Tektites—An Answer to the Moon's Origin?

They look like a long drop of water, a prune, or even a button.

They are usually larger than a pea, but smaller than a baseball. Perhaps the size of a walnut.

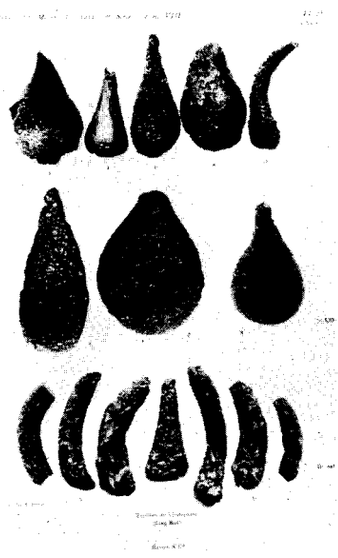
They are made of homogeneous natural glass—a very rare substance in nature—which is primarily silica.

They are strange and beautiful and in many parts of the world—from Georgia to Australia—they are used as gems.

They are inconsistent and evasive, and they yield their secrets stubbornly.

These are tektites and they have baffled scientists for years.

They are found in strewnfields of irregular sizes and shapes in Texas, Georgia, Europe, Southeast Asia, Australia and the Ivory Coast. Their distribution is spotty, but then so are the facts to explain where they come from and how they get there.



TEKTITES FROM VIET NAM

"We suspect they come from the moon or at least the material does," said Dr. John O'Keefe, assistant chief of the theoretrical division. "If we knew for sure, it would help us to understand the moon's chemistry and what to expect when man gets there."

Two pieces of evidence indicate that tektites or their materials are produced by impact somewhere in the earth-moon system. First, some contain spherules, a nickel-iron alloy indicating formation by meteoritic impact on a body. This discovery was made in 1960 by the U.S. Geological Survey under a contract with NASA. In addition, they contain practically no aluminum 26, an isotope produced in space by the action of cosmic rays and a characteristic of regular meteorites. Absence of the aluminum isotope means the tektites haven't come across interplanetary space.

"They have been in space not more than 10,000 years," said Dr. O'Keefe, "which is long enough to get here from the moon by orbit perturbations but not nearly the time required from Mars or asteroid belts."

Regular travel time for a tektite by orbit perturbation through interplanetary space would require tens of millions

(Continued on page 7)

GODDARD NEWS

GODDARD SPACE FLIGHT CENTER / GREENBELT, MARYLAND

VOLUME III, NUMBER 5 THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION AUGUST 27, 1962

Dr. Goett Keynotes Editors' Seminar

"The Press and the Exploration of Space" was the subject of the keynote address last week by Goddard's Dr. Harry Goett to the Syracuse university's science seminar for editors.

Topic of the seminar — attended by 35 to 40 editors of the Newhouse newspaper chain —was Public Affairs and Science in the Space Age.

Purpose of the three-day seminar was to keep the editors abreast of new scientific developments, problems of reporting them and keeping the public informed of this progress.

Those attending had a chance to hear and talk to prominent scientists who comprised the seminar staff. Included were Dr. Fred Sherman, head of the Syracuse university department of zoology, who spoke on "Biology and Public Affairs"; Dr. William Wildhack, associate director of the National Bureau of Standards, whose topic was "Frontiers of Basic Research by the Federal Government," and Dr. Lewis Dexter, American Academy of Arts and Sciences, who talked on "Social Implications of the Space Age."

Goddard—Italy In Space Link

Goddard will assist in training Italian scientists and engineers for the launching of the first Italian satellite from a portable platform.

The San Marco project will measure local density in the upper layer of the atmosphere between 200 and 300 kilometers by continuously measuring the total drag of the satellite by means of balances.

In addition, other experiments will measure air density, temperature, pressure and composition, and electron temperature and total content.

During the past six months, Bruno Ratti and Giorgio Ravelli of the Italian Space Commission have been learning satel-

(Continued on page 2)

Goddard Awards 5 Fellowships for Graduate Study Program

Five Goddard scientists and engineers will initiate a new program of graduate study this fall with The Catholic University of America.

Fellowships in aerospace engineering have been awarded to Albert Fleig, spacecraft systems branch; Thomas Flatley, mechanical systems branch; and Kenneth Rosette, thermodynamics branch. Physics fellowships recipients are Donald Kniffen, field and particles branch and John Stolarik, field facilities branch.

The new program, called the three-quarter credit program in aerospace engineering and physics, enables selected Goddard employees to do graduate study two work days each week while working the other three. Each participant will carry an academic load of ten credits each semester.

Thomas Flatley, Albert Fleig, Donald Kniffen, John Stolarik receive fellowship awards from Dr. Goett, center. Not pictured is Kenneth Rosette.

