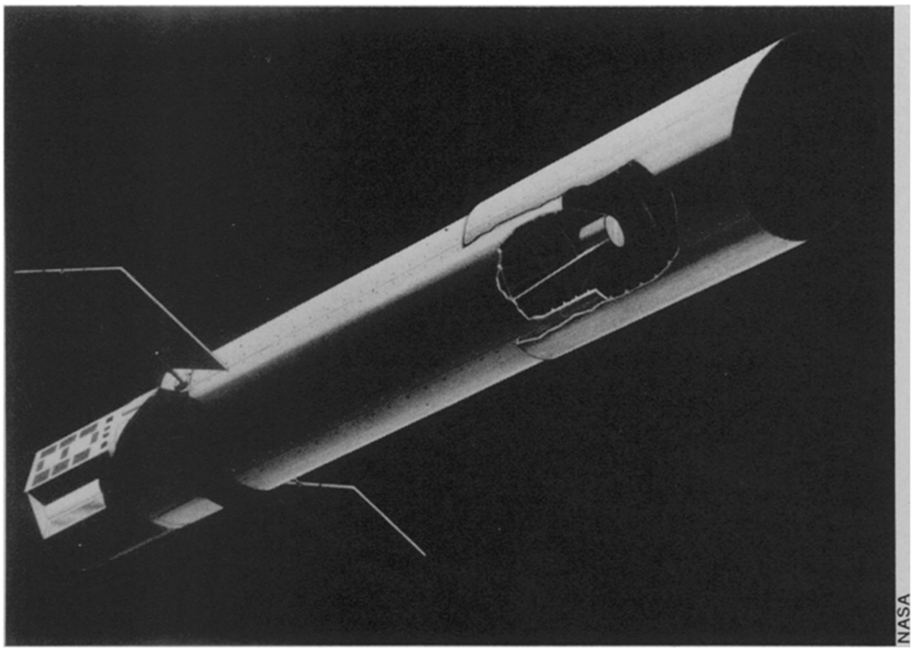
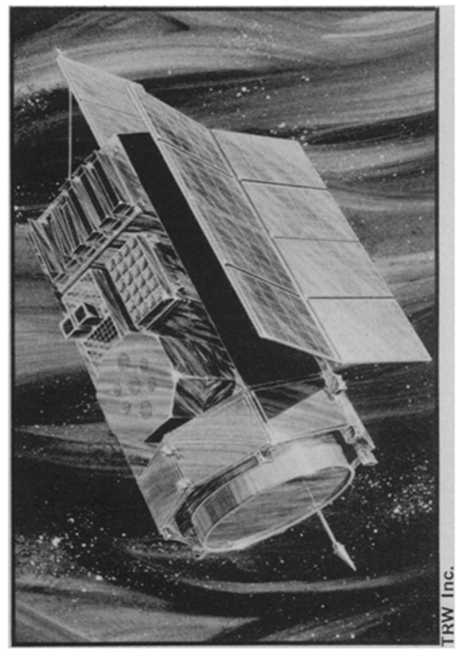
STARWATCH FROM SPACE

Astronomy by satellite, free from the blanket of atmosphere, faces an intriguing future

by Jonathan Eberhart



The Large Space Telescope may find objects far dimmer than any seen before.



HEAO-A will probe the X-ray spectrum.

It used to be that the astronomer's domain was limited by the size of his "windows"—the parts of the electromagnetic spectrum that could get through earth's atmosphere from sources deep in space to observers on the ground. The entire X-ray sky, much of the infrared sky and the ultraviolet sky below about 20 angstroms were simply off-limits to earth-bound astronomers. Balloons, aircraft and sounding rockets have helped in getting the blinders off, but the major breakthrough has been the advent of star-gazing from orbit: satellite astronomy.

The Orbiting Astronomical Observatory satellites and their small companion Uhuru have already given scientists a virtually new sky to look at, while Skylab's observatory, called the Apollo telescope mount, opened new horizons in the study of the sun. Looking toward the future, the National Aeronautics and Space Administration is studying plans for satellites as far downstream as the 1990's, ranging from a tiny polyhedron weighing only 620 pounds to huge robot laboratories as much as 58 feet long and weighing almost 23 tons.

Already built, and scheduled for launch late this year, is Helios (SN: 8/3/74, p. 74), designed to follow a path that will take it closer to the solar disk than any previous man-made object to study the sun and the space around it. Helios 2 will follow about 18 months later.

