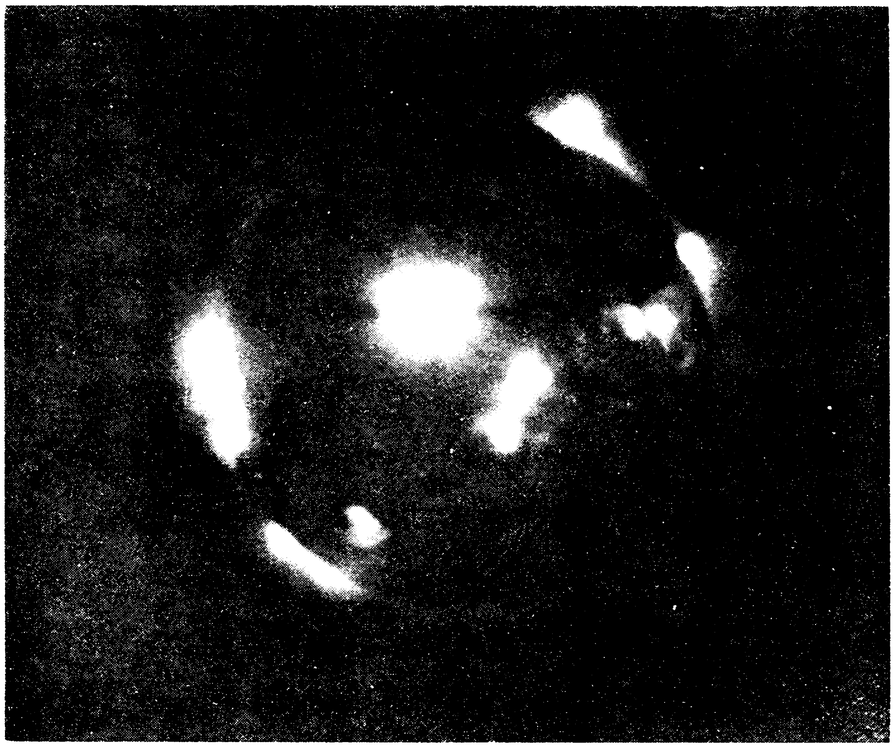
SOLAR PHYSICS

The sun in X-rays



American Science and Engineering

Solar flare in X-rays: first sharp pictures were taken at 90-mile altitude.

The first high resolution images of the sun in X-rays while it was in the process of flaring were made in a rocket-borne experiment on June 8.

The solar X-ray pictures, taken at an altitude of more than 90 miles during the occurrence of a class-one solar flare, show structural details down to a few seconds of arc, one second being the apparent diameter of a penny from two and a half miles.

Data from the experiment by scientists from American Science and Engineering, Inc., in Cambridge, Mass., reported in the Aug. 9 SCIENCE, represent the first results on solar X-ray emission obtained with techniques and hardware which are being developed for the Apollo Telescope Mount program.

The launch from White Sands Missile Range in New Mexico, planned for several months, had been ready to go for days, awaiting a flare.

The rocket payload was launched within three minutes after project director Dr. Guiseppe Vaiana and his co-workers received word from astronomers that a flare had begun. Twelve pictures were taken with the nine-inch X-ray telescope.

The X-rays observed in these photographs were emitted by plasmas having temperatures of several millions of degrees. Loops connecting active regions on the solar surface were found to extend some 150,000 kilometers into the corona, much farther than many scientists had believed.

Comparison of the X-ray photographs with those taken from earth's surface in the red radiation of hydrogen alpha showed that all regions active in the latter wavelength have brightened counterparts in the X-ray pictures.

The AS&E scientists found evidence for the dominant role played by magnetic fields in the storage and release of energy in the solar atmosphere. They also found that the X-ray flare developed along a neutral magnetic field line.

FREQUENCY SHIFT

Mass and radio waves

An unpredicted decrease in frequency of a radio wave when it passes near a large mass has been discovered by scientists at the Naval Research Laboratory.

There are two known effects that can decrease frequency. One is the Doppler shift, which occurs as a light or radio source moves away from a stationary observer. The other is the gravitational red shift, a decrease in frequency due to the gravitational field of the source.

The NRL scientists, Drs. Dror Sadeh, on leave from the Universities of California and Tel-Aviv, Stephen Knowles and Benjamin Au, report two experiments that indicate there may be a third effect.

In the first experiment, 21-centimeter radiation from the radio source known as Taurus-A was observed for a few days around the time it passed behind the sun, as it does each June. Their results indicate a decrease of the frequency when the optical path approaches the sun.

"If the Taurus-A experiment showed a genuine change in frequency and if this change is caused by the mass of the sun, such a decrease must manifest itself in an experiment on the surface of the earth. It is sound logic to assume that if a mass affects the frequency, the effect will be greater the longer the rays are under the influence of the mass," the experimenters say in the Aug. 9 issue of SCIENCE.

Based on this reasoning, the NRL scientists used the ticks of two atomic clocks as an earth-bound frequency standard to measure the change in a radio signal at varying distances. One clock was kept at Cape Fear, N.C., and the other was placed on a truck.

Ten miles apart, the rate of the clock on the truck was found to be higher than the frequency of the radioed ticks from the Cape Fear clock, setting a base.

The truck was then moved to Elizabeth City, 270 kilometers from Cape Fear—thus increasing the amount of the earth's mass between the clocks—and their rates were again compared. There they found the frequency of the clock on the truck had decreased. Although still higher than the Cape Fear clock, the difference wasn't as much. Monitors checking both clocks found that their ticking rate hadn't changed, so the shift in frequency had to be attributed to a shift in frequency of the signals that transmitted the ticks between the two clocks.

As they went farther and farther away from the transmitter, the mobile clock's frequency (or the rate of its ticks) dropped lower and lower compared to the Cape Fear signals. The last place tested was Yarmouth, Nova Scotia. The truck was then driven back to the starting place 10 miles north of Cape Fear and the two clocks compared again. The frequency difference after the 3,000-kilometer journey turned out to be the same as it was at the beginning of the experiment.

There is no known explanation either for the Taurus-A or for the Nova Scotia results.

Dr. Sadeh and his co-workers conclude: "We are aware of the enormous theoretical difficulties implied by the apparent results and of the need to seek further confirmation."

During August they are measuring the pulsed radiation from Pulsar CP-950 to see if they can detect a change in its frequency as this source approaches the sun.