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# ELODIE metallicity-biased search for transiting Hot Jupiters*

## III. A hot Jupiter orbiting the star HD 185269

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**ABSTRACT**

We present new results of a search for extrasolar planets. The survey uses radial-velocity techniques and focuses on metal-rich stars. We used radial velocity measurements obtained with the echelle spectrograph ELODIE at the Observatoire de Haute Provence. New data have revealed a planetary companion to the slightly evolved star HD 185269. It belongs to the hot Jupiter class of planets, with a projected mass $M \sin i = 1.0\ M_{\rm Jup}$ and period $P = 6.84$ days. We describe the measurements that led to this discovery and discuss the orbital solution.

**Key words.** stars: individual: HD 185269 – planetary systems – techniques: radial velocities

## 1. Introduction

There are approximately 40 known extrasolar planets with a semi-major axis smaller than 0.1 AU, the so-called hot Jupiters. Among them, seven have a mass of less than about 0.1 $M_{\rm Jup}$ and should better be called hot Neptunes. These hot Neptunes could be very abundant as only recently have they become available above the detection limit of intruments. 85% of these short-period planets have a metal-rich parent star, in comparison to 70% for the whole sample of extrasolar planets. There is thus an indication that the frequency of planets versus the metallicity of the parent star relationship is stronger for short-period planets (see also Sozzetti 2004). To understand whether this trend is significant, we need data from more short-period planets orbiting metal-rich stars. This is the goal of two observational programs using radial-velocity techniques; both surveys started in 2003 and several planets have been discovered: HD 88133 (Fischer et al. 2005), HD 118203 (Da Silva et al. 2006), HD 149026 (Sato et al. 2005), HD 149143 and HD 109749 (Fischer et al. 2006; Da Silva et al. 2006) and HD 189733 (Bouchy et al. 2005). The observational strategy of these programs, introducing a bias in the selection of target stars based on their metallicity, allows a more efficient detection of planets, and will clarify the link between the metallicity of stars and the planet formation and migration. Also, the discovery of short-period planets opens the possibility to discover new transiting systems (as e.g. HD 149026 and HD 189733, see references above), with precise determinations of their mass and radius. However, non-biased target sample surveys are still needed in order to explore other parameters of the origins of planetary systems.

In this paper, we report the detection of a new planetary system around the main-sequence star HD 185269 at the Observatoire de Haute Provence. In Sect. 2 the observations are described; in Sect. 3 we derive the stellar parameters and the interpretation is discussed in Sect. 4.

## 2. Observations

Radial-velocity measurements of the main-sequence star HD 185269 were obtained with ELODIE from June 2005 to July 2006 in the framework of the survey of metal-rich stars as described in Da Silva et al. (2006). ELODIE is a fiber-fed echelle spectrograph (Baranne et al. 1996) mounted on the 193-cm telescope at the Observatoire de Haute Provence (France), designed to obtain simultaneous spectra of a star and a calibration ThAr lamp, for precise radial-velocity measurements.

A first observation of HD 185269 shows its enrichment, with a metallicity deduced from the cross-correlation function of 0.15. Further measurements of this star revealed fluctuations in the radial velocity over a few days. The star was then regularly monitored. Individual measurements of HD 185269 have errors of the order of 10−12 $\rm m\,s^{-1}$ (Table 1) while the standard deviation of the series is about 90 $\rm m\,s^{-1}$. A 6.8-d periodicity is clearly visible.

* Based on observations collected with the ELODIE spectrograph on the 1.93-cm telescope (Observatoire de Haute Provence, France).

