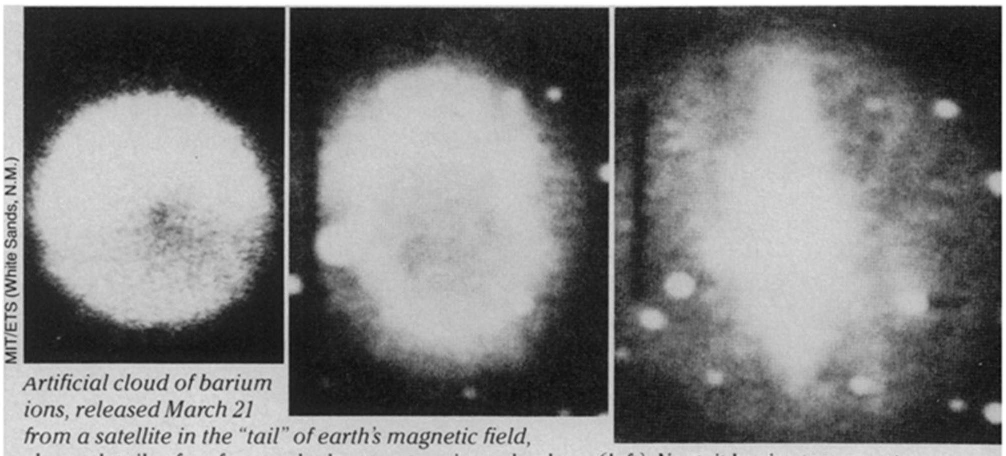
Chasing the Earth's Magnetic Tail

The earth's magnetic field, chock full of charged particles trapped on its lines of force, would resemble a giant apple spinning on its axis—were it not for the sun. As the far larger particle stream, called the solar wind, "blows" by from the sun, it drags earth's magnetic field lines out into a vast "tail," stretching into space for millions of kilometers. It is a strange domain, where the incoming particles are somehow pumped up to electrical energies far higher than those with which they arrived, yet where some of those ions, instead of being swept away in the flow, are transported back "upstream" toward the earth.

The tail's rampant exotica, however, are almost entirely invisible — detectable to spacecraft that fly through them, yet frustratingly inaccessible to scientists trying to stand back and look at the big picture.

Enter AMPTE, the international suite of satellites (the Active Magnetospheric Particle Tracer Explorers) that made headlines two days after Christmas when it generated a cloud of barium ions in space to produce the first artificial comet (SN: 1/5/85, p. 6). The geomagnetic tail is right down AMPTE's alley. Flying through the tail on March 21, a German satellite called the Ion Release Module (IRM) cast forth another barium cloud, while the U.S. Charge Composition Explorer monitored the results from closer to earth. Numerous ground-based observers in New Mexico, Arizona, Massachusetts, Alaska, Hawaii, Argentina and other locales, as well as aboard two aircraft flying over the Pacific, stood by with telescopes and other instruments to photograph the effects of the invisible tail on AMPTE's visible cloud, which was essentially serving as a tracer, like a dye marker in a stream.



MIT/ETS (White Sands, N.M.)

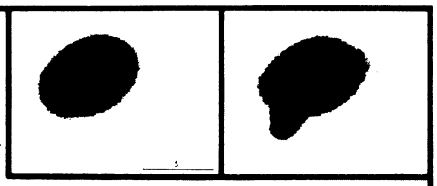
Artificial cloud of barium ions, released March 21 from a satellite in the "tail" of earth's magnetic field, shows details of surface and edge structure in early phase (left). Next, it begins to separate into a diffuse "halo" and a brighter central "cavity" (middle, after 2 min. 56 sec.), which thins (right, after 4 min. 56 sec.) as the cavity collapses and the ions spread along the geomagnetic field lines. (Vertical black streak in middle and right photos is part of telescope cross hairs.)

One problem for the AMPTE researchers trying to decide whether to go ahead with the barium release was that they could not know in advance about the condition of the interplanetary magnetic field that transports the solar-wind particles that ultimately populate earth's magnetic tail. Until the summer of 1982, a satellite named ISEE-3 was stationed on the sunward side of the earth, where it could report on the oncoming solar wind to give as much as an hour's advance notice. But ISEE-3 (since renamed the International Comet Explorer) is now on its way to a September flight through the tail of Comet Giacobini-Zinner, leaving the sun-watching post unattended and AMPTE's planners little to go on but theoretical predictions. And indeed, the field conditions within the tail itself at the time of the cloud's release turned out to be less than optimum: A key index of magnetic activity dropped to almost zero, says Stamatios Krimigis of the Johns Hopkins Applied Physics Laboratory in Laurel, Md., and the cloud "kind of just sat there."

And yet, notes principal investigator Gerhard Haerendel of the Max Planck Institute for Extraterrestrial Physics in Munich, there was still plenty to see. Fortunately, clear skies meant good viewing for the widespread observing teams (poor visibility had previously delayed the artificial comet experiment until the last possible day).

The cloud first appeared with the characteristic light-greenish hue of neutral barium, turning purplish as the barium

When quasars have supernovas



Campbell et al.

Before- (left) and after-supernova images of the quasar 1059 + 730.

The question of what quasars are has been a controversial topic for the last two decades. Lately a consensus seems to have formed among experts in the field that quasars are highly energetic versions of the centers of galaxies. Evidence cited for such a view includes the discovery that some quasars are surrounded by a luminous "fuzz" in which some astrophysicists have found spectra characteristic of stars. Now there is further evidence that quasars are surrounded by stars, as galactic centers should be: the discovery of a supernova in the vicinity of a quasar.

Supernovas are giant explosions of stars, and tend to be individually visible at distances where ordinary stars are not. The quasar in question, catalogued as QSO 1059 + 730, was observed on May 10, 1983, as part of a program of studying the colors and brightness profiles of the fuzz surrounding several quasars. On the image a bright object appears near the quasar where no such thing was on earlier pictures. This is the first discovery of a supernova associated with a quasar, according to the discoverers, Bruce Campbell of the Dominion Astrophysical Observatory in Victoria, British Columbia, Carol Christian of the Canada-France-Hawaii Telescope Corp. in Kamuela, Hawaii, Chris Pritchet of the University of Victoria and Paul Hickson of the University of British Columbia in Vancouver.

In analyzing their discovery, the observers rule out possible foreground objects in our own galaxy, such as flare stars, asteroids and dwarf novas, on grounds that the object, though variable, does not vary quickly enough for a flare star. It does not move as an asteroid should, and dwarf novas are very rare and improbable. The object's blue appearance and absolute magnitude (−17.6) are consistent with its being a supernova in the "host" galaxy of the quasar. The discoverers conclude that the discovery of more quasar supernovas could aid studies of the energetics of quasars and the galaxies that host them. —*D.E. Thomsen*