

Variation of Radiation in Pleione During Shell and Be Phases

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The analysis of the spectrophotometric observations of Pleione, a wonderful object in Pleiades cluster, has been carried out in the wavelength range of 3200-5500 Å. The amount of emitted radiation at Balmer continuum and Balmer jump has been measured in term of magnitudes. Our present measurements have been combined with the earlier measurements to investigate the relation between the variation of the emitted radiation and phase changes in Pleione.

Key Words: Shell star, Balmer jump, Variations.

INTRODUCTION

Phase transitions from Be-shell to Be and/or B normal and conversely, remain unpredictable in single Be stars. They may occur over time-scales ranging from months to decades. Therefore, phenomena associated with such type of phase transitions still remain poorly understood. Because of the unpredictable behaviour such events have been monitored only in a very few cases. These phase transitions have serious implications on modeling. Pleione (HR1180; HD23862; 28Tau; BUTau; Sp.T.B8Vpe; $v_{\text{ini}} = 320 \text{ km s}^{-1}$) is an interesting shell star that had been the subject of a number of peculiarities. This fantastic object belongs to those few Be stars whose phase variations has been studied in much more detail for over 115 years. Pleione is well known Be-shell star with quasi-regular spectral changes. This is one of the most known active Be star.

During 1888, the presence of narrow emission at the centre of a wide hydrogen absorption line was noticed¹. This was the first signature of this star as a Be star. Pleione began to enter the Be phase in 1887-1888. The behaviour of Pleione since 1888 showed that this star passed through B, Be and Be-shell phases. The behaviour of Pleione from 1940-1972 has been investigated in detail²⁻⁵. The detailed studies of the latest shell phase and other activities of Pleione from 1972 onwards⁶⁻⁸ have shown an increase of near-UV radiation of Pleione during 1991. Spectral changes during 1988-1999 and strongest H-alpha emission was noticed⁹ during 1995-1999. Pleione entered in a new Be phase since 1988 and during 1992-1999 the star showed beginning of the new phase of spectral activities^{10,11}.

Keeping in view the interesting behaviour of Pleione as described above we planned to observe this fascinating object around Balmer continuum and Balmer jump regions. We made our spectrophotometric

observations in 1980 and 1982 when Pleione was passing through the latest Be-shell phase (1972-1990). We have analyzed the shell behaviour of Pleione on the basis of emission of radiation from the Balmer continuum and Balmer jump.

OBSERVATIONS

To study the nature of Balmer continuum and Balmer jump in Pleione we have adopted the earlier measurements¹² made during 1975 to 1981. These measurements are combined with our present spectrophotometric observations made during December 27, 30 1980 and during November 2, 1982. The present observations were made on the 104 cm reflector of Aryabhata Research Institute of Observational Sciences (ARIES), Nainital, India, using their Hilger and Watts spectrum scanner¹³. An exit slit 0.7 mm wide admitting 50 Å of the spectrum to fall on the photomultiplier tube EMI 9658B was used for obtaining the observations. In all, six forward and reverse scans of Pleione were taken during the night and the free hand continuum was drawn through each of them. The spectral region was covered from 3200 to 5500 Å. Each scan was reduced to instrumental magnitudes separately and their average was adopted. The magnitudes were measured every 100 Å of the continuum.

Alongwith Pleione the comparison star 18 Tau (B8V) and the standard star alpha Leo were also observed. The standard star alpha Leo was observed many times during the night and was used for deriving extinction corrections and to convert instrumental magnitudes of Pleione and 18 Tau into absolute magnitudes. The absolute magnitudes thus obtained correspond to Taylor's¹³ calibration of alpha Leo. The standard deviation of the measurements does not exceed ± 0.03 mag. in the entire wavelength range.

We have further added and analyzed the spectrophotometric observations of Pleione made by Ohja and Joshi¹⁴ during November 19 and December 3, 7, 1988 and during January 9, 1990. These observations were also made on the 104 cm reflector with the same scanner and same all other settings of (ARIES) as were used by us mentioned above. The differential magnitudes (Δm) of Pleione (Pleione - 18 Tau) were computed and compared with the earlier measurements and are displayed in Fig. 1.

RESULTS AND DISCUSSIONS

It is obvious from Fig. 1 that since 1975 there is gradual increase in the differential magnitudes (Δm) of Pleione. The highest value was attained during 1981. This was followed by a rapidly decreased value of

delta m during 1982. The value of differential magnitudes further decreased and almost became zero during 1988-1990.

