Astronomy

Jovian auroras in the infrared . . .

It was a dark and stormy night.

On Aug. 8, 1997, astronomers at NASA's Infrared Telescope Facility on Mauna Kea in Hawaii were taking routine observations of Jupiter when a magnetic storm struck the distant planet's polar regions. The auroras that grace Jupiter's poles—souped-up versions of the northern and southern lights that shimmer in Earth's upper atmosphere—intensified. For the first time, researchers detected winds of charged particles whipping around the poles like cars around a racetrack.

Known as electrojets, these high-speed winds may explain how energy from the auroral regions spreads around the planet. This energy maintains temperatures throughout the upper atmosphere that are hundreds of degrees higher than what the meager sunlight shining on Jupiter could ever produce.

Jovian auroras are fueled by charged particles, mostly electrons, belched by the planet's volcanically active moon, Io. Captured by the planet's powerful magnetic field, these particles crash into the atmosphere a few hundred kilometers above Jupiter's magnetic poles, where they collide with hydrogen molecules. The battered molecules collect into oval patches centered on the poles and emit ultraviolet light.

Slightly higher in the atmosphere, hydrogen molecules ionized by the incoming electrons combine with hydrogen atoms to become ionized triatomic hydrogen (H_3^+). Swept around by the planet's magnetic field, these triatomic ions form the bulk of the circulating electrojet stream. By analyzing the infrared glow from these ions, Steve Miller of University College London and his colleagues measured the velocity of the electrojets. During the 1997 storm, they whirled faster than the speed of sound, the team reports in the May 13 NATURE.

The electrojets rotate in the direction opposite that of the planet, causing friction between these winds and the rest of the atmosphere. This generates heat that can be transported around the planet by small whirlpools and eddies, Miller suggests. He notes that although H_3^+ is only a tiny constituent of the Jovian atmosphere, it easily imparts its energy to the much larger population of neutral hydrogen molecules.

Electrojets may also explain another phenomenon. Like a twirling ballerina's skirt, a giant sheet of charged particles spins around Jupiter, keeping pace with the planet's rotation. That requires a lot of energy. Miller suggests that the electrojets siphon rotational energy from Jupiter, electrically transferring it to the giant sheet. *—R.C.*

. . . and in the ultraviolet

While studying the high-energy light radiated by Jupiter's auroras, John T. Clarke of the University of Michigan in Ann Arbor and his colleagues have found some intriguing activity. Time-lapse images taken by the Hubble Space Telescope's imaging spectrograph reveal that within the auroral regions, "flares come up for 10 seconds and become as bright as anything else and then go away to almost nothing," Clarke told SCIENCE NEWS. The flares appear and disappear independently of the overall brightness of the auroras, indicating that the auroras have a variable structure generated by more than one force. *—R.C.*

An ultraviolet flare emerges within one of Jupiter's auroras.

Technology

Remote control in deep space

On May 17, artificial intelligence software for the first time took charge of a spacecraft's activities. Known as Remote Agent, the craft-based computer program operated NASA's Deep Space 1 mission in a 2-day test. Launched on Oct. 24, 1998, the craft's goal is to evaluate several innovative, but risky, space-exploration technologies. When the test began, Deep Space 1 was nearly 76 million miles from Earth and on its way to a July encounter with the asteroid 1992 KD (SN: 1/3/98, p. 8).

Developed jointly by researchers at NASA's Ames Research Center in Mountain View, Calif., and the Jet Propulsion Laboratory (JPL) in Pasadena, Calif., the Remote Agent software package includes components for determining the sequence of activities needed to carry on tasks specified only in general terms. It also monitors the spacecraft's health and position in space and responds to emergencies. With no guidance from Earth-based controllers, the program can order engine firings to rotate the craft or keep it on course. Other commands direct the craft to aim and operate an on-board camera.

The test started off well. Remote Agent's initial task was to photograph distant asteroids and stars to set its navigational course. It formulated a plan, then set about executing it, only to find that when it tried to switch off the camera, it was unable to. This failure, actually a simulation, came courtesy of the Earth-based operations team. In response, Remote Agent successfully generated an alternative long-term plan, taking into account the extra power that the stuck camera would consume.

About 16 hours into the test, however, the software failed to shut down the spacecraft's main engine when it should have. Several hours later, after retrieving diagnostic data from the spacecraft, the ground team turned off Remote Agent, halting the experiment.

Mission engineers traced the failure to a software error—a minor timing glitch between two processes running simultaneously in the module responsible for issuing commands. "It was a very rare occurrence," says Peter Norvig of Ames. "That was something we couldn't test on the ground."

By the time it was halted, the Remote Agent experiment had achieved nearly 80 percent of its objectives. Because the software fault was relatively minor, the ground team quickly designed a new, shorter experiment for May 21 to complete the testing. At the same time, the researchers responsible for Remote Agent learned some important lessons that could lead to improved designs.

"I think of Deep Space 1 as a flying laboratory," says JPL's Marc Rayman. "For such a complicated system [as Remote Agent] to work as well as it did on the first try is amazing." *—I.P.*

Electronic ink debuts in store signs

Installed in the athletic-wear section of a J.C. Penney store in Marlborough, Mass., the display hanging from the ceiling looks like a printed sign 4 feet wide, 6 feet long, and less than 3 millimeters thick. Its message, however, changes every few minutes. Moreover, unlike conventional electronic displays, the curved surface looks the same from any angle and in any light.

Based on technology developed by E Ink Corp. of Cambridge, Mass., the sign represents the first commercial use of electronic ink (SN: 6/20/98, p. 396). The display's surface is coated with millions of tiny capsules, each containing a dark liquid and hundreds of electrically charged white particles. Circuits built into the display apply a voltage, either pulling particles to a capsule's front to make the capsule look white or pushing them to the back to make the capsule look dark. Signals sent to a built-in communication device orchestrate the voltage pattern to form the letters of a message. Even when updating messages every 10 seconds, the sign consumes less energy than a household light bulb does. *—I.P.*

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