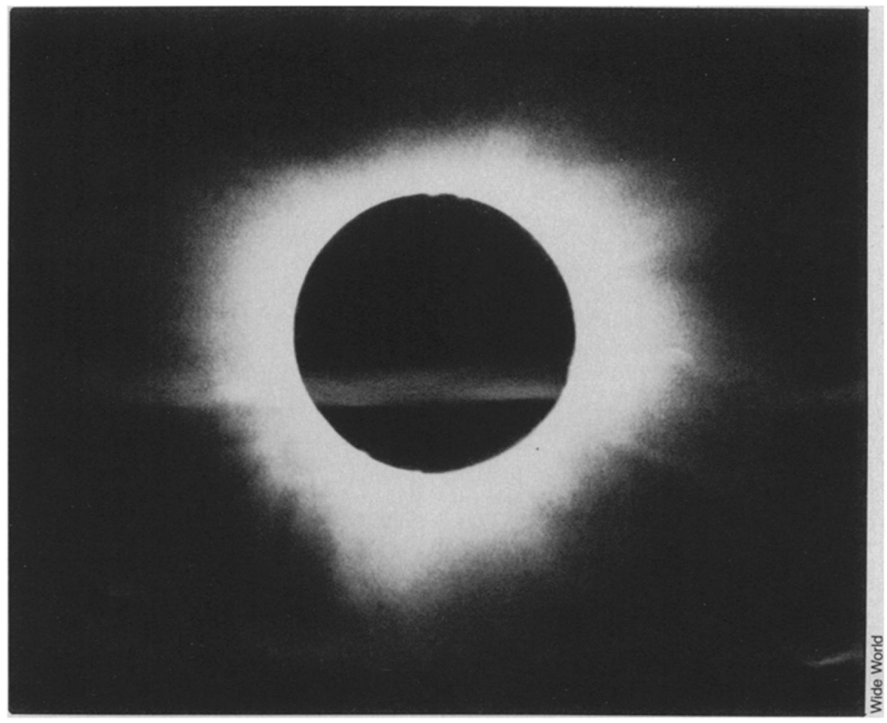
THE LAST ECLIPSE

Thousands of scientists, amateur scientists, spectacle followers and commercializers made the most this week of the final opportunity of this century to experience a total eclipse of the sun over North America

BY JANET HOPSON AND MICHAEL ROGERS



Totality: The clouds broke for a few seconds over Olympia, Wash.

Monday's total eclipse of the sun over the northwestern United States and central Canada was similar to, and yet unique from, past eclipses: It provided its viewers the same spectacle as the thousands of recorded eclipses before it, as well as the opportunity for modern atmospheric and astronomical data-gathering. But the continental United States' last total eclipse of the century was distinguished by unusually large numbers of observers, by the tension it caused many of them (due to overcast skies) and by a high degree of publicity and commercialization.

Several million viewers, both in person and via television, witnessed the partial eclipse phases and the relatively short periods of totality along the 1,200-mile-long eclipse track. The moon's full shadow crossed numerous population centers, including Portland, Salem, Yakima, Great Falls, Butte, Helena and Winnipeg. Many amateur and professional astronomers, as well as two major television networks, chose as their viewing base Goldendale Observatory, near the Columbia River in south-central Washington State.

The population of that small rural town tripled in 24 hours, as nearly 6,000 people arrived in cars, buses, recreational vehicles and even helicopters to set up their viewing equipment — everything from large telescopes and filtered cameras to 50-cent aluminized mylar "sun peeps." Fully 1,700 of those viewers amassed on the grounds of the small private observatory — a crowd eight times larger than any event had previously drawn there, including the 1918 total solar eclipse (which, coincidentally, also passed directly over Goldendale).

