δ ANDROMEDAE (K3 III) : A HYBRID GIANT IN AN EXTENDED DUST SHELL

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ABSTRACT. Observations made with the Infrared Astronomical Satellite (IRAS) showed the existence of a set of K stars with excess emission at 60 μ. The brightest star in the group is δ And (K3 III). Spectra of δ And have been obtained with the International Ultraviolet Explorer (IUE) in both the long and short wavelength regions. These spectra show several features unusual in a K giant as cool as δ And, in particular, emission from CIV, MgII h and k lines with blue wings stronger than the red and MgII absorption blue shifted to up to 300 km s^{-1}. Overall δ And is similar to the known hybrid bright giant α TrA (K4 II). We have discovered the first 'hybrid' giant star. The IRAS observations are interpreted in terms of a cool (~100 K) dust cloud surrounding δ And - a spectroscopic binary system-and a third component at 1200 A.U.

1. INTRODUCTION

Low resolution spectra of giant stars led Linsky and Haisch (1979) to propose that these could be divided into two types, 'solar' and 'non-solar' according to whether or not they showed CIV emission. The 'dividing line' proposed occurs between K0 III and K2 III. Whilst X-ray observations (e.g. Haisch and Simon, 1982) support a similar division into hot and cool coronae, some authors have doubted the existence of a sharp dividing line (e.g. Dupree, 1981). Later observations of K bright giants, e.g. α TrA (K4 II), showed that several have a combination of CIV emission and MgII absorption indicative of high velocity stellar winds. Since massive winds are thought to develop to the cool side of the dividing line these bright giants are known as 'hybrids' (e.g. Reimers, 1977, 1982; Hartmann, Dupree and Raymond, 1981).

Observations with the IRAS satellite showed a set of K-stars with an unusual 60μ excess, indicating the presence of cool dust (Rowan-Robinson et al. 1984, Rowan-Robinson, private communication). In view of the unusual properties of the K bright giants we have observed two of these IRAS sources with IUE, including the brightest, δ And (K3 III).

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2. OBSERVATIONS AND RESULTS

A paper giving full details of the IRAS and IUE observations and their analysis is in press (Judge, Jordan and Rowan-Robinson, 1986). A long-wavelength, high dispersion spectrum of δ And shows MgII emission line profiles with a stellar self-reversal such that the blue emission wing is stronger than the red. This is characteristic of 'solar' type chromospheres. However, absorption further to the blue, extending to ~300 km s^{-1} is also observed, showing the presence of a wind. The short-wavelength low dispersion spectra show transition region lines, including CIV emission. Thus δ And (K3 III) is a 'hybrid' giant, the first to be discovered. The surface fluxes are similar to those of the known hybrid giant α TrA (K4 II). We can demonstrate that the emission is unlikely to come from the companion in the spectroscopic binary. Moreover, δ And is a photometric standard for its class and is most unlikely to be an earlier type star misclassified. The second star, HD 129456 (K3 III) shows MgII profiles similar to those of δ And.

The dust cloud extends around both δ And and the third member (M2 V) of the triple system at 1200 A.U. It may be analogous to an Oort cometary cloud or a disk system, in which case the position of the stars may lead to interesting dynamic interactions.

Given the long period of the spectroscopic binary (41 years) mass transfer is not expected and δ And does not appear to have evolved abundances. The rotation rate is uncertain, but could be faster than average perhaps as a consequence of formation in a multiple system. Several of the hybrid bright giants are also possible binaries (Reimers, 1982). At present there does not seem to be a *direct* link between the dust and the hybrid properites, both could be consequences of the multiple system.

The discovery of δ And as a hybrid giant casts doubt on the concept of a simple and sharp dividing line for giants.

REFERENCES

Dupree, A.K. 1981, in '*Effects of Mass Loss on Stellar Evolution*' (Eds. C.Chiosi and R.Stalio) D.Reidel, p.87.
Haisch, B.M. and Simon, T. 1982, *Astrophys. J.*, **263**, 252.
Hartmann, L., Dupree, A.K. and Raymond, J.C. 1981, *Astrophys.J.*, **246**, 193.
Hartmann, L., Jordan, C., Brown, A. and Dupree, A.K. 1985, *Astrophys.J.* **296**, 576.
Judge, P.G., Jordan, C. and Rowan-Robinson, M. 1985, *Mon. Not. R. astr. Soc.* In Press.
Linsky, J.L. and Haisch, B.M. 1979, *Astrophys. J.* **229**, L27.
Reimers, D. 1977, *Astron. Astrophys.*, **57**, 395.
Reimers, D. 1982, *Astron. Astrophys.*, **107**, 292.
Rowan-Robinson, M. et al. 1984, *Astrophys. J.*, **278**, L7.