Exobolygók és csillagszerkezet

- öt év után a Lendület-program hatásairól -

Kiss László (MTA CSFK KTM CSI)

MTA X. Földtudományi Osztály előadóülés

Budapest, 2015. február 11.

A Lendület előtt

- 1996: JATE, okleveles fizikus
- 1996-1999: SZTE, PhD hallgató
- 2000-2002: SZTE oktató-kutató
- 2002-…: Univ. Of Sydney

  posztdoktori ösztöndíj: vándorlás a világban

iPad
0:14
49 %
Keresés
Útvonaltervek
Subotica
Kalaallit Nunaat (Greenland)
Ísland (Iceland)
Norwegian Sea
Sverige (Sweden)
Suomi (Finland)
Norge (Norway)
North Sea
Danmark (Denmark)
United Kingdom
Ireland Éire
Polska (Poland)
Беларусь (Belarus)
Deutschland (Germany)
Україна (Ukraine)
Österreich (Austria)
France
Bay of Biscay
România (Romania)
Italia (Italy)
España (Spain)
Portugal
Ελλάς (Greece)
Türkiye (Turkey)
Mediterranean Sea
Россия (Russia)
Казақстан (Kazakhstan)
Монгол Улс (Mongolia)
O'zbekiston (Uzbekistan)
Türkmenistan (Turkmenistan)
中国 (China)
日本 (Japan)
대한민국 (South Korea)
East China Sea
Sea of Okhotsk
North Atlantic Ocean
India
Myanmar (Burma)
South China Sea
Philippine Sea
Việt Nam (Vietnam)
Pilipinas (Philippines)
Bay of Bengal
Arabian Sea
Malaysia
Indonesia
Papua New Guinea
Mali
Niger
Tchad (Chad)
Nigeria
Ghana
South Sudan
Ethiopia
Soomaaliya (Somalia)
Kenya
DR Congo
Tanzania
Angola
Zambia
Moçambique (Mozambique)
Namibia
Zimbabwe
Botswana
Madagasikara (Madagascar)
South Africa
South Atlantic Ocean
Indian Ocean
Brasil (Brazil)
Bolivia
Paraguay
Uruguay
Argentina
Australia
Coral Sea
Tasman Sea
Great Australian Bight
Google
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Takács - Kiss (Uni. Sydney) - Szabó (Uni. Szeged)

Sydney-től Budapestig

- 2009: MTA Lendület Fiatal Kutatói Program
- 2010-2012: tud. igh. + 13 fős csoport
- 2009-2014: kb. 600M Ft
- 2013. május: az MTA levelező tagja

Bolygórendszerek fejlődése más csillagok körül

Kiss László

MTA KTM CSKI, Lendület Fiatal Kutatói Program

Space Agency–European Southern Observatory (ESA-ESO) Working Group Report no. 4, Paris, 2008].
32. G. Torres, J. Andersen, A. Giménez, *Astron. Astrophys. Rev.* **18**, 67 (2010).
33. P. Marigo *et al.*, *Astron. Astrophys.* **482**, 883 (2008).
34. L. Girardi, M. A. T. Groenewegen, E. Hatziminaoglou, L. da Costa, *Astron. Astrophys.* **436**, 895 (2005).
35. A. Miglio *et al.*, *Astron. Astrophys.* **503**, L21 (2009).
36. Kepler is a NASA discovery class mission, which was launched in March 2009 and whose funding is provided by NASA's Science Mission Directorate. The authors thank the entire Kepler team, without whom these results would not be possible. The asteroseismology program of Kepler is being conducted by the Kepler Asteroseismic Science Consortium.

Supporting Online Material
www.sciencemag.org/cgi/content/full/332/6026/213/DC1
Materials and Methods
Figs. S1 to S3
References

16 December 2010; accepted 22 February 2011
10.1126/science.1201827

HD 181068: A Red Giant in a Triply Eclipsing Compact Hierarchical Triple System

A. Derekas,[1,2*] L. L. Kiss,[2,3] T. Borkovits,[4,5] D. Huber,[3] H. Lehmann,[6] J. Southworth,[7] T. R. Bedding,[3] D. Balam,[8] M. Hartmann,[6] M. Hrudkova,[6] M. J. Ireland,[3] J. Kovács,[9] Gy. Mező,[2] A. Moór,[2] E. Niemczura,[10] G. E. Sarty,[11] Gy. M. Szabó,[2] R. Szabó,[2] J. H. Telting,[12] A. Tkachenko,[6] K. Uytterhoeven,[13,14] J. M. Benkő,[2] S. T. Bryson,[15] V. Maestro,[3] A. E. Simon,[2] D. Stello,[3] G. Schaefer,[16] C. Aerts,[17,18] T. A. ten Brummelaar,[16] P. De Cat,[19] H. A. McAlister,[16] C. Maceroni,[20] A. Mérand,[21] M. Still,[15] J. Sturmann,[16] L. Sturmann,[16] N. Turner,[16] P. G. Tuthill,[3] J. Christensen-Dalsgaard,[22] R. L. Gilliland,[23] H. Kjeldsen,[22] E. V. Quintana,[24] P. Tenenbaum,[24] J. D. Twicken[24]

