# CoRoT 101186644: A transiting low-mass dense M-dwarf on an eccentric 20.7-day period orbit around a late F-star★


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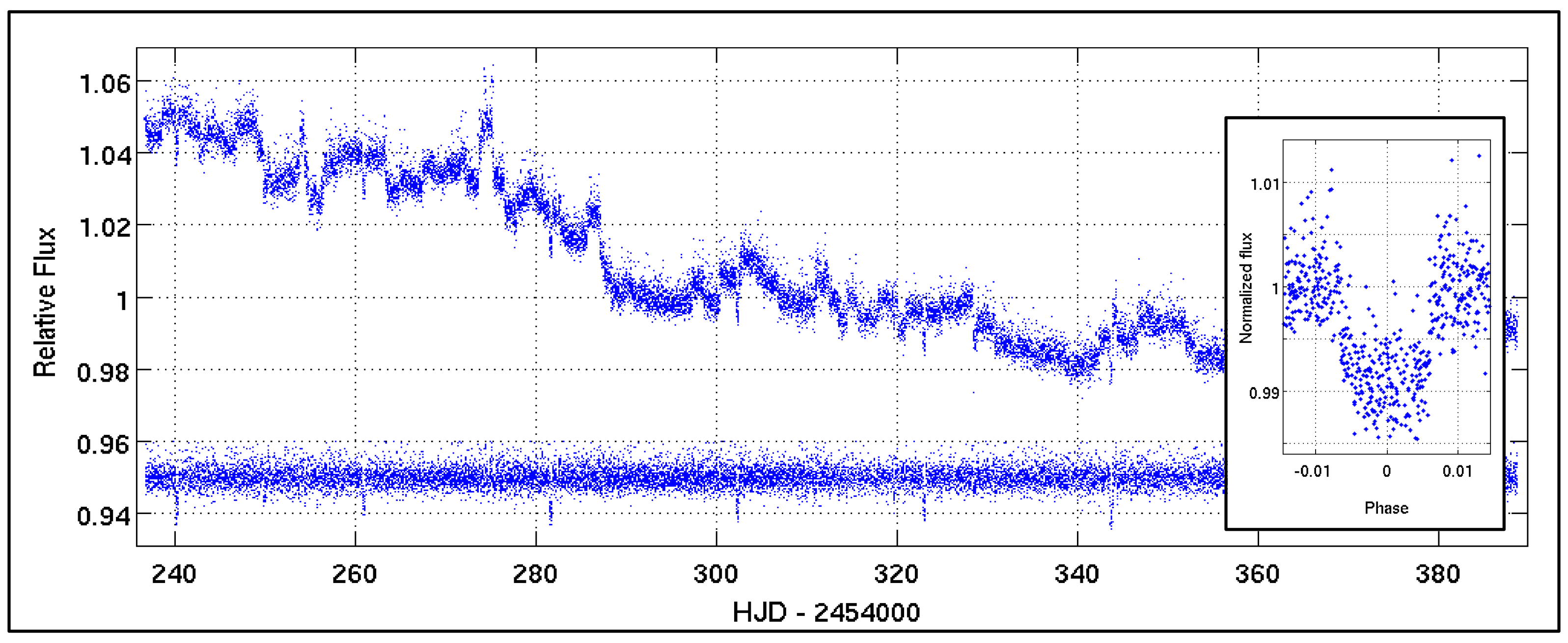
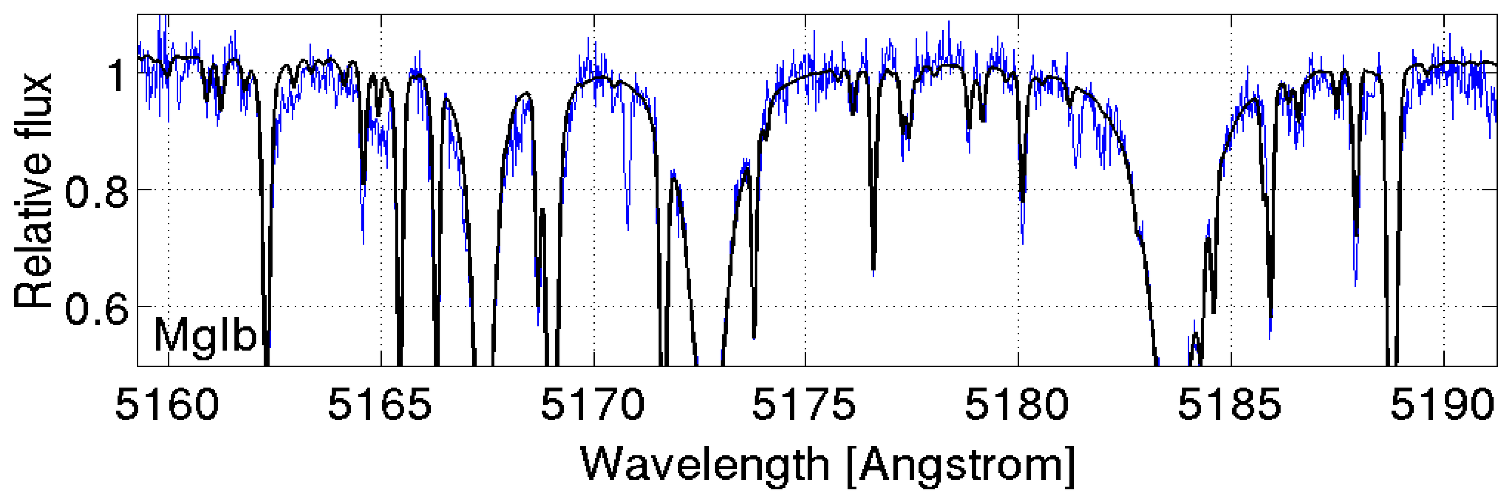
**CoRoT 101186644 ( = LRc01_E1_4780 = C4780) was initially identified as a candidate for a Jovian planet in the "period valley" (Cabrera et al. 2009).** The table lists some basic properties of C4780 and of its CoRoT lightcurve. The figure shows its original and detrended lightcurves with an inset zooming on the transit in the phase-folded lightcurve:

| Parameter | Value |
|---|---|
| RA (J2000) | 19*h*26*m*59s.08 |
| Dec (J2000) | +00°29'06".4 |
| V (mag) | 16.05 ± 0.07 |
| Period (day) | 20.68369 (11) |
| Transit depth (%) | 0.96 |

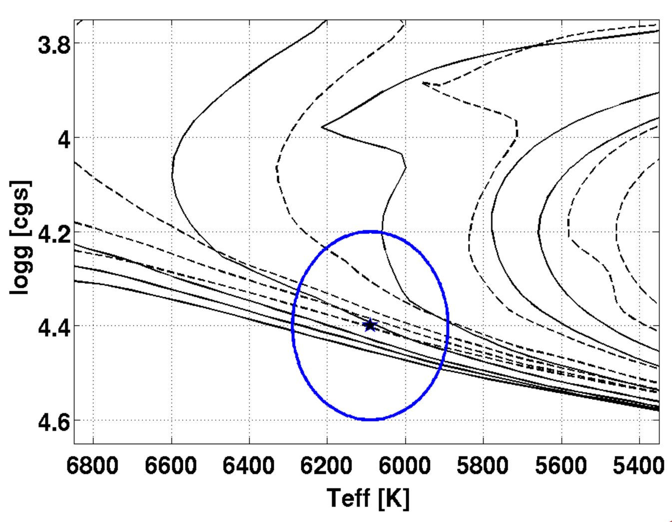



**Nine HARPS spectra were recorded between June 21, 2008 and July 20, 2010 with exposure times of 45–60 min.** The primary atmospheric parameters detailed in the table were derived from the co-added HARPS specrta using SME (Valenti & Piskunov 1996). The figure shows one part of that spectrum (blue), together with the fitted model spectrum (black):

