YU ISSN 0351-2651
HOBUD7 7(1) 155(1983)

A NOTE ON THE VARIABILITY OF λ ERI AND THE PULSATION IN Be STARS

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UDC 524.338:524.33-563
conference paper

1. SPECTROGRAPHIC AND PHOTOELECTRIC OBSERVATIONS

Short period variability in Be stars has been observed by several authors and it has been interpreted particularly in terms of nonradial (NR) pulsations (see Percy, 1982). One of such stars, λ Eri (B2IVe), has been observed intensively by Bolton (1982), and he has found a period of light and radial velocity (RV) variations of 0.701 d. In particular, it seems that the pulsational behaviour of this star is strictly related to the Be activity (RV amplitudes from 30 to 60 km/sec).

We have made photoelectric and spectrographic observations (thirty-eight spectrograms; dispersion: 35 Å/mm) of λ Eri during five nights at the end of 1980 at the Merate Observatory. Here we report the main results of these observations.

The spectrograms show very broad spectral absorption lines, and the hydrogen lines do not show emissions or other features indicating some activity. For the reduction, a visual digitized comparator was used; as a check, owing to the broadness of lines (V sin i = 328 km/sec), several spectra were measured more than once. The RV is variable with a period of about 0.65 d and an amplitude of about 30 km/sec. Taking into account all the uncertainties in the RV measurements and the small number of observations, we may conclude that our results are not in contradiction with Bolton's ones.

The photoelectric measurements (comparison CF star: HR 1671; check CK star: GC 6266) indicate a small variation of the luminosity of the star ($\Delta B < 0.02$ mag; the CF-CK data have a dispersion of 0.0050 mag) with a period of about 0.26 d. This result does not agree with the period of 0.701 reported by Bolton, but it is similar to that obtained by Balona (1977) during one night (0.28 d). The period of 0.26 d does not seem to be spurious or due to some observational effect, hence we can conclude that the RV and the light variations show different periodicities (at least during our observing time). This result cannot be explained easily in terms of pulsations of the star. It reminds the result obtained by Baade (1982a) for 28 CMa; indeed, the light variations of 28 CMa are very small, and the period (as in our case) is about 1/3 of the RV variation period. This star also seems to have variable RV amplitude according to the Be activity.

2. NONRADIAL PULSATIONS

As we are concerned mainly with periods $P \gtrsim 0.3$ d, we are interested in the possible NR modes which are responsible for such 'long' (from a pulsational point of view) period of variations in dwarf or subgiant B stars.

For a model of a nonrotating star, the periods of radial and NR p-modes are too short to explain the observed variability; however, as it was pointed out by Baade (1982b), the rotational velocity effects on the NR modes make the periods of retrograde ($m > 0$) p-modes very long (the angular rotational frequency is assumed to be positive). The second order effect of rotation on the NR pulsations of polytropic stars has been studied by Saio (1981), who has derived a formula similar to the following one

$$\sigma = \sigma_0 - (1 - C_1) m\Omega + C_2 \sigma_0 \left(\frac{\Omega}{\sigma_0}\right)^2 ,$$

where σ_0 is the frequency of the radial or NR p-, g-, f-mode of the unperturbed star, C_1 is a coefficient depending on the structure of the star, and C_2 is another similar coefficient which, in particular, depends on m^2. This last property breaks the well known equidistant separation of pulsation frequencies which arises in first order. In general, $0 < C_1 < 1$ for p-modes and $C_2 < 0$; hence, considering retrograde traveling waves ($m > 0$), for a high angular frequency of rotation Ω one can obtain a pulsational frequency $\sigma \ll \sigma_0$.

If we take into account the results of Hansen et al. (1978), the instability of a mode (for a given ℓ-order) increases from $m = \ell$ to $m = -\ell$; hence, prograde modes might be more instable than retrograde ones. This result may have some importance because it is general (i.e. it is not related to a particular model), and it depends only on the quasi-adiabatic treatement and the assumption of slow rotation. In general, indeed, the observed $m \neq 0$ modes in β Cephei, 53 Persei and δ Scuti stars are prograde ($m < 0$) modes (Smith, 1981). Hence, for the present, it is difficult to understand why a highly excited retrograde p-mode is present in pulsating Be stars rather than a prograde mode.

Other two types of NR modes can have 'long' periods, not necessarily related to high rotation: the g- and r-modes. Smith (1981, 1982) has made an interesting study of these modes, with an application to the observed pulsations in B stars (in particular the 53 Persei variables). A characteristic of these modes is the small radial displacement compared to the horizontal one. In particular, in a first order theory, the radial displacement for r-modes is zero, and the main effect is an essentially symmetric line profile with wings which, during some phases, can be very strong. This is not the case for our stars, whose main feature is the high amplitude of RV variations.

In conclusion, if we want to explain the observations by the classical pulsational hypothesis and we do not consider the results of Hansen et al. (1978), we have to assume ad hoc that there are two different oscillations: a 'high' ℓ-order p-mode with $m > 0$ (in order to have a high RV amplitude and a small or undetectable light amplitude), and a radial or a low ℓ-order NR mode (with low amplitude).

REFERENCES

Baade, D.: 1982a, Astron. Astrophys. 110, L15.

Baade, D.: 1982b, Astron. Astrophys. 105, 65.

Balona, L.A.: 1977, Mem. Roy. Astron. Soc. 84, 101.

Bolton, C.T.: 1982, in 'Be stars', eds. M.Jaschek and C. Groth, D. Reidel,

p. 181.

Hansen, C.J., Cox, J.P. and Carroll, B.W.: 1978, Astrophys. J. 226, 210.

Percy, J.P.: 1982, Be Stars Newsletter, ed. M. Jaschek, Strasbourg, n. 6 p. 8.

Saio, H.: 1981, Astrophys. J. 244, 299.

Smith, M.A.: 1981, in 'Workshop on pulsating B stars', eds. G.E.V.O.N. and C. Sterken, Observatoire de Nice, p. 317.

Smith, M.A.: 1982, Astrophys. J. 254, 708.

DISCUSSION

HARMANEC: With which instrument you have obtained the RV data?

ANTONELLO: At our observatory, using the spectrograph attached to the 1.37 m telescope.

HARMANEC: Have you checked if there is some dependence of your radial velocities on hour angle?

ANTONELLO: We have made some proofs by some standard stars, but there is not a clear correlation.

WAELKENS: Where did you perform the photometry?

ANTONELLO: Also, at our observatory...

WAELKENS: This star has a declination -9°, so from Italy it reaches air mass 2 quite near the meridian. I observed it also in Chile, and I do not remember such a large variations in 1981. Well, I did not observe it so often as you did and I should check my results.

BOLTON: I didn't catch if you showed plot of the Comparison - Check star photometry...

ANTONELLO: Yes, it was up there. The dispersion of comparison minus check star data is smaller than the amplitude of observed variations.