

## A POST ECLIPSE REPORT ON EPSILON AURIGAE

A PAPER PRESENTED AT THE 1985 I. A. P. P. P. BIG BEAR SYMPOSIUM

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### I. INTRODUCTION

Epsilon Aurigae is a star system that undergoes an eclipse every 27.1 years. The eclipse lasts nearly two years, which is part of the mystery. What is the nature of the eclipsing object? To produce an eclipse lasting two years implies gigantic size. All sorts of ideas have been presented, from black holes to proto-planetary systems. Another mysterious feature is that the eclipse is essentially gray, in other words, there is no change in the color of the system from outside eclipse to inside eclipse. All wavelengths decrease in brightness equally. In fact the spectrum seen outside eclipse is the same as the spectrum seen during the eclipse.

In 1982 a campaign was organized to study the eclipse in detail. I. A. P. P. P. was contacted for photometry support and played a significant role in covering the 1982-1984 eclipse. Coverage was in the UBVR<sub>i</sub> photo-electric photometry bandpasses. In fact, nearly all of the nearly 3000 photometric observations submitted to the campaign were obtained by I. A. P. P. P. members. To provide a focal point for information on this eclipse, an Epsilon Aurigae Eclipse Campaign Newsletter was published, thirteen altogether. The first one was published before the eclipse and the last one was published this month. As a summation of the campaign, a two-day workshop on the eclipse was held following the January 1985 meeting of the American Astronomical Society in Tucson, Arizona.

### II. PREVIOUS EPSILON AURIGAE BIG BEAR PAPERS

At the two previous Big Bear Symposia I presented papers on Epsilon Aurigae. The first, at the beginning of the eclipse, was presented at the 1982 Symposium and covered information on the system as was known before the eclipse (Hopkins 1983). The second was given at the 1984 Symposium and provided an update and preliminary results of the campaign (Hopkins 1984).

### III. THE JANUARY 1985 EPSILON AURIGAE ECLIPSE WORKSHOP

Approximately 50 scientists convened in Tucson following the January 1985 meeting of the American Astronomical Society for a two-day workshop to discuss data obtained during the recent eclipse. Although final conclusions about this mysterious object are still to be written, Stencel (1985) has provided an approximate consensus of what developed, in the form of tables pertaining to the F supergiant star, the mysterious secondary component, the system itself, predictions, and necessary future observations. Issue No. 13 of the Epsilon Aurigae Campaign Newsletter, the final edition, contains also the abstracts of the papers presented at the meeting.

Figure 1 shows a more popular idea of what the system is. The F supergiant is surrounded by its own disk while the secondary object consists of a tilted disk with a hole in the middle and two B stars within the disk.