**Table 1.** Radial-velocity measurements of HD 185269 obtained with ELODIE from June 2005 to June 2006.

| JD-2 400 000. day | $VR$ km s$^{-1}$ | error ms$^{-1}$ |
|---|---|---|
| 53551.55350 | 0.535 | 0.011 |
| 53552.57440 | 0.639 | 0.013 |
| 53553.54090 | 0.697 | 0.012 |
| 53554.55910 | 0.690 | 0.008 |
| 53555.54490 | 0.663 | 0.009 |
| 53574.55610 | 0.687 | 0.012 |
| 53576.51360 | 0.631 | 0.011 |
| 53577.53300 | 0.532 | 0.010 |
| 53587.46980 | 0.672 | 0.011 |
| 53588.45620 | 0.677 | 0.009 |
| 53589.46500 | 0.606 | 0.012 |
| 53590.45090 | 0.631 | 0.014 |
| 53591.48810 | 0.530 | 0.011 |
| 53592.41560 | 0.543 | 0.011 |
| 53594.47180 | 0.672 | 0.010 |
| 53596.43110 | 0.677 | 0.010 |
| 53610.43430 | 0.652 | 0.010 |
| 53613.41040 | 0.593 | 0.008 |
| 53624.43320 | 0.630 | 0.008 |
| 53625.37140 | 0.551 | 0.010 |
| 53626.37360 | 0.508 | 0.008 |
| 53627.36100 | 0.597 | 0.008 |
| 53628.32940 | 0.672 | 0.008 |
| 53667.33630 | 0.502 | 0.008 |
| 53720.25140 | 0.617 | 0.010 |
| 53723.22240 | 0.603 | 0.011 |
| 53808.68270 | 0.640 | 0.012 |
| 53869.60890 | 0.672 | 0.008 |
| 53871.55960 | 0.538 | 0.008 |
| 53872.61180 | 0.538 | 0.012 |
| 53873.56570 | 0.589 | 0.015 |
| 53875.60370 | 0.716 | 0.010 |
| 53894.58770 | 0.648 | 0.010 |
| 53896.56560 | 0.683 | 0.009 |
| 53897.56800 | 0.681 | 0.009 |
| 53901.58760 | 0.661 | 0.014 |
| 53932.46560 | 0.609 | 0.015 |
| 53934.42560 | 0.518 | 0.009 |

## 3. Stellar characteristics of HD 185269

HD 185269 has been observed by HIPPARCOS (ESA 1997). It is a G0IV star with a visual magnitude $V = 6.67$ and color index $B - V = 0.58$ and is located at 47.37 pc from the Sun. This results in an absolute $V$ magnitude of 3.29. Strömgren narrow-band photometry on this star derives a metallicity of 0.02, i.e. almost solar (Nordström et al. 2004). Comparatively, the metallicity derived from the cross-correlation function (0.15) is slightly higher. Direct spectroscopic analysis as described in Santos et al. (2004) allows us to derive: $T_{\rm eff} = 5983$ K, $\log g = 4.05$ and [Fe/H] = 0.10 (Table 2).

By comparison with the evolutionary tracks calculated by Girardi et al. (2002), we obtain a stellar mass of $1.33 \pm 0.07\ M_{\odot}$ and an age of $4.0 \pm 1.0$ Gyr. The star is slightly evolved, as also suggested by the lithium content in the spectrum.

The projected rotational velocity derived from a calibration of the cross-correlation function is $v \sin i = 5.5$ km s$^{-1}$.

The stellar chromospheric activity of HD 185269 is low, as deduced from the absence of emission in the core of the CaII lines (Fig. 1). This excludes large amplitude radial-velocity jitter due to intrinsic activity of the star.

