Glowing doughnuts flash high above storms

Scientists have discovered a new kind of lightning that flares in the shape of a vast, 400-kilometer-wide doughnut at the outer reaches of Earth's atmosphere. These fleeting flashes—too quick to be seen with the naked eye—join an ever-growing roster of electric fireworks detected in the night sky high above thunderstorms.

Researchers call the newfound bursts elves, short for "emissions of light and very low frequency perturbations due to electromagnetic pulse sources." They blaze for less than one-thousandth of a second in Earth's mesosphere and ionosphere at altitudes of 70 to 100 km, says meteorologist Walter Lyons of Atmospheric Simulation Testing and Environmental Research in Fort Collins, Colo.

"It looks just like a disk that flashes on and off," says Lyons, adding that theory predicts a hole in the center of the disk. He and others documented the existence of elves last summer. The group described its work last week at the annual meeting of the American Geophysical Union in San Francisco.

During the summer experiment, researchers from Japan and from institutions across the United States convened at Lyons' home on Yucca Ridge, Colo. There, they could monitor thunderstorms across the Great Plains from the Canadian border to Mexico. "Virtually every night you can see a thunderstorm out our back door," Lyons says.

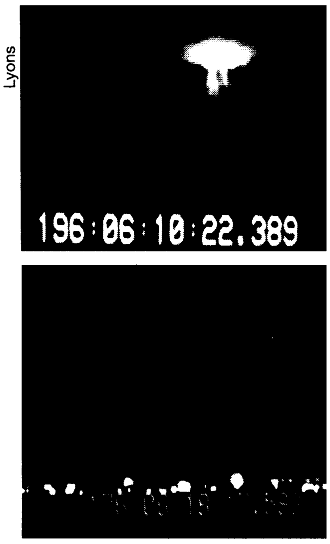
The group had planned the experiment primarily to study sprites, jellyfish-shaped blobs that flash bloodred at altitudes of 40 to 80 km. Only in the last few years have scientists discovered these red sprites and much rarer flares, called blue jets (SN: 12/17/94, p.405).

Red sprites, blue jets, and elves (which may be red) appear over the parts of a thunderstorm that produce the most powerful cloud-to-ground lightning. Using video monitors and high-speed photometers, the Yucca Ridge team discovered that elves occur often just before sprites and sometimes on their own. Although elves burn with 10 times the intensity of sprites, the latter look brighter because they last 10 times as long, report Hiroshi Fukunishi and his colleagues from Tohoku University in Sendai, Japan.

The discovery of elves traces back to researchers at Stanford University who observed ionospheric radio disturbances above thunderstorms in the 1980s. In 1992, space shuttle astronauts captured an image of light emissions now thought to be elves. Stanford University's Umran Inan and Yuri Taranenko then theorized that when powerful lightning sparks to the ground, it sends up a pulse of electromagnetic energy that heats the ionosphere, causing atoms and molecules there to glow. The recent observations of elves seem to support that theory, says Taranenko, now at Los Alamos (N.M.) National Laboratory.

While researchers have observed only 50 elves and a like number of blue jets, they have documented thousands of sprites. At the San Francisco meeting, two research groups reported results that help explain sprites. Experiments this summer showed that emissions from excited nitrogen molecules produce the red glow of sprites. Physicists haven't determined how the nitrogen molecules get energized.

Taranenko and Los Alamos colleague Robert Roussel-Dupré proposed last year that an upward-moving avalanche of electrons may cause blue jets and red sprites. Just after a lightning bolt, the leftover charge in storm clouds creates a temporary electric field above the storm. If a stray cosmic ray collides with an air molecule, it knocks loose an energetic electron. Accelerated upward by the field, that electron collides with air molecules and tears more electrons free. The upward cascade of electrons eventually collides with nitrogen molecules, causing them to glow blue at lower altitudes and red at higher ones.



Lyons

Elves can occur with sprites (above) or alone, like this one (bottom) captured over city lights.

Los Alamos researchers plan to test this theory next summer by sending balloon-borne instruments above thunderstorms in the Midwest.

Lyons predicts even more discoveries of electric surprises now hiding above storms. "Every year we look, we see something new. I'm not sure what we'll see next year, but there are new phenomena up there." — *R. Monastersky*

Diabetes complications: More than sugar?

Physicians have long thought that consistently high concentrations of sugar in the blood lead to the various complications of diabetes, but new studies hint at subtler causes.

Last week, scientists suggested that one complication, diabetic neuropathy, may stem in part from the problem that causes diabetes in the first place: an autoimmune attack.

In type I diabetes, a person's own antibodies destroy the pancreas cells that make insulin. This disease, which usually begins in childhood, often causes some degree of neuropathy, or nerve cell degeneration. Typically, nerve cells in the legs, feet, and hands gradually deteriorate. If neuropathy affects the heart, death may result.

Researchers at the Eastern Virginia Medical School in Norfolk report evidence that antibodies in the blood of people with diabetic neuropathy can kill nerve cells. They speculate that these antibodies trigger apoptosis, a built-in mechanism that leads to a cell's demise.

Lead researcher Gary L. Pittenger presented the work on Dec. 13 at the annual meeting of the American Society for Cell Biology in Washington, D.C.

In their study, the scientists added diluted blood serum from people with diabetic neuropathy to laboratory-grown nerve cells derived from tumors of the human nervous system. Within 4 hours, the cells began to die. Serum from diabetics without neuropathy failed to produce such an effect.

To identify the agent causing the cell death, the researchers turned to its likely target, a protein called Fas/apo-1 that can trigger apoptosis. The team tagged an antibody with dye and added it to the nerve cells. The antibody homed in on Fas/apo-1 on the cell surfaces.

When the researchers also added the diabetics' serum, however, the tagged antibodies failed to bind to the cells. This result suggests that the serum contains an antibody that competes with the tagged one, says Pittenger. "It's probably an antibody against Fas/apo-1."

The researchers now aim to isolate and identify the suspected antibody. After that, says Pittenger, they must examine diabetics with and without the antibody: "That's critical."

Pittenger admits that his hypothesis "invites controversy, because the predominant thinking is that neuropathy comes from high glucose levels." However, about 40 percent of diabetics who carefully control their sugar intake still suffer nerve degeneration, he points out.

The immune system, glucose concentrations, and other factors may all contribute to diabetic neuropathy, he notes. "In some patients, high glucose may be the dominant factor. In others, autoimmune considerations may be important."

"This is a tantalizing, if rudimentary, observation that needs more evidence," says Douglas A. Greene of the diabetes center at the University of Michigan in Ann Arbor. "Multiple mechanisms for diabetic neuropathy are becoming evident on a clinical level, however, as well as a molecular one." — *M. Centofanti*