GEOPHYSICS

# Years of the Quiet Sun

**Since the days of the sun-worshippers, man has probed the sun's secrets; as the New Year starts, more than 60 nations are cooperating to study our life-giving star at solar minimum.**

By ELIZABETH HALL

**See Front Cover**

➤ WHAT HAPPENS on earth and in outer space when the turbulent sun "quiets down" is today's leading question for geophysicists all over the world.

The sun never really quiets down completely, but it is now near the low point in its 11-year cycle. In order to better understand the effects of the sun at this time, scientists from more than 60 nations will orbit satellites, including observatories, fire rockets, launch balloons and watch the sun daily through telescopes, as well as conduct many observations at regular geophysical observatories.

Of particular interest during the International Years of the Quiet Sun (IQSY) program is the part satellites will play.

Some of the spacecraft that will have an important role in the program are EGO (Eccentric Orbiting Geophysical Observatory), IMP (Interplanetary Monitoring Probe), OSO (Orbiting Solar Observatory), POGO (Polar Orbiting Geophysical Observatory), PIQSY, a Pioneer-type spacecraft, and Mariner R, which will carry a probe to Venus.

The IQSY begins Jan. 1, 1964 and will last until Dec. 31, 1965. During that period the effects of the sun's minimum activity on the weather, auroras, airglow, magnetic field, ionosphere, cosmic rays and many other phenomena will be studied.

## Sunspot Cause Not Known

Astronomers measure the sun's activity in terms of the frequency of spots that daily freckle the sun's face. No one knows what causes sunspots. Scientists do know they are associated with other solar disturbances, for example, flares, which produce intense X-radiation and sometimes streams of high-energy particles. Occasionally these streams of particles are showered upon the earth, causing a large-scale ionospheric-geomagnetic storm. The atoms in the upper atmosphere may be induced to give off light, causing the glow known as the aurora. These after-effects of a sunspot may also interfere with long-distance radio communications that depend upon the earth's radio reflecting mirror, the ionosphere.

What a sunspot looks like through a 12-inch refracting telescope at 80,000 feet above the earth's surface is shown in the photograph on this week's front cover, taken from a balloon as the sun was approaching its low point in the 11-year cycle of solar activity. Magnetic lines of force can be seen near the rim of the sunspot.

Sunspots usually reach a peak of maximum activity every 11 years. The International Geophysical Year (IGY) in 1957-58 was held during the last solar maximum. That cycle is now ending and a new one beginning that is expected to reach its peak in 1968.

The IQSY is not the first attempt to study the earth at a period of solar quiet. During the First International Polar Year in 1882 the sun was studied at maximum activity and during the Second International Polar Year in 1932-33, at minimum activity.

## Complete Atmosphere Picture

During the upcoming IQSY, astronomers hope to obtain a more complete picture of the earth's upper atmosphere from about 12½ to 60 miles up. The United States program in meteorology includes an extension of the conventional balloon program—the Meteorological Rocket Network (MRN) for carrying sensors into the high atmosphere. Advanced weather satellites will expand current satellite coverage of the lower atmosphere.

One meteorological aim is to study more closely the link between the weather and the amount of ozone in the stratosphere. The ozone content is important since it shields life from the destructive effects of ultraviolet radiations. Other objectives of the program concern the atmospheric distribution of radiation, water vapor, electricity, the infrared spectrum of energy and the "solar constant," the amount of radiant energy reaching the earth.

In the area of geomagnetism, geophysicists will attempt to explore, determine and map the shape of the earth's magnetic field, while solar disturbances disrupting the magnetic field are at a minimum. The magnetic field governs the auroras, electric current systems, ionospheric winds and other magnetic phenomena.

Since advances in rocketry have made it possible for man's instruments to travel beyond the earth's magnetic field, scientists can follow a geomagnetic disturbance from the beginning as the plasma approaches earth and interacts with our magnetic field. During the IQSY, interplanetary space probes will be used to study the fringes of the earth's magnetic field as well as that of Mars, Venus and the moon.

## Behavior of Aurora

Auroral studies planned during the IQSY will compare the occurrence and behavior of auroras at solar maximum with solar minimum. All-sky camera networks situated in a ring around the north and south poles, visual observers and satellite instruments will be used to help draw a clearer picture of auroras in terms of time and space.

Scientists at the National Aeronautics and Space Administration's Goddard Space Flight Center plan rocket flights directly into the auroras, whereas other space probes will gather information on plasma composition, magnetic fields, and slow and fast particles coming from the sun and contributing to the aurora.

The airglow and the earth corona are faint, permanent luminescent phenomena that cover the sky day and night, arising from chemical processes in the upper atmosphere of the earth. A much-needed study involving the Lyman-alpha glow from the hydrogen corona of the earth is the leading objective in the airglow area.

Scientists also hope to gain direct information on the flow of the solar wind past the earth. The day and twilight airglow will be observed from the ground, while rocket flights will determine the height of particle emissions from the airglow.

Using many powerful new tools that have been developed since the IGY, geophysicists will again probe the ionosphere. One new method, for example, is the use of satellites such as the Alouette to explore and monitor the upper atmosphere.

While solar activity is at a minimum, geophysicists will complete their study of whistlers, signals originating from lightning discharges and propagating through the magnetosphere, and ionospherics, signals of unknown origin coming from the region of the magnetosphere. By understanding the ionosphere better, scientists hope to be able to improve radio communications over long distances.

