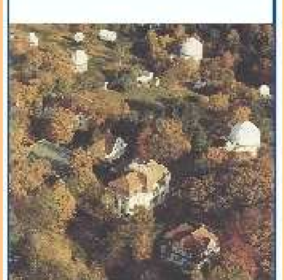
CS 16

Hamburger Sternwarte



Doppler shadows of CoRoT-2b

Using a transiting planet as an occulting mask

Uwe Wolter[1], Stefan Czesla[1], Sebastian Schröter[1], Klaus Huber[1], Jürgen H.M.M. Schmitt[1] and Eike Guenther [2]

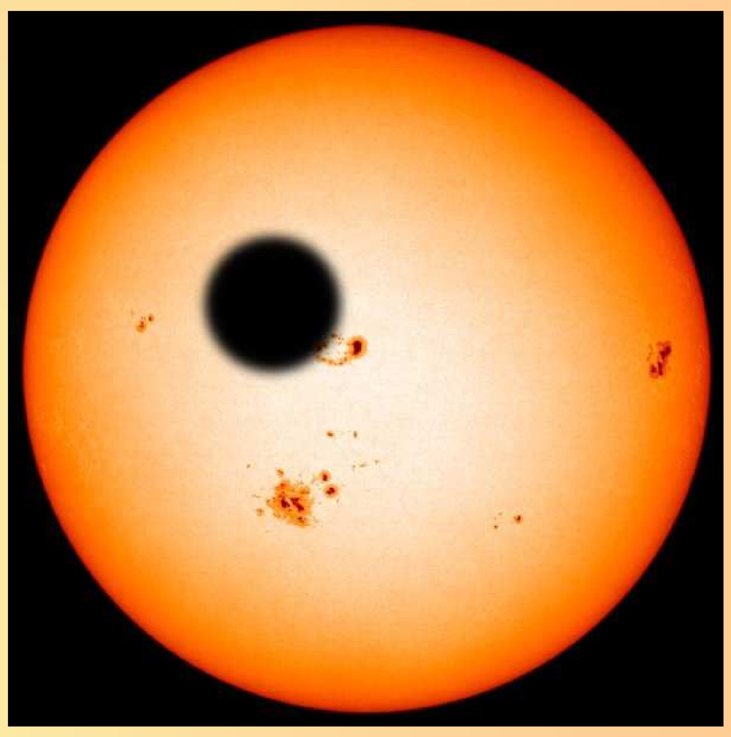
[1] *Hamburger Sternwarte, Universität Hamburg*

