"It really made a difference," she says. The patients responded to all three approaches; as a group, their screaming or moaning dropped by roughly half in response to one-on-one interactions or the videotape, and by one-third in response to music.

In Cohen-Mansfield's study, the one-on-one interaction produced the biggest results, and in general researchers are finding that social interaction helps slow behavioral decline. Reisberg cites two striking cases: women with late-stage disease whose wealthy husbands have lavished professional attention and care on them. Normally people at their stage are bed-bound and withdrawn, but these women attend social events and appear to enjoy life. "They are doubly incontinent and say not a word, but they are happy," he says.

Back to school

For families who can't afford costly private care, many parts of the country have day care centers for Alzheimer's patients, where they engage in developmental-age–appropriate activities, such as games or relearning daily living skills such as brushing their teeth. "The patients respond to the activities and the socialization," says Reisberg. Medication can be lowered, the patients become less agitated, "and when they come back at the end of the day, they have a lot to say to their family. It's a lot like school."

With all the new behavioral interventions, there is one caveat researchers have learned: The success of a program depends absolutely on caregivers' diligence in carrying it out. Studies by Alabama's Burgio and UCLA's Schnelle have shown that nursing home staff members tend to drop new techniques unless they are continually urged to use them. For example, a follow-up of Bourgeois's memory book study found that once the researchers left, says Burgio, "the memory book use went down."

Burgio developed a program to combat this problem, adapted from motivational programs used in industry, which combines monitoring of the nursing home staff with incentives for good performance. In a carefully controlled trial, staff members who received his program consistently used the interventions they had learned for months, while those not in the program tended to drop the interventions when the training period ended. Burgio says he tells nursing homes that are interested in behavioral therapies, "if you aren't going to use a staff motivational program, don't even bother with the behavioral intervention, [because] it won't be used."

Indeed, the new behavioral methods face many hurdles. "It is a really long road," says Teresa Radebaugh of Khachaturian, Radebaugh, and Associates, "to take something that is well tested, well described, carefully peer reviewed, and published, but done in a sophisticated setting ... and get it out to a nursing home in a small town." Burgio agrees: "A lot of people still believe [nursing homes] should be following a custodial model, not a treatment model. It will take another 10 years before people are really accepting of the treatment model." But these researchers are committed to spreading their word and making life a bit easier for Alzheimer's sufferers and their caregivers. —MARCIA BARINAGA

ASTRONOMY

Meteor Shower Sets Off Scientific Storm

The return of comet Tempel-Tuttle has triggered a debate over whether its debris poses a threat to the world's satellites

BOSTON—During a cold and clear night in 1833, hundreds of people here rushed outdoors to watch falling stars so thick they looked like a light snowfall. This past February the comet responsible for that spectacular meteor storm—comet 55P/Tempel-Tuttle—swung around the sun after a 33-year absence from the solar system. And on 14 November, Earth will start plowing through a fresh stream of particles that boiled off its surface and were left behind. But this time the show is of interest to more than just idle skywatchers: Its intensity is a matter of some debate among scientists and great concern to those who operate satellites that may encounter the comet's trail.

The annual displays, called the Leonid meteor showers, were recorded over 1000 years ago by Chinese astronomers and are often most dazzling just after the return of Tempel-Tuttle. But unlike 33 years ago, today the space above the protective atmosphere is filled with satellites full of sensitive electronics that provide global communications, warn of missile launches, and gather research data.

Just how seriously to take the danger from Tempel-Tuttle's dust is a matter of dispute between NASA, on the one hand, and the U.S. Air Force and Canadian astronomers on the other. "Could everyone lose their pagers and their television connections? All that is possible," says Lt. Col. Don Jewel, deputy chief scientist for the U.S. Air Force Space Command. But some NASA researchers say the concerns are overblown. "People hear a storm is coming and there is all this excitement—far more than the threat deserves," says Donald Yeomans, an astronomer at NASA's Jet Propulsion Laboratory in Pasadena, California.