## Surveillance of Planets

In the field of radio astronomy, workers at the University of Florida will begin a radio surveillance of other planets, especially Jupiter, which is believed to have great zones of magnetically trapped radiation.

During the IQSY, scientists are not only concerned with the earth and the surrounding atmosphere. An extensive program is planned to study the sun and the interplanetary medium. This medium consists of neutral gas and low-energy plasma that originates on the sun and travels through space.

Astronomers will study the zodiacal light (sunlight scattered by particles in space) and the cislunar gas (the gas between the earth's ionosphere and the moon) among other things.

The international warning network initiated during the IGY will again serve to warn of any unusual occurrences on the sun that would have repercussions on the earth, as well as to give notification of extreme solar or geomagnetic quiet. With new orbiting solar observatory spacecraft and high power radar, scientists hope to learn the complete history of a solar disturbance, since these events are expected to occur separately during IQSY.

Also found in the atmosphere and outer

space are the high-energy streams of charged particles called cosmic rays. Under quiet sun conditions, cosmic ray instruments will be invaluable in exploring the zones of charged particles trapped in the earth's magnetic field. These trapped particles were discovered during the IGY, and their relation to solar disturbances as well as how they entered the atmosphere in the first place are still largely unknown. Cosmic rays are also valuable in studying the basic nature of the interplanetary medium of our solar system, which can best be done during solar minimum. The lowest energy cosmic rays reach the earth only during times of solar quiet.

The last general area of research in the IQSY is that of aeronomy, the science of the physical, chemical and electrical properties of the atmosphere. The nature of the true "undisturbed" atmosphere can only be studied during solar quiet.

Geophysicists hope to enlarge their knowledge of solar radiation—and consequent ionization—electron density, interplanetary dust, ionospheric winds and the temperature and density structure of the atmosphere.

The experiments and programs mentioned in this story are only a fraction of the research planned for these two years. The information accumulated by the individual countries will be exchanged through the world data centers, located in the United States, the Soviet Union, several countries in Western Europe and Japan.

A special calendar for the two years has been established. It will operate on universal time (0000 UT to 2400 UT), and includes designated special days of the week and special seasonal intervals for concentrated study. Regional warning centers, established during the IGY, will alert the scientific community to any unusual geophysical events such as magnetic storms, cosmic ray events or solar flares.

The National Science Foundation is the official Government agency for supporting special IQSY projects and collating the efforts of various Government agencies under its coordinator, Dr. Robert Fleischer. NSF operates in conjunction with the National Academy of Sciences IQSY Committee, responsible for the overall U.S. program and representation in international programs.

• Science News Letter, 84:362 Dec. 7, 1963

INVENTION

# Patents of the Week

➤ A CHEMICAL METHOD for protecting the world from radioactive waste materials earned patent 3,110,557 from the U.S. Patent Office.

The process was invented by Marshall L. Spector, head of exploratory research in the Research and Development Laboratory of the M. W. Kellogg Company, Jersey City, N. J.

"Radioactive wastes are chemically bound in a stable solid or rock form through a chemical reaction in this process," Mr. Spector told SCIENCE SERVICE.

These artificial rocks then can be stored to allow the radioactivity to decay without great danger to the public.

The process is being seriously considered as a solution to the crucial problem of what to do with the "hot" by-products of nuclear reactors. Mr. Spector's method would treat the wastes with silicon.

Metal oxides, which may either be found in the radioactive wastes or added separately, react with the silicon to form an insoluble silicate rock, thus trapping and binding the radioactive material permanently. Rights to the patent were assigned to Mr. Spector's firm.

## Blood Gas Analyzer

A newly-patented instrument measures gases and anesthetics in blood and can also help determine the quality of such liquids as water, orange juice and hydrocarbons.

The U.S. Patent Office issued patent 3,111,390 for this apparatus, 150 of which already are in laboratory use all over the United States.

Made by the Fisher Scientific Company of Pittsburgh, Pa., the device is known commercially as the Fisher Clinical Gas Partitioner. It was invented by Billy W. Taylor, a Fisher employee in charge of the clinical instrumentation section of the research and development laboratory.

The amount of oxygen, nitrogen, carbon dioxide and carbon monoxide present in blood is analyzed automatically by gas chromatography instead of gas analysis by the traditional Van Slyke technique. The older method requires a highly-skilled operator and eight to ten time-consuming operations.

In the patented apparatus, the operator introduces a small sample of blood into a reaction chamber where the gases are extracted automatically. An inert gas, such as helium, carries the blood gases into two columns where they rise at different speeds. A detector tells the different gas concentrations in the blood.

## Other Significant Patents

Other patents include:

A tiny plunger to unclog openings in salt and pepper shakers and other similar containers for which radio and television entertainer Paul Winchell earned patent 3,110,424. At the same time he received patent 3,110,501 for laminated disc pad phonograph records. Rights to both patents were assigned to his corporation, Chelwin Productions, Inc., of New York.

A means for spreading insecticide by storing it around a bomb which is then set off for which Michael D. Barber of Brunswick, Ga., was awarded patent 3,110,256.

A human body heater for hunters and other persons exposed to cold for a long period which earned patent 3,110,301 for Lewis J. Bricker of Waynesboro, Pa.

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