SOLAR OBSERVATORIES

One more in the line

Swinging into high gear this week is the fifth in one of the National Aeronautics and Space Administration's most complex satellite series, the Orbiting Solar Observatories. Launched Jan. 22, OSO-5 carries eight experiments from the United States, England and France to study the sun by X-ray, ultraviolet and gamma radiation, as well as the earth's airglow and the zodiacal light that results from the sun's reflection off tiny particles of matter concentrated in the plane of earth's orbit.

Last week, as the final experiment was turned on, scientists at the NASA Goddard Space Flight Center jubilantly proclaimed their bird a success.

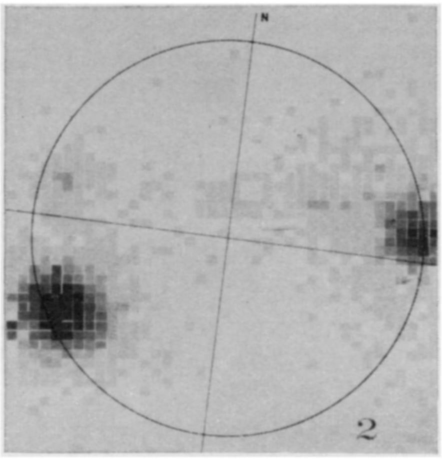
The OSO series has been both successful and valuable ever since it began with the launch of OSO-1 on March 7, 1962. Operating for almost three times its intended six-month lifetime, OSO-1 made its mark by clearly establishing that, at least in the extreme ultraviolet range, changes in the solar corona often indicate active regions below them on the sun's surface.

It also showed scientists that there was more to be learned about the sun's effect on earth's atmosphere. The difference in temperature between sunrise and sunset, for example, was revealed to be less than some existing models of the atmosphere had indicated.

The second OSO, though troubled by electrical arcing and stray light, specialized in airglow, the bright haze caused by sunlight diffusing around through earth's atmosphere. By analyzing reams of OSO-2 data, scientists determined that at least 80 percent of the visible airglow is produced in a layer some 56 miles above the earth, and that seen from above that layer, the brightness of the sky changes relatively little. Some researchers had previously concluded that brightness changes of as much as 30 percent might take place over days or weeks. However, the airglow was found by OSO-2 to undergo much smaller day-to-day variations, in both brightness and color, seemingly unrelated to latitude, longitude or time of night.

The only failure in the series occurred on Aug. 25, 1965, while OSO-2 was still working. A prematurely firing rocket stage kept what would have been OSO-3 from ever getting into orbit; a replacement was launched March 8, 1967.

The new OSO-3, however, has been the star of the program, and is still working after almost two years aloft. Among its experiments is a grating spectrometer that can be set to pick out the characteristic lines of a single element from the solar spectrum, and observe them over a period of time. By studying the resulting light curves, scientists are probing the mechanism of energy transportation in the solar corona, a basic element in the sun's behavior.



American Science & Engrg.

OSO-4 mapped the sun by X-ray.

The same satellite has measured the absorption of solar ultraviolet radiation by earth's atmosphere, and enabled these data to be correlated with altitude, season and latitude, all important in the overall picture of the atmosphere's behavior, climate and even short-term weather.

The probe is also acting as a watchdog for researchers at the Environmental Science Services Administration's Solar Flare Warning Network, designed to alert astronauts to streams of dangerous high energy particles.

Though OSO-3 is some 23 months old, data from one of its experiments are just beginning to be interpreted. A detector on the satellite is hunting sources of hard gamma rays, those with energies higher than 50 million electron volts, as a clue to galactic structure and evolution. Because the experiment picks up only about one photon of energy per day from the sky, compared to about 200 per day as background noise from the earth, observations of several years' duration are required, though the experiment has already revealed that the influx of hard gamma rays is only about a third as great as was previously believed.

Only seven months after the launch of its predecessor came OSO-4. By far the most ambitious satellite of the four, it includes among its experiments a monitor designed to chart the X-ray background level around the entire world. Another experiment is a study of the eclipse of the sun by earth's atmosphere. Correlated with this study, and with it providing valuable information on the behavior of the ionosphere, is the monitoring of fluctuations in a particular line in the solar spectrum (the helium II, Lyman-Alpha, 304-angstrom line) which is believed to be primarily responsible for atmospheric heating some 124 miles above earth's surface.

OSO-4's most unusual contribution, however, has been a scanning device which has enabled it to map the sun by X-ray, rather than merely measuring its overall output. As the satellite sees the sun again each time it orbits the earth, scientists can watch areas of X-ray activity move across the solar face, providing an unprecedented first-hand view of the sun's ceaseless shiftings.

The newest member of the series, OSO-5, does a little of everything. Besides watching the sun by X-rays and ultraviolet light, it is monitoring zodiacal light, terrestrial airglow and stellar gamma rays. At least two more Orbiting Solar Observatories are planned, one of them late this year and one in 1970. The space agency would like to fly them as late as 1973 if possible, to carry out the program's goal of watching the sun throughout an entire 11-year solar cycle.

SHOREBOUND

Vibration aboard the Queen

Britain's promising new ocean liner, the Queen Elizabeth 2, is generally considered a fine ship, having high standards of comfort and service. But deep in the engine room there has been trouble enough to keep her off the seas.

In each of the liner's two turbines a row of blades—the same row in each—has been severely damaged; vibration seems to be the main cause.

As with land-based turbines, those in the Cunard ship are simple in principle though complex in design. They function rather like a windmill. Jets of hot steam force aerofoiled blades to turn a shaft at high speed. The shaft drives a propeller.

Since a single row of blades could not absorb all the available steam energy, repeated rows of blades are provided. Batches of blades, each of a different size, operate at different pressures; the smallest blades are subjected to the highest pressure, the next to an intermediate pressure, and the largest to the lowest pressure. These are the three stages of the turbine. In the Elizabeth 2, it is the last row of blades in the first, or highest-pressure, stage, that has been damaged. The steam at this stage is at a temperature of 500 degrees C. and at a pressure of 800 pounds per square inch.

The force exerts high stresses on the blades and can cause them to vibrate. They can vibrate tangential to the shaft, axially or in a twisting mode