AN AD HOC HYPOTHESIS ON THE PULSATION OF DELTA SCUTI STARS

E. Antonello
Osservatorio Astronomico di Milano-Merate, Italy

Taking into account the possible influence of external factors such as the orbital motion in binary systems and the rotational velocity on the pulsation of δ Scuti stars, it may be possible to explain some properties of these variables.

INTRODUCTION

It is well known that the incidence of variability within the lower part of the instability strip is of about 30%, and that the luminosity, metallicity and rotational velocity are only some of the factors responsible for the variability (Breger, 1979; see also Kurtz, 1978). Hence it is not clear why, during their evolution, similar stars can pulsate or not. There is a well known P-L-C relation for δ Scuti stars (Breger, 1979), and also a clear relation between the amplitude of pulsation, the period and luminosity of the low amplitude δ Scuti stars (Antonello et al., 1981); hence it would be possible to predict the period and the amplitude of any star (variable and non variable) in the lower part of the instability strip. These facts are difficult to explain with internal differences between variable and non variable stars; for classical Am stars that is possible (see e.g. Baglin et al., 1980), but in this case there is also an evident effect on the surface of these stars. Therefore we believe there should be different external conditions.

HYPOTHESIS

Fitch has shown that the tidal interaction in a close binary could explain some properties (periods) observed in some δ Scuti stars (e.g. Fitch, 1967, 1980). More recently, Fitch (1980) has suggested that nonradial mode excitation (in stars above the main sequence) will usually occur only

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in those stars with significant departures from spherical symmetry; these departures are due either to high rotation or to close companions. Smith (1980) has suggested that nonradial pulsation excites radial pulsation in β Cephei stars. Nonradial modes may be common in δ Scuti stars (e.g. Dziembowski, 1980), hence, taking into account Smith's suggestion also for δ Scuti stars, we can make this hypothesis: the stars in the lower part of the instability strip are pulsating if they have a sufficiently high rotational velocity and/or if they are in an appropriate binary system, that is they need some sort of nonradial hard excitation to pulsate. This should be valid at least for the low amplitude variables.

According to Vauclair's theory (1976), the Am phenomenon requires a slowly rotating star and/or a binary system with synchronous orbital and rotational motions. On the contrary, a variable star should require a high rotational velocity and/or an appropriate binary system without synchronization. Since there is a continuous distribution of possible rotational velocities and elements of binary systems, there will be stars with intermediate properties.

HYPOTHESIS VERIFICATION

The results of various studies on the δ Scuti stars do not show a clear confirmation or rejection of this hypothesis. The known binary systems (Batten et al., 1978) with normal spectra (and within the instability strip) in the surveys of Millis (1967; excluded Hyades cluster), Breger (1969), Jorgensen et al. (1971) are eight, and only one was found to be variable. Taking into account the variables in the Catalogue of Bright stars (Hoffleit, 1964), there are only 23 stars indicated as spectroscopic binaries among 92 δ Scuti stars. As regards the rotational velocity, it has some importance, as shown by Breger (1979), but its behaviour in dwarfs is different from that in giants, and the results are contradictory in various clusters.

However, if we consider the stars in the well studied Hyades cluster (Millis, 1967; Breger, 1970; Horan, 1979), we can see that, also excluding the Am stars from the sample, the rotational velocity has some importance for the discrimination between variable and nonvariable stars in the sense of our hypothesis (Antonello et al., 1981). Moreover, the different incidence of spectroscopic binaries among variable and nonvariable stars is remarkable, as shown in the Table 1 (the Am stars are excluded, and only stars in the instability strip are taken into account). These facts seem to support our hypothesis at least for dwarfs; hence only the stars which satisfy our hypothesis could pulsate with the period and the amplitude predicted by the relations above mentioned.

	Variables	Nonvariables
Number of stars	7	11
S.B.'s with known orbit	3	1
Total number of S.B.'s	6	3

Table 1. Hyades cluster.

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