Spectacular shower. This woodcut depicts the 1833 Leonid shower over Niagara Falls.

SOURCE: 1998 SKY AND TELESCOPE

Part of the disagreement about risk reflects different interests. Whereas NASA researchers are eager to study the little-known composition of the comet, Air Force and Canadian officials are more concerned about its effect on the global satellite network. So each group is going its separate way in monitoring the 1998 Leonids.

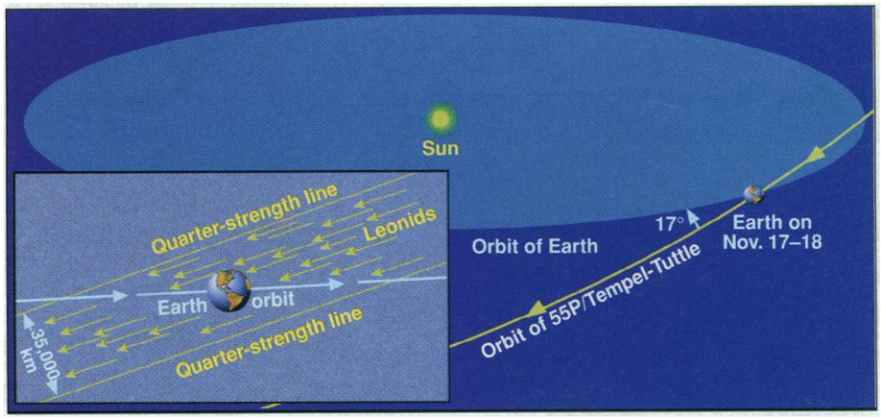
The comet has a path roughly intersecting Earth's orbit (see drawing). Based on that trajectory, the best viewing site for the peak night of showers on 17 November will be in Asia. Teams of Air Force and Canadian astronomers will set up camp in the Gobi desert of Mongolia and the Australian outback to gather real-time data and alert satellite operators if the shower turns into a storm. Meanwhile, NASA will fly airborne observatories to observe the sun's glow off meteoroids, the persistent meteor trains, and the neutral atom and particle debris.

Most satellite owners, including NASA, aren't taking any chances, recalling the stray meteoroid that is believed to have knocked out the European Space Agency's (ESA's) research satellite Olympus in 1993. NASA will turn the Hubble Space Telescope's optics away from the stream of particles and ground its shuttle, while Mir cosmonauts likely will retreat to their escape capsule as

the Leonids pass. Meanwhile, the Air Force has readied a 400-page classified plan that outlines steps to avoid meteoroids, which are the physical objects seen as meteors—shooting stars—from Earth. (Those that hit the ground become meteorites.) European and Japanese officials likewise are taking precautions. Some commercial satellite operators also plan to reorient their spacecraft away from the speeding particles.

History and complex mathematical models are the only guides to predicting the density of the Leonids, which typically produce 15 to 20 visible meteors an hour for a few days. Most of those particles are tiny, and, because the comet debris and Earth meet nearly head on, these meteoroids hit the upper atmosphere about four times faster than most stray meteoroids. During the last Leonid storm, in 1966, the skies above the western United States were pelted for a few hours with an estimated 150,000 meteors per hour, which observers likened to the density of a steady rain.

But predicting meteor rates is like guessing how many raindrops will fall during a downpour. The comet's exact trajectory and debris stream are hard to pinpoint, and the gravity of other planets such as Jupiter can pull the stream away from an intercept with Earth. A slight perturbation can mean the difference between a few dozen and thousands of meteors an hour.



Crossing paths. Earth cuts an annual swath through the debris left by comet Tempel-Tuttle.

SOURCE: 1998 SKY AND TELESCOPE

Estimates for this month's event, expected to peak for about 2 hours on the evening of 17 November, vary widely. Whereas NASA astronomers like Yeomans expect between 200 and 5000 meteors an hour, Peter Brown, an astronomer at the University of Western Ontario in London, Ontario, and a few others put the high end closer to 10,000. Still, that number is an order of magnitude lower than Brown and some colleagues were predicting a few years ago before they obtained new data on the comet's trajectory. And Brown says his models suggest that the 1999 shower could surpass this year's levels if Earth passes more directly through the stream the next time around.

