Chemical collisions cause shuttle's halo

An experiment to test a 50-year-old theory of astrophysics has solved the mystery of why orbiting spacecraft sometimes develop a golden glow.

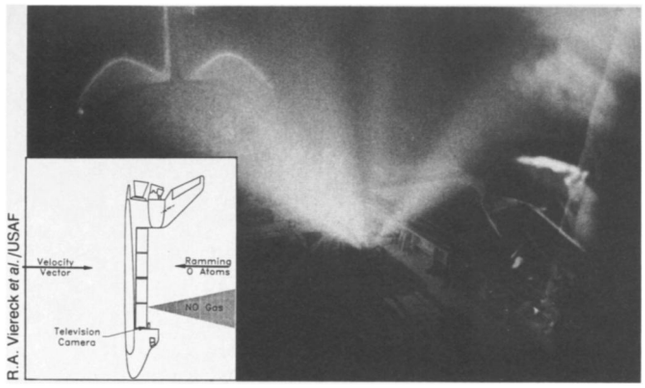
The halo along a satellite's leading edges results when nitric oxide combines with oxygen atoms to form nitrogen dioxide, reports Edmond Murad of the Phillips Laboratory at the Hanscom Air Force Base in Massachusetts. After this reaction occurs, electrons in the molecules become temporarily excited and the molecules leave the shuttle surface, Murad and his colleagues explain in the Nov. 7 NATURE. Then, as the electrons return to their normal state, the molecules emit light, creating an aura that extends about 20 centimeters out from the shuttle surface.

Shuttle astronauts first noticed this glow in 1982. Also, during two flights of the Atmospheric Explorer satellites, these unmanned spacecraft had picked up signals that differed from what researchers expected. At first, scientists blamed the instruments, but as a result of the early shuttle flights, "it became clear there was a reason for these anomalies," says Murad. The mysterious glow — rather than poorly calibrated instruments — could be the cause.

Scientists then tried to reproduce the glow in their laboratories, but they got a different color than what shuttle astronauts saw outside their windows, says Murad. And for good reason, he adds: The researchers needed air filled with oxygen atoms, not the two-atom oxygen molecules found in air at Earth's surface. Also, since the shuttle orbits Earth at about 7.8 kilometers per second, the free-floating oxygen atoms that collide with the shuttle hit their target quite fast. "It's not easy to make a very fast neutral oxygen in the lab," Murad says.

During last April's flight of the shuttle Discovery, Murad and his colleagues were testing whether accelerated atoms or molecules can reach high enough speeds to become charged briefly and then release energy as they return to a neutral state. This phenomenon, called the critical ionization velocity, can help explain the formation of the solar system; it was first suggested by Hannes Alfven, a Nobel-winning plasma physicist.

To study the phenomenon, the Discovery astronauts conducted four experiments. In each one, they used a nozzle with 27 tiny holes to shoot a different gas outside the shuttle bay for 10 seconds. A videocamera recorded the event, picking up any energy emissions — in the form of light — from the gases. In addition, a detector on the outside of the shuttle monitored for the discharge of any electrons.



This view of the shuttle bay from inside the craft shows the glowing plume and the bright halo around the shuttle's tail. Inset indicates direction of travel and experimental setup.

Neither the astronauts nor the ground-based researchers expected what they saw when they ejected nitric oxide into space.

"They were startled by the light; it lit up the shuttle," says Murad. The plume of nitric oxide created an intense blue-white glow. Then the orange halo along the shuttle's tail got much brighter for about 3 seconds as the nitric oxide settled back onto the shuttle surface and reacted with the oxygen that collided with the craft.

Now that scientists know how the glow originates, Murad says, they should try to mount space-bound instruments to face away from the craft's leading edge to prevent these instruments from "seeing" the glow. Otherwise, they should adjust their measurements to account for any artifacts caused by the halo. — *E. Pennisi*

Dinosaurs' swan song: Out with a bang

Paleontologists have grown frustrated during the last dozen years as physicists, chemists and other researchers outside their specialty have speculated that a huge meteorite may have wiped dinosaurs from the face of the planet 65 million years ago. Many of those who actually study dinosaurs believe other scientists have oversimplified the issue without consulting the fossil record to see whether the great beasts died out gradually or abruptly.

A group of paleontologists has now completed an intensive study indicating that dinosaurs did indeed die off rapidly at about the same time as the proposed impact. "We found no evidence of a gradual decline," says study leader Peter M. Sheehan of the Milwaukee Public Museum.

He and his co-workers addressed the extinction question by conducting a dinosaur census in the Hell Creek formation, a group of rocks from the last 2.5 million years of the Cretaceous period, which ended with the dinosaurs' extinction. Located in North America's upper Great Plains, this formation has for decades yielded an exceptional record of the last known dinosaurs.

Over three summers, paleontologists and volunteers surveyed undisturbed parts of Hell Creek in western North Dakota and eastern Montana. Walking 10 feet apart in search-party style, they scoured the area for dinosaur bones protruding from rock. Paleontologists then identified the bones and surrounding sediments, making sure the fossils had not been washed away from their original locations. The crew found some 4,100 bones representing almost 1,000 individual dinosaurs from eight taxonomic families.

Analysis of the bones showed the presence of all eight families in the lower, middle and upper portions of the formation, suggesting no gradual decline, the team reports in the Nov. 8 SCIENCE. Moreover, the relative strengths of these families remained constant from the earliest portion to the latest, indicating that ecological diversity was not waning, Sheehan says.

The new findings contradict previous studies, conducted at different sections of Hell Creek, that suggested the dinosaurs died off gradually over millions of years. Sheehan says his results fit with an abrupt-extinction scenario, but he adds that the data cannot resolve whether the extinctions unfolded over weeks or 100,000 years.

Past studies of Hell Creek pollen fossils, however, have revealed that many plant species in this region died out extremely rapidly at the end of the Cretaceous, suggesting that the purported impact caused the die-offs, says Douglas J. Nichols of the U.S. Geological Survey in Denver.

David Weishampel, a paleontologist at the Johns Hopkins University in Baltimore, says Sheehan's study represents a significant improvement over earlier work because the research team devised better methods for addressing problems inherent in fossil collecting. Nonetheless, he says, "I don't think their data are sufficiently strong to make the case they're trying to make."

Weishampel says the researchers need to collect more data on dinosaur bones in floodplain sediments, a type of deposit that yielded equivocal results in the new study. — *R. Monastersky*