND

VOLUME VIII, NUMBER 4 THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION DECEMBER 14, 1964

Leo R. Davis (left), EPE-D Project Scientist, and Gerald W. Longanecker, Project Manager, inspect the satellite at Cape Kennedy, Fla., in Hangar AE, Goddard Launch Operations Branch.



EPE-D Slated For Launch This Week

Next up on the launch pad of the long line of Goddard's satellites is EPE-D (Energetic Particles Explorer). It is being readied at the Cape for launch later this week.

EPE-D's mission is radiation detection. It will carry on the work of its sister satellite, Explorer XV, which was launched on October 27, 1962. Explorer XV was designed to measure a new artificial radiation belt created by nuclear explosions in the South Pacific area just prior to that time. Explorer XV was a major contributor to our current knowledge of our environment.

EPE-D, formerly called S-3c, is very similar to its predecessor, Explorer XV. The 101-pound spacecraft has an octagonal main body made of honey-combed fiberglass, a platform which houses most of the experiments, electronics and other instruments needed for operation. It is 17 inches high and slightly more than 27 inches in diameter.

Four solar panels extend from the main body to furnish power. A 34-inch aluminum tube protrudes from the center of the spacecraft: on this is the fluxgate magnetometer experiment.

Five experiments are aboard EPE-D. They are:

(Cont'd on Page 2)

(From Page 1)

Electron-Proton Angular Distribution and Energy Spectra provided by Dr. Walter L. Brown of the Bell Telephone Laboratories. This is a series of solid-state detectors to measure the spatial and angular distribution and energy spaectra of electrons and protons.

Electron-Proton Directional-Omnidirectional Detectors provided by Dr. Carl E. McIlwain of the University of California, San Diego. These scintillator-type detectors were originally developed for use on the RELAY satellite; however they were flown on Explorer XV instead. Their purpose is to measure the intensity and angular distribution of protons and electrons.

Magnetic Field Measurements (Fluxgate Magnetometer) provided by Dr. Laurence Cahill of the University of New Hampshire. This instrument will measure the magnitude and direction of the earth's magnetic field from about 6,000 miles above the earth out to the satellite's apogee. Data from the electron and proton experiments will be correlated.

Ion-Electron Detector provided by Leo R. Davis and James M. Williamson of the Goddard Space Flight Center. This scintillator detector is designed to measure relatively low energy particles by type and energy as a function of direction, time and position. This experiment has also flown on Explorers XII, XIV and XV.

Solar Cell Damage provided by Luther W. Slifer, Jr., also of Goddard. This experiment will determine damage to a group of solar cells by radiation from the Van Allen and artificial radiation belts. It includes four groups of ten n-on-p silicon solar cells with different cover shield thicknesses and base-resistivenesses. The cells are mounted on the side of the spacecraft's main body.

Deep Into Radiation Belt

The three-stage Delta will carry EPE-D into an oval orbit deep in the Van Allen radiation belt. Its apogee will be about 15,800 miles, it perigee 200 miles, which will require a little more than seven hours per orbit on its angle of inclination, about 21 degrees to the equator.

The Van Allen belt might be described as a lopsided doughnut-shaped ring around the earth, roughly ranging from 600 miles above the earth over the geomagnetic equator and extending out to more than 40,000 miles. The belt is a complex mixture of energetic particles—best described as the fourth state of matter because it is neither a solid, liquid or gas.

First Clues to Belt

Explorer I gave space scientists their first clues to this belt when a Geiger counter aboard went dead over long stretches. These silent periods occurred with regularity as the satellite crossed the equator and the count seemed to decrease on upward climbs and increase on the way back to perigee. The experiment was repeated on Explorer III and the same results were obtained. It was then realized that the Geiger tube was not faulty, but was jammed into silence in certain areas by a tremendous flood of energetic particles.

At first it was thought there were two Van Allen belts, one some 2,000 miles above earth consisting of high-energy protons, and another 10,000 miles above earth of high-energy electrons. Later investigations proved there was one belt, of varying intensity, and of greater extent than had first been presumed.

Solar Wind Creates Shock Wave

The whole region, now called the magnetosphere, appears to be egg-shaped, more than 100,000 miles long on the axis away from the sun, and much less on its other axis. Charged particles stream from the sun, at times of solar flares with considerable strength and intensity. On the sunlit side of the earth, the magnetosphere is compressed by the solar wind; the outer boundary, about 40,000 miles from earth when the wind is normal, can be compressed to within 25,000 miles by a strong gust. The solar wind creates a shock wave when it hits the magnetosphere, then streams around it and tapers out as it leaves the earth, shaping the magnetosphere as a long tail on the dark side, leaving an area of turbulence.

The process by which particles are trapped is unknown. It is not known how the trapped particles maintain themselves and accelerate in energy.

When the STARFISH device was detonated over Johnston Island in the Pacific on July 9, 1962, creating the artificial radiation belt, it was thought that the test would temporarily increase the electron density of the natural radiation belts, it was not expected that the artificial radiation would prove to be as intense as it proved to be.

