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RADIAL VELOCITIES WITH THE GAIA RVS SPECTROMETER

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Abstract. Four different method are used to derive radial velocities from spectra observed by the Gaia Radial Velocity Spectrometer (RVS). They are briefly presented here together with very preliminary results.

1 Introduction

The main aim of the Gaia Radial Velocity Spectrometer (RVS) is to determine the radial velocities of nearly 100 to 200 millions of stars, with an expected accuracy of 1 km/s up to magnitude $V = 13$ and 15 km/s down to $V = 16$. These data will be a very useful tool for kinematics and dynamics studies of our Galaxy.
The Gaia data will be processed and analyzed by an international consortium (DPAC) including ESA and european institutes participating to the mission (Mignard & Drimmel 2007). Within DPAC nine coordination units CU have in charge a specific scientific or management problem. The processing of spectroscopic data provided by the RVS is devoted to CU6. The aim of this paper is to briefly present the work done within the development unit (DU) "Single transit analysis (STA)" in charge of analysing the data obtained during a unique transit of an object through the RVS field of view.

2 Radial velocity determination of single stars during a single transit

Deriving radial velocities of the observed object is an important task of DU STA. We restrict here to radial velocity determination of single stars. Four different algorithms have been developped using Java programming language : i) Cross-correlation between the object spectrum and a template spectrum in direct space, ii) Cross-correlation between the object spectrum and a template spectrum in Fourier space, iii)Cross-correlation between the object spectrum and a template spectrum in Fourier space using the Chelli's method (Chelli 2000), iv) Method of minimum distance between the object spectrum and a series of templates. A detailed escription of these methods can be found in (Viala et al. 2007).
For a given set of astrophysical parameters/magnitude, Monte-Carlo simulations (provided by CU2) led to 1000 spectra differing only by noise realisation but all shifted by 20 km/s. Radial velocities from the series of spectra were derived by the 4 algorithms. As an example, figure 1 shows histograms of the radial velocities for solar type stars of magnitude 8.6, 10.6 and 12.6. The mean value of the distribution slighly differ from 20 km/s : this small bias is due to different slopes of the continuum between the object and the template spectrum. The dispersion of the distribution gives the error on the radial velocity determination. Preliminary error derivations are listed in table 1 for several spectral types.

3 Conclusion

For a single transit and for the three methods discussed, radial velocities can be determined with an fairly good accuracy in the range 1 to 8 km/s down to magnitude $G_{RVS} \leq 14$ for F-G-K spectral types. Accuracies and magnitude limit are much less good for hotter stars (Spectral types O, B and A). Tests have not yet been done for cool M stars. Tentative determination of the projected rotational velocities, using the three algorithms developped within DU STA is planned for a near future.

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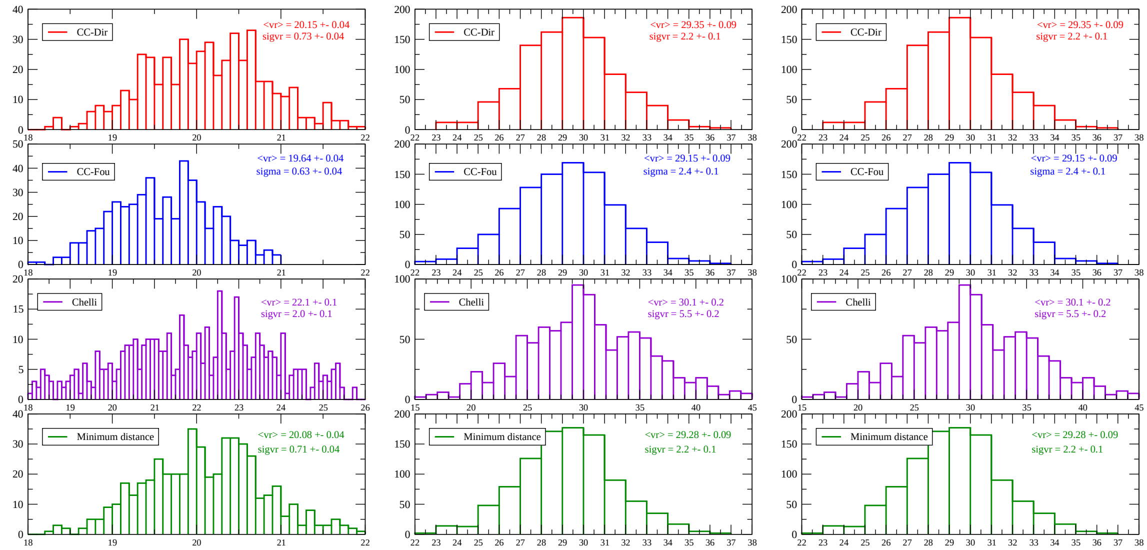

Fig. 1. Histograms derived radial velocities by the 4 algorithms for a G5V star of RVS magnitude 8.6, 10.6 and 12.6

Table 1. Errors from Monte Carlo simulations on radial velocity derivation for single stars of various spectral types

Sp. type	T_{eff}	logg	Fe/H	RVS magnitude	error on vrad in km/s			
					CCDir	CCFou	Chelli	MinDist
K5V	4000 K	4.0	0.0	8.7	0.63	0.63	1.8	0.62
				12.7	7.1	7.5	22.2	7.4
G5V	5500 K	4.0	0.0	8.6	0.73	0.63	2.0	0.71
				12.6	7.9	8.1	26.6	8.1
F5V	7500 K	4.0	0.0	8.2	0.87	0.85	3.7	0.86
				12.2	8.6	8.8	46.2	8.5
A5V	10000 K	4.0	0.0	7.5	0.94	0.92	5.9	0.96
				11.5	11.1	12.9	46.2	10.6
B2V	20000 K	4.0	0.0	6.8	3.0	3.1	15.5	2.4
				10.8	31.9	33.7	315	24.8
B0V	30000 K	4.0	0.0	6.4	2.7	2.8	17.0	2.3
				9.9	33.5	18.3	204	28.9
O6V	39000 K	4.0	0.0	6.4	4.1	0.5	14.5	53.0

References

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