According to Jim Reese, chief of the employee development branch, the program is the result of the mutual recognition by Goddard and Catholic university of the need for a graduate study program in science and engineering which would be more intensive than the part-time study program now available.

"This program is a new approach to the problem of providing advanced education to capable scientists and engineers. It has positive benefits for the graduate program of Catholic university, for Goddard's research and development mission, and for the participants."

The school of engineering and the physics department at C.U. are concentrating the courses to be included into two work days each week.

Goddard plans to offer other professionals the chance to compete for the fellowships each year.

International Program Expands in Scope

Out of the space age, a new frontier in international cooperation has developed.

From the far corners of the earth—Korea to Turkey—Argentina to Norway—space experts come to Goddard to work, learn and contribute.

They represent the scientific and engineering communities of more than a dozen nations.

This new program is opening up a new means of exchanging information between Goddard scientists and those of other countries.

"They bring fresh ideas and enthusiasm to Goddard," said Gil Ousley, assistant for international programs. "We don't have a patent on scientific knowledge about space and the exchange of information helps us both."

This aspect of NASA's international program has two areas of emphasis.

On the theoretical level, about 15 nationals from other countries are participating as research associates. Some are studying at Goddard's Institute for Space Studies in New York: others are working at Goddard on theoretical problems in the theoretical division.

The research associate program is administered by the National Academy of Sciences under a NASA grant.

On the practical engineering level, Argentina, Italy, France, India and Great Britain presently have fulltime, active participants.

The associates come to learn how Goddard builds satellites, launches them, and evaluates the resulting data.

"All are practicing engineers or scientists who have had professional status for years," said Mr. Ousley. "In addition, all speak fluent English."

During their stay here — which lasts a minimum of six months for engineers and a year for scientists — the associates may receive exposure in a number of space oriented disciplines.

For example, up to a dozen French experts are expected soon for training in the areas of RF systems, space electronics, control and thermal systems and structural design. They intend to return to France in approximately six months to form a satellite team.

In addition to obtaining fresh ideas and technical contributions from these foreign scientists, this international training program helps Goddard in another way.

"Many of the foreign scientists and engineers in this program will represent their respective countries in future NASA cooperative sounding rocket and satellite programs," said Mr. Ousley. "As a result, it makes our international space program run more smoothly because we have previously worked together at Goddard."

Research associates working at Goddard are:

Israel—David Stern.

Japan—Dr. Shinko Aoki and Dr. Kaichi Maeda.

India—Dr. S. Malurkar, Dr. R. Jaggi and Dr. Sushil Chandra.

Argentina—Sandro Radicella.

Italy—Bruno Ratti and Giorgio Ravelli.

France—Xavier Namy and Bernard Saint-Jean.

Working at the Institute for Space Studies in New York are:

Turkey—Dilhan Ezer.

India—Shiv Sharan Kumar.

Pakistan—Ishtiaq Rasool.

Canada—Hubert Reeves.

S. Korea—Kiu S. Suh.

Holland—H. C. Van De Hulst.

LEFT TO RIGHT, French engineers X. Namy and B. St. Jean, research associates at Goddard, meet a visiting countryman and give him a first-hand explanation of computer operations.

FRENCH VISITORS listen intently during a tour explanation given by Goddard's John Jackson.

Goddard To Assist Italians In First Satellite Program

(Continued from page 1)

lite programming at Goddard. Three more of their countrymen will join them for spacecraft training, consulting, and review of satellite plans.

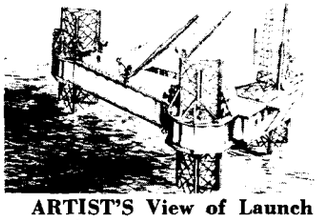
"This period has been valuable not only from a technical standpoint but also as a personal experience," said Mr. Ratti. "We have had a chance to see the development of a satellite project, learn its problems and find out how they are solved."

Named as project manager for Goddard is Anthony Caporale of the project management group.

"Mr. Caporale has an extensive systems background, is familiar with the project, is conversant in Italian and has worked closely with the Italian scientists at Goddard," said Gil Ousley, assistant for the international programs.

The satellite launching will take place in about three years from a Texas tower type platform in the Indian ocean off Africa's east coast.

The 165 pound sphere will be the first equatorial launched and orbited satellite. It also will be the first related to the study of the ionosphere in the equatorial region where the magnetic equator is coincident with the geodetic equator.



ARTIST'S View of Launch Platform.

The satellite, launch platform, all launch support and data reduction will be Italian-supplied.

Goddard Float In Parade, Fair

Greenbelt's eighth annual Labor day parade and Prince Georges county Showcase and Fair in Upper Marlboro, Sept. 6-9, will feature a Goddard float of full-scale satellite models.

The float will consist of models of satellites from each major area—meteorolgy, Nimbus; communications, Relay; and scientific, OSO. An actual flight model of America's first scientific satellite, Vanguard I, also will be shown.