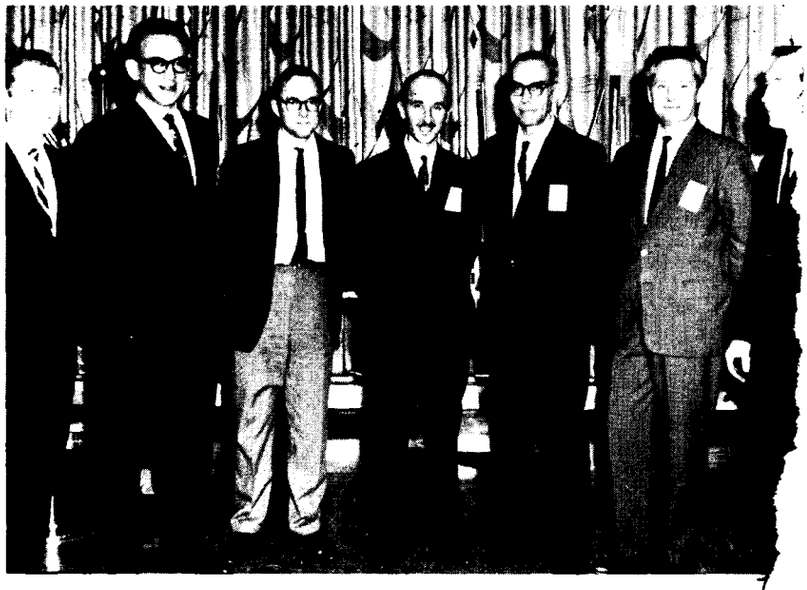
How Particles Stream From Space

Explorer XV was launched to measure the new belt. Except for the intermediate altitudes of 1000 to 2000 miles above earth, the STARFISH belt decayed rather rapidly. The particles in that area are expected to last 10 years more as a distinct belt and their residue may last at least 20 years among the naturally trapped particles.

It is hoped that the EPE-D satellite studying both the Van Allen belt and the remains of the STARFISH belt will provide answers to exactly how particles stream from interplanetary space, become trapped and eventually lost.

Gerald W. Longanecker is EPE-D Project Manager. Herbert Meyerson is Assistant Project Manager. John Braham is Project Coordinator and Leo R. Davis, Project Scientist.

***EPE–D PRESS BRIEFING** at Hangar "AE," Cape Kennedy, Fla., Dec. 7. Describing the flight model is Leo Davis (left), Project Scientist, and Gerald W. Longanecker (back to camera), Project Manager. In foreground is the EPE–D prototype.*



RUSSIANS VISIT GODDARD. Soviet members of the United Nations' committee on "Peaceful Uses of Outer Space" paid us a visit November 2. From left are Dr. Joseph C. Cain, Head, Goddard's World Magnetic Survey Section; Bill Krimer, Russian interpreter, U. S. State Department; Andri Konradi, Goddard physicist and Russian interpreter; Prof. O. G. Gazenko, USSR; Prof. Yu. D. Kalimin, USSR; Mr. I. V. Milovidov, USSR; and Dr. James P. Heppner, Head, Goddard's Fields & Plasmas Branch.

Syncom Used for First Communication to Aircraft via Satellite

Goddard's Syncom III has achieved a history-making "first" in successfully relaying a teletype message to a Pan Am plane on scheduled flight, announced NASA and Pan American Airways November 30. Syncom is in stationary orbit over the mid-Pacific.

Waldo W. Lynch, Vice President-Communications for Pan American, said, "Error-free data communications were received for one hour by Pan American Flight 875 operating between San Francisco and Honolulu on a routine flight."

The messages were sent from a ground station at Camp Roberts, Calif., via Syncom. NASA said that the relay of communications to an aircraft in flight from a station on the ground is another "first" for Syncom III.

"This capability of Syncom III, although not intended nor specifically designed for the relay of communication to and from aircraft, was utilized in this unique test," said Harry Stafford, NASA Syncom Program Manager.

Two-way communications between Syncom III ground terminals and Pan Am aircraft are scheduled for the near future.

The use of satellites for communications with aircraft was initiated in July by the Air Transport Association of America, an organization of scheduled airlines. A team of experts in satellites, communications and aircraft antenna design were brought together by ATA. The team included NASA; Pan Am; Hughes Aircraft—the satellite designer and producer; Bendix Radio—designers and producers of aircraft communications and electronic systems; and the Boeing Company—producer and designer of the aircraft.

Mr. Reed Whittemore (left), Poet-in-Residence, Library of Congress, and Dr. John A. O'Keefe, Assistant Chief, Theoretical Division, during the poet's day-long visit to Goddard recently. The telescopic photos of the moon are on the walls of Dr. O'Keefe's office.

Mr. Lewin Wheat (right) Maryland Schools Science Supervisor, looks over the Dr. Robert Goddard sculpture in the Building 8 lobby during a recent visit with Mr. Elva Bailey, Educational Programs Officer, PAO.

Swedish Station Joins Ground Satellite Net

Another communications satellite ground station, this one at Rao, Sweden, about 225 miles southwest of Stockholm, officially joined the growing world network of communications satellite ground stations Nov. 26, Thanksgiving Day.

