Struve, Otto. The problem of the β Canis Majoris and β Cephei stars.

Recent studies of seven representatives of this group have revealed a variety of phenomena and have opened up a new and fascinating field of astrophysical exploration. The principal results are as follows:

1) The spectral types are concentrated at B1 and B2 and the luminosities are in Morgan's classes II to IV. Dr. Morgan has expressed the opinion that the difference between β CMa and the rest of the group is less pronounced than I had previously believed it to be.

2) The periods range between 4 and $6\frac{1}{2}$ hours, in brightness and in radial velocity.

3) The presence of two interfering periods, though not always detectable, is probably a fundamental property of these objects. The beat periods range between 7 and 49 days, and are the same for velocity and brightness. P_1 , K_1 and P_2 , K_2 produce beat period P_3 .

4) The absorption lines usually vary in width, but not in equivalent width. This variation is associated with only one of the two oscillations (P_2 , K_2), if beats are observed.

5) Those objects that at some stage present dish-shaped lines with rotations of the order of 100 or 150 km/sec always show large changes in line-widths. These same stars usually show large amplitudes of velocity which often are subject to irregular variations, and relatively large amplitudes in brightness (0.1 to 0.2 mag.).

6) There is no change in color or spectral type.

7) It is probable that stars which have large changes in line widths have rapid rotations, with their axes at right angles to the line of sight. In these stars the beat phenomenon is either undetectable ($K_1 \ll K_2$) or, if present, is complicated by a large amount of scatter that is produced by the irregular changes in K_2 . A. Slettebak and I have been discussing the possibility that dish-shaped lines in O and B giants and supergiants may not be caused by rotation, but at present no such suspicion has arisen with regard to the more normal main-sequence B stars like σ Sco.

8) The absorption lines become clearly double at maximum and minimum radial velocity in at least two of these stars. One component is sharp, the other diffuse. The periodic alternation of sharp and broad components, observationally resembling a double-lined spectroscopic binary, accounts for one of the two interfering oscillations (P_2 , K_2). The star is brightest when the lines

are broadest and the sharp components are invisible.

9) Three stars show one additional periodic variation of the mean velocity of the short oscillations. This may be due to ordinary binary nature, not otherwise related to the oscillations.

10) No theory is as yet entirely adequate. It is tempting to relate the great variety of phenomena to differences in the orientation of the axes in stars having a considerable range in angular velocity of rotation. The two oscillations may represent the polar and equatorial regions, respectively. The hypotheses of Ledoux and of Menzel both appear to be promising in this respect. Van Hoof has suggested that perhaps the rotation itself causes the frequency of oscillation of the equatorial bulge (P_2 , K_2) to differ from that of the polar regions (P_1 , K_1), and M. Wrubel has called attention to the fact that if the magnetic pole does not coincide with the pole of rotation it would define on the star a kind of a "spot."

11) The presence of a sharp-lined stage in a star that otherwise is characterized by dish-shaped, rotational line profiles led me to suggest that a fixed region on the rotating star produces lines of turbulent profiles. This idea meets many of the requirements, but neither my own data nor Aller's curves of growth for σ Sco show the kind of lines we associate with the concept of turbulence. Nevertheless, the inference is that the (P_2 , K_2) oscillation somehow produces on the star an area of limited size, perhaps $\frac{1}{3}$ of the star's diameter, which has stronger absorption lines than the rest of the star, and rotates with it.

12) I am now inclined to abandon as unnecessary the idea of a satellite as the cause of such an area. That idea was originally based upon an effort to relate the two periods to a forced (satellite) oscillation and a free (pulsation) oscillation—somewhat like the forced (12 months) and free (Euler or Chandler 14 months) oscillations of the earth. The hypothesis was reasonable so long as only one star was known to show the beats, β Canis Majoris. Since we now have at least three stars with beats, out of seven, it is no longer reasonable to believe that in all three the period of the satellite would be so very close to that of the free vibration of a B1–B2 main-sequence star.

13) It will be seen that these ideas have become crystallized after numerous discussions with other astronomers, and to them all I give my thanks.

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