Enterprising townspeople met the influx with all manner of eclipse souvenirs, including shopping bags, bumper stickers, glow-in-the-dark T-shirts, commemorative medallions and a mysterious product called "canned darkness." Unfortunately, the weather at Goldendale was not so accommodating. Located in the rain shadow of the Cascade Mountains, the observatory had been assigned the highest probability for clear skies in Oregon and Washington, surpassed only by points in the frigid northern plains. Rainy skies on Sunday broke into scattered clouds on eclipse morning, and several stages of the partial eclipse were plainly visible. But a patch of alto-cumulus clouds arrived just 20 seconds after the start of totality and obliterated the view of the corona. Television audiences across the country, and observers in Montana, North Dakota, Manitoba and those in Oregon and Washington where there were scattered pockets of sunshine were favored with a clear view of the entire event.

In those areas, the sun's blazing corona was round and appeared somewhat narrower than many people had predicted. However, according to astrophysicist Robert Rubin of California State University at Fullerton (present at Goldendale), in periods of high sunspot activity such as the present, one would expect to see a uniform but not extensive corona. An impressive solar prominence was seen in the lower right quadrant at totality, and was estimated to extend about 40,000 miles into space — a distance far greater than the earth's diameter.

The availability of coronal and other solar data from Skylab has, over the years, changed the nature of earthbound studies. Aside from detailed measurements of the lunar orbit, the largest eclipse research effort this time involved NASA flights inside the earth's atmosphere. A Lear jet from Moffet Field in California flew over southern Canada, in an effort by University

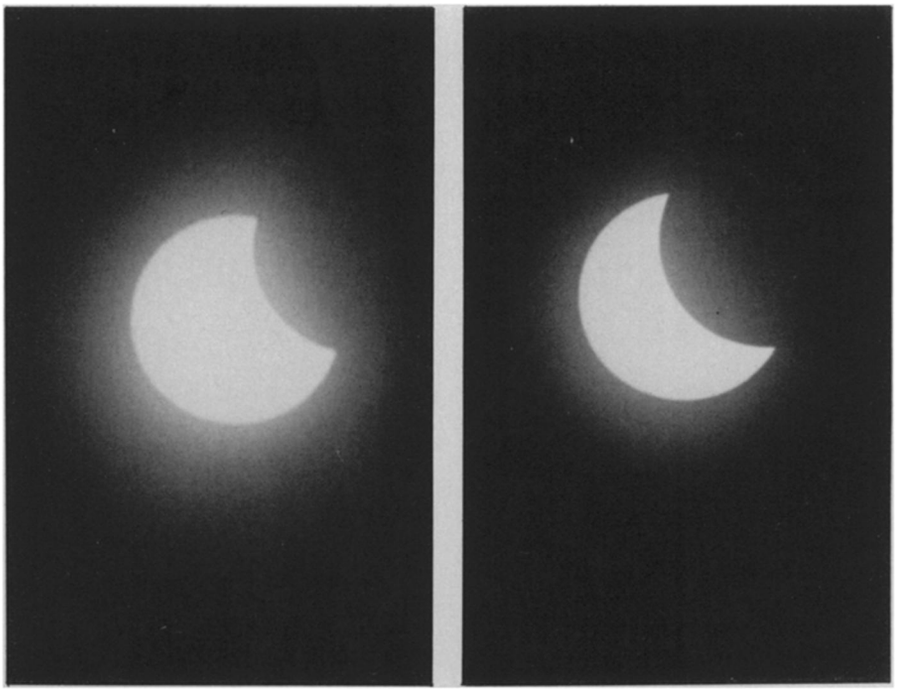
It wasn't total in New Orleans, but even there it was something to see.

Janet Hopson and Michael Rogers, San Francisco-based science writers, were among the thousands who journeyed to Goldendale Observatory to view the total eclipse.

of Calgary scientists to observe a phenomenon first noted in a 1973 eclipse. In that eclipse, observers aboard a Concorde jet over Africa measured a significant brightening of infrared radiation from the edge of the sun's disk as compared to the center.

Two other NASA planes — a U-2 and a Convair 990 — performed experiments over Helena, Mont., in order to study chemical changes in the upper atmosphere as the result of ultraviolet radiation from the sun. In addition, at two Canadian sites, groups from the Wallops Flight Center launched a total of 15 sounding rockets into the upper atmosphere to carry out a variety of experiments.