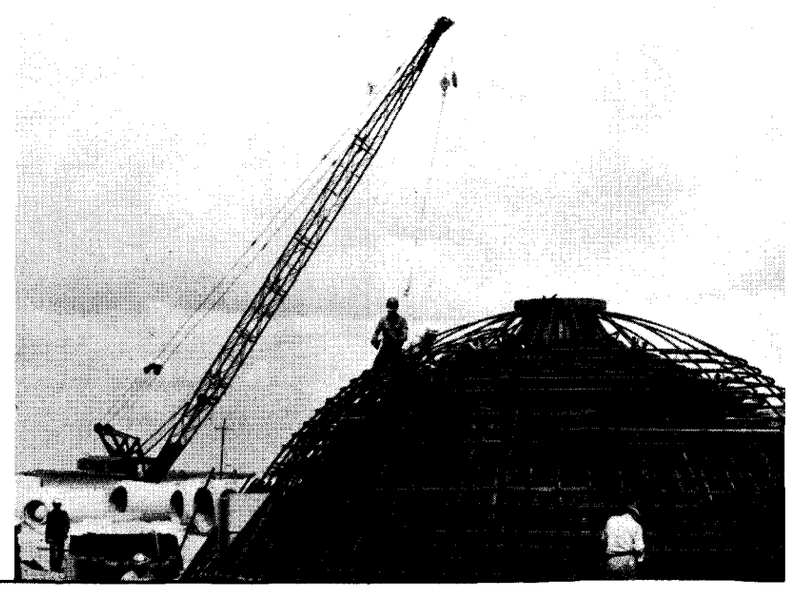
Taped television messages were sent to the new station via Relay I satellite from NASA's ground station at Mojave, California.

Associate Administrator Robert C. Seamans, Jr., and the ambassadors of Sweden, Norway and Denmark participated in the taped program produced by the United States Information Agency. The ambassadors are Count Kield Gustav Knuth-Winterfeldt of Denmark, Han Dristian Engen of Norway and Hubert de Besche of Sweden.

The ten-minute program was received perfectly by about five million viewers in Scandinavia via a network pickup at the Rao station.

The station is a joint effort of Norway, Denmark and Sweden. These countries joined the United States, Britain, France, Germany, Italy, Brazil, Japan and Spain in the communications satellite ground station network.

Bending steel at Merritt Island Launch Area (MILA) near Cape Kennedy, Fla., results in this igloo-type structure. It is an air intake and egress facility, part of Launch Complex 39, due for completion in October, 1965. The "igloo" will be a vital part of the area where the first Saturn V will be launched.



A NEW STADAN STATION IS BORN . . . TANANARIVE, MADAGASCAR

Ideally located in Madagascar at a point where polar-orbiting satellites go into orbit—and 12,000 miles directly opposite the Western Test Range, Vandenberg AFB—the new Goddard-operated station will have powerful dual capabilities.

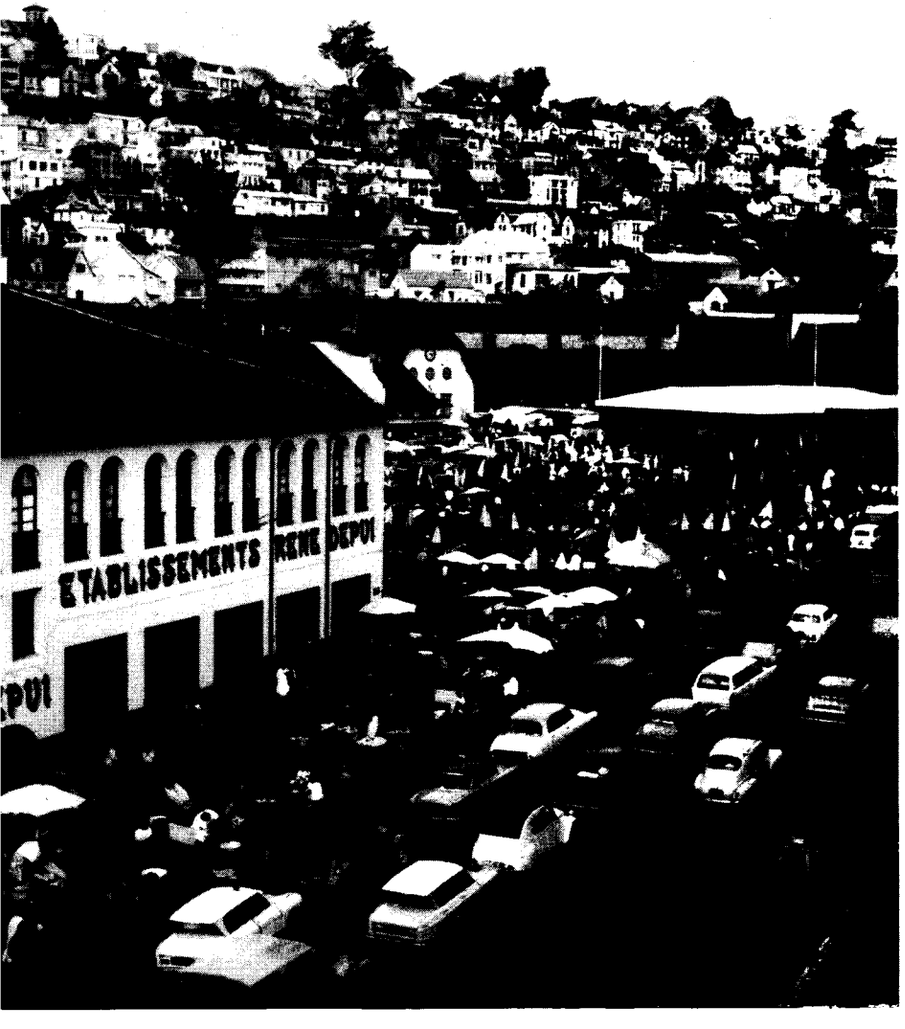
It will be an integral part of the STADAN network, providing tracking and data acquisition for scientific satellites as well as telemetry and air/ground communications with manned spacecraft.

