Carrying fuel into the galactic center

The Milky Way galaxy, like many others, has an intensely luminous center. A team of astronomers now reports identifying a stream of gas, 15 light-years long, that appears to mark the pathway by which gas is being funneled from a giant molecular cloud toward a massive, gaseous shell surrounding the galaxy's core. This gas streamer seems to be acting as a pipeline carrying fuel from a huge reservoir to the galaxy's central "engine."

"This may be the first evidence for the feeding of gas toward the center of the galaxy," says astrophysicist Paul T.P. Ho of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass. Because the Milky Way's center is only about 30,000 light-years away from Earth, studying the details of its behavior provides useful clues to what may be happening in quasars and other more distant, brighter objects. Ho and his collaborators reported their discovery at this week's meeting in Boston of the American Astronomical Society.

The streamer shows up in radio signals detected at a wavelength of 1 centimeter by the Very Large Array radio telescope near Socorro, N.M. Consisting almost entirely of molecular hydrogen from a nearby cloud, the streamer feeds gas toward a dusty, rotating, gaseous shell about 6 to 10 light-years from the galactic center. The streamer's flow speeds up, from 10 to 100 kilometers per second, as the gas gets closer to the shell.

The discovery is consistent with a proposal that places a compact, extremely massive object — possibly a supermassive black hole — at the Milky Way's center. Matter falling through such a strong gravitational field would release tremendous amounts of energy. A gas streamer provides a means by which fresh material can be continuously fed from a nearby reservoir to the shell and then into the black hole, which acts as a powerful energy source.

"One of the key problems that we want to resolve is what happens to this gas streamer as it gets closer," Ho says. "If it is really going into the galactic center, we expect its physical condition (temperature, density and so on) to change. We're trying to piece that together."

Ho and his colleagues also have observed that the gas streamer seems to originate where a supernova remnant impinges on the molecular cloud. The explosion of a massive star may have somehow "loosened up" the cloud's edge, making it easier for the material to be drawn toward the galactic center. "You can imagine whacking the cloud on its side, causing it to puff up a little along the edge," Ho says. "The part that puffs up gets sucked in." *— I. Peterson*

The Martian atmosphere: Old versus new

Many planetary scientists believe the atmosphere of Mars, less than 1 percent as dense as Earth's, was once much thicker than it is today. It is now too thin for liquid water to form on the Martian surface, but photos taken by the Viking spacecraft have shown widespread networks of "fluvial" valleys, apparently carved by flowing liquid. These are often cited as support for the idea of an initially thicker Martian atmosphere.

This week, however, at an international Mars conference in Tucson, Ariz., two scientists contended that such features alone do not prove the point.

made over after the numerous impacts thought to have taken place in the solar system's early history, when meteorites were presumably more common. This period of "heavy bombardment" may have ended about 3.9 billion or 3.8 billion years ago, Baker says, and features such as branching channel networks exist in several places on the ancient, heavily cratered terrain.

Channel networks are scarce on the younger regions, however, making Alba a rarity and supporting the idea that, over time, much of the atmosphere escaped into space or was chemically

Photos: Gulick, Baker

Viking photos of Mars show apparently fluid-formed channels not only on ancient, heavily cratered terrain (left) but also on a smoother region called Alba Patera (right), which may be as much as 2 billion years younger.

More than mere quibbling over details, the question touches fundamental issues of the planet's evolution, ranging from its water content to the extent of its volcanic activity. It is of growing interest as the U.S. and Soviet space programs focus on planned returns to Mars. The U.S. Mars Observer mission is to take off in 1992, and two unmanned Soviet craft will soon arrive to study Mars and its moon Phobos (though one is apparently unusable due to a ground controller's error, and problems have been reported with the second).

The uncertainty about how substantial the atmosphere of Mars used to be arises from an area known as Alba Patera in the Martian northern hemisphere, according to Virginia C. Gulick and Victor R. Baker of the University of Arizona in Tucson. Like other parts of the surface, Alba Patera shows a number of "fluvial" features—details such as branching, dry "stream beds" or other channels apparently created by flowing liquid, presumably water.

Unlike most such regions, however, Alba appears to have been formed as recently as 1 billion or 2 billion years ago, judging from the number of meteorite impact craters on its surface, the researchers say. It is relatively smooth, suggesting the surface was somehow

bound in the rock, leaving too little surface pressure for liquid water.

In that case, the Arizona scientists ask, where did all the water needed to form the Alba valleys come from? According to Gulick and Baker, the "drainage densities" calculated for the Alba valleys "are among the highest estimated on any Martian surface," greater than the ancient terrain and more like those of fluvial features on Earth such as the flanks of Hawaii's volcanic peak Mauna Kea. Earth's atmosphere was thick enough to sustain liquid water, but how did liquid last long enough on Alba to sculpt the terrain?

Basaltic-lava flows typically harden and crack, so that surface water is absorbed rather than flowing along to cut channels. Some volcanoes, however, explode with ash flows whose chunks are then weathered into finer particles that pack more closely together, almost, says Gulick, like clay—or the surface of Alba. On Mars, water beneath the surface might have been released during volcanic explosions, or heated from beneath into hydrothermal systems that emerged to flow across the ground. With Alba lacking the permeability of the ancient basaltic flows, the researchers ask, was a thick atmosphere really necessary? *— J. Eberhart*