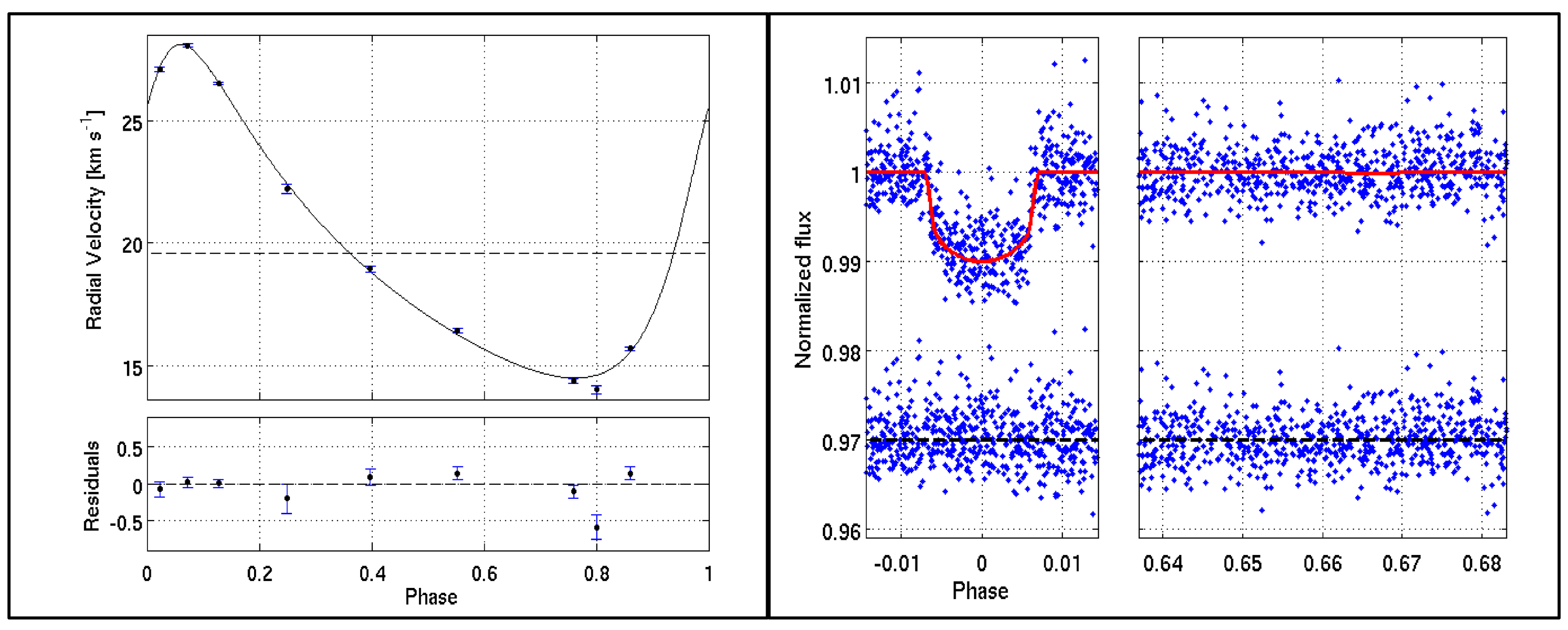
| Atmospheric parameters | Value |
|---|---|
| Effective temperature (K) | 6090 ± 200 |
| logg (cgs) | 4.4 ± 0.2 |
| Metallicity (dex) | +0.2 ± 0.2 |
| Projected rotational velocity (km/s) | 3 ± 2 |