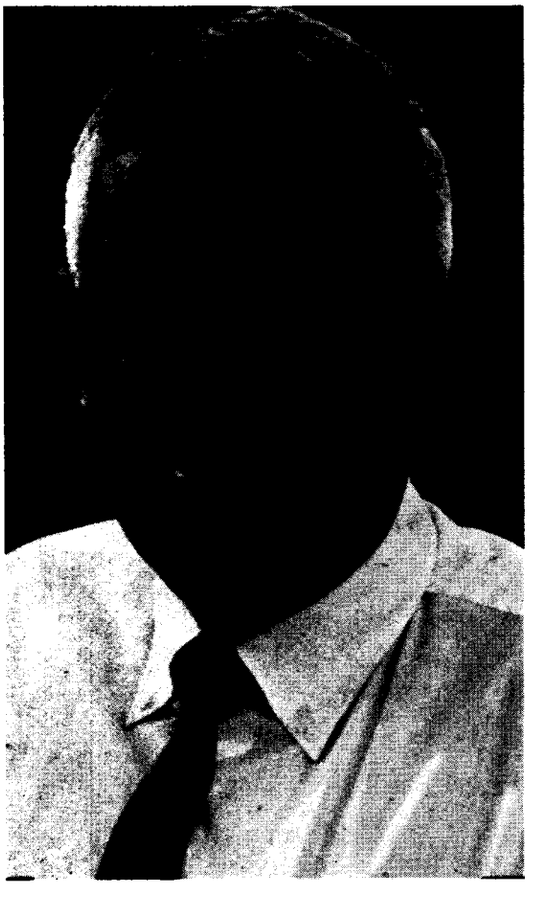
Its STADAN facilities are currently operational from mobile vans, and R&RR is presently being installed.

The site is about 125 miles inland and 20 miles from Tananarive, the capital city of the Malagasy Republic, which occupies one of the largest islands in the world—Madagascar—nearly 1000 miles in length with a maximum width of 360 miles. The island has a population of more than five million, and is located in the Indian Ocean off the east coast of Africa. French is the official language while Malagache, a Polynesian dialect, is popularly spoken.

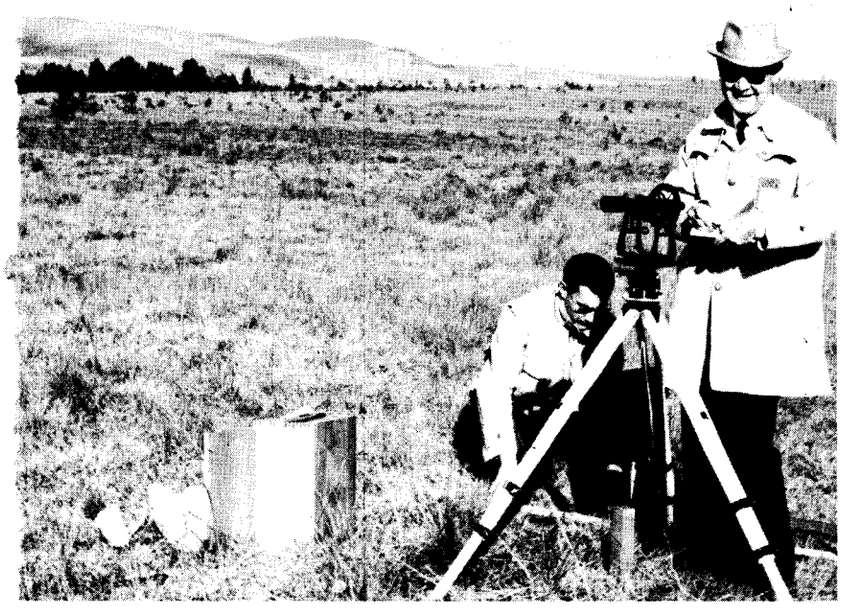
Aerial view of the new STADAN station site near Madagascar.

Downtown Tananarive, capital city of the Republic of Malagasy, 20 miles from the new station site. Tananarive has nearly 175,000 population.





Chester B. Cunningham, newly appointed director of the Goddard-operated Tananarive station, arrived at the site December 12. Prior to his three years in Santiago, Chile, Mr. Cunningham was Station Director at Lima, Peru, for four years.



