A 'BRICKBAT' IN THE SKY

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The multiple star system Epsilon Aurigae fascinates astronomers every 27 years

Multiple star systems — two or more stars bound together by gravity and orbiting a common center of mass — are quite numerous. In fact, a majority of the stars visible to earth's telescopes appear to reside in such systems. Eclipsing systems, in which a darker companion periodically moves in front of a brighter one, are far from rare. But among these the system called Epsilon Aurigae is quite unusual. Astronomers can't completely decide what it is that eclipses the bright primary star of Epsilon Aurigae. Nothing as simple as another starlike body seems to fit. It seems there must be at least one oblong cloud involved, a model that is called the "sliding brick."

Epsilon Aurigae's eclipses come once every 27.1 years—two or three times in an average working lifetime. The mystery is thus all the more frustrating, as between times astronomers can only chew over past observations. Epsilon Aurigae's latest eclipse occurred between 1982 and 1984, and a special North American Workshop on the Recent Eclipse of Epsilon Aurigae was held in Tucson, Ariz., immediately following the recent meeting there of the American Astronomical Society. The last two previous eclipses of Epsilon Aurigae took place between 1927 and 1930 and between 1955 and 1957. According to Frank Bradshaw Wood of the University of Florida at Gainesville, "systematic" study of Epsilon Aurigae goes back to the eclipse of 1821, which was described by J. H. Frisch. "It has been said that the history of studies of Epsilon Aurigae 'is in many respects the history of astrophysics since the beginning of the 20th century,'" Wood says. "... I am sure we will add to that history."

It is a history to which both professional and amateur astronomers have made significant contributions. The best way to observe such an eclipse is by making repeated measurements at frequent intervals—of the changes in brightness of the object or of its spectrum to see which features appear, disappear or shift in wavelength as the eclipse progresses. Large telescopes cannot always justify the expenditure of so much of their time on a single object, even when that object seems, as Wood puts it, "unique in our part of the galaxy." Indeed, as Douglas S. Hall of Vanderbilt University in Nashville, Tenn., and Russell M. Genet of Fairborn (Ohio) Observatory point out, "Epsilon Aurigae, because of both its brightness and the long duration of its eclipse, is a difficult photometric object for large telescopes at major observatories, but for the same reasons it was ideally suited for small telescopes at the smaller observatories."

One such observatory is the Hopkins Phoenix (Ariz.) Observatory, where Jeffrey L. Hopkins did more than 1,000 measurements of the brightness of Epsilon Aurigae himself and coordinated more than 2,000 by 29 observers from nine countries. He admits that a location in the suburbs of a large city does not enjoy very dark skies. Having the observatory in his backyard, however, he could observe whenever sky conditions permitted, and good photometry of objects brighter than eighth magnitude (of which Epsilon Aurigae is one) was possible. The Vanderbilt-based International Amateur Professional Photoelectric Photometry, which has more than 500 members in 40 countries, oversees such small-observatory efforts.

The models for Epsilon Aurigae proposed by different observers differ in detail, but all tend to agree on the sliding brick model: The eclipsing body is more than a secondary star; it must somehow include at least one oblong cloud of obscuring matter.

As to how the brick is made, observers differ. Dana E. Backman of the University of Hawaii at Manoa in Honolulu, reporting on infrared observations at Mauna Kea and Kitt Peak (Ariz.) National Observatory and with the Infrared Astronomy Satellite (IRAS), considers the eclipsing object to be a dark cloud with a binary star embedded in it. That is, two stars revolve around each other inside the cloud, and the whole thing revolves around the primary star. The secondary system would have 28 times the mass of the sun but only 10 percent of the sun's luminosity. Its temperature would be about 525 kelvins.

A two-disk model is proposed by James C. Kemp of the University of Oregon in Eugene as a result of more than 320 nights spent observing the polarization of Epsilon Aurigae's light with G. D. Henson, D. J. Kraus and I. S. Beardsley (all of the University of Oregon) at the Pine Mountain Observatory in central Oregon. According to this model, the primary star is a supergiant of spectral class F rotating around an axis inclined at 45° to the plane of the system. One cloud surrounds the primary's equator. The other cloud surrounds the secondary star. These observers regard the secondary disk as a "protoplanetary disk," that is, a planetary system beginning to form. They also see evidence that the primary is itself a pulsating or variable star.

Edward F. Guinan, George P. McCook and Robert Donovan of Villanova University in Villanova, Pa., opt for a single disk around the secondary star, which they also think is protoplanetary. They calculate its size as almost a billion miles across and several hundred thousand miles thick.

Ultraviolet spectroscopy done with the International Ultraviolet Explorer satellite leads Thomas B. Ake of Computer Sciences Corp. in El Segundo, Calif., to opt for a model with two disks and two secondary stars. The ultraviolet observations are difficult to interpret, he says, but they raise the suspicion that one secondary star is hot.

Something hot is also detected by Steno Ferluga and Margherita Hack of the University and Astronomical Observatory of Trieste, Italy. They did a variety of spectroscopic observations at wavelengths between 3,500 and 7,000 angstroms at the Haute Provence Observatory at St. Michel l'Observatoire, France. The hot spot seems to be in the center of the eclipsing body, which then would be a hot source surrounded by a cool region or cloud.

These various models, although all tend to agree on the sliding brick, are divergent in some important details. It may be that as astronomers continue to meditate on the actual observational data, they will come together on a single model. Otherwise, we will have to wait until 2009 for the solution of the problem. □