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The behaviour of Vega-type stars in the EXPORT sample

A. Mora, C. Eiroa, J. Palacios

Dpto. Física Teórica, Universidad Autónoma de Madrid, Spain

D. de Winter

TNO/TPD-Space Instrumentation, The Netherlands

R. Ferlet

CNRS, Institute d'Astrophysique de Paris, France

F. Garzón

Instituto de Astrofísica de Canarias, Spain

R. D. Oudmaijer

Imperial College of Science, UK

EXPORT

Abstract.

We present a brief summary of the EXPORT observations of a sample of 30 Vega-type systems and post-T Tauri (PTT) stars. The spectroscopic and photopolarimetric data of PTT stars show no evidences on significant amounts of gas and dust in the environments close to these stars, even in those with a far-infrared excess. On the other hand, our data indicate a rich gaseuos and dusty environment around Vega-type stars. Spectroscopic events similar to those observed in β Pic have been detected towards some of the Vega-type stars. In addition, many of the stars are polarized and show colours suggesting the presence of dust very close to the star. At least two of the observed Vega-type stars possibly are pre-main sequence objects.

1. Introduction

Vega-type objects are main sequence stars still surrounded by circumstellar disks (Backman & Paresce 1993). The detection of strong variable absorption components in the spectral lines of several elements, e.g. CaII towards β Pic, the prototype of this class of objects, has been explained as due to the evaporation of large solid bodies, i.e. cometesimals, falling onto the star (e.g. Beust et al.

1998). Some shell stars have been found to share with β Pic these spectral characteristics. Thus, the Vega-type/β Pic disks seem to be sites of planet formation, and they even might host planets in some cases. In addition, post-T Tauri stars (PTTs) are young objects very close to the main sequence; in some cases PTTs show far-infrared excesses revealing the presence of dust in the circumstellar environment (Ray et al. 1995). Both types of objects likely represent intermediate scenarios in the road to the formation of planets.

In the EXPORT project we selected a sample of Vega-type stars and PTT candidates to look for optical spectroscopic evidences of circumstellar gas. In addition, optical photopolarimetry and near-IR photometry of these stars are helpful to investigate the characteristics of the circumstellar dust. In this contribution we present the sample of stars we observed and give a short summary of the basic results. A detailed analysis of the whole data set and of individual objects will be published elsewhere

2. The EXPORT sample

Table 1 present the observed stars. Information on instruments and telescopes are given in other EXPORT contributions to this volume. The type of object (Vega or PTT) and spectral type are given in columns 2 and 3. PTTs are from the Lindroos' binary star list, in which the secondary component is thought to be in the post-T Tauri phase, while the primary is an early type star (Lindroos 1986). In some of the PTT stars we have observed only the bright companion (note that this companion also is referred to as PTT in the table). Columns 4-7 indicate the telescopes. A blank in these columns means that the object was not observed. A + sign in the NOT and CST columns means that the stars are polarized or reddened or, in the cases of HD 34700 and 51 Oph, have a near-IR excess, ; a – sign means that the stars are unpolarized or have near-IR colours in accordance to their spectral type. The INT and WHT columns provide information after a quick look on some lines of the stellar spectra. A – sign in these columns means that the spectrum of the stars seems photospheric without any obvious non-stellar characteristic. Hα means the line is observed in emission (normally double-peaked), LiI means that the 6708 Å LiI line is present in the spectrum. In the WHT column we provide information on the CaII H and K lines only. The symbols mean the following: *cs*: circumstellar, *n*: narrow, *c*: chromospheric, *e*: emission, *w*: wide.

3. Results

Our data allow us to draw some general preliminary conclusions, although definitive statements must wait for a detailed analysis of the data.

PTT stars in our sample, i.e. the low mass PTT stars and/or their bright companions, do not show evidences on the presence of significant amounts of gas or dust in their environment, even though some of them are IRAS sources. We do not find any obvious "peculiarity" in any of the PTT stellar spectra. The stars are unpolarized, there is no photometric variability and their colours are normal, in accordance to their spectral types. Thus, we find no indications about the existence of hypothetical protoplanetary disks around these objects.

Table 1. Observed stars

Object	Class	Sp. T.	INT	WHT	NOT	CST
HR10	Vega	A4V	–	CaII: cs	–	–
HR26	PTT	B9Vn	–	–	–	–
HR26b	PTT	G5	LiI			
HR419	PTT	B9V		CaII: n	–	–
49Cet	Vega	A3V	–	CaII: n	–	–
HR836	PTT	B6V				–
BD+31° 643	Vega	B5V	–	–	+	+
HD23362	Vega	K7	–	–	+	+
HD23680	Vega	G5	–		+	+
HR1369	PTT	B9V			–	–
HD34700	Vega	G0III	Hα, LiI	CaII: n	+	+
HR 1847	Vega	B7	–		+	
HR 1847 b			Hα		+	
HR2174	Vega	A2Vn	–	CaII: n	–	–
HR2147 b					–	
HD233517	Vega	K2V	LiI	CaII: c	+	
HD 233517 b			–			
17Sex	Ash	A1	–	CaII: cs?	–	
HR4757	PTT	B9.5V	–	-	–	–
HR4757 b	PTT	K2V	–	CaII: e	–	–
HD 109085	Vega	F2V	LiI weak?	–	–	
24 Cvn	Ash	A5	–	–	–	
HD 123160	Vega	K5	–	CaII: c	+?	
λ Boo	Vega	A0Vpsh	–	–	–	–
HR5422	PTT	A0V	–	CaII: n	–	–
HR 5422 b	PTT	G5V	–		–	
HD142764	Vega	K7V	–	CaII: c	+	+
51Oph	Vega	A0Ve	Hα	CaII: n	+	+
HD218396	Vega	A5V				–
HR9043	Vega	A5V	Na: w	CaII: n	–	–

