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The SARG Planet Search: Hunting for Planets Around Stars in Wide Binaries

R. Gratton, E. Carretta, R. U. Claudi, S. Desidera, S. Lucatello

INAF – Oss. Astronomico di Padova, Vicolo dell'Osservatorio 5, Padova, Italy

G. Bonanno, R. Cosentino, S. Scuderi

INAF – Oss. Astrofisico di Catania, Via S.Sofia 78, Catania, Italy

M. Barbieri

CISAS – Universitá di Padova, Via Venezia 15, Padova, Italy

F. Marzari

Dipartimento di Fisica, Univ. di Padova, Via Marzolo, Padova, Italy

M. Endl

McDonald Observatory, Austin, TX 78712, USA

E. Brocato, M. Dolci, G. Valentini

INAF – Oss. Astr. di Teramo, Via Mentore Maggini, Teramo, Italy

Abstract. We present the first results of the planets search survey ongoing at the Italian National Telescope TNG (Canary Islands) using SARG, a very high resolution spectrograph (R = 150000) equipped with an iodine cell. We are currently achieving a radial velocity precision below 5 m/s in best cases, over a 2 years baseline. We are observing about 100 stars in wide binaries, with projected separation 100-1000 AU. The first aim is to study the possible effects of binarity on the formation and evolution of giant planets. The second aim is to investigate the planet-metallicity connection, by comparing the chemical composition of the components of the pairs. Thanks to the similarity of the components of the binaries we selected, differential abundances can be determined with errors as small as 0.01 dex. We identified one pair (HD 219542) whose components differ in metallicity by 0.10 dex (Gratton et al. 2001, A&A 377, 123).

1. Introduction

Binary systems are ideal laboratories to study the dynamical effects on planetary systems due to the presence of the stellar companion, providing basic data about the minimum binary separation for planet formation and possible perturbations

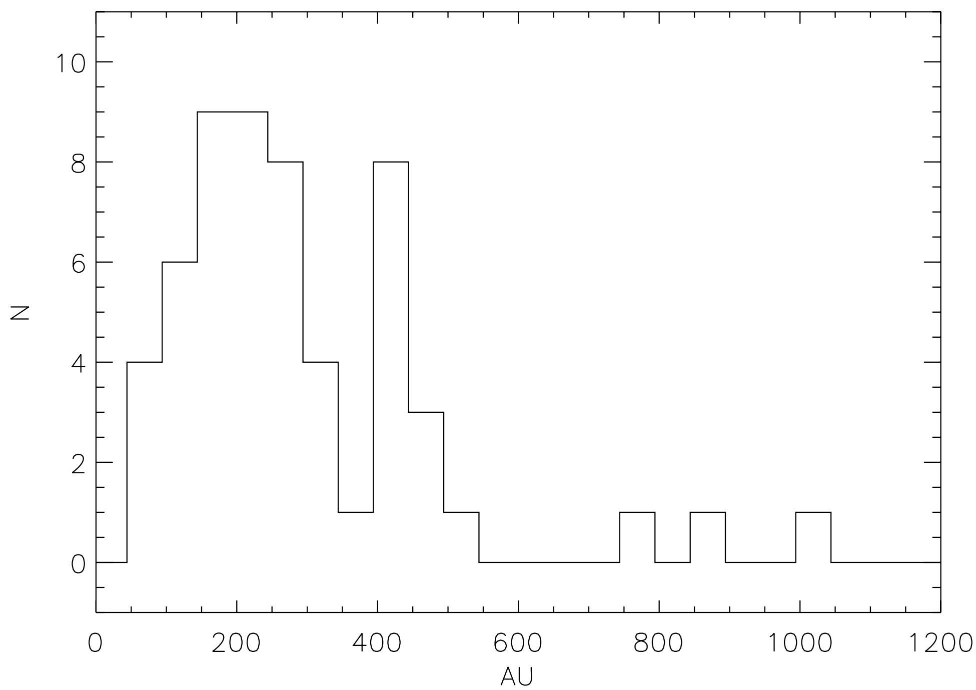

Figure 1. Distribution of the projected separation of the selected binary stars in AU.

of planetary orbits. Furthermore, the discovery of planets in binary systems may allow to identify possible chemical anomalies of the star with the planet, by comparing the chemical composition of the components. If the high metallicity of the parent stars of planets is the results of planets or planetesimal ingestion, some systematic differences are expected between members with and without planetary companions.