475 Riverside Drive, New York City

Institute for Space Studies— A Vital Link in Goddard's Mission

This summer the Goddard Institute for Space Studies completed its first year of operation in New York City. Established by NASA as a branch of the Goddard Space Flight Center, the Institute is concerned with basic theoretical research in a broad variety of fields, including atmospheric physics, astrophysics, planetary structure, and problems in the evolution of the solar system.

The Institute's primary mission is to assist in the analysis and interpretation of data gathered by NASA space probes. Its programs are directly related to the experimental activities of Goddard, and at the same time they are geared to the most general aspects of space science, including all fields of astronomy and the earth sciences to which space flight vehicles make a special contribution.

The second major mission of the Institute is to arouse the interest of university scientists in the space program and to enlist their participation in some of the major theoretical problems of space research.

With its location in New York, the Institute has a unique opportunity for direct contact with the metropolitan university community. In its first year, it has developed associations with Princeton, Yale, Columbia, New York university, University of the City of New York, and Brooklyn Polytechnical Institute.

INSTITUTE STAFF MEMBERS work out a problem in Dr. Albert Arking's office. From left to right. Dr. Robert Jastrow, Dr. Jackson Herring, Dr. Hong-Yee Chiu and Dr. Arking.

Research Supports Goddard

In reviewing the operations of the Institute for Space Studies, Dr. Robert Jastrow, director, commented: "In the course of this past year, our program has grown to a high level of activity in support of the main lines of research at Goddard and in the general NASA space science program.

"Out of our original interest in the specific fields of upper atmosphere physics and lunar studies, we have developed a broadly based program of inquiry into the physics of the lower and upper atmosphere and all problems of planetary structure. the history of the solar system, and the formation and evolution of stars.

"In this coming year," he added, "we plan to continue our current level of research in astrophysics and upper atmosphere physics and expand our activity in the analysis of TIROS data.

"We hope that these projects will make a substantial contribution to the Goddard science program."

Growth of the Institute

When the Institute opened its offices last year, its staff numbered three: Dr. Jastrow; Lois Steff, his secretary; and Arthur Levine, executive officer. The fledgling organization was housed on the fourth floor of the Interchurch center, a block-sized structure at 475 Riverside drive, overlooking the Hudson river and adjacent to the Morningside Heights campus of Columbia university.

As present, the staff is operating at a full level of research activity, with papers published at a current rate of one a week. To date, 38 papers have been or are in the process of being published. In addition, members have presented 120 speeches to scientific and general audiences in the past year.

The research staff consists of Ph.D.s in physics and astronomy. It is made up partly of permanent employees and partly of NASA research associates appointed by the National Academy of Sciences-National Research Council. The associates are appointed for a maximum of two years, during which they contribute their talents to the space program. Thereafter, they return to their regular positions or accept other appointments. In the case of foreign associates, NASA receives an additional return because when they go back to their home countries they carry with them news of the extensive scientific programs which the U.S. is conducting in space, and plant a seed of interest in these new and relatively unexplored fields.

Research Activities

At the moment, the regular research staff consists of Dr. Jastrow, whose interests are primarily in radiative transfer and upper atmosphere physics; Dr. A. G. W. Cameron, who is exploring a variety of geophysical and astrophysical questions related to the origin of the solar system; Dr. Albert Arking and Dr. Jackson Herring, who have been studying problems in convective and radiative transfer which are common to both atmospheric physics and astrophysics; and Dr. Myron Lecar, who is working on problems in stellar atmospheres.

The Academy-appointed research associates, both from the United States and abroad, join the permanent staff in carrying out theoretical research related to the space program. Thus far, 23 scientists have

held or will shortly enter on such appointments in New York.

Among the research associates are Prof. Hong-Yee Chiu, who came to Goddard from Cornell university. Prof. Chiu has been investigating the effects of neutrino emissions on the evolution of stars. He has been with Goddard as an associate for a year and a half, and has been exceptionally productive during his NASA visit, with eight major papers to his credit in the field of neutrino astrophysics. He created this new branch of astronomy during his stay at Cornell, in collaboration with Prof. Philip Morrison. Now he is extending his research on neutrinos with the assistance of several graduate students from Columbia university.

Prof. Hubert Reeves, who is visiting the Institute as a research associate on leave from the University of Montreal, is also working in neutrino astrophysics. The work of both Dr. Chiu and Dr. Reeves has profited greatly from frequent visits by Prof. Edwin Salpeter of Cornell, who is one of the most active members of the Institute consulting staff.

