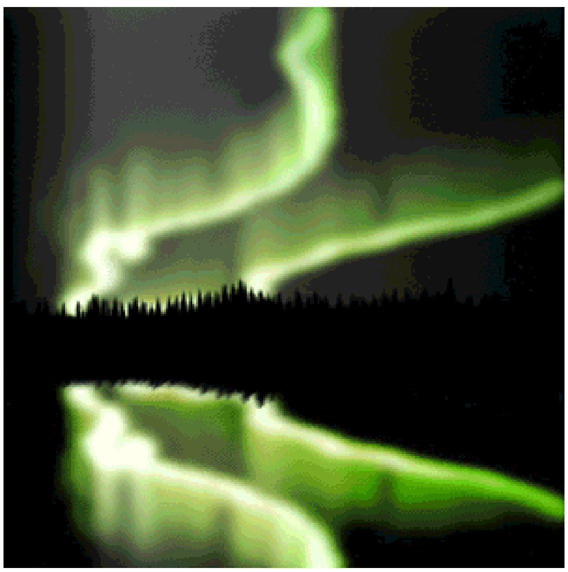
30 March 2001 7:00 PM

Inside the Northern Lights

The ethereal beauty of the northern lights hides a violent origin. Storms in the magnetic plasma that surrounds Earth send showers of electrons and ions smashing into the atmosphere, which then radiates the hues of an aurora. But how can so much magnetic energy be released in such a short time? In this week's *Nature*, Chinese and Japanese researchers provide a possible answer.



Whistling in the dark. Physicists say "whistler waves" may explain the massive energy release taking place in northern lights.
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Most researchers think the explosive release of magnetic energy, during a phenomenon called magnetic reconnection, happens in regions where the magnetic field reverses. There, the magnetic field lines trace the outline of the letter X, never crossing but bent into four chevrons--top, bottom, left, and right. Energy is released as plasma is pulled in from above and below the X and then accelerated out the sides. The problem has been that plasma in Earth's magnetosphere flows out at much higher speeds than conventional theories would allow. Those theories hold that ions and electrons must move together and the heavier, slower ions limit the speed of the plasma flow.

In recent years, theorists have developed an alternative idea under which the ions and electrons move independently. Then, so-called whistler waves, in which the velocity varies inversely with the wavelength, accelerate the electrons. Electrons have less mass than ions, so they travel faster--fast enough to generate massive outbursts of energy. While this theory had been bolstered by some laboratory experiments, whistler waves had never been observed in the wild.

Now Xiao Hua Deng, of Wuhan University, China, and Hiroshi Matsumoto of Kyoto University, Japan, have reexamined data previously collected by the Plasma Wave Instrument carried on the Geotail satellite, a joint Japan-U.S. mission to study Earth's magnetosphere. The team spotted a quadrapolar magnetic field which theorists think can only occur when whistler-mode waves are generated.

"This paper is quite important" because it confirms the whistler-mode theory, says Toshio Terasawa, a space plasma physicist at the University of Tokyo. There's intense interest in magnetic reconnection, because it could also help clarify the processes at work in plasmas surrounding protostars and even galaxy clusters. "In such remote regions, we cannot observe the physical processes directly," Terasawa says. "Earth's magnetosphere plays an important role as an astrophysical laboratory."

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The Geotail spacecraft home page
Discussion of magnetic reconnection and the role of whistler waves, on the home page of James Drake