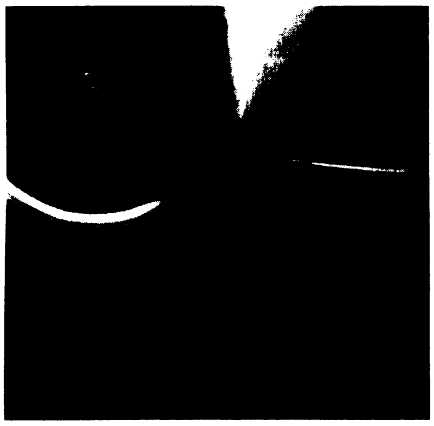
Sun-grazers: A hot road to the end

They seem to evoke the death of mythic Icarus, killed after the wax holding together his homemade wings melted when he flew too close to the sun. On rare occasions, astronomers have observed comets passing so near the sun that the heat has caused them to fragment or even disappear completely. Only eight such sun-grazers, plus three or four "possibles," have been discovered over the centuries with ground-based telescopes, and another six appeared in photos taken by a U.S. Air Force satellite equipped with a coronagraph for solar studies.

Now NASA's Solar Maximum Mission satellite (SMM), or Solar Max, has turned up two more and a possible third.

The Air Force satellite, known as P78-1, was launched in 1979, but its career ended six years later when it was deliberately destroyed in a U.S. antisatellite test (SN: 11/28/85, p.197). Solar Max went into orbit in 1980, and although it did detect one of the Air Force craft's six comets, it failed until recently to find any sun-grazers of its own.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Comet SMM-2, seen nearing the disk of Solar Max's coronagraph last October. Arrow indicates sun's north pole.

The new pair, dubbed SMM-1 and SMM-2, was announced July 1 by the National Center for Atmospheric Research in Boulder, Colo. Photographed last Oct. 5 and 17 by Solar Max's coronagraph — which blocks out the sun's central disk to highlight its rim — they were subsequently spotted in the images by Sharon Beck of the center's High Altitude Observatory. In both cases, the coronagraphic observations continued for many hours beyond the time of the initial discovery images, but later photos did not show either comet emerging from behind the instrument's sun-masking "occulting disk."

The coronagraph photographed a still more recent candidate on June 27. It has not yet been dubbed SMM-3, since scientists have yet to complete their analysis of its orbit. Such analysis is necessary to determine not only that it is a previously unknown comet in need of a name but also that it is indeed a sun-grazer.

A reasonable assumption, says Brian G. Marsden of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass., is that all but one of the known sun-grazers were once part of a single comet, which long ago passed so close to the sun that it fragmented. They are called the Kreutz group, after German astronomer Heinrich Kreutz, who around the turn of the century conducted an extensive study of the ones known at that time. He determined that all of them circled the sun in a clockwise or retrograde direction, in orbits tilted about 40° to the plane of the ecliptic and with the orbits' major axes aligned in the same direction.

The Kreutz group now also seems to include all of the sun-grazers detected by the two satellites. All appear to have the required orbital tilt, though Marsden notes it is impossible to determine from the coronagraphic images whether they are also circling in the necessary retrograde direction. If they are, he says, the orbits' major axes are oriented in the proper direction for the comets to be defined as members of the Kreutz group.

"The fact that this one assumption [that the orbits are retrograde] allows each of the sun-grazers found from space to fit with the Kreutz group suggests that the assumption is valid," Marsden says. If so, he adds, their present orbits suggest that some of the initial fragments split again in subsequent trips past the sun.

— J. Eberhart

As the world wobbles . . .

The earth seems as stable as the weather is changeable, but in fact scientists have long known that movements of air masses can make the planet wobble on its axis for periods of a year or more. Now, researchers using very sensitive satellite and radio astronomy techniques have found "rapid" wobbling of the earth on a time scale of two weeks to several months, and have shown that the wobbling is at least partially caused by atmospheric changes.

When high- and low-pressure air masses move about the earth, the weight distribution of the atmosphere is changed. This can make the rotating earth wobble, just as moving the balancing weights on the wheel of a car can change the way the hub rotates. The effect was anticipated in 1862 by Lord Kelvin, and has since been observed to at least partially cause the earth's annual wobble and the 14-month Chandler wobble.

Improvements in wobble-monitoring systems and in detailed, worldwide collection of weather data allowed the discovery of the shorter-period wobbling and its correlation with changes in weather patterns, reports a team of scientists in the July 14 NATURE. The researchers, from the Jet Propulsion Laboratory in Pasadena, Calif., and Atmospheric and Environmental Research Inc. in Cambridge, Mass., used two methods involving extraterrestrial bodies to pinpoint to within 5 centimeters the two surface points of the earth's rotational axis.

The group obtained highly accurate measurements of the earth's movement with a technique called satellite laser ranging, which involves bouncing laser beams off the moon and/or an artificial satellite and measuring the time it takes to travel the distance there and back. They confirmed this information with very long baseline interferometry, in which a number of radiotelescopes on different continents observe a quasar at the same time and compare the signals to get information about the relative motion of the observatories.

Using these techniques, the scientists were able to observe the earth's axis of rotation moving 6 to 60 centimeters over these shorter periods.

The researchers are not sure whether all of this short-period wobbling is caused by atmospheric changes or if there are other possible reasons, says Richard Rosen of Atmospheric and Environmental Research Inc. This is because air-pressure changes over the ocean cause sea-level changes of about 3 to 4 centimeters, and the team is unsure of what effect that water movement has, he says.

"We get better correlations if we ignore air masses over the ocean," but then the mass changes aren't enough to account for all the wobble, Rosen says. Other factors might be earthquakes and the shifting of tectonic plates, wind patterns around the earth or redistribution of water in rivers and lakes, he says. "There are a lot of things that there just aren't good data for, so you can dream up all sorts of possibilities," he says.

The laser ranging and interferometry measurements used to spot the wobble can also be used to measure the movement of tectonic plates and local changes in the earth's gravitational field, says coauthor Jean Dickey of the Jet Propulsion Laboratory. For instance, comparison of satellite and radiotelescope measurements will reveal gravitational changes, she says, because the satellite is affected by these changes while the interferometry measurements are not. Tectonic motion can be detected by comparing motion measurements from different points on the earth.

— C. Vaughan