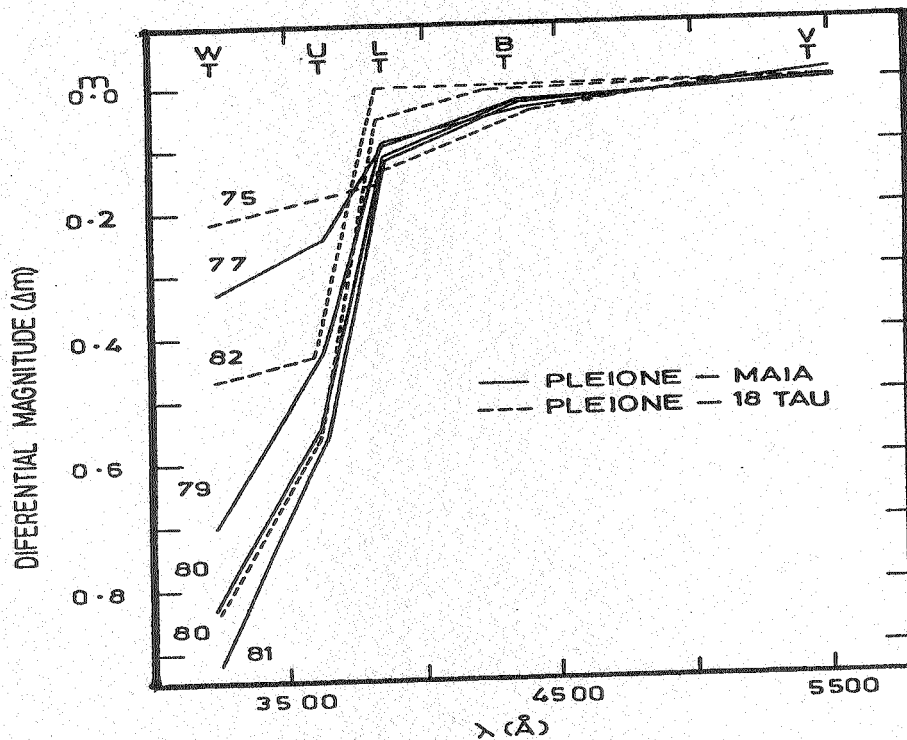


Fig.1. Variation of the Balmer continuum in Pleione. All curves are normalized to 5500 Å

Fig. 1 shows highly variable behaviour of Balmer continuum and Balmer jump in Pleione. Since 1975 the star showed continuous decrease in the emitted radiation at Balmer continuum. The star attained minimum level of radiation during 1981 with the largest value of Balmer jump. This shows that the shell strength was maximum during 1981. Thereafter, the emission strength of radiation started increasing as is shown by our observations made in 1982 in Fig. 1. The emission strength of emitted radiation further increased and attained a normal level during 1988 and 1990. This indicates that the latest Be-shell phase of Pleione, which started in 1972, attained maximum strength in 1981 and ended in around 1988-1989, lasting for about 17 years. It is important to mention here that ours is the only study of its kind that is explaining the latest Be-shell behaviour of Pleione (from 1972-1990) on the basis of analysis of emission of radiation from the Balmer continuum and Balmer Jump.

From the spectral analysis^{4,5} it has been shown that the last Be-shell phase in Pleione began in 1972. From the inspection of the spectroscopic observations made during 1978-1987, it has been reported¹⁵ that Be-shell phase reached maximum around 1982 and decrease in strength was noticed in 1984. From the analysis of UBV observations Pleione was

found¹⁶ to show increase in brightness since 1985, but the trend slowed down after 1989 (Max level). In 1987-1988, emission lines were strong, shell lines almost disappeared¹⁷ (with the exception of FeII multiplet). From the spectrum of Pleione it was noticed that shell lines were completely absent¹⁸ during 1990.

The beginning of the recent new B-phase of Pleione were explored^{18,19} from the H-alpha observations and it was found that Pleione entered the recent new Be-phase in 1991-1992. But from the inspection of the original spectrum scans Pleione was found to show quite a strong H-alpha line emission on all four nights in 1988 and 1990, thereby suggesting that the new Be-phase of Pleione began around 1988-89.

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