The considerable amount of data gathered during the moments of totality probably won't be fully collated for several months. But it already is obvious that, thanks to both its proximity and generally excellent weather conditions, the Feb. 26 eclipse — besides providing a memorable experience for millions of people — will prove an unusually rich source of information. It will also, almost certainly, give rise to new questions. But then that's one dependable quality of total solar eclipses: As long as earth, moon and sun continue their motions, there will always be another one to observe.



The eclipse photos on this spread were taken by photographer Tim Harmon of

Eclipse Mechanisms

The cause of a solar eclipse is quite simple: For a brief period of time, the moon slides between the sun and the earth. In a sense, the moon is casting a shadow, a tiny darkened dot that moves across the earth's surface (or more accurately, that the earth, during its daily rotation, moves under).

Solar eclipses only occur at new moon — that is, when the moon is up during the daytime and invisible at night.

On the average, the precise alignment of sun, moon and earth that causes a solar eclipse occurs at least twice each year, and, under very special circumstances, as often as five times. Why was last Monday's eclipse such an event? For starters, not all solar eclipses are total. Thirty-five percent are *partial* — regardless of where you view them from — and even an 80 percent partial eclipse is not really so impressive a sight. Thirty-seven percent of all solar eclipses are *annular*. In an annular eclipse, the moon is at its farthest point from earth, and so does not completely cover our view of the sun. A ring of sunlight thus still shines around the dark circle of the moon. The next solar eclipse this year will be annular — and only visible from Antarctica. Due to tidal influences, the moon is gradually spiraling away from the earth, and so (a few million years from now) *all* eclipses will be annular — and total eclipses will exist only in archeologic records.

The *total* eclipse — the remaining twenty-eight percent — is the crown jewel of astronomical phenomena. The shadow that the moon casts is less than two hundred miles wide, and a thousand or so long. Outside of that precise track, the eclipse appears only partial — and abruptly less spectacular. On the average, any given spot on earth will see a total eclipse only once every 360 years.

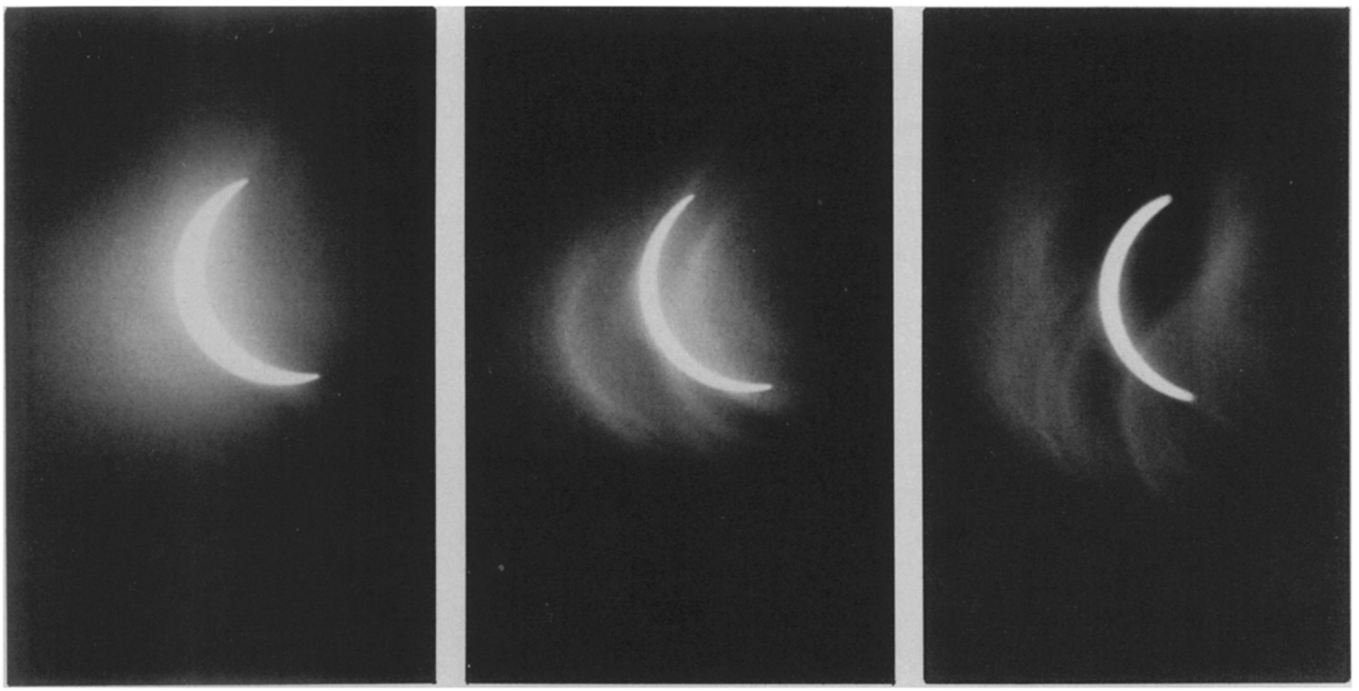
During a total eclipse, the sky becomes nearly as dark as night, and if there are no clouds, stars and planets will appear. Animals revert to their nocturnal behavior. And astronomers use those precious moments to photograph and take spectrographs of the sun's corona — the glowing, gaseous envelope around the sun, normally invisible, but breathtakingly beautiful during totality. In years past, totality was also an opportunity to search for the additional planet hypothesized to exist between Mercury and the sun.