James Harris (standing at transit), Field Facilities Branch, and Claude Fontana, National Administrator for the Tananarive station, survey the new station site.

PRESIDENT DROPS IN! His Excellency Philibert Tsiranana, the President of lagasy Republic (front center in decorative cap) visited the Tananarive station y with members of his staff and U. S. Ambassador Vaughan Ferguson (right ident). The acting station director, Hugh Turnbull, is second from left in the ow.

Gemini installation at Tananarive, Madagascar.

The approach road to the new Tananarive station site.

U. S. Ambassador Vaughan Ferguson (left) and the President of the Malagasy Republic, His Excellency Philibert Tsiranana, are talking to Washington on the SCAMA circuit. Madagascar time is 8 hours ahead of U. S. Office-hours, transmission times are 8-9 a.m. our time, 4-5 p.m. their time.

First Telecast to Scandinavia via RELAY—Excellent

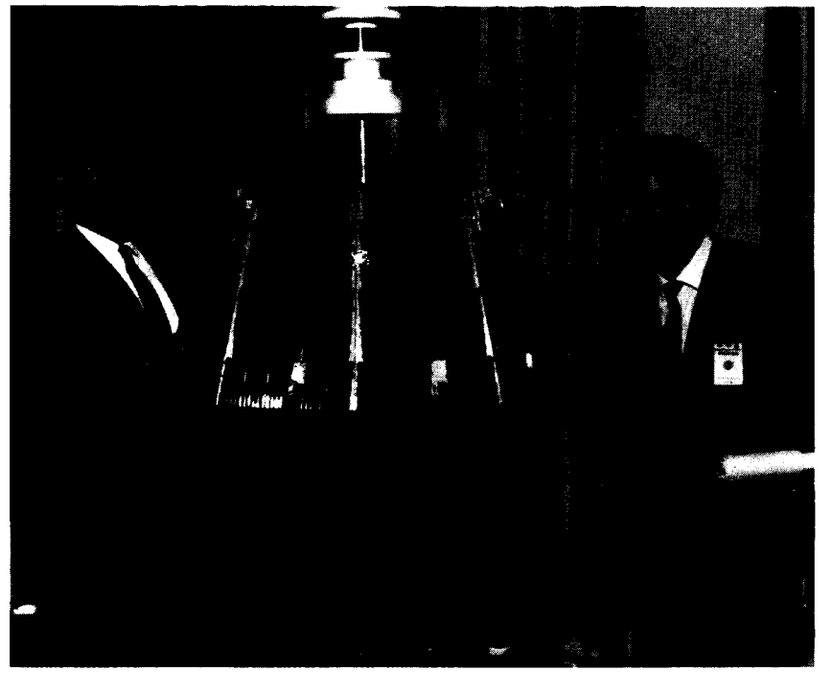
"Our reception of the inaugural telecast to Scandinavia via RELAY was excellent," said Mr. Lennart Hansson, manager of the Scandinavian ground station at Gothenburg, Sweden. Mr. Hansson was at Goddard last week following a meeting of the international Ground Station Committee at Cape Kennedy on December 1-3.

The Committee, headed by Leonard Jaffe of NASA Headquarters, is responsible for establishing policies and procedures used in the international network of ground stations which are experimenting with the RELAY satellites.

Delegates attended from Brazil, Canada, Denmark, France, Germany, India, Italy, Japan, Norway, Spain, Sweden and the United Kingdom, as well as from AT&T, ITTFL, Goddard and the Mojave Test Station.

Mr. Hansson was one of several of the Committee who visited Goddard after the meeting. Others were Mr. O. L. Britney, Chief Engineer, Research, Development and Programming of Canada's Department of Transport's Telecommunications and Electronics Branch. Mr. Britney is the man in charge of building Canada's new 85-foot experimental antenna at Mill Village, Nova Scotia, which should be in operation by the middle of next year.

The Scandinavian station was inaugurated with a telecast from the United States on November 26, with talks from each of the Scandinavian ambassadors. The station is an 85-foot dish, located at Rao, a suburb of Gothenburg, Sweden. It is a cooperative venture of the three Scandinavian nations, Denmark, Norway and Sweden, in experimental telecommunications via satellite and radio astronomy.



Mr. Lennart Hansson (right) Scandinavian station manager at Gothenburg, Sweden, discusses the RELAY model in Bldg. 1's Satellite Museum with Mr. O. L. Britney, Chief Engineer of Canada's Telecommunications and Electronics Branch.