Hierarchical triple systems comprise a close binary and a more distant component. They are important for testing theories of star formation and of stellar evolution in the presence of nearby companions. We obtained 218 days of Kepler photometry of HD 181068 (magnitude of 7.1), supplemented by ground-based spectroscopy and interferometry, which show it to be a hierarchical triple with two types of mutual eclipses. The primary is a red giant that is in a 45-day orbit with a pair of red dwarfs in a close 0.9-day orbit. The red giant shows evidence for tidally induced oscillations that are driven by the orbital motion of the close pair. HD 181068 is an ideal target for studies of dynamical evolution and testing tidal friction theories in hierarchical triple systems.

The Kepler space mission is designed to observe continuously more than 10^5 stars, with the ultimate goal of detecting a sizable sample of Earth-like planets around main-sequence stars (*1*). We obtained 218 days of Kepler nesses, so that when the BC pair is in front of A, their mutual eclipses do not change the total amount of light coming from the system (in accordance with the nearly equal depths of the two deep minima). When the BC pair is in front of A, the over, almost all flares appear right after the shallower minimum of the BC pair, suggesting that this activity might be related to the close pair.

We looked for optically resolved companion(s) with a 1-m telescope [section 1.1 of (*6*)] but found none. We also obtained 38 high-resolution optical spectra to measure the orbital reflex motion of the A component (*6*) (fig. S1). The orbital parameters for the wider system (Table 1) reveal that star A revolves on a circular orbit, which has an orbital period twice the separation of the two consecutive flat-bottomed minima in the light curve (*6*). Long-baseline interferometry using the PAVO (Precision Astronomical Visible Observations) beam combiner (*8*) at the CHARA [Center for High Angular Resolution Astronomy (*9*)] Array show that the angular diameter of HD