With these two aims, we selected a sample of binary stars from the Hipparcos Multiple Star Catalog with: separation larger than 2 arcsec (to avoid contamination of the spectra), magnitude difference less than 1.0 (this is useful in the comparison of the chemical composition of the components, avoiding systematic effects due to different temperatures and gravities), colors in the range $0.45 < (B-V) < 1.1$, and parallax larger than 10.0 mas (with errors smaller than 5 mas). Typical projected separation are in the range 100-1000 AU (Figure 1). Dynamical stability for a planet up to 20-30 AU is possible in most cases, according to the simulation of Holman & Weigert (1999).

2. The Survey

A radial velocity survey of the selected stars started in April 2001 using SARG (Gratton et al. 2002), the high resolution (R=150000) spectrograph of the Italian National Telescope. The spectrograph is equipped with an iodine cell

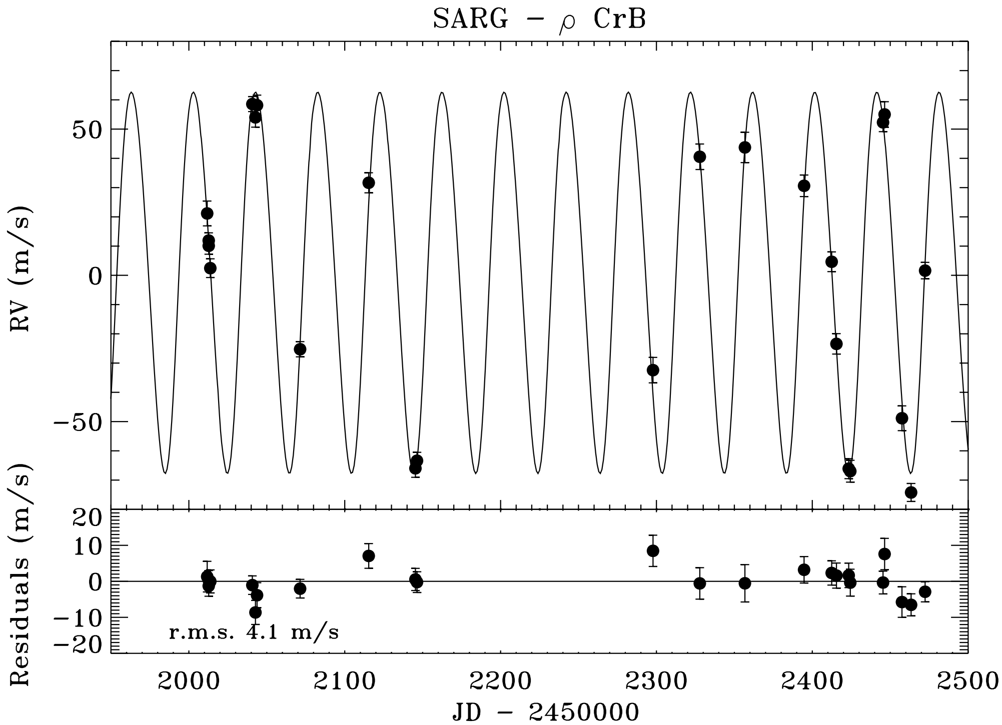

Figure 2. Upper panel: SARG Radial Velocities of the planet bearing star ρ CrB. The best orbital fitting is overplotted. Lower panel: residuals from the orbit.