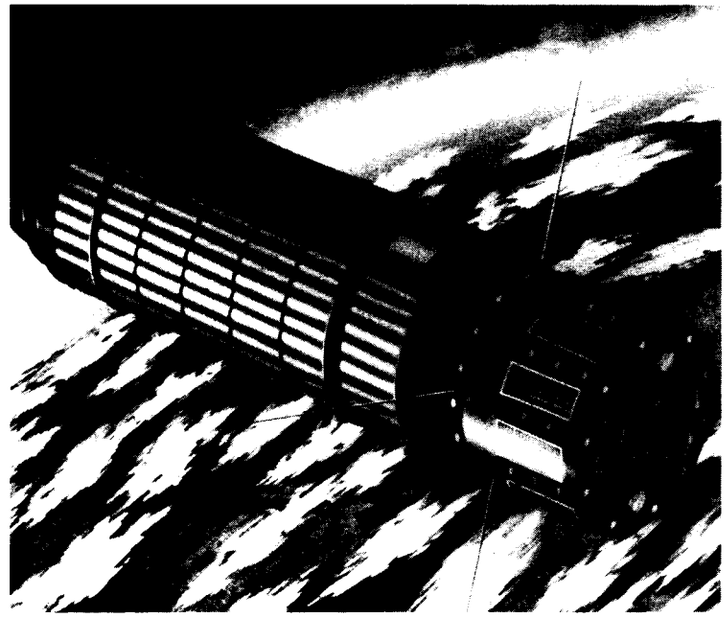
RELAY I Celebrates Second Birthday!

On Sunday, December 13, RELAY I was two years old and still going strong. Going strong, that is, for a spacecraft despaired of shortly after launch and only designed for a year of service.

RELAY I's timer failed to finish it off a year ago.

Since then, it has kept right on its mission, and added to its long list of historic broadcasts.

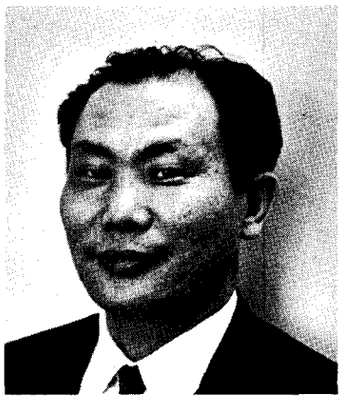
SANTA'S BIG HELPERS, trimming Goddard's Christmas tree with giant electric decorations, are electricians (from left on ladder) Jimmy Higgs, Bill Duelley and Ed Davis. The king-size tree faces Building 8.



EXPLORER XXIII. Sent aloft last month from Wallops Island, it records penetrations by high-velocity particles and studies effects of space environment on spacecraft systems and components. Goddard handled the instrumentation of the fourth stage Scout rocket and tracks it.

news from the Institute

Dr. Obayashi Offers New Concept of 'HM' Emissions



Dr. Tatsuzo Obayashi

A new concept to explain the nature and origin of hydromagnetic emissions (hm emissions) in the magnetosphere has been suggested by Dr. Tatsuzo Obayashi of Kyoto University's Ionosphere Research Laboratory.

Dr. Obayashi, who recently concluded a four month visit to the Goddard Institute for Space Studies, introduced his theory in a paper presented before the Symposium of Ultra Low Frequency Electronic Fields at Boulder, Colorado.

As a result of initial satellite investigation, interest in hm emissions in the magnetosphere has increased in recent years. Dr. Obayashi's concept provides some of the theoretical answers to questions posed by the observed behavior of hm emissions.

These disturbances are found to travel back and forth along geomagnetic field lines of the magnetosphere. In earlier descriptions of this behavior, hm emissions are often called "pearl-necklace" micropulsations. The expression is used because hm emissions appear on instruments as a series of wave packets separated at intervals of several minutes. The instruments are located at one terminal point of the geomagnetic field line. They are used to record the frequency of intervals between successive hm emissions.

The interval between a recording of any two wave packets corresponds to the time it takes the wave to travel along the geomagnetic field line from one terminal point to the other, to be reflected back at the other terminal point and to return. The behavior of the wave is much like the vibration of a violin string which is propagated by being reflected back at each end.

"Pearl-necklace" micropulsations appear on instruments as a series of overlapping wave trains of rising frequency. Periodicity, or the time interval between wave packets, and rising frequency are the two principal characteristics of hm emissions. Because of the rising frequency of the hydromagnetic waves, Dr. Obayashi has called them "hydromagnetic whistlers." Although the waves cannot be heard, their behavior is analogous to the rising frequency of a violin string which results in a rising musical tone.

Dr. Obayashi explains the rising frequency of hm emissions as hydromagnetic waves in an anisotropic mode propagating along the geomagnetic field lines. The rising frequency of emission Dr. Obayashi attributes to the dispersion of the wave velocity at difference frequencies.

From observational data, it has been found that one frequency band of hm emissions is around one cycle per second. The hm emissions have a clear structure during periods of quiet geomagnetic conditions when solar flare activity is at a minimum. This structure seems to be destroyed during active solar conditions.

It has been recognized that hm emissions of higher frequency travel along magnetospheric field lines whose terminal points are in the middle earth latitudes. The interval between two wave packets is less than a minute. The hm emissions of lower frequency whose intervals vary from two to five minutes, travel along the magnetospheric field line whose terminal points are found at the earth's auroral latitudes.

In recent years, several theories have been suggested in an effort to understand how hm emissions are produced. One theory holds that the hm emissions are due to the diamagnetism of a fast electron bunch. The emission frequency is associated with the bounce period of the electrons between the terminal points of the geomagnetic field line. The theory also suggests that the rising frequency and fine structure of the hydromagnetic waves may be associated with electron acceleration. The theory gives no account of the repetitive nature of hm emissions.

