have recognized that there is a mother lode of information about gene function to be mined from the data now stockpiled in computer databases. "The genome project has taught us the power of information and the power of collective action," Tilghman says. But as the burgeoning commercial interest in bioinformatics experts indicates (see p. 1730), striking gold in veins of genetic data requires search programs and well-organized databases, and programmers are scrambling to provide them.

The first step in computer genome analysis is to pick out likely genes from raw sequence data. One strategy comes from Gregory Schuler of the National Center for Biotechnology Information, who uses expressed sequence tags (ESTs), bits of DNA that signal the presence of a functionally active stretch of DNA and have been identified in huge numbers by mappers. So he and colleagues have spent the past year creating UniGene, a computer program that organizes these known coding stretches of DNA into groups that likely represent unknown genes based on how similar they are at one end. Thus far, they have converted ESTs into some 46,000 clusters that may include half the genes in the human genome.

Schuler calls these clusters "diamonds in the rough," which researchers are now "polishing" by using other databases to pin down the genes hidden in the clusters and find clues to their function. For example, Andrea Ballabio of the Telethon Institute of Genetics and Medicine in Milan, Italy, and her colleagues tapped a variety of such database programs, including UniGene, to find 66 human equivalents to known *Drosophila* genes. They then located these genes on the human genetic map and looked for diseases linked to mutations at those locations. Seven of the new genes seem to be tumor-related; about two dozen are involved in eye or neural development; and four relate to ion-channel proteins, the group reported in the June issue of *Nature Genetics*. Because researchers know how mutations in these genes affect fruit flies, they have a jump on understanding how the human counterparts may work, Ballabio says.

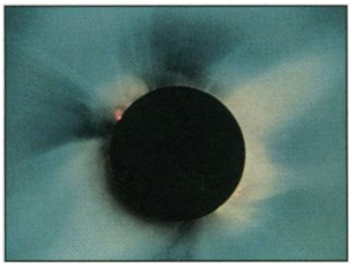
As the number of databases continues to explode, scientists are relying more on clever software to help tease out the meaning behind all the data. "The time is coming when a graduate student thinking about a project will begin with a fairly long time at the computer coming up with a problem through sequence analyses," Hieter says. And thanks to the rapidly expanding tool kit of both computer and laboratory analysis, when students do choose a problem, the project will likely be quite different from the old model of finding and analyzing a single interesting gene. "There's going to be a paradigm shift in the way we think about biology," Tilghman predicts. "We're going to be able to ask questions that I could only dream about as a graduate student."

–Elizabeth Pennisi

SOLAR PHYSICS

Putting Some Sizzle in the Corona

MADISON, WISCONSIN—The most eloquent reaction of all came from Robert Bless, the University of Wisconsin astronomer who hosted last week's American Astronomical Society meeting here. When a reporter told him that an instrument aboard the Solar and Heliospheric Observatory (SOHO) satellite had detected 100-million-degree oxygen ions in the sun's atmosphere, he silently dropped his jaw. That temperature is tens of times higher than has ever been measured before in the corona, the sun's halo of ionized gases. It's fully 100 times hotter than the temperature of electrons in the same part of the corona. SOHO project scientist Art Poland of NASA's Goddard Space Flight Center had a more vocal reaction: The results "just blew me away."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Hot zone. The corona, seen in white light during a solar eclipse.

Announced here on 11 June by members of the team operating SOHO's Ultraviolet Coronagraph Spectrometer (UVCS), the findings are all the more surprising because they turned up in what was thought to be a cool spot: a coronal hole—a region of the corona where the sun's magnetic field lines wander into space rather than arching back to its surface. Coronal holes look dark in x-ray images of the sun because the free electrons there are cooler than elsewhere in the corona. But a handful of solar physicists say the detection of superhot oxygen provides crucial support for theories that would solve a long-standing mystery: what heats the corona to millions of kelvin when the surface of the sun is a mere 6000 degrees.

Details of the corona's temperature are hard to get from the ground, because many of the bright lines in its spectrum, given off by ions like hydrogen and oxygen, fall in the ultraviolet region, which is blocked by Earth's atmosphere. So when SOHO was launched last December as an all-purpose solar observatory (*Science*, 10 November, p. 921), it carried the UVCS to fill in the picture. The UVCS blocks the disk of the sun, creating an artificial solar eclipse that allows it to analyze the ultraviolet lines at distances out to several times the sun's radius, explains John Kohl of the Harvard-Smithsonian Center for Astrophysics (CfA), principal investigator for the UVCS.

To determine the temperature of the ions responsible for the lines, the instrument relies on the Doppler effect, which broadens the lines in proportion to the ions' velocities toward or away from an observer. In a coronal hole above the sun's north pole, early results showed that "the higher we went, the higher the oxygen temperature went up," says Kohl. It still hadn't peaked at the limit of the measurements 0.9 solar radii above the surface, where the temperature soared to 100 million degrees.

In the same structure, hydrogen nuclei reached a peak of 6 million degrees at about one solar radius and then gradually fell off, and separate measures had the electrons topping out at about a million degrees. Meanwhile, in the brighter regions of arching field lines called helmet streamers, UVCS generally found that both oxygen and hydrogen peaked at about 2 million degrees.

The results are "grist for my mill," says Jack Scudder, an astronomer at the University of Iowa who has proposed a controversial theory of coronal heating that relies on gravity to confine cooler particles near the surface, allowing hotter ones to escape into the distant corona—a filtering mechanism that would act more strongly on heavier species (*Science*, 11 February 1994, p. 757). But Scudder's isn't the only theory predicting hot heavy ions.

In a picture developed by Ian Axford and James McKenzie at the Max-Planck-Institut für Aeronomie in Lindau, Germany, for example, so-called magnetohydrodynamic waves, which could be driven by disturbances near the solar surface, would pump energy into particles by driving their gyrations around magnetic field lines. Such waves would tend to be more intense at low frequencies, best matched to the gyration frequencies of heavier ions. As Axford puts it, hot, heavy ions are "something we have expected for a long time." Both theories also predict that the preferential heating would be less noticeable in the denser, trapped gases of the streamers than in coronal holes.

To figure out what kinds of measurements could distinguish between these and several other competing theories, Kohl has organized a meeting to take place at CfA next week. What's already clear, says solar physicist Joseph Hollweg of the University of New Hampshire, is that the new observations "are going to get very close" to unraveling the mystery of the hot solar corona.

–James Glanz