**Table 2.** Stellar parameters of HD 185269.

| | |
|---|---|
| Spectral Type | G0 IV |
| $V$ | 6.67 |
| $B - V$ | 0.58 |
| Distance [pc] | 47.37 |
| $M_V$ | 3.29 |
| BC | –0.06 |
| $M_{\rm bol}$ | 3.228 |
| $T_{\rm eff}$ [K] | 5983 ± 62 |
| $\log g$ | 4.05 ± 0.22 |
| [Fe/H] | 0.10 ± 0.08 |
| $v\sin i$ [ km s$^{-1}$] | 5.5 |
| Star mass [$M_{\odot}$] | 1.33 ± 0.07 |
| Age [Gyr] | 4.0 ± 1.0 |

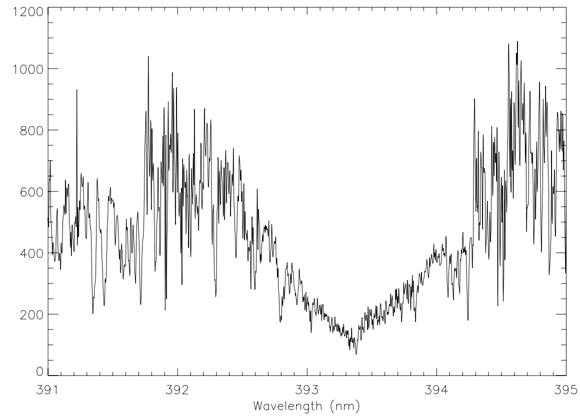


**Fig. 1.** The CaII K absorption line of the ELODIE spectrum of HD 185269, which shows no emission feature in its core.

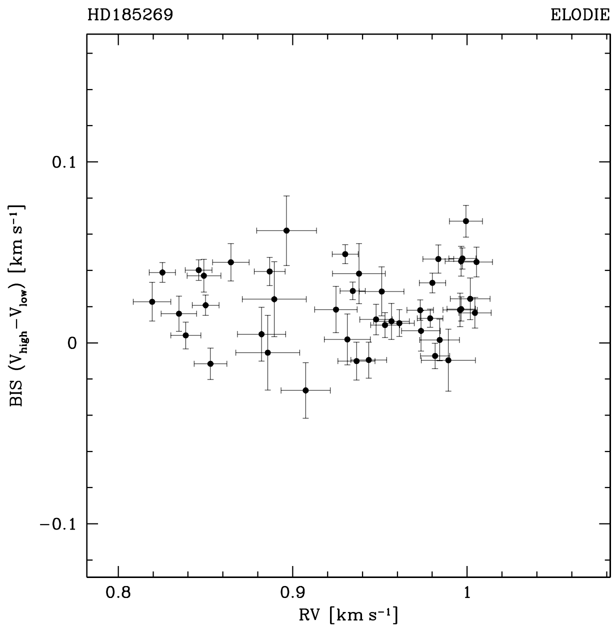


**Fig. 2.** The inverse slope of the bisector is shown against the radial-velocity measurements of HD 185269. No correlation is observed.

The bisector analysis of the cross-correlation functions shows no correlation with the measured velocimetric variations. The shape of stellar lines is therefore not related to the observed fluctuations in radial velocity (Fig. 2).

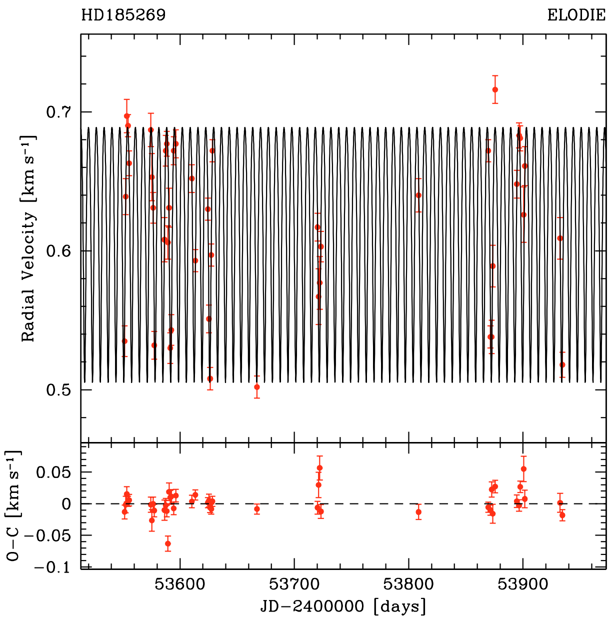


**Fig. 3.** Radial-velocity measurements of HD 185269 superimposed on the best Keplerian solution. Error bars represent the photon-noise uncertainties.

