quencing data has already resulted in several published studies on newly identified chromosome-22 genes. Still, picking out all the genes remains a formidable task. A computer analysis of the sequence predicted the presence of more than 800 genes, but the software produces many false positives, warn the scientists. Using more stringent criteria, they count 545 genes.

"The real issue is how you find a gene if you know nothing about it. The problem is that genes don't come with little flags saying, 'I'm a gene,'" notes Peter Little of Imperial College in London, who wrote a commentary in the same issue of NATURE.

From their tally of genes on chromosome 22, the scientists who sequenced it predict that the human genome contains at least 45,000 genes. Finding all those genes isn't the ultimate goal, however.

"Even when you can identify the genes, there's a lot more to be done on what does a gene do, what does its protein do, and how is it expressed in different tissues," notes Ian Dunham of the Sanger Centre.

To address some of those questions, biologists must also study the noncoding DNA that surrounds genes and regulates their activity. "Because we have the entire [chromosome-22] sequence, we should have all the elements used to control the expression of its genes," says Dunham.

Beyond these genes and regulatory regions, about 40 percent of the chromosome-22 sequence turns out to consist of seemingly useless, repetitive stretches of DNA, often labeled junk DNA.

"We don't know what [those sequences] do, if they do anything at all. They may just be relics of the evolution of the genome," says Dunham.

The investigators haven't sequenced every base on chromosome 22. They've largely ignored one of its two arms, the much shorter one, because past research showed that it doesn't contain genes that encode proteins. Like the short arms of a few other chromosomes, it has many copies of genes that code for the RNA component of ribosomes, the protein-making factories in cells.

Even the DNA sequence for the long arm of chromosome 22 has 11 gaps, ranging from a few thousand bases to 150,000. Scientists expect to fill in some of those gaps, especially one thought to contain a gene involved in breast cancer, but a few may prove very difficult to sequence. —*J. Travis*

The best Leonid show is yet to come?

The streaks of light came fast and furious. Some raced across the sky in nearly parallel tracks, leaving behind hazy trails. A few seemed to dive into the moon.

If last month's Leonid meteor shower proved disappointing in the United States, it took Europe and the Middle East by storm. And if the predictions of two astronomers continue to hold true, Earth will be in for a *really* big show in 2001 and another in 2002.

At the shower's peak, on Nov. 17, some observers saw between 3,000 and 5,000 shooting stars, or meteors, in a single hour. Activity reached a crescendo at 9:05 p.m. EST—just 3 minutes earlier than predicted by David J. Asher of Armagh Observatory in Northern Ireland and Rob McNaught of the Australian National University in Weston.

This is the first accurate prediction of a meteor storm, says Brian G. Marsden of the Smithsonian Astrophysical Observatory in Cambridge, Mass.

The Leonid meteor shower happens every November, when Earth passes through a stream of dusty debris, or meteoroids, expelled by Comet 55P/Tempel-Tuttle. Dust grains slam into Earth's atmosphere and burn, creating the streaks of light known as meteors. About every 33 years, when the comet passes near, Earth encounters a large amount of debris, resulting in a heavy shower or storm.

Exactly which years the Leonid dust particles will generate a storm has been difficult to predict. That's because astronomers hadn't realized that the debris stream is composed of distinct, narrow strands of dust, each expelled by the comet during a different passage by the sun, notes Asher. It's a matter of hit or miss: If Earth plows through the center of a dense strand, a storm will occur.

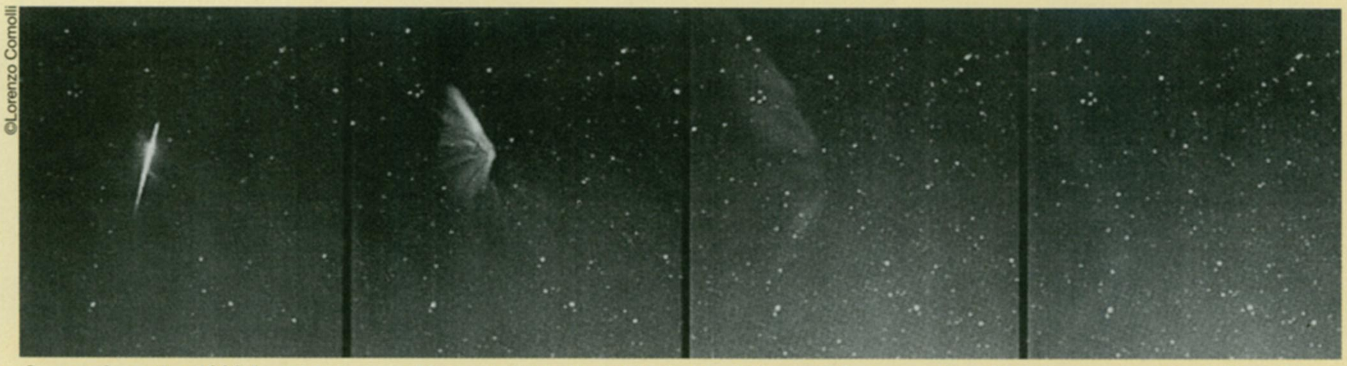
By simulating the motion of strands in the solar system, Asher and McNaught conclude that the dust strand Earth traveled through last month was shed by the comet in 1899. Although that's the same material the planet traveled through during the spectacular storm of 1966, last month's event wasn't as dazzling because Earth crossed the strand's edge rather than its center, Asher says.

Donald K. Yeomans of NASA's Jet Propulsion Laboratory (JPL) in Pasadena, Calif., says he agrees with the pair's explanation for the 1999 event. "I do take their future predictions more seriously now," he adds.

Next year, McNaught and Asher calculate, Earth will pass for the first time through the edge of a band of dust cast off by the comet in 1866, yielding a puny shower. In 2001, however, Earth will plow sequentially through no less than three trails—debris expelled in 1767, 1699, and 1866—and the light show should prove more stunning than last month's. In 2002, when Earth again encounters material from 1866, as well as from 1933, the Leonids should also put on a great show, McNaught and Asher say.

Their findings may shed light on a puzzling feature seen just hours after the Leonid shower reached its 1999 peak. Observers saw flashes of light near the moon, as if meteoroids had crashed on its surface. Researchers reported the phenomenon in a Nov. 26 circular of the International Astronomical Union.

The brilliance of these flashes requires that the meteoroids have as much mass as a bowling ball—a rare but not extraordinary occurrence, estimates Alan W. Harris of JPL. Moreover, Asher and McNaught calculate that the moon intercepted a denser part of the 1899 stream than Earth did and thus encountered a greater number of large meteoroids at the time the flashes occurred. However, cautions Paul R. Weissman of JPL, the flashes could merely have been sunlight glinting off satellites or space debris. —*R. Cowen*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Scenes from the 1999 Leonid shower: Meteor's fireball and its fading light seen for more than 20 minutes over the Italian Alps.