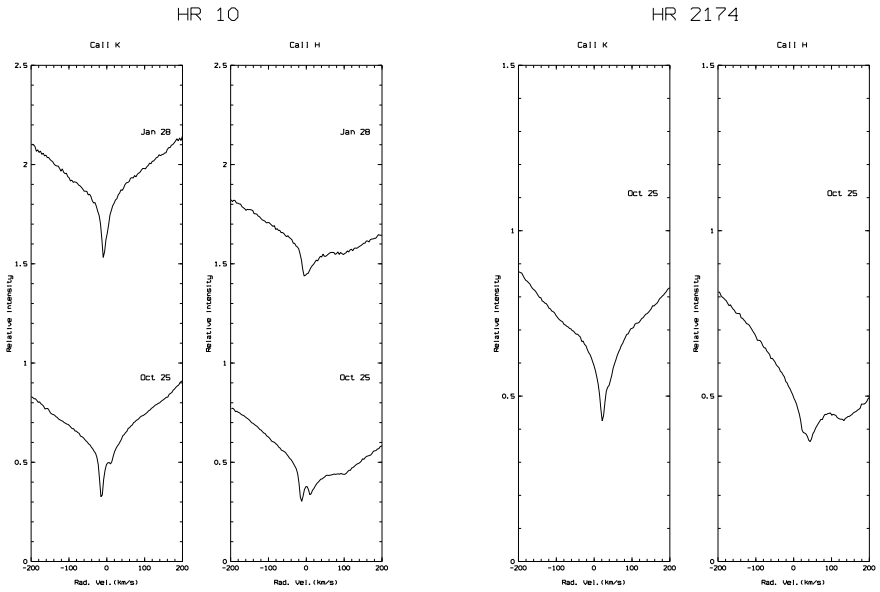

Figure 1. WHT high-resolution CaII H and K lines of HR 10 (left panel) and HR2174 (right panel). Flux units are arbitrary. HR 10 shows a redshifted absorption component in the Oct 25 spectrum which is not seen in the Jan 28 spectrum. In the case of HR 2174 the main absorption in the K line is centered at a velocity of 21 km/s and a weak redshifted absorption at velocity ∼43 km/s seems to be present. This absorption at 43 km/s is the strongest one in the CaII H line

Very different is the situation concerning the Vega-type stars of our sample. Most of these stars show CaII lines which are not purely photospheric. Narrow CaII absorptions are seen superimposed on the photospheric line, which could be originated in the interstellar medium, in a shell or in a circumstellar gas disk. Particularly interesting is the case of HR 10, where we detected a transient redshifted absorption component superimposed to a 'main absorption' with also is experienced a velocity change (Fig. 1). These data confirm earlier results on this star (Welsh et al. 1998) with respect to the similarity of HR 10 with β Pic. Absorption components are also present in the only WHT spectrum we obtained of HR 2174 (Fig. 1). Undoubtedly some of the Vega-type stars deserve further observations aiming for velocity structures in some lines of their spectra.

Some Vega-type stars show the LiI 6708 Å line. These stars have large IRAS excesses. HD 34700, the only one from them which also was observed in the near-IR, shows a weak $H-K$ colour excess. It is likely that they are pre-main sequence stars.

Around 50% of the Vega stars in the sample are polarized. Polarization variability is not obvious. The polarization degree clearly exceeds 1% in several cases. Since the distance to these stars is relatively small, it is likely that at least part of the polarization must arise in the vecinity of the stars. The observed

stars do not show any clear sign of photometric variability. 4 out of 12 Vega stars observed in the near-IR are reddened and 2 have a weak near-IR excess. Since the extinction deduced from the IR colours (and also from the optical ones) is usually around or larger than $A_V \sim 2$ mag and the stars are relatively close, it is plausible to assume that part of the reddening is circumstellar, as also suggested by the polarimetry. In fact, when we have both polarimetric and near-IR data there is a correlation between the polarimetry and the near-IR behaviour, in the sense that stars with colours departing from the intrinsic stellar ones are polarized. On the other hand, there is no apparent correlation with the amount of IRAS excess, neither with a "peculiar" optical stellar spectrum.

4. CONCLUSIONS

Our data show that the hypothetical protoplanetary disks which might exist around PTT stars, as suggested by IRAS fluxes, are not prominent enough to show up at optical and near-IR wavelengths, at least in the stars of our sample.

On the other hand, circumstellar gas and dust seem to be detected at optical and near-IR wavelengths in a large fraction of Vega-type stars. This conclusion is based on the spectroscopic and the photopolarimetric results. Further studies are needed, however, to elucidate in which cases these signatures come from the presence of gas and dust around the star or, alternatively, from the interstellar medium. In addition, more information is needed to try to find out the geometrical distribution of the gas and dust when they are circumstellar.

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