[2] *Thüringer Landessternwarte,Tautenburg, Germany*

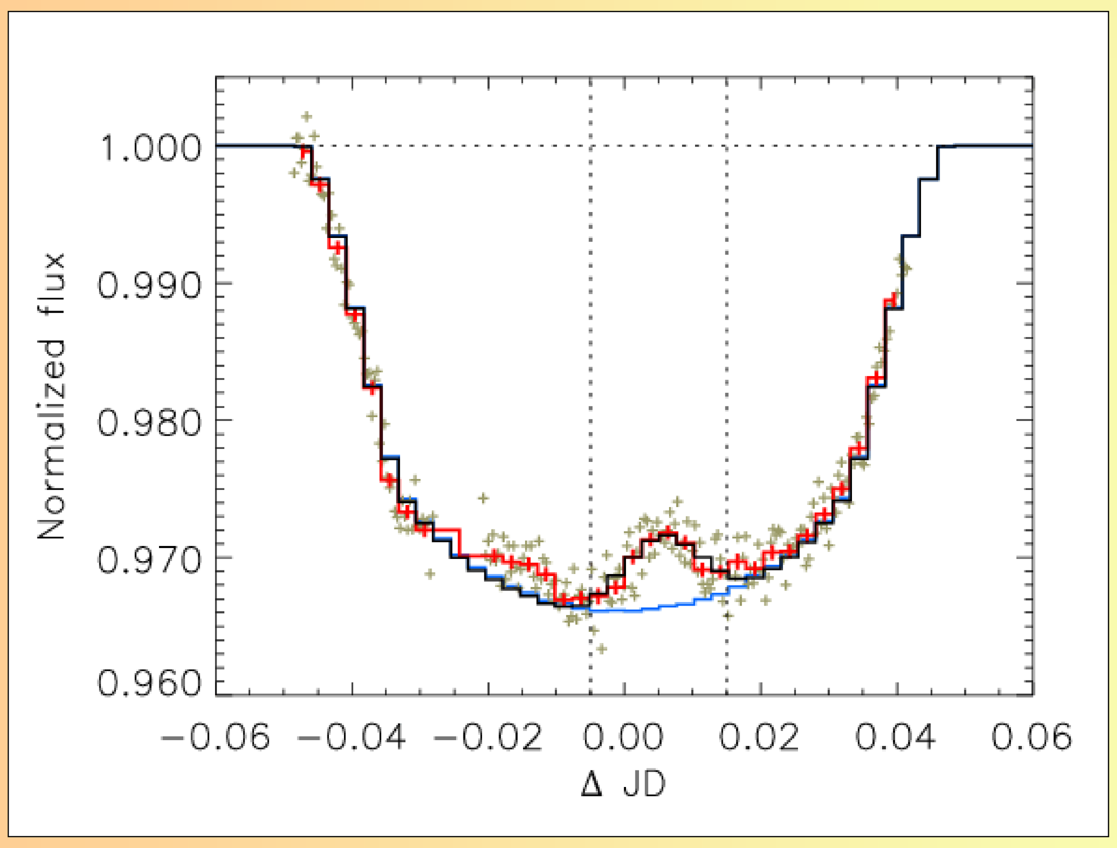
e-mail: uwolter@hs.uni-hamburg.de

Abstract

A transiting planet acts as a sharply defined shutter that scans the surface *of its host star*.
Based on very-low-noise photometry from the CoRoT satellite and high-resolution spectra taken with VLT/UVES we employ this shutter to resolve surface features of the highly active G-type star CoRoT-2a which is transited by the planet CoRoT-2b.



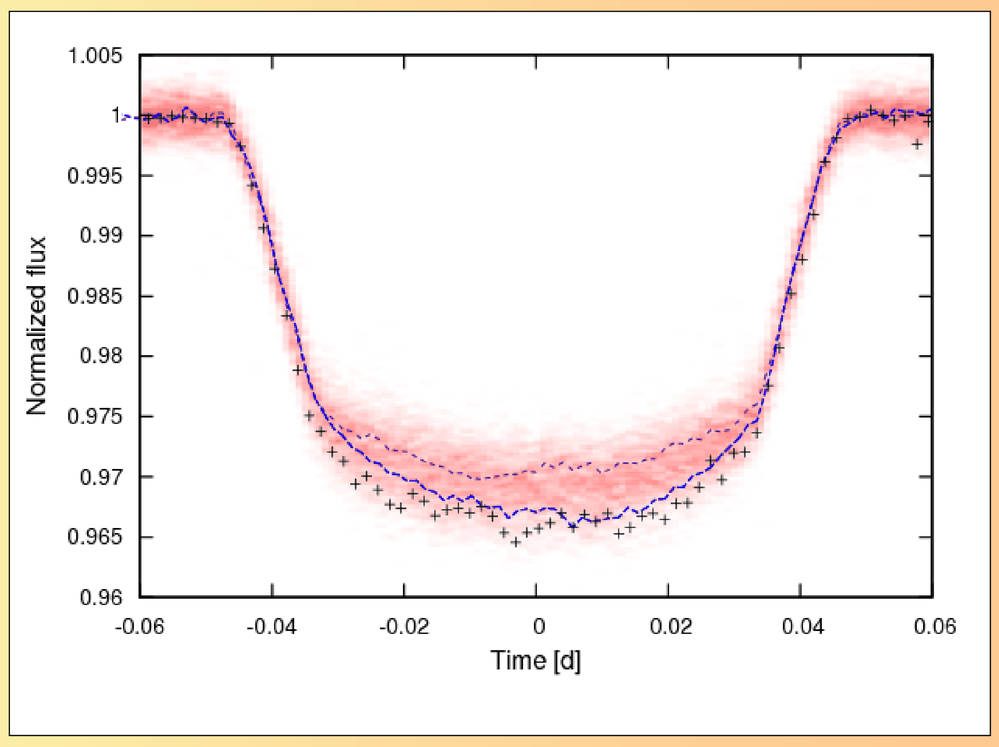
Photomontage using a solar image, illustrating the transit geometry of the CoRoT-2 system.
(SOHO-MDI, U. Wolter)



