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SARG@TNG: asteroseismology of solar like stars

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Abstract. Since 1995, the extrasolar planet search has driven the high resolution spectroscopy community to build more and more stable spectrograph in order to reach the photon statistics limit in radial velocity measurements. This situation opened the possibility of asteroseismic observations of stellar p-mode pulsations in solar - like stars. In this paper we describe the possible performance of the SARG spectrograph itself in asterosimological campaigns on fainter solar-like stars.

Key words. Asteroseismology – Solar like oscillations – Techniques: radial velocities

The results obtained with the Procyon campaign (Claudi et al. 2005 and Leccia et al. this issue) encourage ourselves to investigate the SARG potentiality in detection of solar like oscillations. SARG (Gratton et al. 2001) is the high resolution optical spectrograph for the Italian Galileo National Telescope (TNG). The spectrograph is a multipurpose instrument with emphasis on high resolution ($R_{Max} \sim 150,000$), high stability (long term stability of 5 m/s), while not sacrifying efficiency. An iodine gas cell (I_2 cell) may be inserted in the optical path to imprint on the object spectrum an absorption spectrum of I_2 lines as reference. Radial velocities are obtained by means of the AUSTRAL code (Endl et al., 2000) which models instrumental profile, star and iodine cell spectra in order to measure Doppler shifts. Figure 1 shows, as an example, the radial velocity time series obtained on 2001/01/06 for Procyon where a 21-minute pulsation pattern is clearly visible. The efficiency of SARG was measured observing the spectrophotometric standard star 58 Aql (HR 7596).

In Figure 2 the total efficiency of SARG is shown interpolated and integrated for 100 Å slices in the spectral range between 3800 Å and 7000 Å. We evaluate the radial velocity uncertainty (see Figure 3) for SARG as a function of magnitude for three different solar – like stars (K7V, G2V, G8V) and a Procyon-like star (F5 IV–V) using the appropriate quality factor (see Bouchy et al., 2001) for the spectrograph resolution, spectral type and rotational broadening. Using the resulting uncertainity in radial velocity measurements we evaluate the number of SARG radial velocity measurements necessary to detect the solar – like oscillation of amplitude v_{osc} with a signal to noise ratio of 4 for

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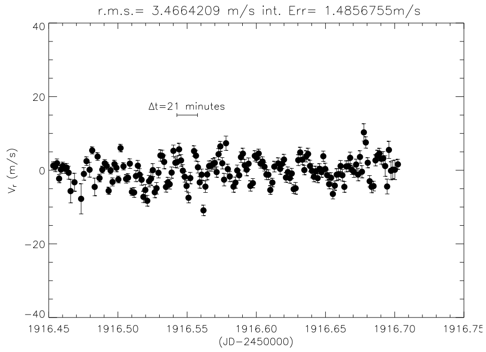

Fig. 1. Radial velocities of Procyon obtained on 2001/01/06. The data are affected by an internal error of 1.48 m/s and a r.m.s. of 3.5 m/s. The 21-minute pulsation is also indicated.

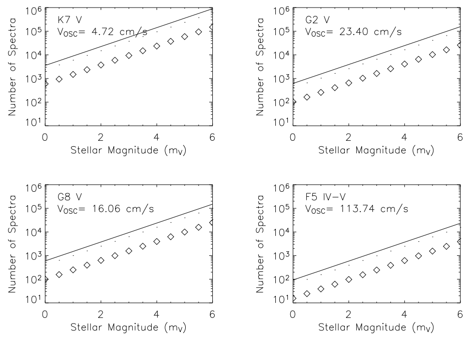

Fig. 4. The minimum number of SARG spectra necessary to determine the indicated stellar oscillation amplitude.The exposure time (10, 15, 60 s) was considered as a compromise between high spectrum SNR and temporal sampling of oscillation

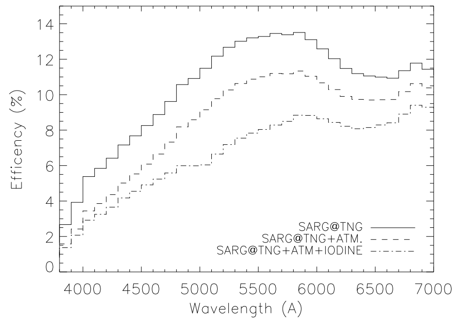

Fig. 2. The measured SARG efficency without and with the iodine absorbing cell

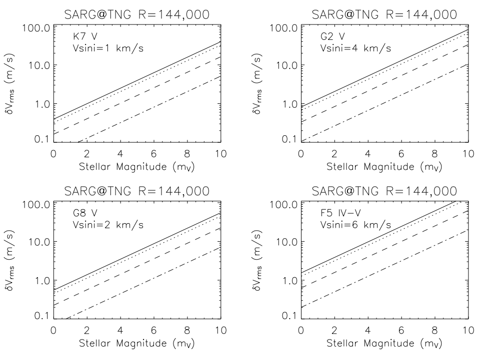

Fig. 3. The radial velocities uncertainty for SARG. The different curves comes from different exposure times. From upper to lower: 10s, 15s, 60s and 600s.

each spectral type considered. The number of points in the time series is given by the balance between the rms of the time series itself and the noise of the resulting amplitude spectrum. As it is possible to see from Figure 4, it will be possible to detect the oscillation with a reasonable number of spectra for brighter solar type stars but K7V . We are aware that the limits of RV measurements are also set by spectrograph instabilities, but analyzing the results obtained with the sub giant star Procyon we can limits the instrumental contribution to RV uncertainty lower than 1 m/s. These characteristics make SARG a competitive spectrograph for radial velocity measurements for both extrasolar planets search and stellar oscillations. In particular SARG could be exploited in the more challenging measurement of strongest oscillation mode of brighter solar like stars.

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