OPTICAL/INFRARED OBSERVATIONS OF RV TAURI STARS

M. J. Goldsmith[1], A. Evans[1], J. S. Albinson[1], M. F. Bode[2]

1. Physis Department, Keele University, ST5 5BG, UK.
2. Astronomy Department, Lancashire Polytechnic, PR1 2TQ, U.K.

ABSTRACT. Optical/infrared observations of RV Tauri stars obtained at SAAO have allowed the natures of the dust shells around stars with infrared excess to be investigated. The data suggest that dust formation occurs sporadically and that some stars have multiple shells. There is no photometrically discernible difference between carbon- and oxygen-rich stars or their dust shells. There is some evidence that stars with higher metallicity have more dust.

1. INTRODUCTION

Near simultaneous optical (UBVRI) and infrared (JHKLMN) broad band photometric observations of RV Tauri (RVT) stars were obtained at SAAO in June/July 1985. The data were corrected for interstellar and circumstellar reddening; black body curves were fitted to the stellar fluxes and, where present, the infrared excesses (see Fig 1). From these curves and the photometric colours, star and (where appropriate) dust shell parameters were inferred.

2. STELLAR PROPERTIES

A number of our programme stars were identified in Kukarkin (1969) either as RVT?, or as variables other than RVT type; W Cen, for example, was classed as a Mira variable. However, while the present data cannot confirm RVT status, Mira classification is unlikely: there is no warm dust present and the spectral type is too early. Similarly, EI Peg cannot be an A-type semiregular (SRA) variable since such stars are by definition class M or later, while EI Peg's intrinsic colours imply an early K type.

Infrared colour-colour plots revealed that the majority of the stars lay close to the G-M giant locus (see Fig. 2). A small group (UY Ara, AI Sco, SX Cen, R Sge) had much redder colours, mainly due to the presence of circumstellar dust.

Comparing the colours and temperatures of the stars with Kurucz's (1979) models shows that, in general, their metallicity is similar to,

I. Appenzeller and C. Jordan (eds.), Circumstellar Matter, 537–540.

https://doi.org/10.1017/S0074180900157262 Published online by Cambridge University Press

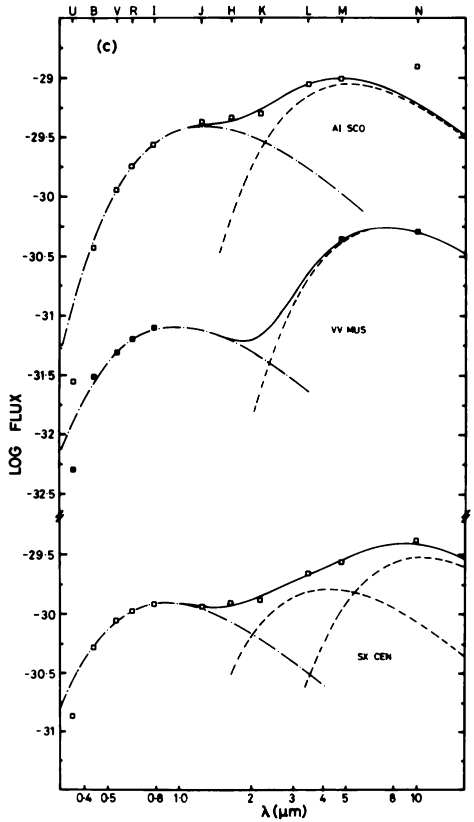

Fig. 1: Flux distributions of RVT stars with infrared excess; fluxes in W cm^{-2} Hz^{-1}.

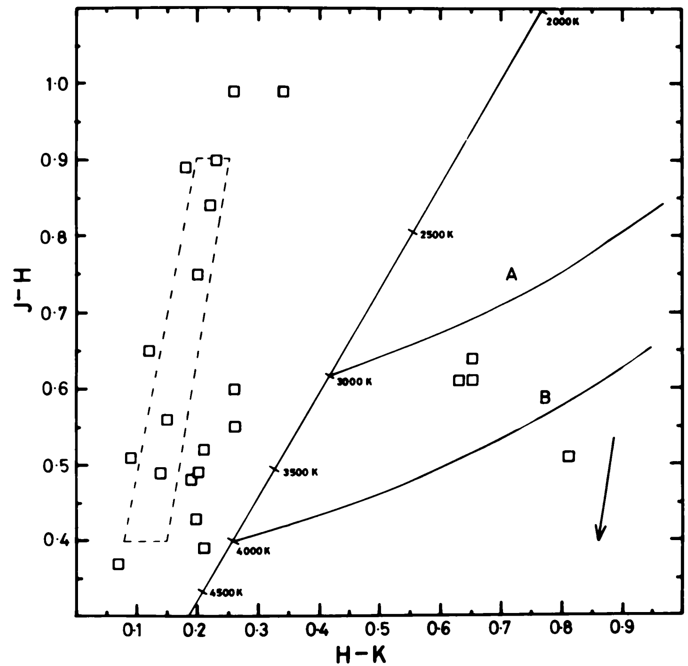

Fig. 2: (J-H)-(H-K) two colour diagram for RVT stars; data not dereddened. Dotted lines enclose region occupied by G-M giants; arrow denotes dereddening appropriate for visual extinction of 1 mag. Full lines denote blackbody locus, and combinations with 1000 K blackbody of 3000 K and 4000 K blackbodies.

https://doi.org/10.1017/S0074180900157262 Published online by Cambridge University Press

or somewhat greater than, that of the sun. However V453 Oph seems to have extreme metal deficiency. This was the only C-type observed. Some of the globular cluster RVT stars are C-type, which would be consistent with the low metallicity of V453 Oph. No dust was found around this star.