Neutrinos Play Key Role

Dr. Chiu and his co-workers have discovered that neutrinos play a dominant role in the advanced stages of stellar evolution. The neutrino is a type of particle, possessing neither charge nor mass, that is emitted in nuclear interactions within a star. These particles are created in large numbers from photons in late stages of the life of the star. Their most striking property is that they pass almost unimpeded through enormous masses of matter. Unlike photons, which require some 50,000 years to transport energy from the center to the surface of an average-sized star, neutrinos reach the surface within three seconds, and usually depart without depositing any energy in the star. Because they are created in such large numbers during the final stages of the star's life, and get out so freely, these peculiar particles carry off about as much energy in the last 1,000 years as was generated by the star in its entire previous history of billions of years.

Atmospheric Physics

Atmospheric physics is a second major area of activity of the research associates. Work in the lower atmosphere includes the research of Dr. S. Ishtiaq Rasool, on leave from the Laboratoire de Physique de l'Atmosphere in Paris. He is engaged in the study of the infrared data gathered by TIROS.

The infrared data are intended to fill out the cloud cover photography with night-time information on cloud patterns. More than that, the infrared sensors record the amount of energy absorbed and returned by the earth in different regions. This energy distribution is an essential element for the understanding of the forces which generate weather phenomena. A sustained analysis of the infrared data may provide the breakthrough in meteorology that could lead to long range forecasts extending over a week or more.

The Goddard aeronomy division is cooperating with the Institute in this effort. Dr. Rasool has been assisted by Cuddapah Prabhakara of India, a graduate student of meteorology at New York university, who is now working at the weather bureau.

Another area of the Institute's activity relates to the question of the energy sources for the upper atmosphere. Studies of the response of the at-

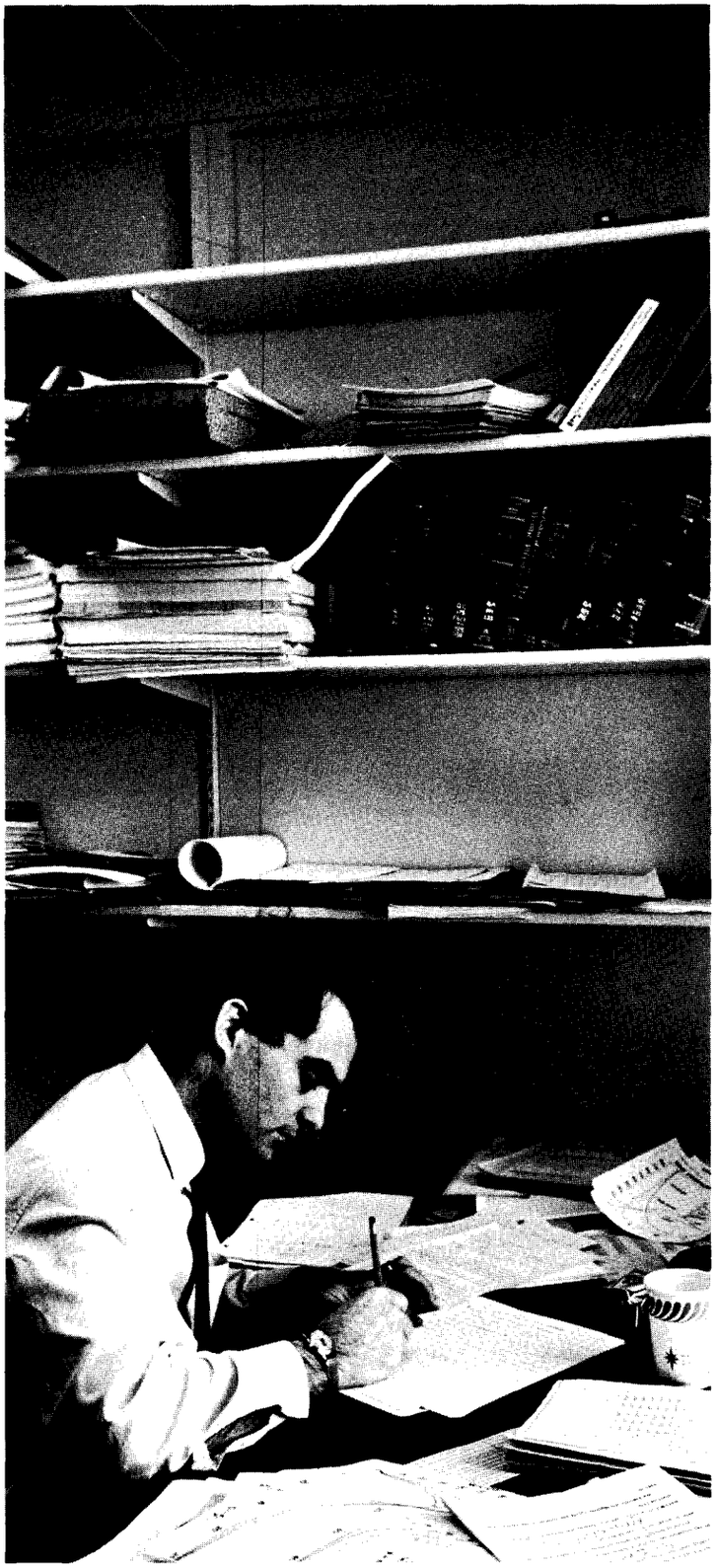
. . . Space Resea in an Academ

DR. WOLFGANG PRIESTER stresses a point during a conversation in the Institute's computer room. Dr. S. Ishtiaq Rasool is to the left and Dr. Robert Jastrow to the right.

