

## THE CATALOG OF RADIAL VELOCITY STANDARD STARS FOR THE GAIA RVS: STATUS AND PROGRESS OF THE OBSERVATIONS

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**Abstract.** A new full-sky catalog of Radial Velocity standard stars is being built for the determination of the Radial Velocity Zero Point of the RVS on board of Gaia. After a careful selection of 1420 candidates matching well defined criteria, we are now observing all of them to verify that they are stable enough over several years to be qualified as reference stars. We present the status of this long-term observing programme on three spectrographs : SOPHIE, NARVAL and CORALIE, complemented by the ELODIE and HARPS archives. Because each instrument has its own zero-point, we observe intensively IAU RV standards and asteroids to homogenize the radial velocity measurements. We can already estimate that 8% of the candidates have to be rejected because of variations larger than the requested level of  $300 \text{ m s}^{-1}$ .

Keywords: Gaia, Milky Way, stars, asteroids, radial velocity, high-resolution spectroscopy

### 1 Introduction

The purpose of this new spectroscopic catalog of standard stars is to calibrate the future radial velocities measured by the Radial Velocity Spectrometer (RVS) on board of the Gaia satellite (see e.g. Jasniewicz et al. 2010, and references therein). We refer to Crifo et al. (2009, 2010) for a complete description of the selection criteria and of the ground observations of the 1420 candidates as reference stars.

### 2 Status of the observations

A total of 4035 measurements is currently available for 1330 stars. It consists in new and archived observations performed with the NARVAL (98 measurements), CORALIE (688), SOPHIE (902), ELODIE (1057) and HARPS (1290) high-resolution spectrographs. Figure 1 (left panel) represents the spatial distribution in the equatorial frame of the number of measurements already obtained for the 1420 candidates. The majority of stars still lacking observations is located in the Southern part of the sky, because the Southern programme on CORALIE started later. In the North ( $\delta > -15^\circ$ ),  $\sim 200$  stars still lack a second measurement. The Northern programme should be completed in 2011.

### 3 Preliminary results

- **Radial velocities of stars:** We have first compared the radial velocities of 320 stars we have in common with Nidever et al. (2002). A mean difference of  $-40 \text{ m s}^{-1}$  exists between both studies. This illustrates the zero-point issue that has to be solved for the calibration of the RVS (Jasniewicz et al. 2010). Among

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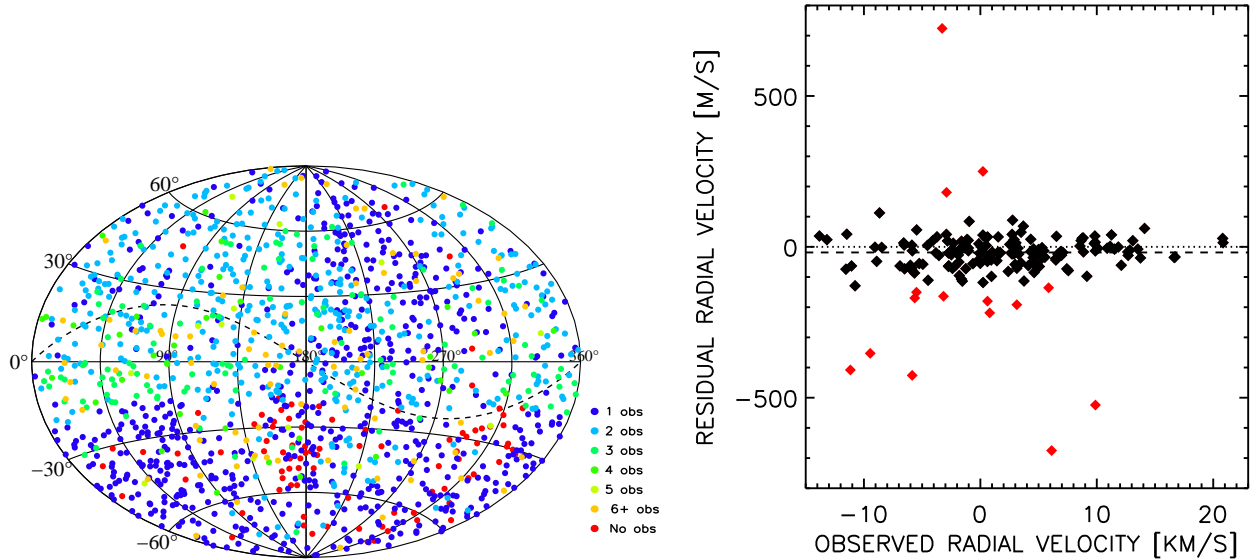
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**Fig. 1.** *Left panel:* Number of ground-based observations of Gaia-RVS reference stars performed as of June 2010. The ecliptic is shown as a dashed line. *Right panel:* Residual velocities (observed - theoretical) for asteroids as a function of their observed velocities. The red dots deviate by more than  $3\sigma$ .

those 320 stars 27 objects deviate by more than  $\sim 300 \text{ m s}^{-1}$ . Such a discrepancy between both studies may be due to variable stars that should not be considered as standard objects in a future analysis.

We have also done a preliminary statistical analysis our catalog. When selecting a sub-sample of 673 candidates for which at least two measurements have been performed it is seen that the velocity for  $\sim 72\%$  of them does not vary by more than  $100 \text{ m s}^{-1}$  during a time baseline of 0.5-2 years. Such a stability of radial velocities is very important to get the most accurate calibration of the RVS. The time variability of the catalog will be studied during the whole lifetime of the Gaia mission. Notice that  $\sim 8\%$  of the 673 stars exhibit a velocity variation of more than  $300 \text{ m s}^{-1}$ . Those objects likely correspond to variable stars.

- **Radial velocities of asteroids:** Observations of asteroids are very important for this project because they will allow the derivation of the zero point of the radial velocities for all reference sources. 171 measurements of 70 asteroids have been performed until now with SOPHIE. Their velocities have been compared with the theoretical values (Fig. 1, right panel) which have been derived using the MIRIADE webservice of the virtual observatory at IMCCE. The scatter of the residual (observed minus calculated) velocity is  $\sigma \sim 45 \text{ m s}^{-1}$ . Points that are more deviant than  $3\sigma$  (red symbols) correspond all to low signal-to-noise observations due to bad transparency conditions, or to badly derived velocity centroids due to e.g. double peaks in the cross-correlation function (observing conditions, contamination by the moon, ...). We are currently investigating the correlations of the observed and computed velocities with the physical properties of the asteroids (diameter, shape, rotation, phase, etc).

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## References

- Crifo F., Jasniewicz G., Soubiran C., et al., 2009, SF2A 2009 conference proceedings, 267  
 Crifo F., Jasniewicz G., Soubiran C., et al., 2010, A&A, accepted, in press  
 Jasniewicz G., Crifo F., Soubiran C., et al., 2010, ELSA 2010 conference proceedings, in press  
 Nidever D. L., Marcy G. W., Butler R. P., Fischer D. A., Vogt S. S., 2002, ApJS, 141, 503