For amateur astronomers, the primary challenge of the total solar eclipse is photographic. Three specific, fleeting images are particularly coveted. The first is the "diamond ring effect" — seen just before the moon totally covers the sun's disk, when only a single bright spark of sunlight remains, looking like a diamond in its setting. A second effect, at nearly the same time, is "Bailey's beads" — when the rapidly disappearing slice of sun takes on the appearance of a string of beads. This is actually due to the remaining rays of sunlight filtering through the peaks and valleys on the moon. And finally, there are "shadow bands" — a poorly understood phenomenon consisting of rapidly alternating bands of light and dark that speed across the ground just prior to the actual arrival of the lunar shadow.

Eclipses occur in families called "saros sequences." A saros is 18 years, 11 and one-third days — the length of time it takes sun, earth and moon to return to the same relative alignment, which produces another eclipse of very nearly the same magnitude and duration. Because of that one-third day excess, each eclipse in the saros "family" occurs about 120° longitude further west than the previous one (the distance the earth rotates during the additional eight hours). Thus the Feb. 26th eclipse's most recent relative — 1961 — occurred over Europe. The one before that, in 1943, was another 120° west of that — over Alaska. This particular saros sequence actually began with a small partial eclipse over Antarctica, in A.D. 933 — and will not end until 2195, with another small partial over the Arctic regions.

Eclipse Viewing

- Most filters, such as smoked glass or overexposed film, are considered unsafe for viewing partial solar eclipses. They do not block out sufficient sunlight, and the eye's lens, in turn, concentrates the light on the retina, thereby burning the delicate tissues the way a magnifying glass can burn a leaf. Aluminized mylar, on the other hand, has recently become accepted for direct viewing, for use with binoculars and telescopes and for photography. The American Optometric Association, however, warns that mylar is not foolproof. (No eye protection, of course, is needed during the minutes of totality.) Mylar is a flexible plastic material, 0.5mm to 2.0mm thick, with a thin aluminum coating. It works by reflecting at least 95 percent of the sun's light before it enters the lens of the eye.
- Monday's eclipse provided more people the chance for more successful viewing than other recent eclipses. The reason is simply that the eclipse track crossed a highly developed area. Airports,



Portland, Oregon, from an airplane moving at a speed of about 120 miles per hour 13,000 feet above Astoria, Oregon.

highways and sophisticated communication systems make possible last-minute relocations for maximally clear skies. This mobility is much less availing when the eclipse crosses a remote desert, ice-cap or expanse of ocean.