THE CONCLUDING SESSION of the conference on the origin of the solar system. In the front are Prof. William Fowler of Cal Tech, Mrs. Margaret Burbidge and Prof. Geoffrey Burbidge of Yerkes Observatory, and Prof. Fred Hoyle of Cambridge university. Standing to the right is Prof. Robert Christy of Cal Tech.

A CONVERSATION DURING a break in the conference on the origin of the solar system. In the foreground, from left to right: Prof. Fred Hoyle, Plumian professor of astronomy and experimental philosophy at Cambridge university; Prof. Thomas Gold, director of the Center for Radio Physics and Space Research and chairman, department of astronomy, Cornell university; and Freeman Dyson, professor at Princeton university's Institute for Advanced Study. In the background, at left, Prof. Edwin Salpeter of Cornell university watches as Prof. Hong-Yee Chiu, of the Institute, writes down a calculation.

rch and Progress ıic Atmosphere



BOOKS AND PAPERS and reports are a part of the scientist's life. Here the Institute's Dr. Jackson Herring is at work.

mosphere to changes in solar activity, as revealed by satellite drag variations, are a prime source of evidence regarding this question.

Priester Studies Energy Sources

One of the pioneers in the analysis of satellite drag data is Prof. Wolfgang Priester, deputy director of the Bonn university observatory, Bonn, Germany, who spent the past year in New York and is now back in Germany. He is expected to return in the spring of 1963.

Prof. Priester's most recent work on satellite drag and density variations was developed in collaboration with Dr. I. Harris of the Goddard theoretrical division. Priester and Harris concentrated their attention on the changes in atmospheric density from hour to hour during the course of the day. They compared the daily variation in density with the results of an IBM 7090 calculation of atmospheric properties, and discovered that the data could not be explained unless they assumed that a second source of energy existed in the upper atmosphere. This would be in addition to the solar ultraviolet radiation which has been considered the major source up to now. Priester and Harris could not pin down the precise nature of the mysterious second source, but its properties led them to suspect that it consists of streams of energetic particles emitted by the sun.

Astrophysics

In the field of astrophysics, a significant contribution to the study of star formation and the early history of the sun has been made by Mrs. Dilhan Ezer, research associate from Turkey, who is working with Dr. Cameron. Through the numerical integration of the equations of stellar evolution, Mrs. Ezer has confirmed Dr. Chushiro Hayashi's prediction, made in 1961, that the sun was at one time highly luminous and fully convective.

Star Formation and Sun's History

Dr. Hayashi was, incidentally, the first foreign research associate appointed by NASA, and spent 1960 at the theoretical division, which was located at Silver Spring, Md. prior to the establishment of GFSC at Greenbelt.

The integrations in Dr. Ezer's work were performed on the Institute IBM computer. They showed that at an early stage the sun was 50 times larger and 600 times more luminous than it is today. This knowledge is important not only in astrophysics but also in the study of the early history of the planets, for it indicates that they were once enveloped by a high temperature environment.

Prof. Hendrik van de Hulst of Leiden observatory in the Netherlands is also with the Institute as a senior research associate. He will be in New York for a six-month term until January, 1963, and plans to work on problems of scattering and inductive transfer in planetary atmospheres. He has played a major role in the international development of space science, and was the first president of COSPAR (the Committee on Space Research of the International Council of Scientific Unions).

Prof. van de Hulst is best known for his prediction that the 21 cm line of hydrogen could be detected by radio telescopes. The 21 cm line is emitted by hydrogen in a "fine structure" transition, in which the spin axis of the orbiting electron in the hydrogen atom is reversed. The existence of the line was subsequently confirmed in the cosmic radio spectrum. This line has since proved to be

DR. J. A. WOOD discusses the surface of a meteorite at the Conference on the Origin of the Solar System.

the most important single tool in radio astronomy.

In addition to the regular staff, the Institute draws on the talents of 24 consultants who, at various times during the year, occupy a desk for a few days or weeks of research and study. These include Harold Urey of the University of California and Bengt Strömgren of the Institute for Advanced Study at Princeton university. The two scientists played a major role in guiding the Institute's early efforts. Other consultants who actively contribute to the Institute's activities through frequent visits are Dr. Edwin Salpeter of Cornell, Dr. Rupert Wildt of Yale, Dr. Edward Spiegel of N.Y.U. and Dr. Robert Dicke of Princeton.

