On the near infrared variability of chemically peculiar stars ⋆

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Abstract. Some CP stars have recently been discovered by Catalano et al. (1991) to be variable also in the near infrared, although with smaller amplitudes than in the visible. Hence an observational campaign was started in which the infrared light variability of a number of CP2 and CP4 stars has been investigated at the ESO-La Silla Observatory in the bands J, H, and K. As a general result, infrared variations show the same behavior in all three filters but amplitudes are smaller than in the visible.

Key words: Stars: chemically peculiar — Stars: variables: other

1. Introduction

Kroll et al. (1987) showed that the near infrared fluxes and colors of Chemically Peculiar stars (or CP stars, according to Preston's (1974) scheme), when compared to a black body, are normal, like that of early main sequence stars. IRAS data could even prove that the normality of IR fluxes is guaranteed to at least 25μ (Kroll 1987): only two CP4 stars showed flux excesses longward of 60μ, showing cold circumstellar material, which is not uncommon among early B stars. Moreover Leone & Catalano (1991) have shown that the solar composition Kurucz model atmospheres, which are used to fit the spectra of CP stars from $\lambda5500$ to $\lambda16500$ Å, give a fair representation of the overall flux distribution, with the exception of the Balmer region, where CP stars appear generally brighter than normal, this excess being just a few percent of the total flux.

However, in spite of this normal infrared behavior, peculiar abundances and/or magnetic fields seem to affect the near infrared too; in fact, Catalano et al. (1991) have shown that, out of the eight CP stars monitored throughout their rotational periods, at least six are variable in the near infrared, although with smaller amplitudes than in the visible. This unexpected result led us to start an observational campaign aimed at searching for infrared variability and also to better understand the origin of the light variability, which is one of the outstanding observational aspects of these stars.

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⋆Based on observations collected at the European Southern Observatory, La Silla, Chile.

Table 1. The CP stars checked for variability in the near infrared.

SrCrEu	HD 3980	HD 24712	HD 49976	HD 72968	HD 83368
	HD 96616	HD 98088	HD 101065	HD 111133	HD 118022
	HD 125248	HD 126515	HD 137949	HD 148898	HD 153882
	HD 164258	HD 203006	HD 206088	HD 220825	HD 221760
Si et al.	HD 10783	HD 12447	HD 74521	HD 90044	HD 116458
	HD 119419	HD 125630	HD 147010	HD 166469	HD 170397
	HD 187473	HD 223640			
Si	HD 12767	HD 19832	HD 25267	HD 29305	HD 37808
	HD 54118	HD 56455	HD 66255	HD 73340	HD 92664
	HD 114365	HD 116890	HD 122532	HD 124224	HD 133880
	HD 144231	HD 145102	HD 203585	HD 221006	
He weak	HD 5737	HD 22470	HD 28843	HD 35456	HD 37151
	HD 49333	HD 74196	HD 125823	HD 137509	HD 142990
	HD 144334	HD 148199	HD 168733	HD 175362	
He rich	HD 36485	HD 37017	HD 37479	HD 37776	HD 59260
	HD 60344	HD 64740			

2. Observations

The observations have been carried out in the near IR bands J, H, and K at the 1-m photometric telescope at ESO, La Silla, Chile, using an InSb detector cooled with liquid nitrogen. A detailed description of the ESO infrared photometers can be found in Bouchet (1989).

The data have been collected during several observing runs from July 1986 through January 1993. All program stars were measured relative to closeby comparisons, which were chosen to have as similar color and brightness as possible. The integration times, the number of cycles, and the desired r.m.s. accuracy in the mean level were optimized to get a 2% maximum error in the observations: the resulting accuracy in the final reduced data is typically 0.006 mag. ESO standard software was used for all reduction steps. Magnitudes in the standard IR system have also been obtained by observing suitable standard stars from the ESO list (Bouchet et al. 1991).

The adopted ephemeris elements of the infrared light curves for the programme stars have been mainly taken from Catalano & Renson (1984, 1988, 1997), Catalano, Renson & Leone (1991, 1993), and references therein. The results concerning the SrCrEu and Si et al. stars have been published elsewere (Catalano et al. 1997, 1998).

3. Discussion and conclusions

Near infrared variability has been found to be present in the large majority of the CP2 stars studied. The typical trend of CP2 stars to present smaller amplitude light variations at increasing wavelength is confirmed: the amplitudes in the near infrared are smaller than in the visible. In most cases the variations have been found to show very similar behavior and in phase with each other in all filters.

In a previous paper (Catalano et al. 1991) we investigated the effects of high metallicity at the near infrared wavelengths and showed that a Kurucz model atmosphere with a metal content ten times the solar one could explain a three percent variation in the near infrared brightness, which is the typically observed value.

The influence of the magnetic field in the atmosphere structure has been quantitatively discussed by some authors in some particular configurations, however the most general approach has been carried out by Stępień (1978) who showed that, according to the direction of the toroidal electric currents in the outermost layers, the star's shape can be prolate or oblate with respect to the magnetic axis: the differences between the polar and equatorial values of the radius being up to 3%. The results obtained by Stępień lend support to a distorted figure of the star up to a few percent and to small variations (2-3%) of the effective temperature over the surface, which in some cases, can contribute to the observed light variations. While this explanation is not valid as far as it concerns the visible light variations of many CP stars, because of the different behaviours presented by the u, v, b, and y curves, it cannot be excluded that the non-spherical shape of the star as seen at the infrared wavelengths could contribute to the observed variability, since the magnetic pressure importance increases in the outer layers.

After completing the analysis of our infrared data, we hope to be able to disentangle the relative contributions of these two mechanisms from the study of the phase relation between the magnetic field and infrared variations.

References

Bouchet, P.: 1989, Infrared Photometry, E.S.O. Operating Manual N.11
Bouchet, P., Manfroid, J., Schmider F.-X.: 1991, *Astron. Astrophys., Suppl. Ser.* **91**, 424
Catalano, F.A., Renson P.: 1984, *Astron. Astrophys., Suppl. Ser.* **55**, 371
Catalano, F.A., Renson P.: 1988, *Astron. Astrophys., Suppl. Ser.* **72**, 1
Catalano, F.A., Renson P.: 1997, *Astron. Astrophys., Suppl. Ser.* **121**, 57
Catalano, F.A., Kroll R., Leone F.: 1991, *Astron. Astrophys.* **248**, 179
Catalano, F.A., Leone, F., Kroll R.: 1997, *Astron. Astrophys., Suppl. Ser.*, (in press)
Catalano, F.A., Leone, F., Kroll R.: 1998, *Astron. Astrophys., Suppl. Ser.*, (in press)
Catalano, F.A., Renson P., Leone F.: 1991, *Astron. Astrophys., Suppl. Ser.* **87**, 59
Catalano, F.A., Renson P., Leone F.: 1993, *Astron. Astrophys., Suppl. Ser.* **98**, 269
Kroll, R.: 1987, *Astron. Astrophys.* **181**, 315
Kroll, R., Schneider H., Catalano F.A., Voigt H.H.: 1987, *Astron. Astrophys., Suppl. Ser.* **67**, 195
Leone, F., Catalano, F.A.: 1991, *Astron. Astrophys., Suppl. Ser.* **242**, 199
Preston, G.W.: 1974, *Ann. Rev. Astron. Astrophys.* **12**, 257
Stępień, K.: 1978, *Astron. Astrophys.* **70**, 509