Astronomy

Mysteries of a massive star

Instead of becoming a showstopper, the massive star Eta Carinae has stopped its show. From early 1996 through the late fall of 1997, the star's X-ray emissions increased, reaching an unprecedented peak in intensity (SN: 12/13/97, p. 373). Some astronomers predicted that the trend would continue through January and that Eta Carinae might exhibit fireworks at other wavelengths. By Dec. 10, however, the X-ray emissions had taken a sudden nosedive.

An unseen companion in a highly elliptical orbit may explain both the recent rise in X-ray emissions and the sudden decline, say Kris Davidson and Kazunori Ishibashi of the University of Minnesota in Minneapolis. As the two stars approach each other, the interaction between their winds creates energetic X rays. At their closest, the companion passes into a thick disk of material surrounding Eta Carinae. Observations with the Rossi X-ray Timing Explorer and ASCA satellites indicate the presence of dense, X ray–absorbing matter, notes Michael F. Corcoran of NASA's Goddard Space Flight Center in Greenbelt, Md.

Davidson cautions that the two-star model is not the only possible explanation for Eta Carinae's behavior—it could simply be a single star undergoing periodic upheavals. If the binary model is correct, it's likely that the X rays will suddenly reappear in April or May, when the companion is expected to move out of the disk. Several astronomers are searching for wobbles in the orbit of Eta Carinae that would indicate the tug of a nearby companion, says Davidson. —*R.C.*

Asteroid impact: Beware the tsunami

Pop quiz: Does an asteroid slamming into Earth do more damage if it lands on solid ground or if it plows into the middle of the ocean?

Give yourself a Bronx cheer if you chose the first answer. Surprising as it may seem, a watery landing holds the greater potential for destruction, says Jack G. Hills of Los Alamos (N.M.) National Laboratory.

An asteroid striking solid ground deposits its energy rapidly in a relatively small volume. A body striking the ocean creates waves that retain enormous energies as they travel great distances across the water's surface, Hills says. These waves, called tsunamis, can scour thousands of kilometers of coastline with debris and towering walls of water. In 1960, an earthquake-generated tsunami that originated in Chile spread halfway across the world, killing 200 people when it reached Japan.

When a tsunami hits a continental shelf, it slows down but grows higher. Hills and Charles Mader, retired from Los Alamos, calculate that a 5-kilometer-wide asteroid striking the mid-Atlantic would swamp the upper East Coast of the United States. The tsunami would also drown the coasts of France and Portugal. Hills presented the findings last month at a meeting of the American Astronomical Society in Washington, D.C.

A 5-km-wide asteroid is expected to hit Earth only once every 10 million years, but rocky bodies as little as 200 meters in diameter are much more common and can also spawn tsunamis. For example, an asteroid 400 m across would create a wall of water reaching 100 m high, Hills and Mader find.

Earlier calculations by Hills and M. Patrick Goda, then at Los Alamos, had revealed that an asteroid slamming into the ocean can pack a wallop. After the researchers published their preliminary findings in the March 1993 ASTRONOMICAL JOURNAL, Hills enlisted Mader, an expert in tsunamis, to help with detailed computer simulations.

Additional modeling over the next 3 years should reveal the damage caused by smaller asteroids, which is more difficult to calculate, Hills says. He notes that if an asteroid can be discovered before it strikes, a nuclear-powered rocket might be used to direct it away from Earth. —*R.C.*

Chemistry

Seeing how much stuff sticks to snow

Even snow that looks white and pure could be ferrying pollutants from the atmosphere to the ground. Volatile organic compounds, often blown in from distant lands, stick to snow's surface and gradually seep into water and soil as the white fluff melts.

By measuring the total surface area of a volume of snow, a team of researchers in Canada is figuring out just how much contamination snowflakes grab out of the air. Other groups have estimated surface area in a variety of ways, says John T. Hoff of the University of Waterloo in Ontario, but the instrument he and his colleagues are using is designed specifically for that purpose.

Hoff collects fresh samples of snow, keeps them cold with liquid nitrogen, and places them in a commercial surface area analyzer. The device is ordinarily used to find the surface area of powdered materials such as soil and industrial catalysts.

By measuring the amount of nitrogen gas bound to the snowy surface, Hoff and his colleagues calculate that the snow's surface area ranges from 0.06 to 0.37 square meter per gram. The results of these experiments compare well to estimates made by examining snow crystals under a microscope and calculating the area mathematically. Despite their intricate appearance, snowflakes actually have less than one-hundredth of the surface area of the same quantity of ice particles made in the lab to simulate cloud crystals.

The group's findings appear in the January ENVIRONMENTAL SCIENCE AND TECHNOLOGY.

Pollutants, especially chlorofluorocarbons, bind strongly to cold surfaces. Now, Hoff and his colleagues are developing a more sensitive method to determine how the surface area of snow decreases as it ages. The modest amount of nitrogen that binds to snow's relatively small surface area makes these studies difficult.

Plus, "it's unusual to work with a powder that melts at room temperature," Hoff says. —*C.W.*

Cocaine-laced locks tell hairy tales

Forensic scientists and toxicologists can read a history of chronic drug use from a person's hair. Unlike urine and blood, which carry remnants of recent drug use, hair preserves those clues from the moment it grows out of a person's head.

One problem limits its usefulness as legal evidence, however. Current analytical methods can't tell for sure how a drug such as cocaine made its way into a strand of hair. The person in question could have ingested it or just happened to be in the room when other people were smoking crack cocaine. Vapors can coat the outside of the hair shaft and show up in a laboratory test.

Scientists at the National Institute of Standards and Technology in Gaithersburg, Md., are testing a new method that may solve this problem. Instead of rinsing the hair with liquid solvents, as labs do now, they dissolve cocaine out of hair with supercritical carbon dioxide (SN: 8/16/97, p. 108).

Their preliminary results, which appear in the Jan. 1 ANALYTICAL CHEMISTRY, show that pure carbon dioxide removes cocaine only from the surface, but a mixture of carbon dioxide, water, and the organic chemical triethylamine removes drug traces bonded inside the hair shaft.

The water and triethylamine molecules "kick off the cocaine" from its binding sites in hair, says study coauthor Janet F. Morrison, now at Trinity College in Hartford, Conn. The method can be tuned to extract only what the researcher wants.

Cocaine can penetrate hair in other ways, too. Perspiration on a person's scalp, for example, might absorb cocaine vapors and then bind inside the hair. Morrison and her coworkers are now treating hair samples with "fake sweat" to test that possibility. —*C.W.*