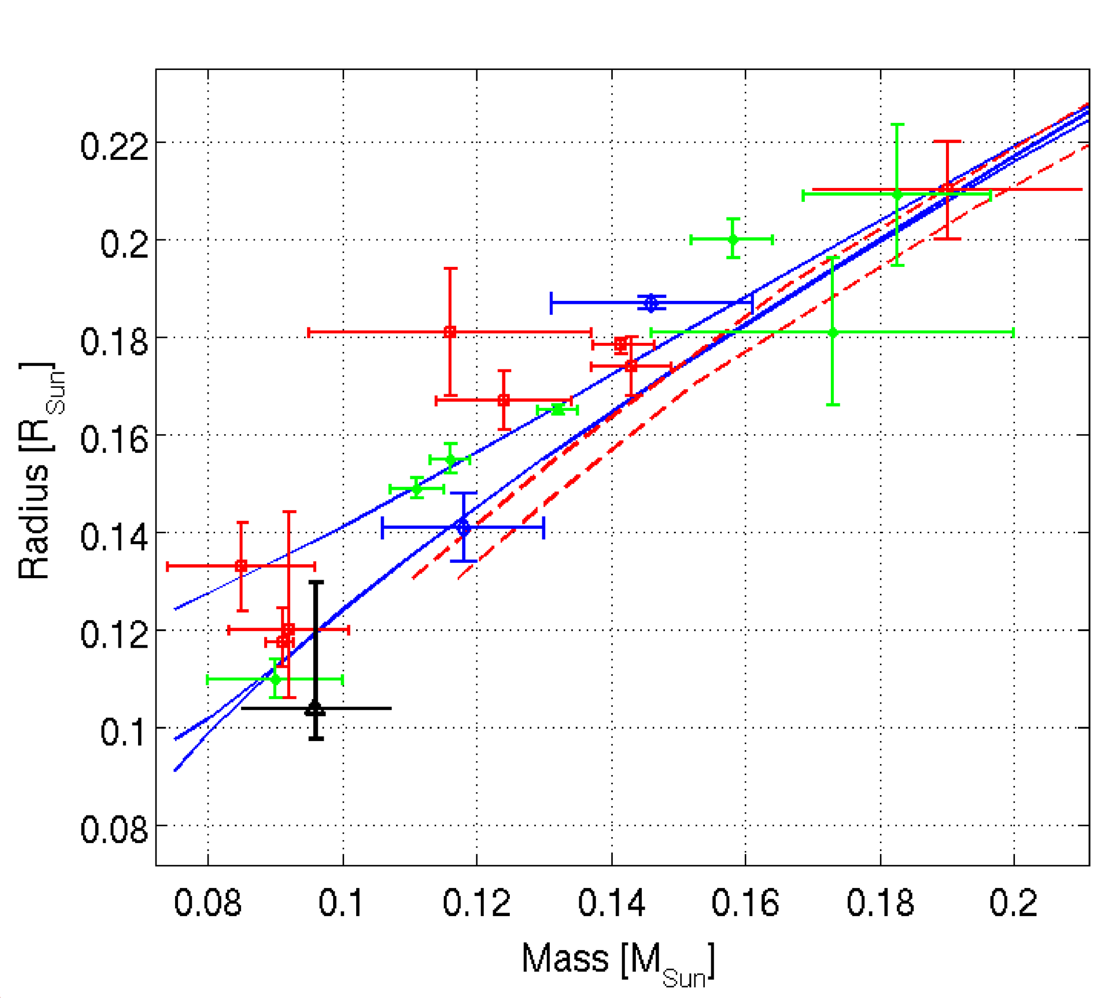

**The mass of C4780-A was estimated using Yonsei-Yale stellar isochrones (Demarque et al. 2004) to be 1.2±0.2 $M_{\odot}$.** The figure shows the estimated atmospheric parameters (blue) and two isochrone sets, one for [Fe/H]=0.05 (solid lines) and one for [Fe/H]=0.39 (dashed lines). Both sets have ages of 0.2, 0.4, 1, 2, 4, 8, and 10 Gyr (going from left to right along the *logg*=4.4 line):




**The rest of the binary parameters were estimated via simultaneous lightcurve and radial velocity (RV) modeling using MCMC. We found the secondary to be a late M-dwarf with a mass of 0.096±0.011 $M_{\odot}$, and a radius of $0.104^{+0.026}_{-0.006}$ $R_{\odot}$. We found the M-dwarf orbit to be eccentric (e≈0.4). We could not detect the secondary eclipse in the CoRoT data.** The figure shows the data used in the MCMC analysis and the model produced from the fitted parameters. **Left panel:** phase-folded HARPS RVs and the Keplerian model. **Right panel:** phase-folded CoRoT lightcurve and model. The primary transit is at the left side of the panel, and the part where the secondary eclipse should have occurred is at the right side of the panel:




**The figure shows mass-radius diagram of very low mass stars (M<0.2 $M_{\odot}$).** Red rectangles are secondary stars of main-sequence eclipsing binaries (Ebs), green circles are secondary stars of white dwarf + M-dwarf EBs, and blue diamonds are single stars (star names are given in the table). The black triangle stands for C4780-B. Solid blue lines correspond to theoretical isochrones of solar metallicity and ages of 0.25, 1, and 5 Gyr (going from top to bottom along the 0.08 $M_{\odot}$ line) from Baraffe et al. (1998). To illustrate the effect of metallicity on size, dashed-red lines show the Dartmouth isochrones (Dotter et al. 2008) of 1 Gyr for [Fe/H] = 0.2 (upper line) and [Fe/H] = −0.5 (lower line):




| Star name (increasing mass) |
|---|
| OGLE-TR 123 B |
| SDSS 0857+03 B |
| J1219-39 B |
| OGLE-TR 122 B |
| C4780 B |
| NN Ser B |
| GK Vir B |
| OGLE-TR 106 B |
| GJ 551 |
| HAT-TR-205-013 B |
| SDSS 0138-00 B |
| KIC 1571511 B |
| WTS 19g-4-02069 |
| GJ 699 |
| SDSS 1210+33 B |
| SDSS 1548+40 B |
| RR Cae B |
| 2MASS 0446+19 B |

## Conclusions

- **C4780-B might be the smallest main sequence star ever detected!**
- **Further investigation of the blending fraction (L3) might reduce the uncertainties on its radius.**
- **The models of very low mass stars display a large theoretical spread, caused by differences in age, metallicity, fast rotation, magnetic activity, strong irradiation, and clouds (e.g., Burrows et al. 2011; Feiden & Chaboyer 2012, and references therein).**
- **No apparent inconsistency between the observed systems and the available theory can be deduced at this point.**


References

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★ **Source paper:** Tal-Or, L., Mazeh, T., Alonso, R., et al. 2013, A&A, 553, A30



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