Spot-induced transit deformations

Fig. 1: Lightcurve of a single transit of CoRoT-2 as observed by CoRoT in 2007 (red curve and error bars). Pronounced deformations are clearly apparent, these ‘bumps’ are due to cool starspots occulted by the planet during its transit across the host star.

- Wolter, Schmitt et al. 2009, A&A 504, “Transit mapping of a starspot on CoRoT-2“
- Huber, Czesla et al. 2010, A&A 514, „Planetary eclipse mapping of CoRoT-2a“

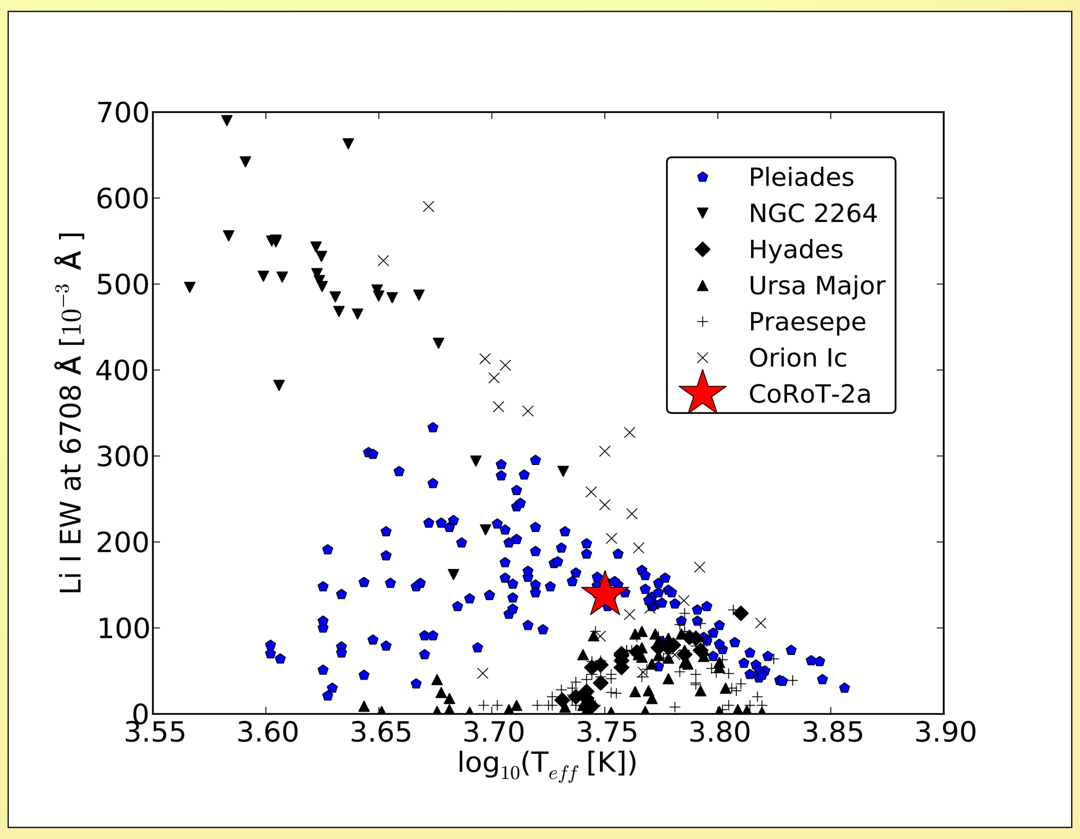


How does the spot coverage influence the transit depth?