3. DUST SHELLS

Of the 25 stars observed, infrared excesses were found in 11. The values of dust shell radii determined from their solid angles were in good agreement (~20%) with those calculated from dust temperatures, assuming the dust to be silicate based. Assuming carbon grains led to discrepancies by factors $\gtrsim 2$. However, it is clear that some non-dielectric component is present and a dirty silicate seems the most probable grain material. The masses of dust present ranged from 10^{-11} $M_\odot$ to 10^{-8} $M_\odot$; mass loss rates, implied by the dust shell parameters, were typically ~ 10^{-8} $M_\odot$ y^{-1}. Such high values may reflect the sporadic nature of dust production in these stars, as they refer to the current state of their dust shells. A likely value for mean mass loss rate, on the basis of the stellar parameters, is 10^{-8} $M_\odot$ y^{-1}. The two velocity groups of RVTs (Joy 1952) may have different mean dust shell opacities, the low velocity, population I, metallic group having more massive dust shells than the high velocity objects.

While in some cases (e.g. AR Sgr and AC Her), the dust shells had their inner edges roughly at the condensation radius in others (e.g. VV Mus and RY Ara), the dust shells were situated much further from the star. The implication is that while dust is currently, or was recently, forming around some RVT stars, others have not formed dust for some considerable time: it is in any case clear that RVT stars do not produce dust at each pulsation, nor at each deep minimum but over some longer time scale, perhaps due to cepheid-like motion about the HR diagram (Deasy & Butler 1986).

Some RVT stars (e.g. SX Cen) had infrared excesses which must apparently be ascribed to multiple dust shells. In the case of SX Cen, optical and infrared variability on a timescale $\lesssim$ 1 week was observed (see Fig. 3); the inner and probably the outer shell cooled significantly on this timescale. This behaviour cannot be ascribed to changes in radiative input to the dust from the underlying star, but may well be due to outward motion of the dust shells; such an interpretation may be supported by corresponding changes in the solid angles of the dust shells.

4. CONCLUSIONS

Simultaneous optical and infrared observations of RVT stars have enabled us to determine dust shell parameters for 11 stars. Dust production in RVT stars is apparently a sporadic process, with long periods of quiescence. When dust formation does occur, it is rapid, and shells may be observed to expand over timescales of days or less. There was no photometrically determinable difference between carbon and oxygen

https://doi.org/10.1017/S0074180900157262 Published online by Cambridge University Press

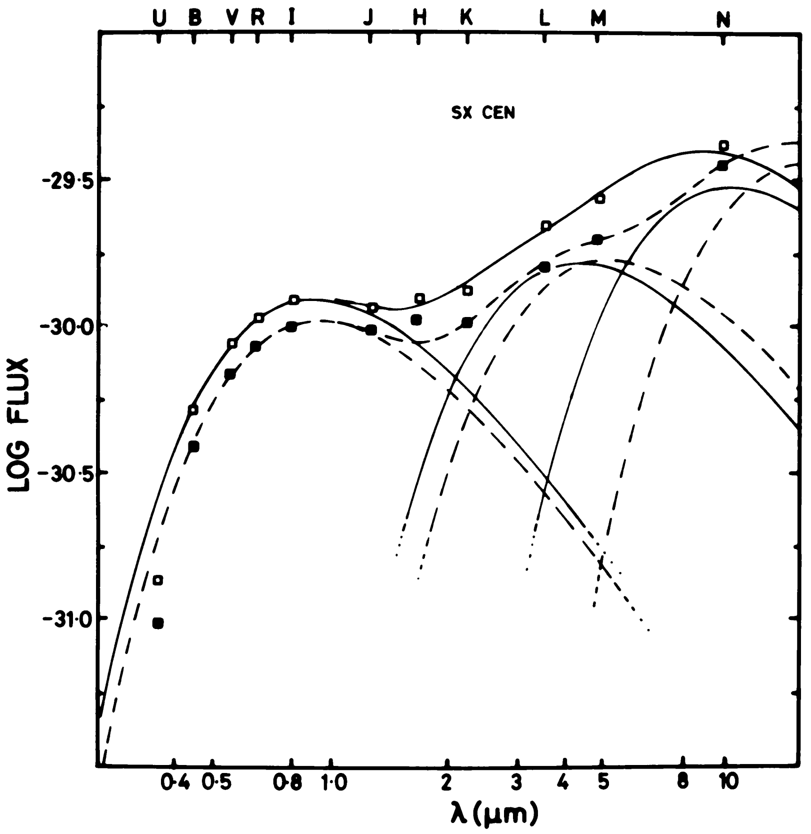

Fig. 3: Variations in the flux distribution of SX Cen over a 4 day period. Open squares (and full curves) denote data obtained prior to data represented by full squares (dotted curves). Flux in W cm^{-2} Hz^{-1}.

rich stars or their dust shells, although metallicity differences may be significant.

ACKNOWLEDGEMENTS

MJG is supported by the University of Keele, JSA and MFB by the SRC.

REFERENCES

Deasy, H. & Butler, C. J., 1986, Nature, 320, 726.
Joy, H. J., 1952, Ap. J, 115, 25.
Khukarkin, B. V. et al, 1969 "General Catalogue of Variable Stars".
Kurucz, R. C., 1979, Ap. J. Supplement, 40, 1.