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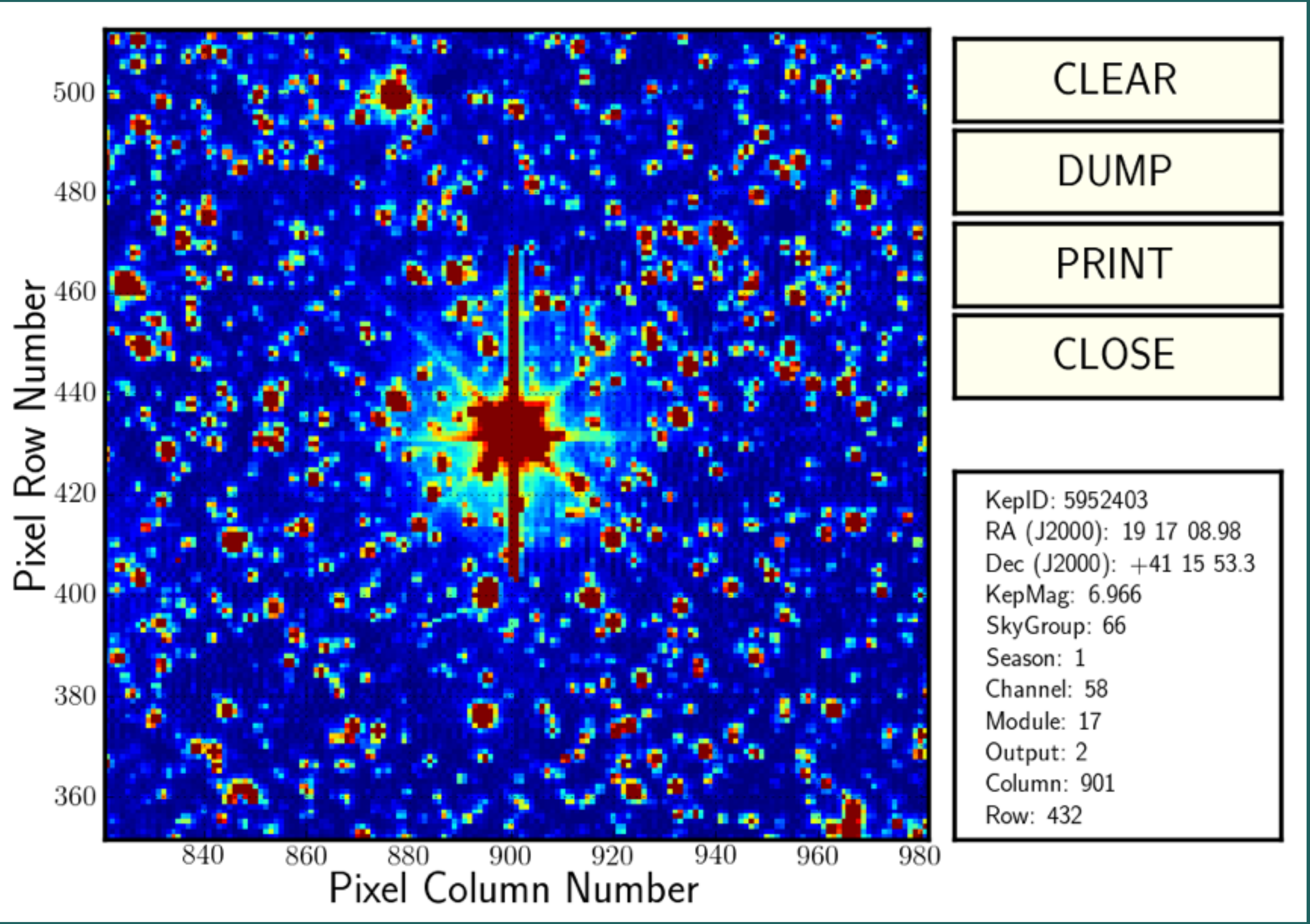
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KepID: 5952403
RA (J2000): 19 17 08.98
Dec (J2000): +41 15 53.3
KepMag: 6.966
SkyGroup: 66
Season: 1
Channel: 58
Module: 17
Output: 2
