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A note on the spectra of ε Aurigae

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Abstract. Spectroscopic observations of the long period variable ε Aurigae were made during its 1982-84 eclipse. It is found that the Ca II H and K lines show variation in their equivalent widths. The equivalent widths of these lines are larger before and after totality compared with that during totality. This phenomenon may be due to the atmospheric effect of the secondary.

Key words : long period eclipsing variable—equivalent widths

1. Introduction

ε Aurigae is a long period eclipsing binary with a period of 27.08 years containing a F2 supergiant and an unseen secondary.

Spectroscopic observations of this binary indicated that during eclipse many strong lines were strengthened and became asymetrical (Struve & Elvey 1930). Kuiper, Struve & Stromgren (1937) interpreted the photometric and spectroscopic observations by non-selective opacity for visual and photographic light concentrated in an outer shell of the cooler star and suggested that this effect is produced by photoelectric ionization from the F2 primary. Struve (1951a, b) discussed the spectrum and physical nature of the system as it was understood at that time. Wright (1955) described the pre-eclipse spectrographic observations to some extent. In the partial phases after the end of totality, Hack (1959) found doubling of the lines similar to the 1929 eclipse, with the violet component appearing to originate in a very rarified shell which surrounds the invisible star. The star was studied extensively during its eclipse of 1982-84 (Stencel 1985).

2. Observations and results

Ten spectra of ε Aurigae were obtained by us during its 1982-84 eclipse at a dispersion of 33Å/mm with the Meinel spectrograph at the Nasmyth focus of the 1.2 metre telescope of the Japal-Rangapur Observatory. The spectra were recorded on Kodak IIa-O emulsion. These were scanned using a microdensitometer to obtain their digital intensity profiles, and were used to measure the equivalent widths. A detailed description of the Meinel spectrograph is given by Raghavender Rao & Abhyankar (1991) and of the microdensitometer is given by Sreedhar Rao & Abhyankar (1990). The measured equivalent widths of H_8, Ca II K and H + H_ε and H_δ are given in table 1. It can be seen from this table that the equivalent widths of H + H_ε and K lines are larger before and after totality compared to that during totality, whereas the equivalent widths of H_8 and H_δ remain more or less constant. This indicates that there is additional absorption in the calcium lines before and after totality.

Table 1. Equivalent widths in angstroms

Date	JD 2445+	Ca II K	Ca II H & H_ε	H_δ	H_8
04 Dec 1982	307.5	8.480	9.505	4.871	4.748
06 Dec 82	309.5	8.580	8.786	3.890	5.035
26 Dec 82	329.5	8.111	9.003	4.201	4.786
28 Dec 82	331.5	8.188	7.695	4.021	4.626
08 Jan 83	342.5	7.980	6.567	3.784	4.045
26 Jan 83	360.5	7.042	7.408	4.860	4.263
08 Mar 83	401.5	7.074	7.844	3.754	4.399
27 Mar 83	420.5	7.623	8.878	5.118	5.093
22 Jan 84	721.5	8.120	7.913	4.043	5.006
15 Feb 84	745.5	9.877	11.527	4.495	4.615
Mean equivalent widths					
During pre-totality		8.340	8.747	4.246	4.799
During totality		7.568	7.722	4.312	4.561
After totality		9.877	11.572	4.495	4.615

3. Discussion

Gussow (1936) and Fredrick (1960) found in the ε Aurigae system light fluctuations far away from eclipse by about 0.1 mag; and 3 to 5 years before and after eclipse the variation may approach but seldom reach 0.2 mag and that in totality the fluctuation may reach 0.3 mag. or even slightly more. Huang's (1965) model which consists of a rotating gaseous disk that appears opaque when viewed edge-on, explains such a manner of light variation for this system. According to him the intrinsic variation of light far away from eclipse is expected from the supergiant F2 primary itself and the greater fluctuation in light near and during eclipse only indicates the unsteadiness of gaseous streams on both sides of rotating disk. During the recent eclipse Ferluga & Hack (1985) noted the appearance of sharp absorption components on the red side of the strong low-excitation lines and of the balmer lines during the ingress phase and on the violet side during the egress phase of 1982-84 eclipse. They attributed this additional spectrum which appears only during the eclipses and is very well observable during partial phases, as due to the extended gaseous envelope surrounding the eclipsing body and rotating in the same sense as the orbital motion. Our observations of the calcium lines support this hypothesis.

4. Conclusion

The variation found in the equivalent widths of the Ca II H and K lines may be understood as due to the shell spectrum only. For further confirmation it is desirable to measure the equivalent widths of other lines at higher dispersions. It is also worth studying the stability of the rotating disk around the secondary on dynamical considerations.

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