Both Yeomans and Brown admit such estimates are in part guesswork. "I don't think anyone has an inside track," says Brown. "It is a bit of a crap shoot," adds Yeomans. In 1899, for example, astronomers were ridiculed when the event turned out to be a dud after they had predicted a fantastic storm to rival that of 1866. Few people were watching when a storm did unexpectedly appear the following year. And historical data are sketchy—the lack of a 1933 record of a Leonid storm, for example, may have been due to cloudy skies above much of America and Europe.

If making accurate predictions of the rate of meteors is hard, forecasting their effect on satellites whirling through orbit is harder still. But it is no mere academic matter: Billions of dollars in hardware and services, not to mention national security, are at stake. In 1966, there were only a handful of relatively primitive satellites; today there are about 650. All satellites, whatever their orbit, are at risk, as they orbit above the atmosphere, which burns up most comet debris.

The high speed of the Leonids—about 72 kilometers per second—means that each particle can pack quite a wallop. But an actual hit could do less damage than the sudden magnetic field that the particles can generate, which could play havoc with the electronics covering most spacecraft. ESA engineers believe that's what sank the Olympus spacecraft. Some U.S. military satellites are built to withstand debris or the effects of a nuclear explosion, but most research and commercial spacecraft tend to have largely unprotected systems.

A joint press release by NASA and the U.S. Space Command on 5 October characterized the threat as "elevated but not serious," although some government officials say the wording reflects an effort by NASA and the White House to minimize the threat. "They don't want to make a fuss," says one government official involved in the discussions. NASA astronomers point out that the threat to humanmade objects is still small—the greatest threat, a 1% to 5% probability of a hit, they say, is to the Advanced Composition Explorer perched at L1, a gravitational balance point between Earth and the sun—and that two NASA satellites in orbit during the 1966 storm survived without a scratch.

Despite the press release's wording, the Air Force is putting up nearly half the $800,000 needed for the Mongolian and Australian expeditions, with Canada, Europe, and Japan providing the rest. The teams will use sophisticated radar to detect the mass of Leonids in all weather and optical telescopes to provide more detailed images. The data will be transmitted to the University of Western Ontario for analysis and then, within minutes, to a U.S. Air Force Web site (not accessible to the public to prevent overloading the system). If the shower strengthens, operators can move quickly to batten down their satellite hatches. "We want to be ready if [a storm] does happen," says the Air Force's Jewel.

NASA officials say that, although they support the data-collection effort, they are skeptical of the attempt at providing real-time warnings. "Going to Australia and Mongolia is a great way to enjoy the display, and getting real-time data is a noble goal," says Nicholas Johnson, head of the orbital debris office at NASA's Johnson Space Center in Houston. "But the equipment has not been adequately tested." Brown admits that the technology is new but says the system was tested successfully last month in Australia. Instead, NASA plans to fly airborne observatories over the eastern Pacific to analyze the composition of the meteoroids and their effect on the atmosphere. "It's important to keep the science of the Leonids in mind, too," says the mission's principal investigator, Petrus Jenniskens of NASA's Ames Research Center in Mountain View, California.

Most communications satellite operators have kept a low profile during the debate. "This is an environmental hazard we are prepared for," says Ahmet Ozkul, a satellite operations specialist at Intelsat, a Washington-based international communications consortium. Although Intelsat will not buy real-time data, Ozkul says, it plans to rotate the sensitive solar panels of its spacecraft away from the showers without affecting operations.

And where will Yeomans be on the night of 17 November? "I'm going up to the San Gabriel mountains," he admits. With Jupiter likely to pull the comet away from Earth's orbit in its next two encounters, he says, "this is a once-in-a-lifetime opportunity."

–ANDREW LAWLER

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