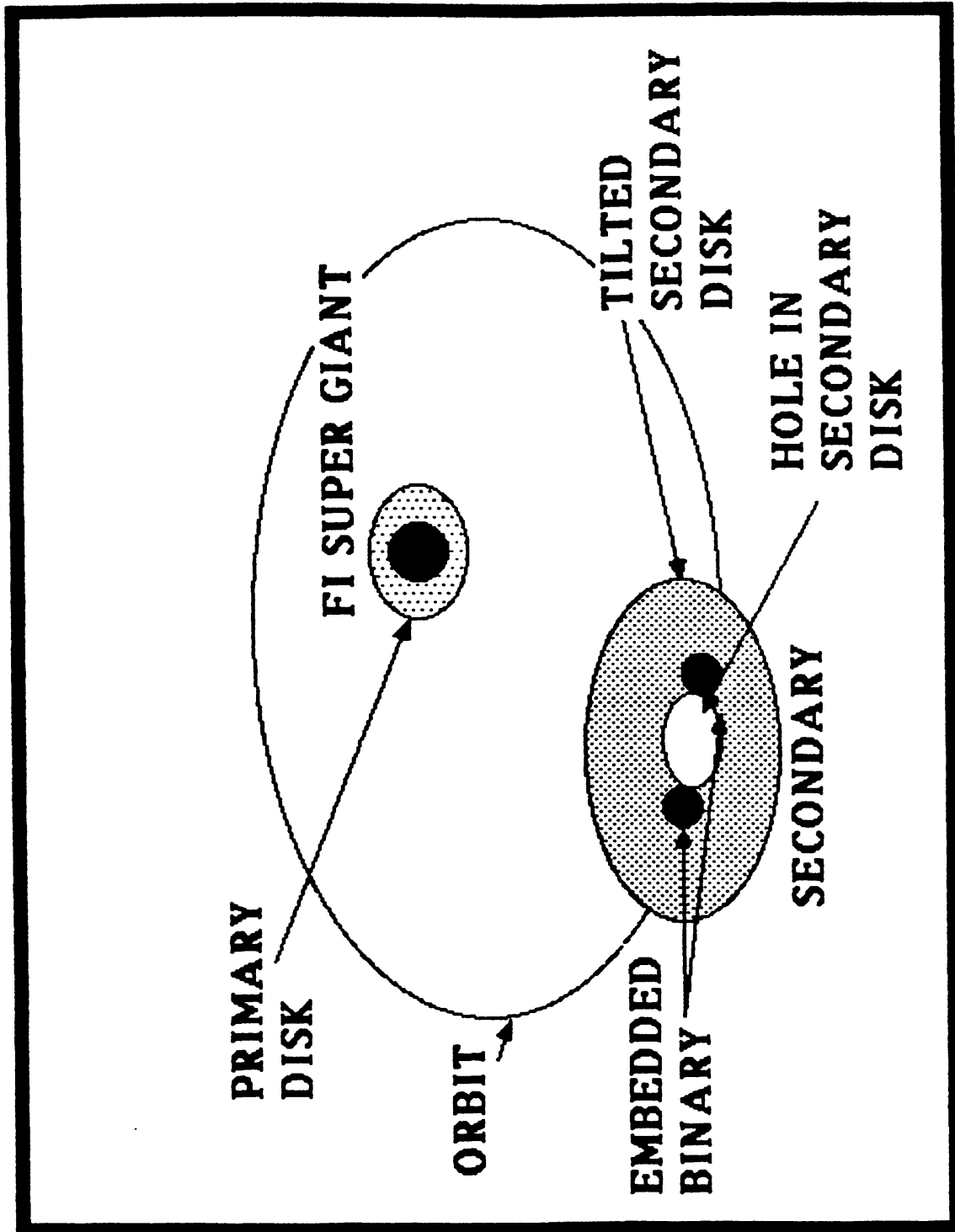


Figure 1. A proposed model of Epsilon Aurigae.

TABLE I  
Epsilon Aurigae Eclipse Durations

	1982-1984 Eclipse	1955-1957 Eclipse	Prior to 1955 Eclipse
Ingress	137 days	135 days	182 days
Totality	446 days	394 days	330 days
Egress	64 days	141 days	203 days

The tilted disk with the hole provides one explanation for the mid-eclipse brightening. Other ups and downs in the light curve can be explained by the Cepheid-like pulsations of the F star. There seems to be a wide variation in the distance estimates. One estimate places the system 600 parsecs or about 2000 light years from us while the other extreme is 2000 parsecs or over 6000 light years. Because important conclusions depend on knowledge of the distance, this is one of the parameters requiring a more accurate determination.

#### IV. SUMMARY OF PHOTOELECTRIC PHOTOMETRY

Schmidtke (1985) has provided an excellent analysis of the photoelectric data submitted to the campaign. A summary of this analysis follows. This system presents a real challenge to determine times of contact, because of the non-eclipse variations of the system. First contact was predicted for 29 July 1982 (JD 2,445,180) and was observed 14 July 1982 (JD 2,445,165) for a difference of -15 days. Second contact was predicted for 11 December 1982 (JD 2,445,315) and was observed 28 November 1982 (JD 2,445,302) for a difference of -13 days. Third contact was predicted for 9 January 1984 (JD 2,445,709) and was observed 17 February 1984 (JD 2,445,748) for a difference of +39 days. Last contact was predicted for 29 May 1984 (JD 2,445,850) and was observed 21 April 1984 (JD 2,445,812) for a difference of -38 days.

Table I shows a comparison of the ingress, totality, and egress durations for the last three eclipses. It can be seen that ingress seems to be decreasing, totality increasing, and egress decreasing. Perhaps the edges of the eclipsing body are becoming sharper.

Schmidtke has examined the idea that the mid-eclipse brightening is the result of a gravitational lens effect. For a calculation using a concentrated mass for the secondary, the probability of a lensing effect is very small. However, he has yet to calculate the probability for an extended mass. There may still be a chance we are seeing a gravitational lens effect during the mid-eclipse brightening.

Figure 2 is a plot of UBV light curves outside eclipse after fourth contact. These data were obtained at the Hopkins Phoenix Observatory.

