ASTRONOMY

# Nature's Fireworks Probed

**The secrets of auroras, or "northern lights," are being uncovered by satellites and human observers to learn how the earth and sun interact, Tove Neville reports.**

➤ THE EXCITING SECRETS of nature's atomic fireworks, the shimmering "northern lights" that blaze across the skies at night, are now being uncovered by rocket probes and human observers.

These magnificent displays of red, green, blue and white light are often seen in the United States as luminous arcs across the northern sky, with rays beaming upward and bright "draperies" spreading to other parts of the sky.

The northern lights, or auroras, are sometimes seen as far south as San Francisco, Memphis and Atlanta, and have even been observed in Mexico City and Cuba. However, they are most likely to be seen at about the 53-degree latitude and most frequently in the middle of the night. The Southern Hemisphere also has its auroras, for the technicolor displays are associated with both the North and South Magnetic Poles.

The light in auroras is believed to be produced by streams of hydrogen ions, or protons, thrown off from the sun at speeds approaching 1,500 miles per second. These protons pull electrons with them and some eventually reach the earth, where its magnetic field separates the electrons and protons.

This produces one of the radiation belts that are detected close to earth. When some of the protons enter the earth's atmosphere, they cause the atmosphere to give off the light astronomers call auroras.

The auroras coincide with solar storms, or flares, which occur near the dark areas called sunspots. When there is little activity on the sun, only few auroras are seen. During times of great sunspot activity, auroras may occur night and day for long periods.

The sunspot cycle from one period of high activity to the next is about 11 years. Every time a period of high solar activity occurs, astronomers and geophysicists study the phenomenon of auroras, trying to confirm their theories or develop new ones.

The most recent intense study was made during the International Geophysical Year from July 1, 1957, to Dec. 31, 1958. Sixty-six countries gathered data about the various phenomena connected with solar activity, and satellite launchings were planned to probe the secrets of the sun and earth. Thus the IGY ushered in the space age.

Studies of the northern lights have been greatly aided by man-made equipment such as satellites, balloons, rockets, cameras, radar and special radio equipment. Information about how protons travel from the sun to the earth and form the radiation belt must be obtained by satellites.

So far the Injun and Explorer XII satellites have carried experiments for measuring protons, and another Injun is scheduled to be launched for further studies. Dr. James Van Allen of the State University of Iowa told SCIENCE SERVICE the experiments are designed to find out if the dumping of trapped particles in the auroral zones comes from the radiation belts already discovered or from separate radiation belts circling above the poles.

Drs. G. Sprague and Carl W. Gartlein of the IGY World Data Center A at Cornell University, Ithaca, N. Y., believe two such radiation belts are located 20,000 miles above each pole. They expect that auroras come down toward earth between these and the equatorial belts.

The scientists said it is known from studies of the light of auroras that the protons come in during the earlier part of an aurora and appear to be gone towards the end. The protons (cores of hydrogen atoms) produce the red and green light seen at the beginning of auroras. Drs. Sprague and Gartlein believe a "storage mechanism" forms nitrogen molecular bands that give off the blue light seen toward the end of auroras.

Although instruments show that the blue occurs late in auroras, only human observers using a blue filter can tell which forms have blue light in them because the eye is greatly superior to any detection system now known. Blue light may be seen in a wide glow or in patches. Blue light in the form of rays has been seen but the blue color is often difficult to see because it blends with the green light or is obscured by moonlight, which makes haze and mist also look blue.

Most of the information about auroras such as form, location, color and motion of the auroral formations comes from human observation. No computer or instrument is yet able to do the work of humans. A very fast TV tube can take an exposure of an aurora in about half a minute in one direction. This means that a TV picture of the whole sky requires about half a mile of graph paper.

Human observers are also invaluable because it would be extremely expensive to set up auroral tracking stations as close

*ALASKAN AURORA—The break-up of an aurora in Alaska was photographed during a study by the National Bureau of Standards and the University of Alaska.*

together as human observers. Therefore a program of visual auroral observations was made a part of the IGY, and the program is still in operation today.

Drs. Sprague and Gartlein, who correlate the material received from observers, have plotted more than 10,000 maps from the observations received during the 18 months of the IGY. Each map covers the time near an exact hour. From these maps the scientists have been able to determine the location of auroras for definite sizes of the magnetic storms of which they are a part. These are the most accurate descriptions of auroral location available anywhere in the world.

Beautiful and awesome as the northern lights may be, the magnetic storms associated with them are a major problem in world communication. Radio, radar, TV and transoceanic telephone connections often are partially or completely blacked out from these disturbances originating in huge solar flares shooting millions of miles into space from the sun.

The disturbances are most severe in high latitudes near the Poles, but any detection system working at high frequencies is affected by a large solar storm. Satellites within 300 miles of the earth are also affected, since their orbital periods are reduced due to the expansion of the earth's atmosphere.

Observers of auroras can contribute important information by watching auroral effects on radio and TV. The IGY scientists report that even before an aurora begins, radio signals broadcast from the Ithaca station at 1620 kilocycles and from Washington, D. C. (WWV), at five megacycles become more difficult or impossible to receive, indicating an aurora is present. When neither station can be heard, the aurora is nearly overhead.

The scientists say information about such radio disturbances from observers may be the only warnings they have of auroras on cloudy nights or during the day when auroras cannot be seen. The interference operates on radio signals from the top of the AM dial, about 1400 kilocycles, to between two and 19 megacycles.

Magnetic disturbances occurring with auroras can also be detected at higher frequencies from 20 to 40 megacycles and on FM radio and TV signals. However, here the opposite effect occurs. Because such signals generally go in a straight line and so cannot travel beyond the horizon, they usually disappear after traveling a short distance. But when an aurora occurs, large numbers of electrons created in the atmosphere can reflect the signals from great distances, and stations unusually far off can be picked up. Signals from nearby stations during auroras are not so good, and black lines are seen on the TV screen when auroras occur.

Two types of auroras have been observed, one which does not move but stays in Canada and one which moves south and is associated with large magnetic storms. As the sunspot activity comes to a minimum in 1964-65, large auroras will become very rare.

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