Seminars Started

The Institute launched its program last fall with a series of seminars on the theoretrical problems of greatest current interest to the space program. These seminars were attended by scientists of the metropolitan area ranging geographically as far north and south as Yale and Princeton.

This fall the series is being continued with lectures on galactic radio astronomy under Prof. van de Hulst. Other seminars are planned in atmospheric physics, under the direction of Drs. Spiegel and Jastrow; and on the astrophysical and geophysical applications of plasma physics, to be conducted by Drs. Chiu and Shen.

International Conference

The most exciting event of the last year was the Conference on the Origin of the Solar System held at the Institute on Jan. 23-24, 1962. The conference discussed questions related to the formation of the sun and planets, which pose some of the most difficult problems in modern science. The attack on these questions represents a remarkable effort to roll back the 4.5 billion year history of the solar system, and unravel the tangled complex of events accompanying the birth of the plants. The search for new knowledge in this field is one of the primary scientific objectives of the NASA lunar and planetary exploration program.

The conference revealed the unsatisfactory state of current theories on the early history of the solar system. It is generally accepted that the planets probably were formed during the process of condensation of interstellar gas and dust in which the sun itself was created. However, the discussion made it clear that basic difficulties remain unresolved in this theory. One of the points raised at the conference was:

How did the solid bodies of the solar system accumulate out of the finely divided matter surrounding the primitive sun? Another question was:

What happened to the hydrogen which must have constituted most of the gas in the primitive solar nebula, and is now largely missing from the current composition of the solar system?

These questions and others were actively debated. In fact the greatest dividend of the meeting was the opportunity to hear an active discussion amongst such vigorous and articulate individuals as Gold, Hoyle, Schwarzschild, Spitzer, Fowler and the Burbidges.

University Relations

The regular work of the Institute depends essentially on its ability to draw talented staff and students from the universities in the New York area. The experience of the Institute has been that the best way of accomplishing this objective is to give courses in the various fields of space physics at universities in the metropolitan area. Staff members are encouraged to take part-time teaching assignments, usually limited to one course conducted at times which do not conflict with their other responsibilities. Drs. Jastrow and Chiu hold unsalaried professorships at Columbia. Dr. Cameron is on the faculty of Yale university, while Drs. Herring and Arking hold appointments at the University of the City of New York. Dr. Rasool lectures at Brooklyn Polytechnical Institute.

This summer Dr. Jastrow took informal leave from the Institute to serve as director of the Columbia University Summer Institute in Space Physics, a NASA-sponsored activity. Eighty-three students from American and European universities and NASA centers participated in this program. They displayed a formidable amount of talent and energy, which transformed the summer session into a 24-hour job for Dr. Jastrow and his staff of seven. The regimen included a two-hour lecture every morning, consultation and special classes in the afternoon, and lecture preparation in the evening.

The program concluded with a tour of the Marshall Space Flight Center, Huntsville, Ala., Cape Canaveral, and Goddard.

Full Program Scheduled

In the fall, Dr. Jastrow will participate in a Columbia university study of non-technical problems related to the space program. The study will explore the impact of the space program on the economic and social sectors of national life. Students assisting in this investigation will be drawn from Columbia's department of public law and government and the schools of business, law and journalism.

Student Assistants

The Institute also relies on students from local universities for research assistance in support of its program. These students are drawn from departments of physics, astronomy, meteorology and geophysics. Most, such as James Walker of the Lamont geological observatory of Columbia university, are carrying out research leading to a Ph.D. under Institute sponsorship, but within their respective universities. Their work at the Institute supports Goddard research efforts directly, while at the same time contributing to general NASA objectives in attracting capable young men and women to the space program.

Knowing Origin of Tektites Could Aid Lunar Landing

(Continued from page 1)

of years. If it came direct from Mars, however, it might take only six months.

"But if that happened you had better open it up and look for a note," said Dr. O'Keefe.

Two different views exist on the origin of tektites. One view supports a terrestrial or earth origin because the chemistry of tektites is similar to rocks of the earth's crust, such as granite. This similarity extends even to the minor elements. The resemblance between tektites and earth materials is much closer than between tektites and meteorites.

In addition, the peculiar distribution of tektites in strewn-fields of irregular sizes supports the terrestrial theory. Each field could be caused by the throw-out from a single meteorite impact nearby. They cannot be the result of the fall of a cluster of tektites nor can they result from the breakup of a single body in a normal atmospheric fall. If the first were the reason, the strewn-fields would probably cover the whole earth; if the latter were true, the field would be only a few kilometers across.

Specifically, the distribution view is supported by the European strewn-field which Dr. Alvin Cohen claims resulted from the impact which created the giant crater Ries Kessel, in Germany and by the Ivory Coast strewn field which Dr. Cohen says was caused by the Bosumtwi Crater in Ghana.

"I don't believe the terrestrial theory because the tektites, when liquid, would be too delicate to withstand an impact on the earth. In addition, they are too small to get through the atmosphere, and with enough speed to go to the edge of the strewn-field and return to earth without burning up," said Dr. O'Keefe.