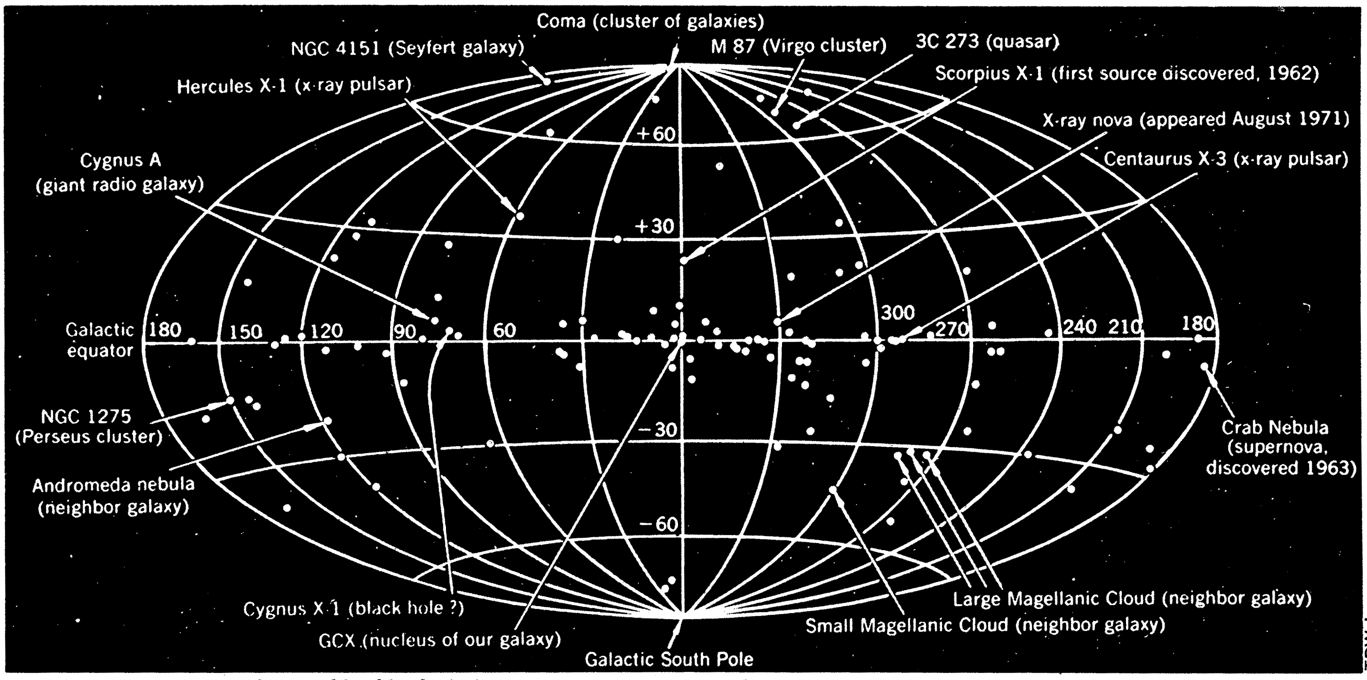
Solar observations from space have so far been primarily those of Skylab, some of the Pioneer deep-space probes (ancestors of Pioneers 10 and 11, which were sent to Jupiter) and a series of complex, heavily instrumented satellites called the Orbiting Solar Observatories. Starting in 1978, NASA hopes to follow up the OSO program with a series of probes based on the OSO design but about 50 percent heavier and carrying about 50 percent more instrumentation. To be launched at two-year intervals, the new sun-watchers would be placed in 315-mile-high circular orbits (where they could be serviced and refurbished by the space shuttle), armed with telescopes, spectrographs and other instruments to study X-ray, ultraviolet and gamma-ray emissions from specific solar phenomena such as the interactions between the corona and chromosphere. As with the OSO group, the series is timed to begin at a period of maximum solar activity.

The sun will also be a research target of Spacelab, the European, sometimes-manned laboratory module that will be the entire payload of many of the space shuttle's missions, beginning in 1980. Spacelab will also double as a testing facility to check out new instrument designs for what is now the biggest solar project in NASA's thinking for the rest of the 20th century: the Large Solar Observatory, or LSO.

The LSO, as it is presently envisioned, will be a behemoth, a 58-foot unmanned cannister packed with more than four tons of scientific equipment for extremely high resolution studies. The huge satellite would be launched and periodically serviced by the shuttle (as will most post-1980 satellites), possibly as early as 1985.

Most of what these various sun-watchers will "see" was completely inaccessible before satellites came to the astronomers' aid. Already in the final design stage, for launch beginning in 1977, is the first of a series known as HEAO (SN: 8/10/74, p. 88), the High-Energy Astronomy Observatory satellites. They will investigate the entire sky by X-ray radiation, formerly the least-known part of the spectrum.