Column: 901
Row: 432
Pixel Row Number
Pixel Column Number
500
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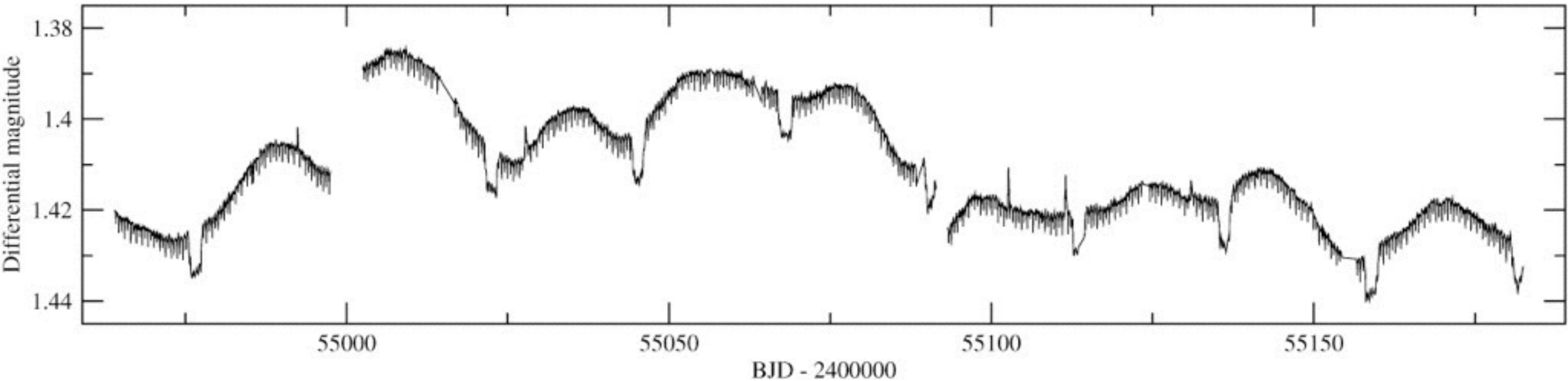
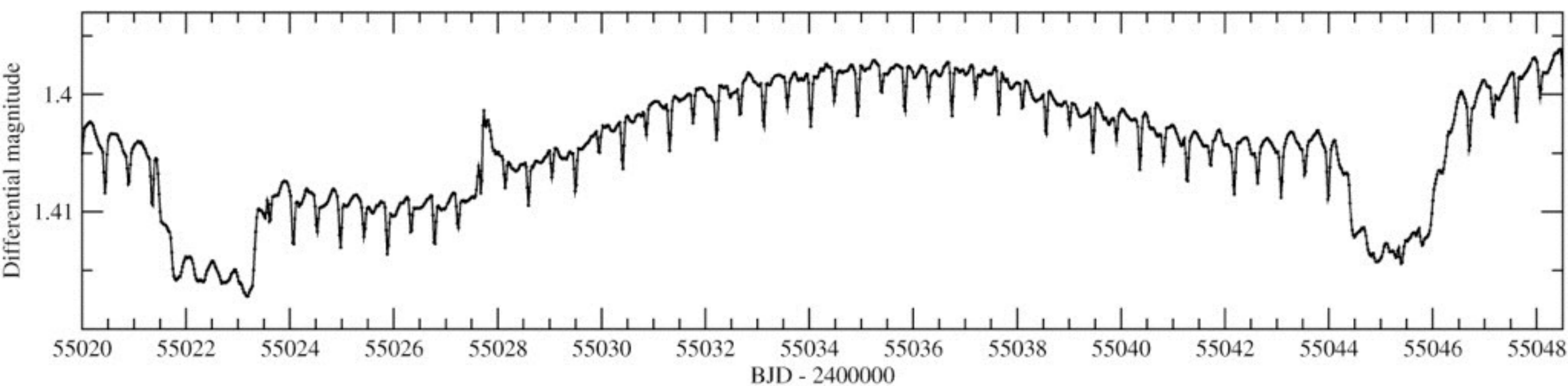
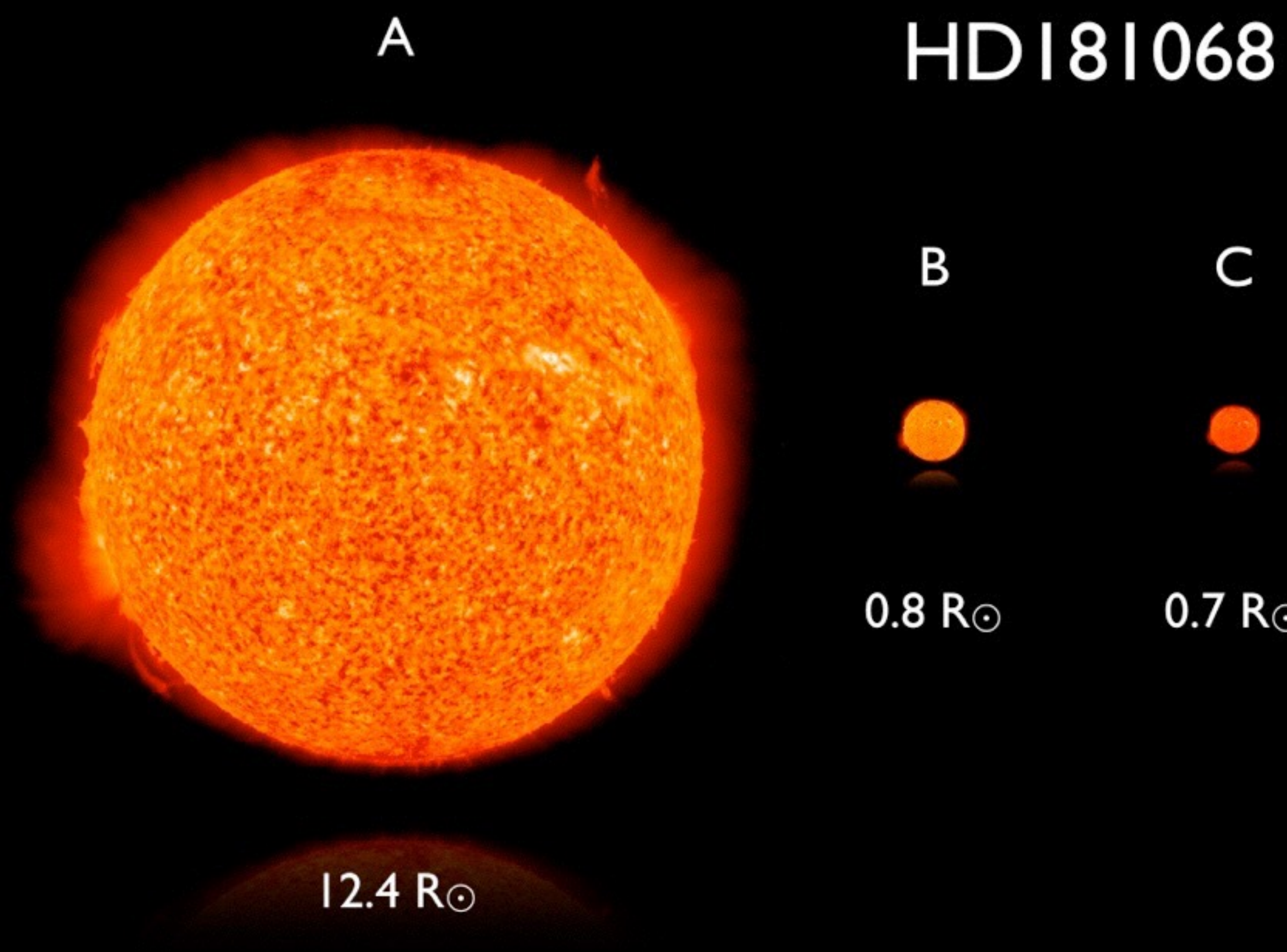
Trinity - triplán fedő hármascsillag

