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ROTATION OF 10 Be STARS THROUGH FOURIER TRANSFORM ANALYSIS

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Abstract. Here we determine the projected rotational velocity of 10 Be stars using the Fourier Transform Method. Also, we discuss the gravity darkening and extent of deviation from the solid body rotation for our sample of stars. We found that 7 of considered stars are affected by a strong gravity darkening or/and solar differential rotation.

1. INTRODUCTION

Since Be stars are fast rotators, our knowledge about their fundamental parameters, in particular the projected rotational velocity, is subject to a considerable uncertainty. Their gravity and temperature are aspect angle- dependent and do not have the straightforward meaning as they have in slow rotators (Slettebak, 1976, 1982; Brown and Verschneren, 1997; Brown and Verschueren, 1997; Halbedel, 1996).

The projected rotational velocity $V_e \sin(i)$ for ten stars in our sample of Be stars has been determined by using spectra from CDS data base[1]. In order to determine the projected rotational velocity, the Fourier Transform Method-FTM (Jankov, 1995; Jankov et al., 2000) has been applied to each individual spectrum of our sample of stars, since the position of the first minimum is determined by the rotational broadening, and does not depend on any other broadening mechanism. Reiners (2003) showed that the ratio of the first two minimum positions q_2/q_1 of the Fourier Transform can be also a reliable parameter to conclude the amount of gravity darkening or differential rotation. A value of $q_2/q_1 < 1.72$ is a direct indication for a gravity darkening or a solar-like differential rotation law, while $q_2/q_1 > 1.83$ indicates anti-solar differential rotation. The measurement of q_2/q_1 can be used without any modelling of line profiles.

[1] http://cdsweb.u-strasbg.fr/cgi-bin/Cat?J/A%2bA/378/861

Table 1: Determined values of $V_e \sin(i)$ in [km/s] and q_2/q_1 for the sample of 10 Be stars. In the last column (denoted with *) are values given by Chauville et al. (2001)

HD	$Wavelenght[nm]$	$V_e \sin(i)[km/s]$	q_2/q_1	$V_e \sin(i)[km/s]^*$
10144	HeI 438.81	217	1.62	235
56139	HeI 438.81	88	1.16	85
57219	HeI 438.81	90	1.17	80
75311	HeI 438.81	264	1.74	268
77320	HeI 438.81	338	1.49	345
189687	HeI 438.81	211	1.27	200
201733	HeI 438.81	351	2.22	340
210129	HeI 438.81	141	1.70	130
120324	HeI 438.81	156	1.74	124
224544	HeI 438.81	239	1.36	260

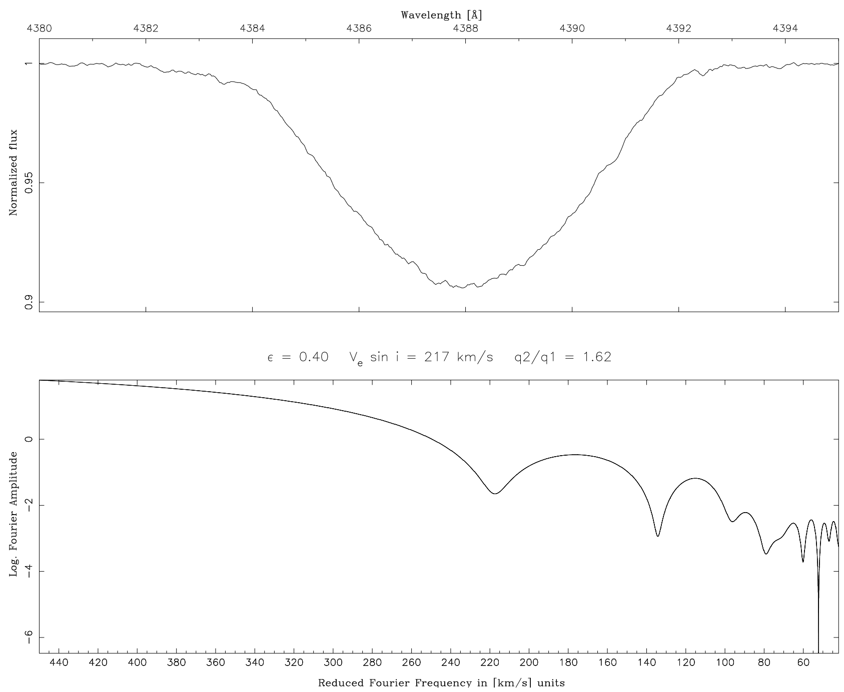

Figure 1: Flux line profile of the HeI 438.8 nm line of HD 10144 (top) and its Fourier transform (bottom). The Fourier frequency was reduced to velocity units, so that the first minimum of the Fourier transform of a rotational profile points to the projected rotational velocity of the star.

2. RESULTS AND DISCUSSION

Using the FTM and values for the limb-darkening coefficient given by Claret (2000), we obtained the projected rotational velocity, and also the ratio of the first two minimum positions for 10 Be stars in our sample. In Table 1. are given values for q_2/q_1, $V_e \sin(i)$ and (the last column) the determination of $V_e \sin(i)$ for considered stars by Chauville et al. (2001). As one can see from Table 1, our calculated values for $V_e \sin(i)$ are in a good agreement with those determined by Chauville et al. (2001). Only three stars from the group have the value $q_2/q_1 > 1.72$, so it can be concluded that stars HD 75311 and HD 120324 have solid-body rotations and the mass concentration in the center of the star. The third one, HD 201733 has an anti-solar differential rotation.

Our analysis for the rest of the stars in the sample revealed a small q_2/q_1 ratio (less than 1.72) which could be interpreted as gravity darkening or/and solar differential rotation.

In the case of Achernar (HD 10144), no evidence has been found for differential rotation in high quality spectroscopy of the star (e.g. Gray, 1977; Howarth and Smit, 2001). It means that our result implies a strong gravity darkening which could be expected taking into account the extremely oblate shape of the star (Domiciano de Souza et al., 2003).

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