Fig. 2: Transit lightcurves are even deformed by starspots not occulted by the planet: Dark spots outside the transit path increase the normalized transit depth because the planet effectively occults a larger portion of the *bright* stellar disk.
For highly active planet host stars this effect must be taken into account when estimating precise planetary radii from low-noise transit lightcurves.

The red color gradient illustrates the changing transit depth due to the variable spot coverage of CoRoT-2a observed by CoRoT during nearly 80 planetary transits.

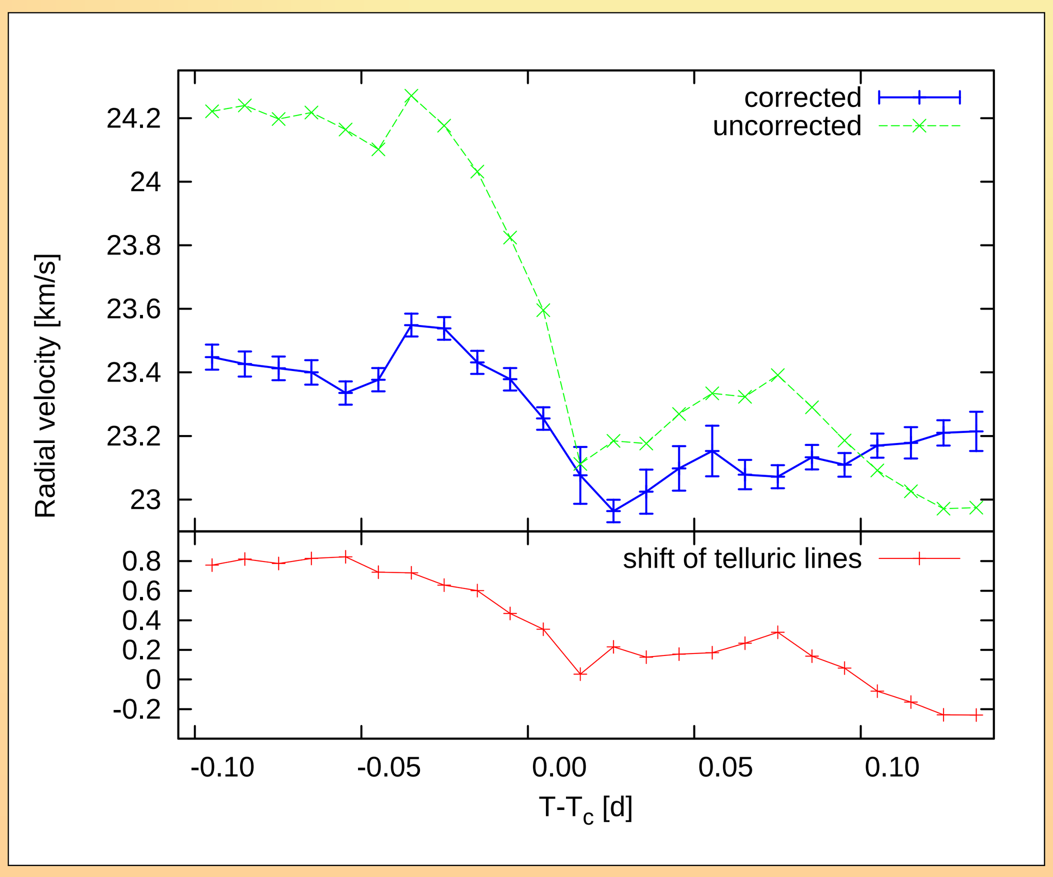
- Czesla, Huber et al. 2009, A&A 505, “How stellar activity affects the size estimates of extrasolar planets “



The age of CoRoT-2a

Fig. 3: The equivalent width of the 6708 Å lithium line as measured in our UVES spectra of CoRoT-2a. It suggests an age comparable to the Pleiades, i.e. about 100 Myr.