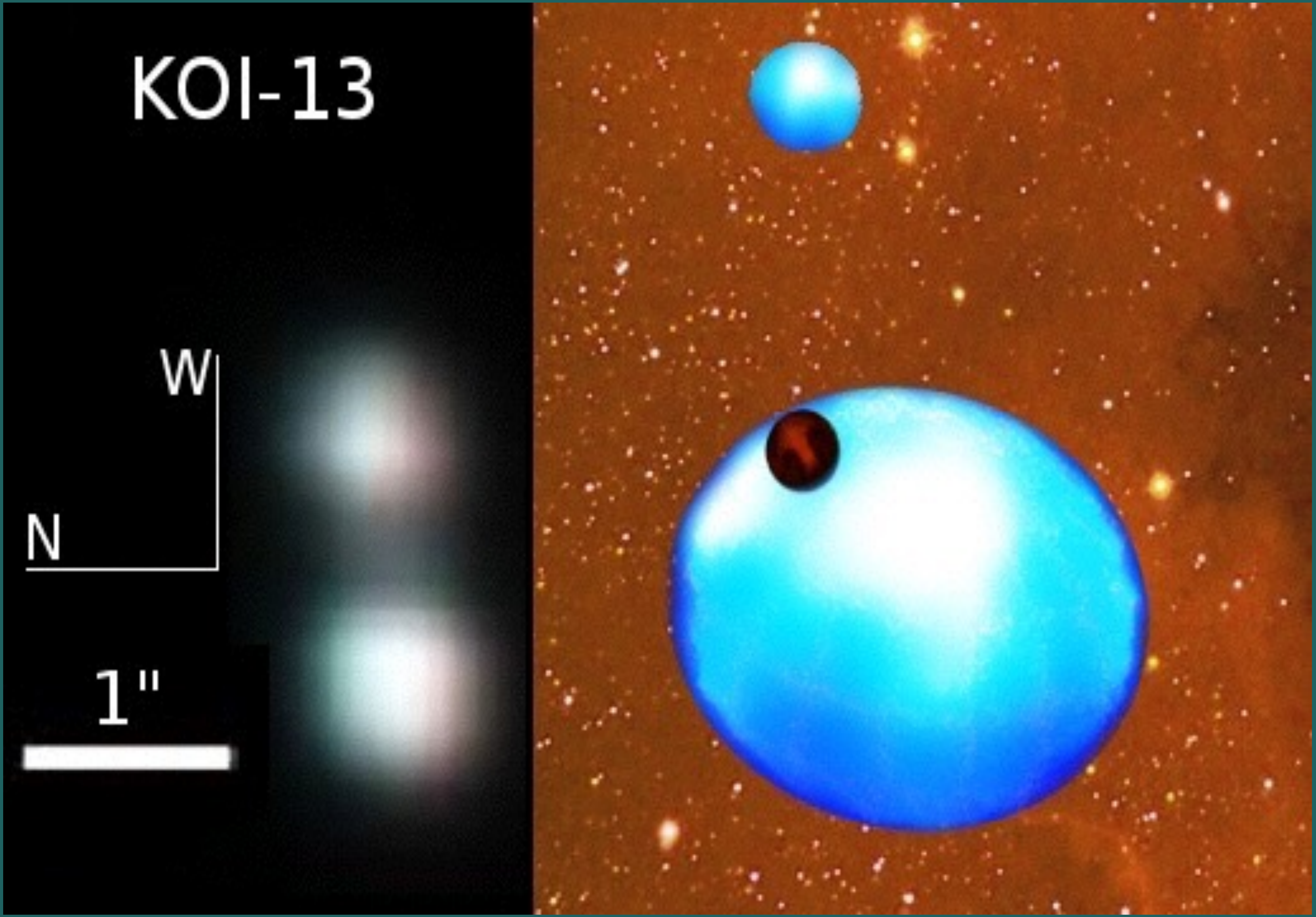


P(A-BC) ~ 45.52 nap

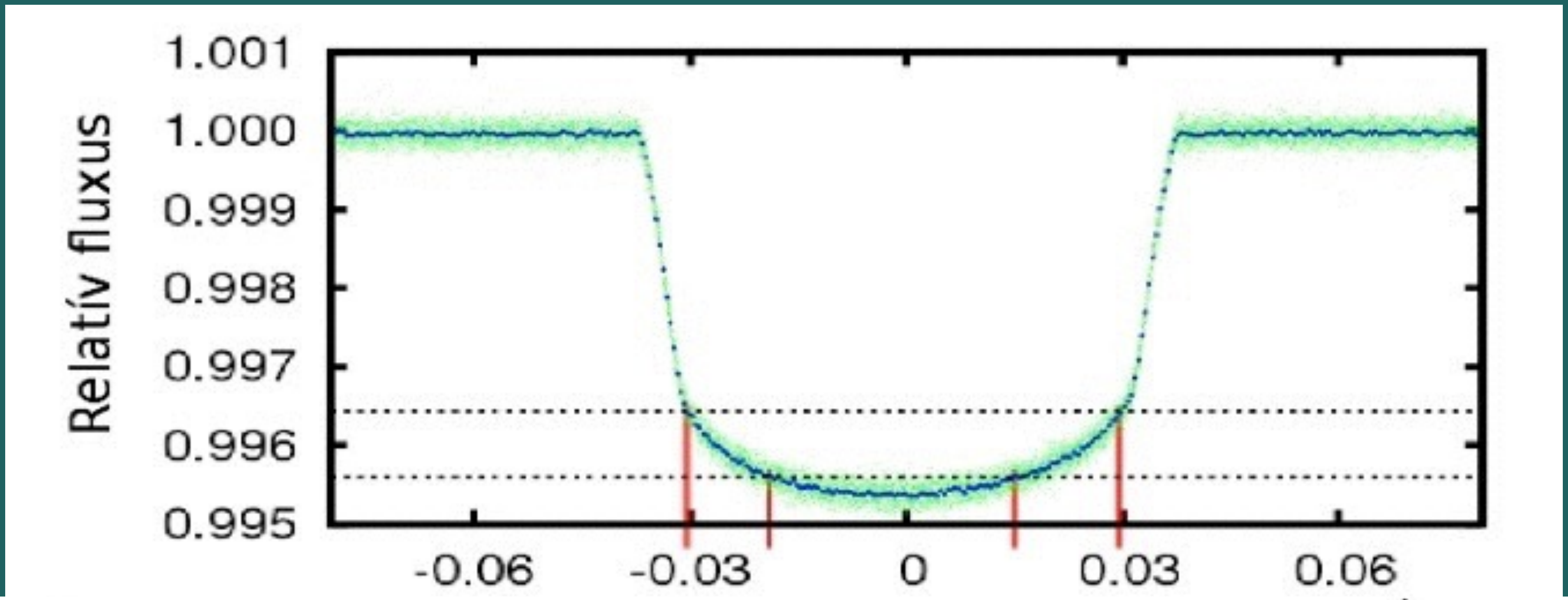


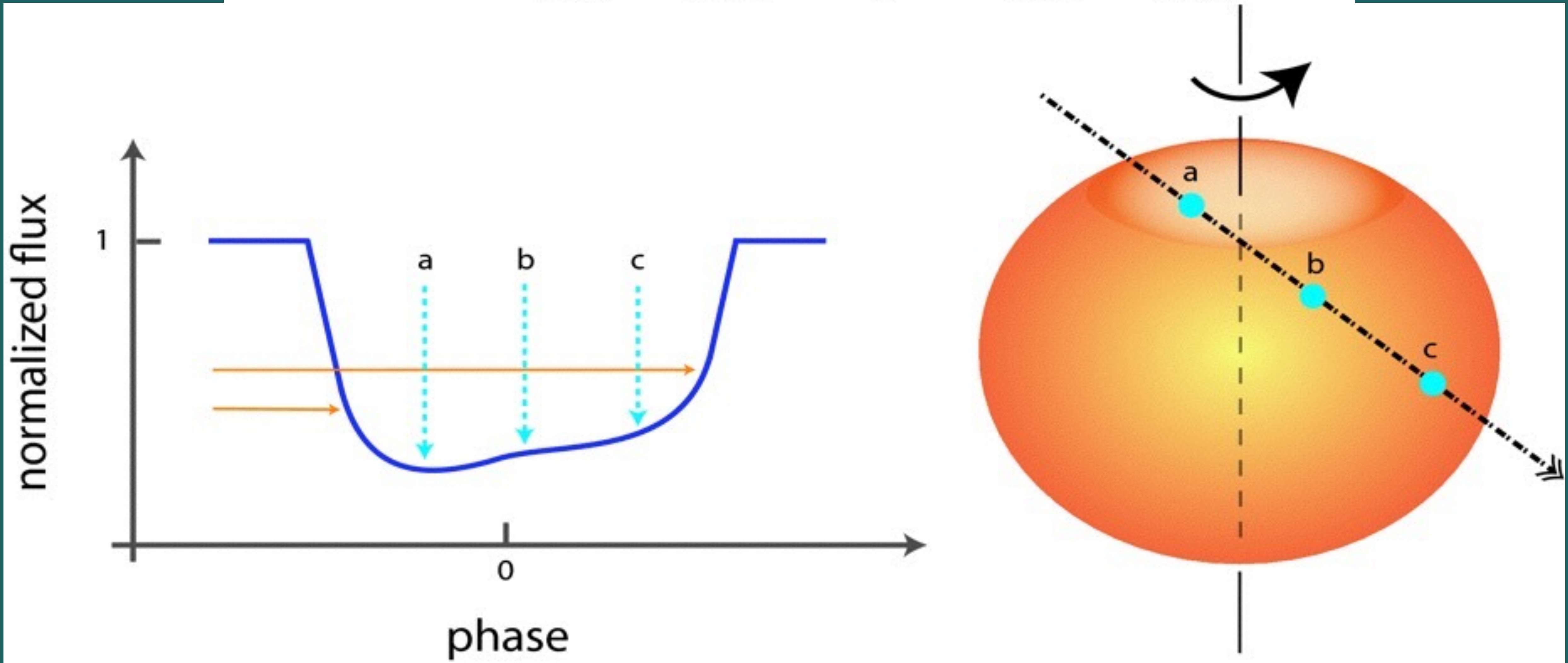
P(B-C) ~ 0.906 nap


HD181068
A
B
C
12.4 R⊙
0.8 R⊙
0.7 R⊙


KOI-13
W
N
1"

Pályadőltség detektálása pusztán fényességmérésből (Szabó et al. 2011, 2012, 2014)






CHEOPS
CHaracterizing ExOPlanet Satellite
esa
100% vapor

y

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Mission Status & Summary

Mission Status

CHEOPS has been proposed as an S-class mission in response to the call for Proposals issued by ESA in March 2012.