The other view on the origin of tektites is that they come from the moon. Supporters say the chemistry of the Ries Kessel and nearby tektites are so entirely different that you can't get one from the other. Besides, the geologically assigned ages are different though not greatly different. This tends to refute the earth or crater origin view, according to Dr. O'Keefe.

"For example, the Ries Kessel contains stishovite and coesite, has primarily crystalline materials throughout, and is bubbly. Tektites lack any of these characteristics except bubbles, in which they are relatively deficient."

In Dr. O'Keefe's view, tektites are produced by the impact of a large body on the moon. The impact breaks large chunks off. Some fall to earth and some go in orbit around the earth. As the chunks orbit, they ablate and the drops which fall to earth are tektites.

The orbit of the meteor shower of 1913 supports the view that tektites come from a natural, orbiting satellite. The great fireball procession on Feb. 9, 1913, called Cyrillids, was seen along an arc 10,000 kilometers (6,000 miles) from Saskatchewan, to a point in the Atlantic off the northeastern corner of Brazil.

"This distance is several times longer than the observed flight of other fireballs," said Dr. O'Keefe. "It seems to have been caused by entry into the earth's atmosphere of a small group of natural satellites orbiting the earth. A shower like the Cyrillids would yield a strewn field which is long and narrow, like that in Europe.

Determining the origin of tektites will be an important scientific advancement for two reasons.

One, if they come from the moon, it indicates continuing volcanic activity as recently as a few hundred million years ago.

Finding out whether volcanic activity exists on the moon will be of immeasurable help in predicting the surface on which the Project Apollo team must land.

"Volcanic activity, if it exists, would result in an ash flow which would be loose on the surface but, like snow, would tend to pack and sinter at small depths," said Dr. O'Keefe.

Secondly, if tektites come from the moon there will be strong evidence that the chemistries of both the moon and earth are the same.

"Based on this, we will be much closer to proving the theory that the moon ultimately came out of the earth."

Congressman George P. Miller, Kay Coffee and Bonnie Biggs of Fairfax high school science club, and Dr. Goett.

Dr. Goett Presents Certificate To Fairfax High Science Club

"It is with a feeling of envy that I contemplate what the young and eager citizens of today will see and do in their life span. Has there ever been a generation that could so confidently contemplate the scientific and engineering advances in which they will be privileged to participate?"

Dr. Harry Goett, Goddard director, last week told members of the Washington Science bureau who met to recognize 50 top high school students who participated in a summer science seminar conducted at Fairfax high school.

Dr. Goett was keynote speaker at a luncheon meeting where he presented a certificate of appreciation to representatives of the school science club.

He also reported briefly on the Center's activities in the scientific exploration of space.

From the vantage point of space, some 18 experiments have acquired new knowledge—knowledge which no longer fits accepted theories and which causes scientists to reexamine their assumptions and search for new explanations, he said.

"The terrible tragedy of science is the horrible murder of beautiful theories by ugly facts, and new data obtained in space has greatly increased this murder rate," he said. "The real story of the space age is the flow of new information which it produces."

"We need well trained scientists to analyze the data which we are gathering," he explained.

Referring to NASA's college grant program which has been inaugurated in ten universities, Dr. Goett hoped that it will have a 'catalytic effect' in the training of a new generation of scientists.

In the science award presentation, Dr. Goett was joined by Congressman George P. Miller, California, chairman of the house committee on science and astronautics, and James Wakelin Jr., assistant secretary of the Navy for research and developments.

Recent Technical Publications Authored By Goddard Staff

Davis, J. F., Hanel, R. A., Stampfl, R. A., Strange, M. A., and Townsend, M. R., "Telemetering Infrared Data From the Tiros Meteorological Satellites," NASA Technical Note D-1293, August 1962.

Musen, P., "Computation of the Perturbations of Nearly Circular Orbits, Using a Non-Singular Set of Vectorial Elements," NASA Technical Note D-1350, August 1962.

Harris, I., and Priester, W., "Theoretical Models for the Solar-Cycle Variation of the Upper Atmosphere," NASA Technical Note D-1444, August 1962.

Cameron, A. G. W., "The Early Chronology of the Solar System," NASA Technical Note D-1465, August 1962.

COMING EVENTS

COLLOQUIUMS: Dr. Ueo Van Wijk, University of Maryland "Modern Astronomy"—Lecture 6 of six lectures
Aug. 30 10 a.m. Aud. Bldg. 3

MISCELLANEOUS:
Goddard Astronomy Club
Sept. 5 12 p.m. Aud. Bldg. 3
Employee Orientation
Sept. 6 8:30 a.m. Aud. Bldg. 3
3rd or 4th Polio Shot
Sept. 10 schedule Rm. 33 Bldg. 1

PUBLIC AFFAIRS:
Labor Day Parade
Sept. 3 10 a.m. Greenbelt, Md.
Prince Georges County Showcase Fair
Sept. 6-9 Upper Marlboro, Md.

