IM Peg:
An interferometry target?

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ABSTRACT :

Stellar interferometry is now starting to reach resolutions where it becomes feasible to map the surface spot features on giant stars. In this poster I present spot maps from the primary of the RSCVn system IM Pegasi obtained through Doppler imaging. This relatively bright (V ~ 6) early-K giant shows long lived polar and low-latitude spot features. Active giant stars like IM Peg would make excellent targets for stellar inteferometry.

1. IM PEGASI

IM Pegasi: (= HR 8703, HD 216489) is a long period RS CVn binary with an early-K giant primary. Its basic stellar parameters are given below (taken from Berdyugina et al. 1999, Lebach et al. 1999 and Marsden et al. 2005):

Stellar parameters:

Star	Sp. Type	Mass ($M_\odot$)	Radius ($R_\odot$)	Lum. ($L_\odot$)	T_{eff} (K)	vsini (km/s)	Orb. per. (d)	Orb. rad. ($R_\odot$)	dist. (pc)
Prim.	K2 III	1.8 ± 0.2	13.3 ± 0.6 (~0.7 mas)	54 ± 9	4450 ± 50	27.0 ± 0.5	24.64877 ± 0.00003	16.19 ± 0.06 (~0.85 mas)	96 ± 3
Sec.	~G2 V	1.0 ± 0.1	1.00 ± 0.07 (~0.05 mas)	0.9 ± 0.3	5650 ± 200	≤ 3			

Aim: IM Pegasi was used as the guide star for the Gravity Probe B (GP-B) satellite mission (designed to measure two predictions of General Relativity). As part of the optical support for GP-B we have undertaken an extensive Doppler imaging survey of the primary of the system to determine if spots on the surface of the primary could impact on the results of the mission.

Observations: High-resolution spectra covering most of the optical wavelength range were obtained for IM Peg nightly (where possible) using the 2-m Automatic Spectroscopic Telescope of Tennessee State University (Eaton & Williamson 2004) along with a number of other telescopes around the world. These observations spanned over 3 years.

The observations obtained for GP-B provided a record of the spot evolution on IM Pegasi covering a 3+ year period

2. DOPPLER IMAGING

Least-Squares Deconvolution (LSD): In order to improve the signal-to-noise of the data we have used the LSD technique (Donati et al. 1997) to combine the signal in each of several thousand photospheric lines in each echelle spectrum into a single high signal-to-noise LSD profile. An example of the profiles from two rotations of the primary are given in Figure 1.

Doppler Imaging (DI): A time series of these LSD profiles, taken as the star rotates, can be used to reconstruct the surface spot topology of the star using DI. We have used the DI code of Brown et al. (1991) and Donati & Brown (1997) which uses a two temperature model (one for the photosphere and one for the spot) and produces maps with the minimum amount of spots required to fit the data to the noise level. The reconstructed maps are given in Figure 2.

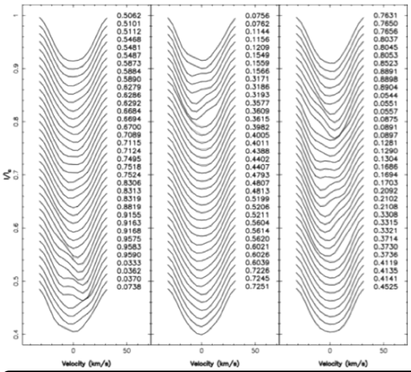
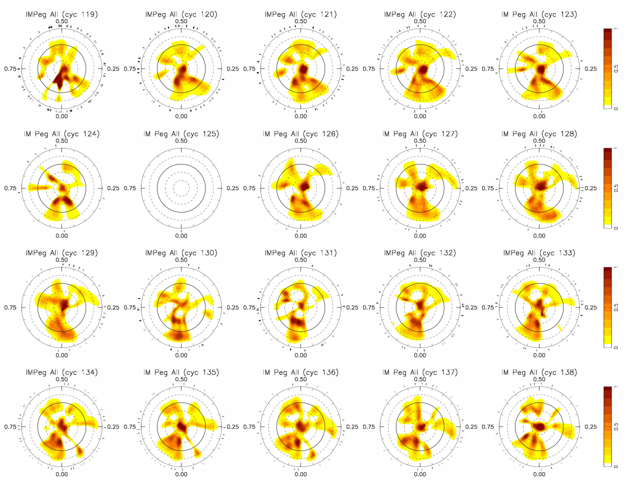


Figure 1: Observed (thin lines) and modelled (thick lines) LSD profiles of IM Pegasi. Each profiles is shifted down for graphical purposes and the rotational phase at which the observation took place is given to the right of each profile.

3. SPOT MAPS

Figure 2: Sample of the reconstructed spot maps for the primary of IM Pegasi covering from ~2004.77 to ~2006.06. These images are flattened polar projections extending down to -60° latitude. The bold line donates the equator and the radial ticks around the plots indicate the phases at which the star was observed. Phase 0.0 corresponds to the side of the primary facing the secondary. The blank image was when IM Pegasi was not observable and no data was obtained.



4. CONCLUSIONS

Spots on IM Pegasi: The spot topologies of IM Pegasi show that it has a significant polar spot as well as a number of intense lower-latitude features. The most intense low-latitude features appear to be on the side of the primary that faces the secondary. Could this be due to some interaction between the magnetic field of the two stars? Importantly, it appears that the spots are relatively stable on time frames of months (if not years).

Stellar interferometry of giant stars: Unfortunately, almost every spotted star known has an angular diameter below the resolution of present stellar interferometry instruments.

However, until the resolution of stellar interferometers significantly improves, there is the possibility of combining Doppler imaging and stellar interferometry using the interferometric Doppler imaging technique (i.e. Jankov et al. 2001). This can give more reliable images than DI alone and can resolve features below the interferometry resolution limit.

Thus the stable and long-lived spot features on IM Pegasi (and many other giant stars) makes them ideal targets for this method as the technique assumes that spot features do not change significantly over a full rotational period of the star.

The large and stable spot features on giant stars, such as IM Pegasi, make them excellent targets for the interferometric Doppler imaging technique.

5. REFERENCES

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