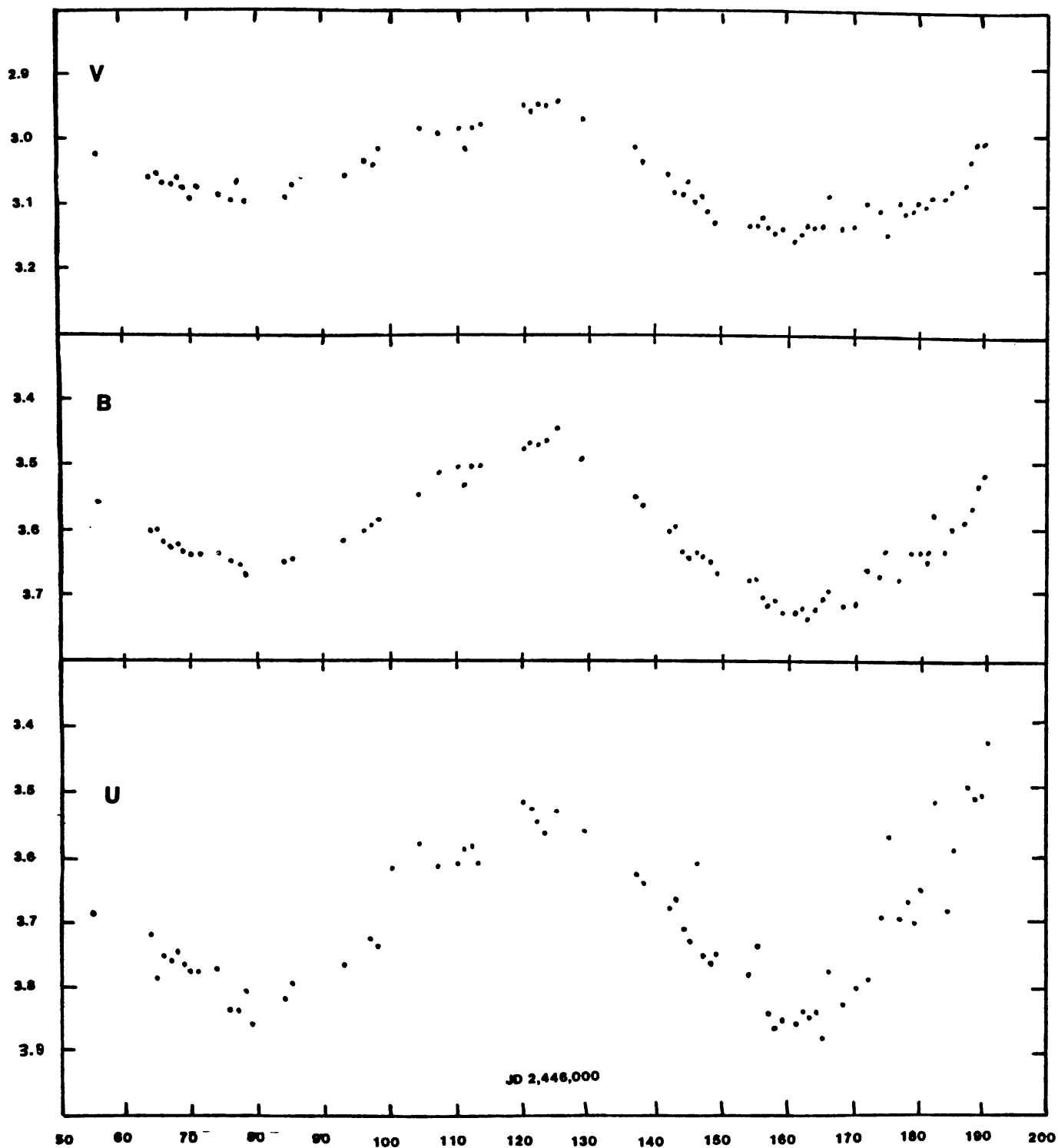


Figure 2. UB light curve of Epsilon Aurigae after fourth contact.

## V. SUMMARY

The eclipse is over but the mystery remains. A Joint Discussion on Long-Period Eclipsing Binaries at the November 1985 International Astronomical Union General Assembly in New Delhi, India will devote time for discussions on Epsilon Aurigae. Hopefully more of the mystery will be explained. Otherwise, make plans for the 2009 eclipse.

## REFERENCES

- Hopkins, J. L. 1983, I. A. P. P. P. Communication No. 9, 73.  
Hopkins, J. L. 1984, I. A. P. P. P. Communication No. 17, 22.  
Schmidtke, P. C. 1985, Epsilon Aurigae Campaign Newsletter No. 13, 17.  
Stencel, R. E. 1985, Epsilon Aurigae Campaign Newsletter No. 13, 3.