VARIABLE BE STARS IN h AND χ PERSEI

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INTRODUCTION

The double cluster h and χ Persei has since long been known to be rich in Be stars (Trumpler, 1926). It belongs to an age group in which various types of variable stars occur (Mermilliod, 1981). Other clusters of this age group are NGC 3293, the cluster that is richest in β Cephei variables (Balona and Engelbrecht, 1983), IC 2581, NGC 4755, and NGC 6871. The comparison of the characteristics of variable stars in all these clusters and in clusters of other age groups could reveal to which extent the cluster stellar content is determined by age and by other parameters, such as galactic location, and so metallicity. Since h and χ Persei are very rich clusters that have not yet been studied intensively as far as stellar variability is concerned (Percy, 1972), we have undertaken a study of the photometric variability of the brightest stars in the double cluster. Our first interest was to detect β Cephei variables, but it rapidly turned out that the double cluster contains a considerable amount of highly variable Be stars.

OBSERVATIONS

Photometric observations of h and χ Persei stars in the Geneva system have been made at Jungfraujoch Observatory (Switzerland) during the last five years. Some eighty program stars in the double cluster were measured several times within one season and also over different years. The most variable stars have been monitored more intensively. We have also reconsidered the measurements in the Geneva system that were made during the late sixties and the early seventies.

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RESULTS

The main results of our photometric campaign are:
(1) Most brightest cluster members are variable above the detection limit imposed by the precision and the amount of our data: for 85% of the program stars the standard deviations of the visual magnitudes exceed the scatter of the standard star measurements.
(2) We did not detect any β Cephei variable.
(3) Except for the supergiants, it appears that all variables are Be stars or are linked to the Be stars. We infer this conclusion from the similarity of the photometric variations (i.e. variations irregular in time, large color variations) of the known Be stars with other variables. Also, the most extreme variations tend to occur in the known emission-line objects.
(4) No conspicuous short periodicity was found. The dominant time scale is mostly months to years.

DISCUSSION

The mutual exclusion between the β Cephei and Be phenomena is confirmed. In a same age group, one encounters a cluster (NGC 3293) in which all stars with $-3>M_V>-4$ are β Cephei variables and another (h and χ Persei) in which most such stars are Be stars.

It is known that mass loss from the most luminous stars increases with metallicity, all other parameters being equal. There seems not to exist a galactic gradient for the Be phenomenon, which is therefore probably not dependent on metal content.

A more detailed account of our results will be submitted for publication in Astronomy and Astrophysics Supplement Series.

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DISCUSSION FOLLOWING WAELKENS

Underhill:

In the first days of this conference we heard about the ways in which the energy distributions of Be stars are distorted by Hα emission in lines and continua. The work of Divan and her colleagues demonstrates this well, as does work with spectrophotometric scanners. Given these distortions of the magnitudes and colors, how can you deduce anything meaningful from a color-magnitude diagram for Be stars? The magnitudes and colors all are not normal for Be stars and furthermore the colors and magnitudes change.

Waelkens:

The uncertainties on the colors of the Be stars could indeed imply an uncertainty on the age of the double cluster. Our conclusion that a large number of stars within a magnitude range of 1 mag are Be stars remains true when the uncertainties in the brightness (some tenths of a magnitude) are taken into account.

Garrison:

There is a paper by Schild and Hiltner, in 1965 or so, in which they found a marked difference between h and χ Persei. One of the clusters (and I can never remember which) has many Be stars and the other has none. They found also a slight age difference. Their results support and strengthen your conclusions that clusters of the same age have different Be frequencies.

Waelkens:

It may be that the inferred age difference is actually due to a different content in Be stars. Another interesting point is that the red supergiants are not distributed in a homogenous way over the cluster: according to recent theoretical work of Maeder, stars that have a rotational velocity in excess of a certain value do not evolve to the red, while stars that have lower velocities do.

Abt:

This is a marvelous body of large and important data. May I suggest that some clusters have mostly rapid rotations, and hence many Be stars and few β Cephei stars? Or that the frequencies of Be and β Cephei stars may be anti-correlated? Then the differences between h and Persei may be due to a difference in mean rotational velocities.

Waelkens:

This idea could be checked by measuring vsini for stars of other clusters in this age group, starting with the cluster NGC3293.

Hirata:

Could you detect the short-term variation in your Be stars?

Waelkens:

We detected it, but our data are not suited for finding short periods. The amplitudes of the longer timescale variations dominate, and, since the observation conditions did not allow us to be sure of long periods of good weather, we have chosen to focus on the kind of statistical long-term program discussed here.

Percy:

About ten years ago, I did a cursory survey of short-term variability in early-type stars in h and χ Per. I was able to detect short-term variability in several Be stars, but did not have enough observations to determine periods.

Waelkens:

Our results agree with yours. The timescales of the rapid variations are too long to be compatible with β Cephei-like pulsations.

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