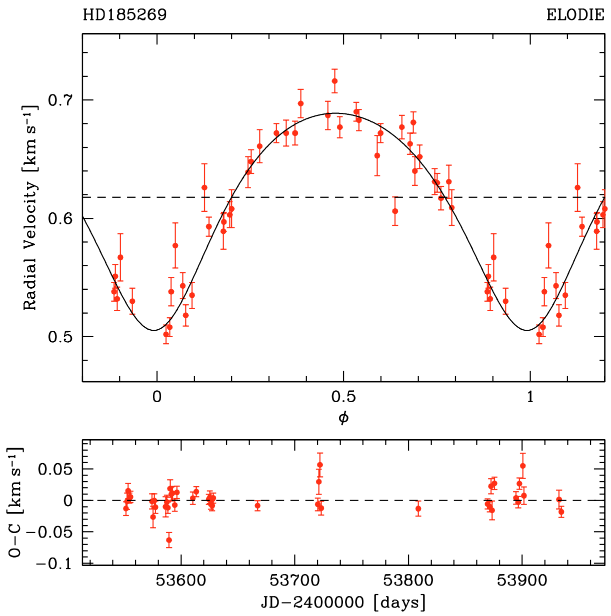


**Fig. 4.** Phase-folded radial velocity measurements of HD 185269 superimposed on the best Keplerian solution. Error bars represent the photon-noise uncertainties. Bottom plot: residuals as a function of time.

**Table 3.** Parameters for the Keplerian solution and the planetary companion.

| | |
|---|---|
| Period [days] | 6.8399 ± 0.0013 |
| Periastron epoch [JD-2453000] | 797.152 ± 0.12 |
| Orbital eccentricity | 0.225 ± 0.025 |
| Radial velocity semi-amplitude [ $m\,s^{-1}$ ] | 93.56 ± 2.5 |
| Systemic velocity [ $km\,s^{-1}$ ] | 0.617 ± 0.002 |
| O–C residuals [ $m\,s^{-1}$ ] | 16 |
| Orbital semi-major axis [AU] | 0.077 |
| Planet mass [ $M_J$ ] | 1.03 ± 0.03 |

## 4. Planetary system

A careful check of stellar properties shows that the radial-velocity fluctuations of HD 185269 were not likely of stellar origin. A Keplerian orbit was then adjusted on the 38 data points with photon noise uncertainty below 15 $m\,s^{-1}$ (Fig. 3); the best parameters of the fit are a period of 6.84 days and an eccentricity of 0.23. The final parameters of the orbital solution are presented in Table 3. The residuals are 16 $m\,s^{-1}$.

With a stellar mass of 1.33 $M_\odot$, the deduced minimum mass is 1.03 ± 0.03 $M_{Jup}$ for the planetary companion in an orbit with a 6.8399 ± 0.0015 day period; the folded orbit is shown in Fig. 4.

Like HD 118203 (Da Silva et al. 2006), HD 185269 has a short-period planet in eccentric orbit. The period of HD 185269 (6.84 days) is above the limit of circularization as expressed in Halbwachs et al. (2005) and evidently, circular orbits are extremely rare when the period is larger than about 5 days (Schneider 2006).

A short-period planet is a good target for transit detectability; for HD 185269, the transit probability is about 8%. However, the eccentricity makes the error on the time reference large and therefore the transit ephemeris is not precise. A photometric observation sequence will nevertheless be scheduled in the following months, in parallel with further radial-velocity measurements aimed at refining the orbital solution.

*Note added in proofs:* After this paper was submitted, an independent discovery of the same planet was announced by Johnson et al. (2006). Both sets of measurements and analysis are compatible and no transit is visible.

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