A fast proton bunch model was also proposed in 1963, similar to that of the fast electron bunch. The emission frequency is attributed to the bounce period of the protons. The fine structure periodicity is associated with the longitudinal drift period or orbital period of proton bunches around the earth. The rising frequency is explained by a latitude spread in the bunch at the time of the particle injection.

A slow proton bunch was also postulated in 1963. The periodicity is associated with the proton bounce period, while the rising frequency was attributed to the latitude variation of the characteristic resonance frequency in the lower magnetosphere.

Because of more observational data about hm emissions, it has become apparent that these models present serious theoretical difficulties. First, hm emissions occur simultaneously at widely spread areas with the same period and with regular repititions. The electron and proton bunch models do not explain the repetitive nature of hydromagnetic waves. Secondly, a 180° phase shift is observed between simultaneous recordings of emissions at both terminal points of the geomagnetic field line. However, hm emissions are received alternately in the northern and southern hemispheres with regular repetitive periods. Since both models of fast particle bunches postulate very rapid oscillation between terminal points, the interhemisphere phase shift theoretically should be small. The observed results, however, show larger delays between wave packets than predicted by the fast particle models.

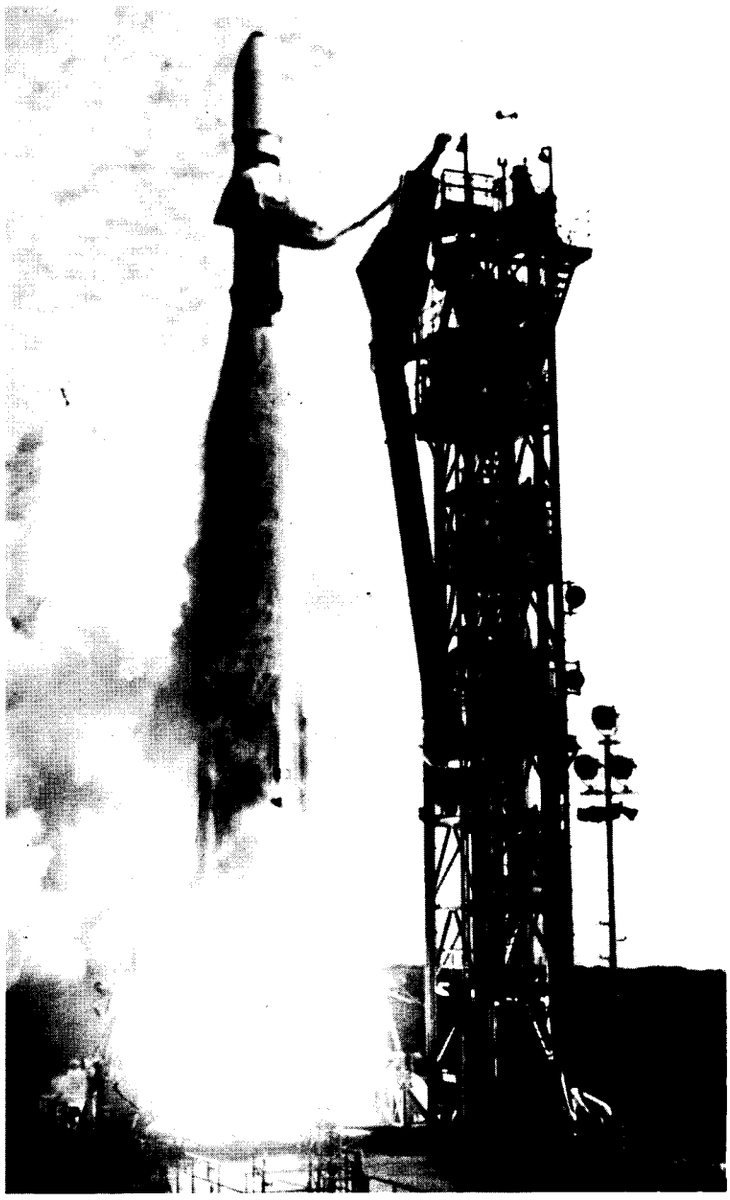
The slow proton model also conflicts with the observed data. The model predicts that the emission frequency should increase with geomagnetic latitude. These frequency variations, however, do not coincide with the observed latitude variations.

It has become clear in the past few years that substantial energy is transferred to the magnetosphere by the arrival of plasma clouds emitted from disturbances on the Sun's surface. However, the mechanism and efficiency of this transfer, one of the most interesting theoretical problems of upper atmosphere physics, has only recently been more fully understood.

In contrast to already proposed theories, Dr. Obayashi suggests that the origin of hydromagnetic waves is the result of the interaction of a plasma beam of high-speed charged particles with the magnetosphere. The charged particles gyrate around the geomagnetic field lines in a coil or spiral-like motion. This motion creates cyclotron emission of electromagnetic radiation. According to Dr. Obayashi, these cyclotron waves trigger the hydromagnetic waves which propagate along field lines of the magnetosphere. At the same time, there is a transfer of energy from particles in the cyclotron wave to the hydromagnetic wave.