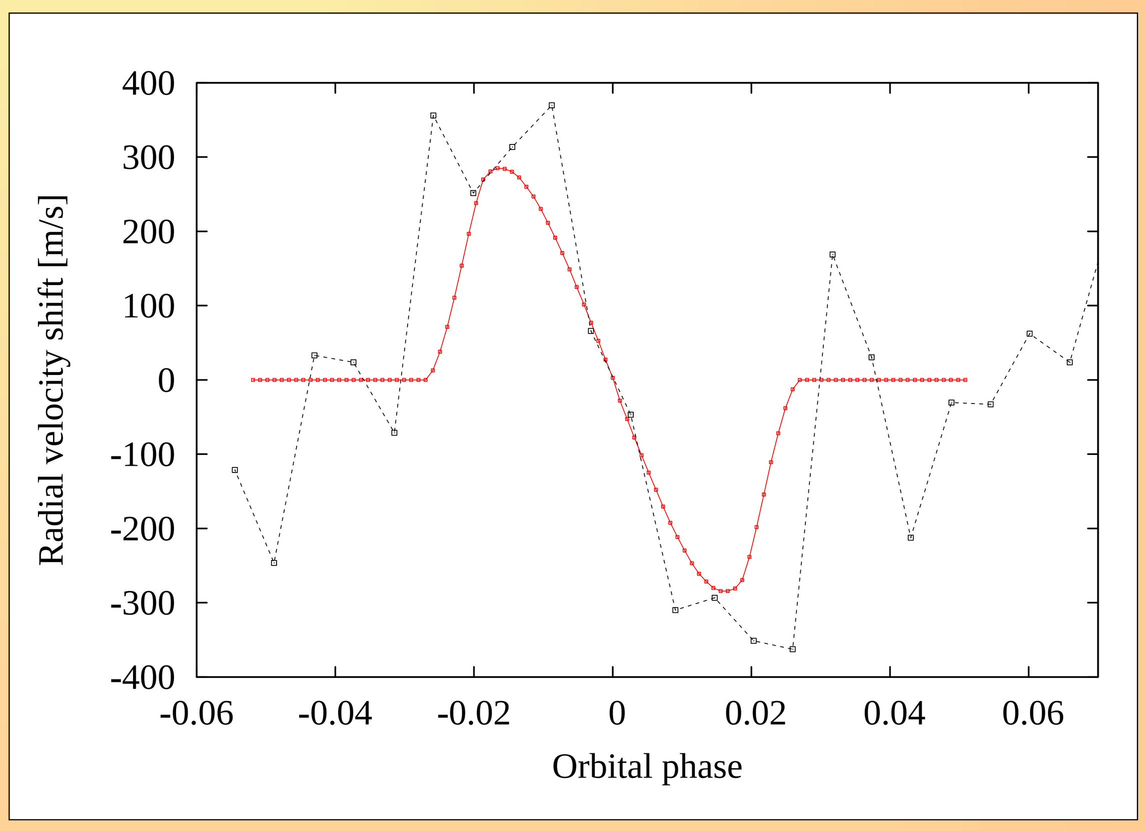
Li data of clusters taken from Soderblom et al. 1990, AJ 99 and follow-up papers.



Corot-2’s Rossiter-McLaughlin effect … revisited

Fig. 4: Our UVES spectra of one transit of CoRoT-2b, taken in June 2010, yield a Rossiter-McLaughlin curve in agreement with Bouchy et al.’s (2008, A&A 482) SOPHIE and HARPS measurements.

Radial velocities (blue) as determined by a cross-correlation with a synthetic PHOENIX spectrum on the wavelength range 5600 – 7600 Å. We applied a time-dependent correction to the wavelength solution (red), determined from shifts of telluric lines.



A “chromospheric” Rossiter-McLaughlin effect ?

Fig. 5: The UVES spectra of CoRoT-2 allow to monitor the behavior of individual spectral lines or line ensembles during the transit. In this way, we intend to study e.g. the distribution and properties of chromospheric features on CoRoT-2a under the transit path of the planet.

The black curve shows the shift of the Ca H&K lines during the transit, determined by averaging their line centroids. A synthetic Rossiter-McLaughlin curve, assuming a photospheric limb darkening, is shown in red for comparison.
The planetary orbital period of 1.7 days and the transit ephemerides of Alonso et al. 2008, A&A 482 are used for the time axis.