(Desidera 2000), allowing a very high radial velocity precision, maintaining at the same time the flexibility required by the multi-purpose nature of the instrument.

The radial velocity analysis is performed using the code developed by Endl et al. (2000). Testing of the analysis procedure and fine tuning of the modeling parameters was achieved by the study of the constant radial velocity star τ Ceti and the planet-bearing stars 51 Peg and ρ CrB. A long term precision of about 3 m/s was achieved. For the much fainter (V=8-9) stars of the binary sample the errors are typically 5-10 m/s, due to the lower S/N of the spectra.

Furthermore, we have started a photometric monitoring of the sample at Teramo Observatory, aimed at providing a better knowledge of basic stellar parameters and the ancillary measurements required to properly understand the radial velocity behaviour of the stars.

3. Preliminary Results

3.1. Chemical Analysis

We are performing the analysis of the chemical abundances using the very high quality stellar templates (i.e., the spectra without the iodine lines). Errors as small as 0.01 dex in the difference of the iron content between the components

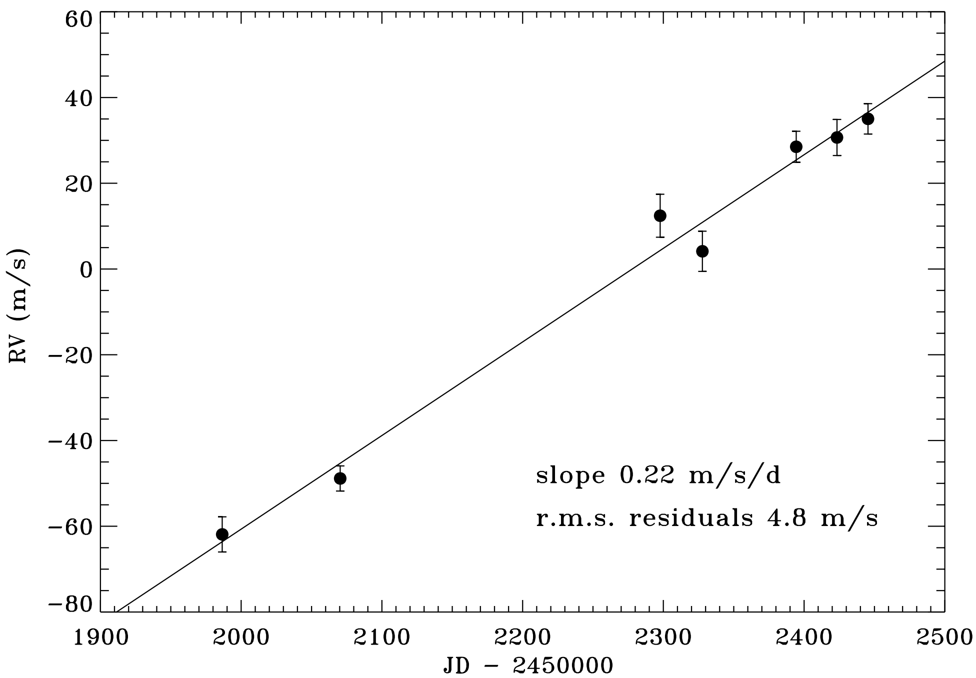

Figure 3. A star with a linear trend (0.22 m/s/d). A substellar companion is still compatible with the data, if the velocities will reveal a significant turn down in the next year.

are achieved, thanks to the strictly differential technique and the similarity of the components. We have found one pair (namely HD219542) whose primary is significantly enriched (by 0.10 dex) with respect to the secondary (see Gratton et al. 2001 for details).

3.2. Radial Velocities

In spite of the still limited number of measurements per star (typically 5-6) the radial velocity variability of some stars is emerging (see Figure 3 for an example). We are intensitively monitoring the components of HD 219542. There are no hints for the presence of short period planets. Further observations to reveal long period planets and low amplitude variations are in progress.

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