Originally there were to have been two huge satellites in the series, each weighing in at about 25,000 pounds. In January 1973 NASA temporarily shelved the program while it sought ways to meet its tightened budget. One way, NASA decided, was to break down the two big probes into three smaller ones. This would not only save money on the satellites themselves, but would allow them to be launched by smaller, less



Pulsars, quasars and possible black holes were among more than 100 X-ray sources charted by the Uhuru satellite.

expensive Atlas-Centaur rockets, rather than the powerful Titan 3E's previously planned. As a result, TRW Inc., which had designed the original HEAO, had to start over almost from scratch, parceling out the planned experiments into three satellites each weighing less than 7,000 pounds.

The first HEAO will be a scanner, instrumented to locate and evaluate X-ray sources over as much of the sky as possible. A year later, a second HEAO will take off, equipped with a high-resolution, grazing-incidence X-ray telescope to make detailed studies of the most interesting of the sources spotted by its predecessor. A third will follow at last to do another wide-ranging sky survey, this time by cosmic-ray and gamma-ray emissions.

After astronomers have had a few years to digest the information, a series of much larger (18,000-pound), advanced HEAO's is planned, possibly beginning in 1982 and orbited by the shuttle. These would expand the study to include extremely heavy cosmic rays, very-high-energy gamma ray sources and even antimatter, using much more elaborate instrumentation such as superconducting magnetic spectrometers and total-absorption nuclear cascade counters.

Augmenting the later HEAO's in 1983 and 1986 may also be a pair of large probes built essentially around a single instrument: a large, focusing X-ray telescope, with an exhaustive instrument array mounted at its focal point.

Spacelab will again have a role to play in X-ray studies, but the real giant in NASA's future planning is a huge, automatic cosmic ray laboratory, a 1987 outgrowth of the HEAO's, which would be one of the largest unmanned satellites of any kind ever put in orbit. The 45,000-pound monster, filling up more than 6,000 cubic feet of space plus antennas, would be concerned with the charge and energy spectra of cosmic ray nuclei, energy spectra of high-energy electrons and positrons, isotopic composition of light elements, and the detection of nucleonic antimatter and extremely heavy nuclei. The giant lab would be expensive, however, and may end up as several smaller satellites or as parts of the advanced HEAO's.

One of the instruments longest sought by astronomers is a large radio telescope in orbit around the earth, which could provide both freedom from atmospheric distortion and the stability of weightlessness, important for such tasks as long-base interferometry. NASA is considering the possibility of just such a device, consisting of a huge, loop-shaped antenna perhaps several thousand feet on a side, held in the shape of a giant parallelogram by four individual satellites, one at each corner, all launched in a single flight of the space shuttle. Envisioned for as early as 1985, it would require an additional push from some kind of secondary booster to carry it from the shuttle's relatively low altitude to its planned distance of more than 45,000 miles from the earth.

Not all of NASA's future astronomical ideas call for ever-larger satellites, however. Far down the line, in 1988, is the possibility of what the agency terms an "interstellar spacecraft." Weighing only 620 pounds, it would be launched outward from earth on a path calculated to take it as far as possible from the influence of any planets, moons or asteroids. Equipped with mass spectrometers and other instruments, it would try to measure the characteristics of interstellar space, undisturbed by planetary magnetic and gravitational fields.

With all this speculative attention being paid to invisible targets such as X-rays, visible light has not been completely neglected. The Large Space Telescope, a 41-foot tube housing a mirror some 10 feet in diameter, is now being planned for 1981, again to be left in orbit by the space shuttle. The 11-ton instrument will float in its orbit, with six instrumentation bays in which succeeding shuttle crews can reload, repair and replace numerous scientific experiments. As the first large optical instrument ever to be free of the muffling blanket of atmosphere, it is expected to be able to detect galaxies and other objects one hundredth as bright as can be seen by even the largest earthbound optical instruments. Its high resolution will make it capable of long-term monitoring of storms and other atmospheric phenomena on other planets of the solar system.

At present, a decision on preliminary funding for the telescope is awaiting the resolution of some Congressional opposition. Among NASA's concerns, astronomy would seem to be one of the most closely related to the space agency's activities, but the initiation of new astronomical research programs has been playing second or third fiddle in recent years to larger, more expensive commitments such as the Viking Mars mission. The Large Space Telescope is expected to survive anyway, but astronomy officials at NASA say that it will probably be about 1976 before they can begin to look with some confidence toward a growing future for star-gazing from orbit. □