• Eclipse-viewing has become the terrain of tourists as well as of astronomy buffs. The ski resort at Big Sky, Mont., was completely booked by 500 tourists, each paying $385 for a four-day skiing and eclipse package. Bozeman, Mont., planned an eclipse festival with laser light displays, ice sculpture contests and speeches by physicists and native American medicine men. And a Berkeley, Calif., firm called Moonshadows Expedition organized a trip — sold out long in advance — to the unbelievably frigid and remote Hecla Island in Northern Lake Winnipeg, Manitoba, so that viewers (many of them first-timers) would have an optimal chance for clear skies and a near-maximum period of totality.

Eclipse Oddities

• The saros cycle of 18 years, 11 and one-third days, turns out to be the precise length of the high and low water cycle observed for Old Faithful in Yellowstone National Park.

• During a total eclipse, animals head for their burrows and nests, birds stop singing and insects fall asleep.

• Eclipses seem to have profound psychological effects on many people. The most common is addiction (or perhaps habituation). Many amateurs have traveled (at great cost and effort) to five or six total eclipses. Some report seeing ten or more. Another effect is temporary hysteria. Says Steve Greenberg, a San Francisco astrophysicist, some people experience the "stupendous psychological impact" of an eclipse by "screaming their heads off."

• Cloudiness did not deter totality watching in 1961: Just before the sun darkened over the Crimean peninsula in the Black Sea, Soviet scientists seeded a layer of supercooled stratiform clouds. It created a large hole that persisted for more than an hour. Similar cloud seeding for this eclipse would have been difficult above the Great Plains due to the frigid temperatures and colloidally stable airborne ice crystals.

• Most unfortunate eclipse publicity blunder: The Australian government launched an eye safety campaign — "Eyes Down on Eclipse Day" — for the June 20, 1974, eclipse, since its path crossed all of Australia's most populous cities (Perth, Adelaide, Melbourne and Sydney). The Rotary, Lions and other social clubs bought $1,200 worth of aluminized mylar filters to distribute at the Bombala racetrack. Unfortunately, the head of the Australian Optometrical Association stated publicly (and erroneously) that mylar was unsafe for use with binoculars or telescopes. Thus many people simply skipped using it altogether. There were scattered clouds but 300 persons, nonetheless, reported to clinics and hospitals complaining of possible eye damage.

Eclipses Past and Future

• The first record of a total eclipse was made more than 4,000 years ago in the ancient Chinese chronicle called the *Shu Ching*. That eclipse took place on Oct. 22, 2137 B.C., but the inscription reveals more about Chinese culture than about planetary phenomena. It seems that the two royal court astronomers, Ho and Hsi, got drunk before the eclipse and failed to predict it accurately. This left little time for the frightened populace to mount their ceremonial display of drum beating and arrow shooting to chase away the dragon that periodically returned to swallow the sun. Ho and Hsi literally lost their heads over the incident. The *Shu Ching* contained specific provisions for such oversights in eclipse prediction: "Being before the time, the astronomers are to be killed without respite; and being behind the time, they are to be slain without reprieve."

• A total eclipse visible from Greece on May 28, 585 B.C., ended a six-year war between the Medes and the Lydians. Seeing day suddenly turn into night over their battlefield seemed a negative portent for continued fighting. By evening, a truce had been signed. Modern people seem better able to separate superstition from war: A decade ago, Lon Nol's Cambodian troops fired automatic rifles at the darkening sun, then, victorious in that battle, returned to their previous one.

• Eclipses have long been sources of scientific information. The Greek astronomer Hipparchus used solar eclipses to determine — with remarkable accuracy — the distance between the earth and moon, and the relative sizes of each.

• Eclipse addicts note: If you missed this total eclipse, the next annular eclipse will be visible from Antarctica on Aug. 27, 1979, and the next total will cross Africa and Southeast Asia Feb. 16, 1980. The next eclipse visible from the continental United States will take place in the year 2017, but a path of totality will cross the Hawaiian islands on July 11, 1991. The best upcoming American eclipse series will occur in the years 2245, 2247, 2251, 2252, 2254, 2257, 2261 and 2263. Better try for Hawaii in 1991.