The transfer of kinetic energy from particle to wave produces the unique oscillating character and rising frequency of the hydromagnetic wave.

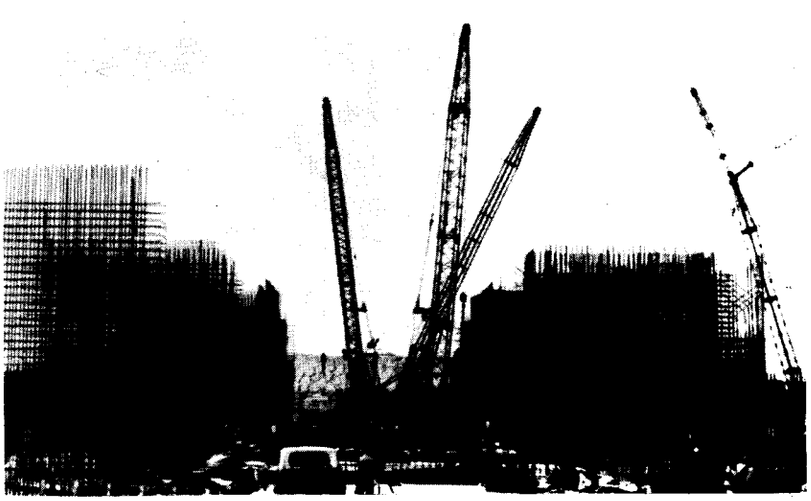
According to Dr. Obayashi, the magnetosphere can provide a good laboratory for exploring the transfer mechanism between particle and wave. The opposite transfer of kinetic energy from wave to particle has far-reaching implications. Once fully understood, according to Dr. Obayashi, the mechanism might be used as an extremely efficient means to raise the temperature in a hydrogen plasma in order to create nuclear fusion.



Mariner IV Heads for Mars

The 575-pound spacecraft was launched November 28 at Cape Kennedy, Fla., after a flawless countdown. Mariner IV should scoot past the red planet late in the evening of July 14. If its television camera withstands the rigors of 6,000 hours storage in the vacuum of space, the craft should then make about 20 pictures of the mysterious Martian surface.

HUGE PAD 'A' at MILA, Cape Kennedy, Fla., shown at about the half-way mark. Giant Saturn V rockets will be launched from here.



GODDARD NEWS

December 14, 1964

"It is difficult to say what is impossible, for the dream of yesterday is the hope of today and the reality of tomorrow."
—DR. ROBERT H. GODDARD

The Goddard News is published biweekly by the Public Information Office of the Goddard Space Flight Center, National Aeronautics and Space Administration, Greenbelt, Md. Phone—Ext. 4141 or 4142

Jerry Stark, *Editor* Shirley Deremer, *Inside Goddard*

Photography by Goddard's photographic branch

* *Press date precedes publication date by approximately seven days.*

Goddard Speech and Paper Presentations

(Technical presentations approved as of December 14, 1964, for period through December 27. Requests for copies of speeches and papers should be made directly to the author.)

Henry W. Price, Catholic University, Electrical Engineering Dept. Seminar, December 18, 1964, Washington, D.C., ***"Stabilization & Control of Earth Orbiting Satellites."***

Dale W. Harris, Nuclear Science & Engineering Seminar, Catholic University of America, December 17, 1964, Washington, D.C., ***"Bremsstrahlung Characteristics of Radioisotope Fuels."***

Paul A. Lantz, Canaveral Section, IEEE, December 17, 1964, Melbourne, Florida, ***"NASA Space Data Acquisition Antennas."***

Robert Schwartz, Second Texas Symposium on Relatabistic Astrophysics, December 15-18, 1964, Austin, Texas, ***"Gravitational Forces of Accompanying Bursts of Radiation."***

Robert A. Schwartz, Second Texas Symposium on Relativistic Astrophysics, December 19, 1964, Austin, Texas, ***"Gravitational Field Accompanying a Burst of Radiation."***

Goddard Coming Events

- **December 14, 1964, 2 p.m., Goddard Institute for Space Studies, Conference Room, Watson Building, 612 W. 116 Street, N.Y., N.Y.—Dennis W. Sciama, University of Cambridge, England, "Physical Conditions in Intergalactic Space."**

Meeting of importance in the field of metals:

December 14, 1964, 8:00 p.m., Westinghouse R&D Center, 2nd floor auditorium, 24th & G Street, N.W., Washington D.C.,—W. N. Platte, "Joining of Refractory Metals."

Safety Note:

Cars Actually Water-Ski on Wet Roads

Did you know that rain can lift your car right off the road? According to information furnished by Edward L. Weller, Spacecraft Systems and Projects, your tires are actually skimming atop a film of water like a water skier when you're traveling at 50 mph on a very smooth, wet road.

However, correct tire pressure can give you a big margin of safety. For example, NASA researchers discovered that on a curve posted for 45 mph, a car with 16 pounds of tire pressure reached hydroplaning speed at 40 mph. But with tire pressure raised to 25 pounds, the car maintained safe control on the curve until it reached 51 mph.

So, here's one more good reason it's safer to keep tires properly inflated and watch your speed during and just after heavy rains.