lines. According to Robert Hoffman of Goddard Space Flight Center, NASA's designated project scientist, a number of other instruments will be flown to provide additional information on this specific problem. The high-altitude satellite will carry two antennas about 215 meters tip to tip, which will allow a direct measurement of the potential difference between them, or the strength of the electric field. Both satellites will carry particle detectors that measure electron and total ion fluxes, with their angular and energy distributions. Investigators for these instruments are J. L. Burch of the Southwest Research Institute (the high satellite), and J. D. Winningham of the University of Texas at Dallas (low satellite). Hoffman explained that these measurements will show the effects of the overall plasma acceleration in two ways:

- If a thermal plasma is energized by an electric field it will retain the characteristic shape of its original thermal energy distribution, but with the average energy increased by the amount of the electric potential.
- A comparison of the angular distributions of the particles in the electric field region and below it will depend also upon the altitude of the electric field region and its electric potential.

William Hanson, also at the University of Texas at Dallas, explained that low-energy particle detectors will also be looking for thermal plasma drift on the lower satellite to correlate with upward ion currents and with the aurora. He reported in Seattle on preliminary observations from similar instrumentation on the Atmosphere Explorer satellites that showed that thermal oxygen ions do leave the ionosphere at approximately the rate required by the Lockheed measurements. —*William A. Flanagan*

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Stellar disk suggests planet formation

A group of astronomers from Steward Observatory of the University of Arizona and NASA-Ames Research Center have found evidence for a central star surrounded by a disk seen face on, a surrounding HII region and circumstellar dust. They feel that they have presented "the first substantial case for a newly formed star with a preplanetary disk." In fact, the group feels that the object, MWC 349, in the constellation Cygnus, may contain a planet or planets in formation.

The group, consisting of Rodger I. Thompson and Peter A. Strittmatter (Steward), Edwin F. Erickson, Fred C. Witteborn and Donald W. Strecker (Ames), reported[1] their results at the American Astronomical Society meeting in Atlanta in June.

The group has been looking at regions where star formation was believed to be occurring, places where dust makes it very hard to see in the optical region. However, they chose to look at objects that could be seen both in the infrared and the visible. They first made ir observations with the 2.3-meter Steward telescope, and the 91-cm telescope on the Gerard P. Kuiper Airborne Observatory. Their ir spectroscopy showed Paschen and Brackett lines of hydrogen, OI fluorescence lines and He I recombination lines. In the visible range, using spectra taken at Lick Observatory by Steven Grandi, they measured Balmer lines, some further oxygen fluorescence lines, and from the HII region of the object, they saw forbidden lines.

The source appears to be in the Cygnus OB2 association; so its distance can be inferred. Using the ir and optical hydrogen lines, the group calculates how much dust surrounds the object and makes a correction for it. Taking the measurements of the HII region and the dust corrections, they compared their observed continuum intensity and spectrum with theoretical predictions for a central star alone. Instead of a Rayleigh–Jeans optical spectrum expected from a lonely star, whose slope with respect to frequency, ν, varies as ν^2, the group finds a slope varying as $\nu^{1/3}$. Furthermore, the intensity in the visible is far greater than would be anticipated.

Instead of a lone star, Strittmatter told us, their results are consistent with what one would expect from a viscous dissipating disk from which matter is flowing towards the central source. The Steward–Ames results are of the form predicted (under certain conditions) for a circumstellar disk by Donald Lynden-Bell and James E. Pringle (Institute of Astronomy, Cambridge University). In the radio region, one can also observe bremsstrahlung from the ionized gas in the HII region around the object. This is consistent with a central star, a surrounding disk, and a dusty HII region.

Another intesesting feature of MWC 349 is that its apparent visual luminosity has been decreasing over the past forty years at a rate of about 1% per month, but Strittmatter says this steady decrease is not crucial to the interpretation.

The new star is about ten times the size and 30 times the mass of our Sun. The disk appears to have a visible diameter 10–20 times that of the central star. As Strittmatter explained, the portion of the disk near the star is hotter and whirling faster. Further out, the disk is cooler, less dense, and hence more difficult to observe. If the disk actually extends to distances 400 times the diameter of the central star, the effective temperature of the outer material would be about 400 K, the group says. Then the density in the disk at that radius would be 10^{14} cm^{-3}.

Strittmatter told us, "Once you have a dense, cool region, conditions ought to be ideal for particles sticking together, forming grains, then rocks, perhaps even a planet."

In their paper, the group says the conditions are ideal for formation of molecules and dust grains and for rapid growth of the latter. They go on to say, "Although this does not necessarily imply formation of larger masses such as planets, the physical circumstances seem favorable to such a process." They say that a natural consequence of star formation from material with initial non-zero angular momentum is the formation of a central source and a surrounding disk in centripetal equilibrium orbit. Because of viscous dissipation in the disk, matter accretes onto the central object, which eventually becomes condensed and massive enough to begin nuclear burning. Most of the mass in the disk, they say, accretes onto the central star. However some mass moves out to larger radius to conserve angular momentum. They conclude that although most of this mass is probably lost to the system, any matter that is condensed enough to resist viscous and radiative forces can remain in orbit in the form of planetary objects. —GBL

Reference

1. R. I. Thompson, P. A. Strittmatter, E. F. Erickson, F. C. Witteborn, D. W. Strecker, Ap. J., to be published in 15 Nov. issue.

Heavy lepton

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from hadrons being misidentified as electrons or muons in the detector. After six months the group showed that only 25–30% could be coming from such background.

A more-difficult-to-eliminate possibility was that the events came from production of charmed mesons, now called D mesons, which at that time had not yet been found, although they had been predicted by Sheldon Glashow (Harvard) and his collaborators. Gary Feldman (SLAC) analyzed the e–μ events, which by then numbered 100. If the events were caused by a charmed meson, one should sometimes observe decays with an electron, a muon and additional