New Activity—Goddard Grows in Many Directions

EARTH WORK PREPARES way for foundation of Building 11.

Work Begins on Construction Of Applied Sciences Building

Boom! Boom! Boom! Goddard is growing again! And when Goddard grows, the motors whir.

An array of heavy equipment —tractor-drawn scrapers, bulldozers and chain saws—moved in last week for a $1,975,600 construction job to add Building 11 to Goddard's roster.

Faced with considerable winter work, the schedule calls for two weeks of clearing and excavation work of the 18-acre tract, followed by stripping and stockpiling of top soil, and foundation work.

According to Phil Miller, chief of the facilities engineering division, first signs of the building structure should be evident in about three months.

"We want to get as much of the foundation and building superstructure done before winter as possible."

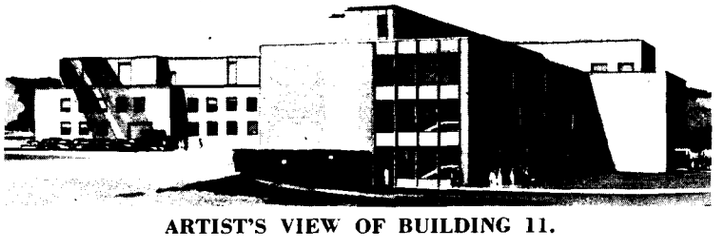
When the building is ready for partial occupancy in mid-June, 1963, it will house about 350 scientists, technicians and supporting staff.

Located behind and identical to Building 6, the three-story applied sciences laboratory will be a reinforced concrete frame structure faced with bricks. Also included in the construction will be a road to the building and parking areas for 397 cars.

An estimated 200,000 bricks — enough for a 6-foot-wide sidewalk a mile long — and 4,000 cubic yards of concrete—enough for a sidewalk seven miles long—are required for the construction.

A temporary access road from Greenbelt road into the construction area is helping the contractor, Norair Engineering Corp. of Washington, in bringing in equipment, materials and supplies.

Final completion is scheduled for late July, 1963.



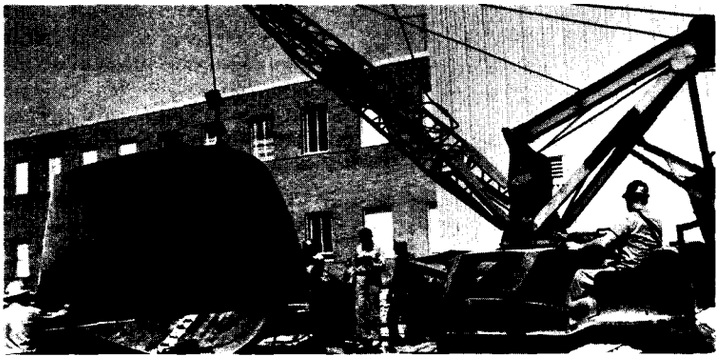
ARTIST'S VIEW OF BUILDING 11.

New Boiler At Power Plant

The two boilers now housed in the central power plant have been joined by a third 700-horsepower boiler.

Capable of producing 33,000 pounds of addition steam per hour, the new boiler will supplement the heating and cooling of buildings now occupied and new buildings under construction.

"When the new boiler is operational, the three boilers will have the capability of producing 90,000 pounds of steam per hour," said Don Forgan, foreman in the central power plant.



SEVENTEEN ALUMINUM SECTIONS weighing 1,000 pounds each will form inner shell of 64,000-gallon tank. Sections resemble orange peel as the tank is being erected at Bldg. 10.

New Nitrogen Tank Arrives; Another Is Being Erected

A giant steel tank that required two railroad flat cars and a month to move from Los Angeles to Goddard will soon provide the Center with a central source of liquid nitrogen.

Capacity of the tank, which is essentially a large metal thermos bottle, is 28,000 gallons or about 100 tons of liquid nitrogen. It is located behind Building 7 and soon will be joined by a 64,000-gallon tank also being constructed at Building 10.

The 64,000-gallon tank is undergoing on-site construction because of its size.

When completed by fall, the tank will weigh 75 tons (200 when filled) and consist of an outside shell 28 feet in diameter. The inner shell or sphere will have a 26-foot diameter.

According to Bill Kitts, of the thermodynamics branch, test and evaluation division, the new tanks will meet the increased demands for liquid nitrogen throughout the Center.

The 28,000-gallon tank weighs 50 tons empty (150 when filled) and will pipe its contents into Building 7 to serve space simulation and test chambers located there. The tank will retain the extremely cold liquid nitrogen (—320° Fahrenheit at atmospheric pressure) in the liquid state until it is required.