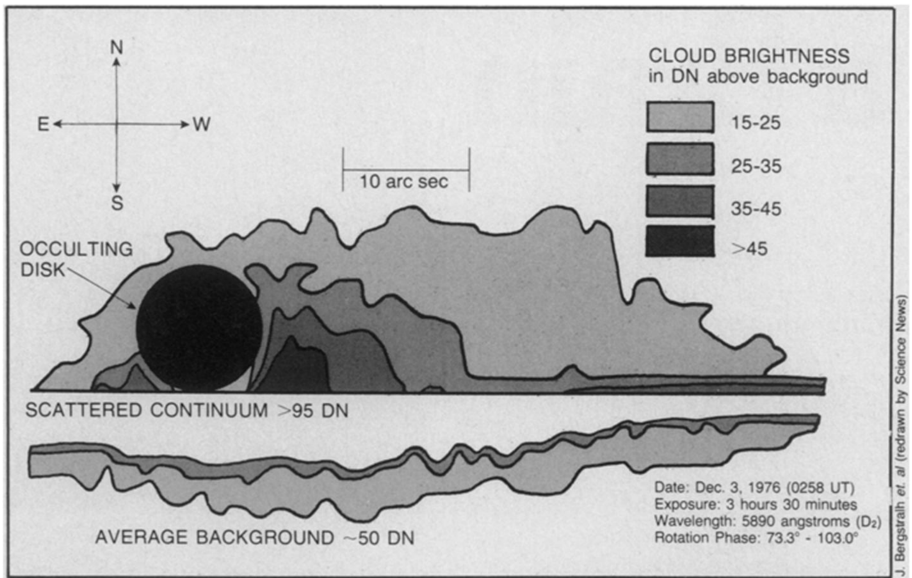
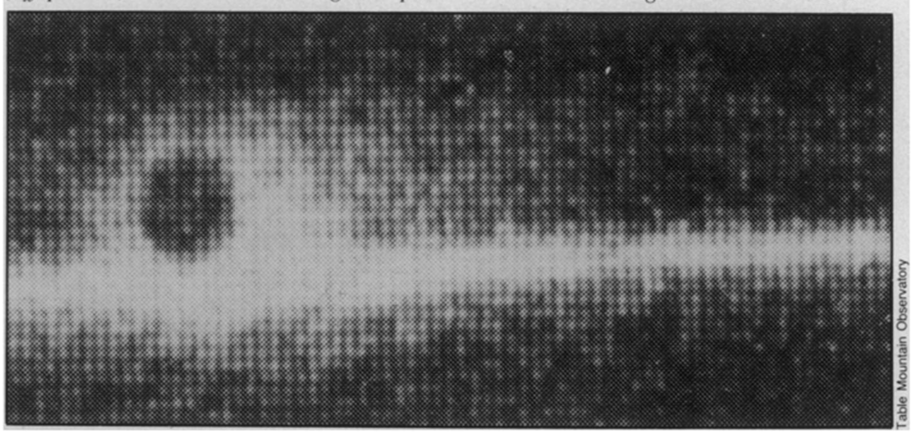
The First Actual *Look* at Io's Cloud

The glowing sodium cloud surrounding one of the solar system's most unusual moons has finally had its picture taken

BY JONATHAN EBERHART



Brightness map of Io's sodium cloud (above) shows contours extending toward Jupiter (off picture), based on occulting-disk photo taken in 5890-angstrom sodium band.



The strange cloud of sodium that envelops Jupiter's moon Io has fascinated planetologists ever since it was first detected in spectral studies several years ago. Apparently sputtered up from the surface by the impacts of charged particles riding in on the lines of the Jovian magnetic field, it is invisible to the eye, in large measure because the much brighter light reflected from Io and Jupiter simply drowns it out. Thus it has heretofore been recorded only as bright lines through the narrow slits of spectrographs and spectrometers. But now, apparently for the first time, a group of researchers has taken its picture.

Visually, as seen in a photograph of the vidicon tube that produced the image, the cloud appears as little more than a smudge. Yet there is enough information in that smudge for Jay Bergstralh of Jet Propulsion Laboratory and his colleagues from JPL and the University of Southern California to have prepared an actual contour map showing regions of differing brightness within the cloud—a far cry from struggling to read the cloud's shape out of a mass of individual slit spectra.

The photo and the map show only a portion of the cloud about six times the width of Io's disk. The entire cloud is believed to be as large as the whole Jovian system, but most of it is too dim, relative to the sunlight reflected from Jupiter, to show up in such an image. Nonetheless, a photo of the portion surrounding Io is a valuable tool in studying the relative contributions of different parts of the satellite to the cloud's evolution and structure.

The photo shows, for example, that the bright portion of the cloud is concentrated more on the side of Io facing toward Jupiter than away from it. This is consistent with a model developed by team members Dennis Matson of JPL and Robert Carlson of USC. The model is further supported by previously made conventional slit spectra suggesting that there may be more sputtering from Io's leading hemisphere (as it moves in its orbit) than from the trailing one.

The key to the image was a tiny glass plate (an inch-square microscope-slide coverglass) upon which Bruce Goldberg of JPL deposited an even tinier aluminum dot about one millimeter across. The dot, placed in the optical path of the 24-inch telescope at Table Mountain Observatory in California, served to block out the bright reflection of Io itself, much as a heliograph is used to mask the sun's disk for photos of the solar corona. And it was the dot that freed the observers from the slit.

With Io's light masked off, and with the observing time chosen so that Jupiter would be out of the picture as far as possible to one side, the primary source of light became the emission from the cloud. If Io had been allowed to shine through, its wide-band brilliance would have made the weak sodium emission of the cloud invisible. The other wavelengths could perhaps have been filtered out, says Bergstralh, but such filters are difficult to tune precisely to a set wavelength, and once tuned they tend to drift—a problem for a photographic exposure 3 hours 30 minutes long. Furthermore, says Goldberg, even the wavelength that is supposed to get through is usually dimmed by more than 50 percent.

The plate actually contains two images of the cloud: one each at 5890 and 5896 angstroms, the D_2 and D_1 emission lines of sodium. The contour map was made of the 5890-angstrom image. A bright line crossing the frame, tangent to the two images, is simply a wide-band light leak created when the bottom edge of Io's image slipped from behind the disk.

In the future, suggests Goldberg, the spot method could turn out to be useful in looking for emissive auras around other solar-system objects, even, perhaps, where slit spectroscopy reveals no such features.

Other team members are Torrance Johnson and James Young of JPL. □