On 19 October 2012 it was selected for study for the first S-class mission.

On 19 February 2014 CHEOPS was adopted by SPC.

Mission Summary:

The following table summarizes the mission.

Name	CHEOPS, CHaracterizing ExOPlanet Satellite
Primary Goal	Characterize transiting exoplanets on known bright and nearby host stars
Targets	Known exoplanet host stars with a V-magnitude < 12.5 (goal: 13) anywhere on the sky
Wavelength	Visible range : 400 to 1100 nm
Telescope	33 cm reflective an-axis telescope
Orbit	Sun-synchronous Low Earth Orbit, LTAN 6am, altitude 620-800 km
Lifetime	3.5 years
Type	S-class mission

(last update Feb 2014)

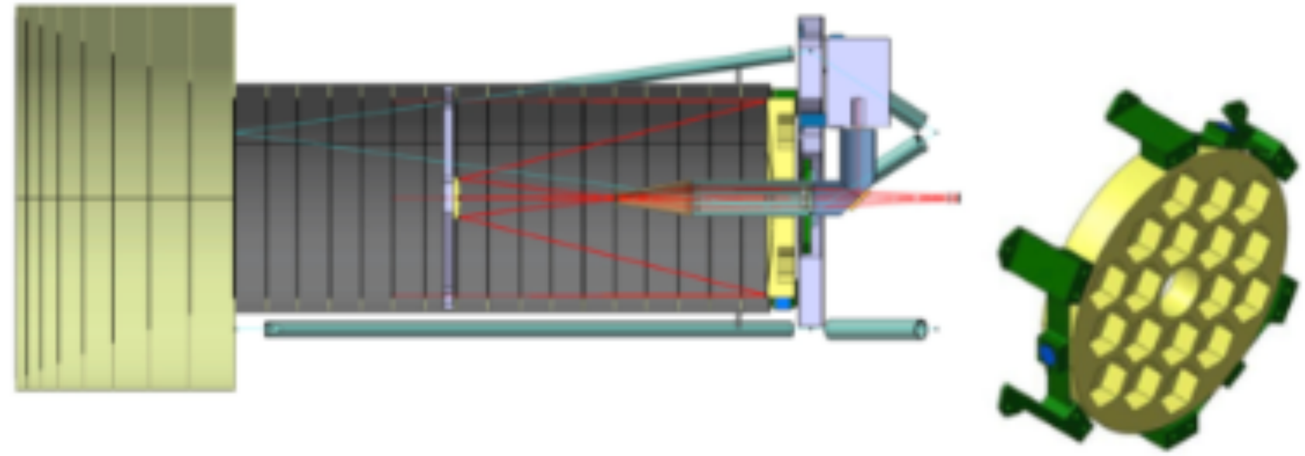


Fig. 2: Initial mechanical concept for the telescope and the lightweighted primary mirror

	Mass (kg, No Margin)	Mass (kg, incl.20% Margin)
Telescope Structure	14.6	17.5
Optical Bench	2.5	3.0
Focal Plane Assembly	2.0	2.4
Lens Assembly	2.0	2.4
Readout Electronics	5.0	6.0
Electronics Box (PCM, DPM, TCM)	5.6	6.7
Radiator	1.0	1.2
Outer Baffle Assembly	11.0	13.2
Total	46.1	55.3
Gyro Assembly	4.5	5.4
Star Tracker Assembly	1.1	1.3
Total (incl. PRS components)	48.3	58.0

Table 1: Current payload mass breakdown

Board Members:

Country	Institute	Name
A	Institut für Weltraumforschung, Graz	Baumjohann Wolfgang
A	Institut für Weltraumforschung, Graz	Steller Manfred
B	University of Liège	Gillon Michaël
B	Centre Spatial de Liège	Renotte Etienne
CH	Universität Bern	Benz Willy
CH	Universität Bern	Thomas Nicolas
CH	Observatory of the University of Geneva	Udry Stéphane
F	Laboratoire d'astrophysique de Marseille	Deleuil Magali
F	Institut d'astrophysique de Paris	Lecavelier des Etangs Alain
GER	DLR Institute of Planetary Research	Spohn Tilman
HU	Admatis	Barczy Tamas
HU	Konkoly Observatory	Kiss Laszlo
I	Università di Padova	Piotto Giampaolo
I	Osservatorio Astronomico di Padova - INAF	Ragazzoni Roberto
P	Deimos	Gutierrez Antonio
P	Centro de Astrofisica da Universidade do Porto	Santos Nuno C.
S	Onsala Space Observatory, Chalmers Univ. of Technology	Liseau René
S	Stockholm University, Stockholm	Olofsson Göran
UK	University of Warwick	Pollacco Don

Konkoly CHEOPS PECS 2014/2015

- Cím: Feasibility studies for the CHEOPS ESA S-Mission
- Szerződés tartama: 2014 május 1.-2015. augusztus 31.
- Teljes költségvetés: 49,746€

Konkoly CHEOPS PECS 2014/2015

- Fő tudományos cél: a CHEOPS mérési stratégiájának optimalizálása az exoholdak detektálására

TESLA

Transiting **E**xomoon **S**imu**LA**tor

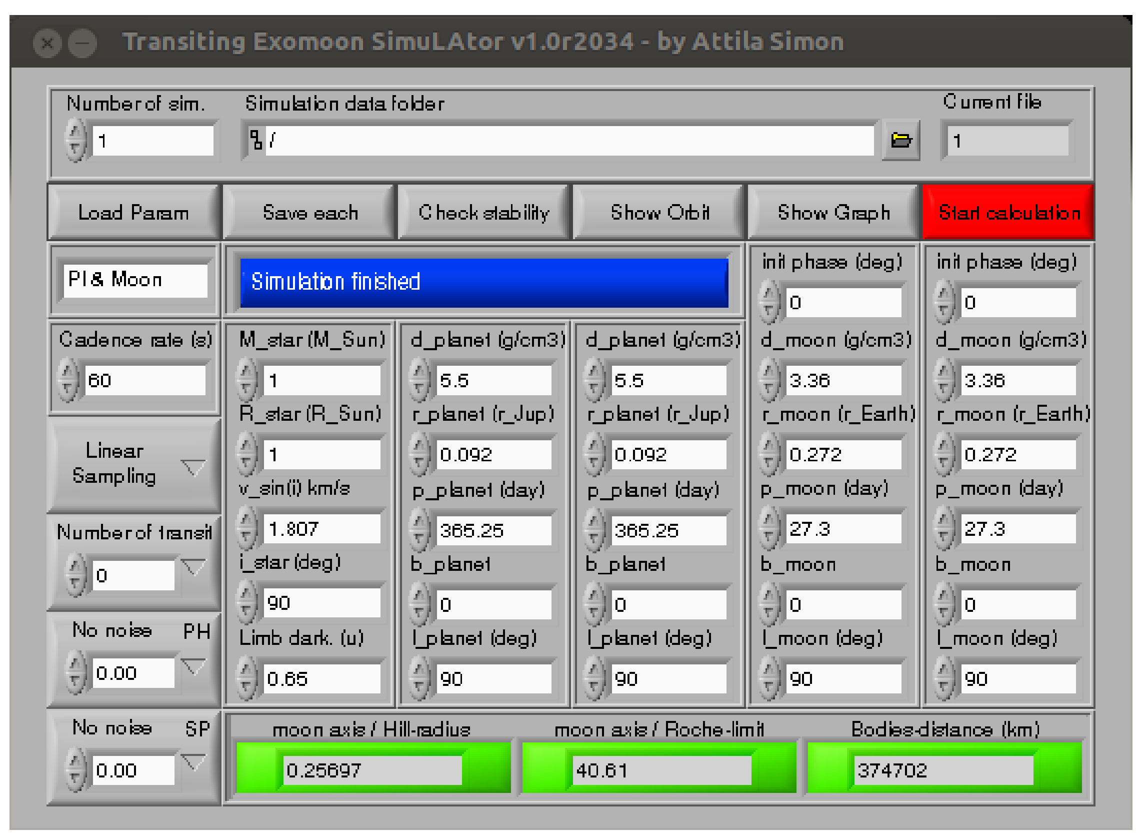
Authors: Attila Simon, PhD

Research Fellow, MTA KTM CSKI

SciEx Fellow, Univerity of Bern

László L. Kiss, PhD, DSc, MAE

Scientific Advisor, MTA KTM CSKI



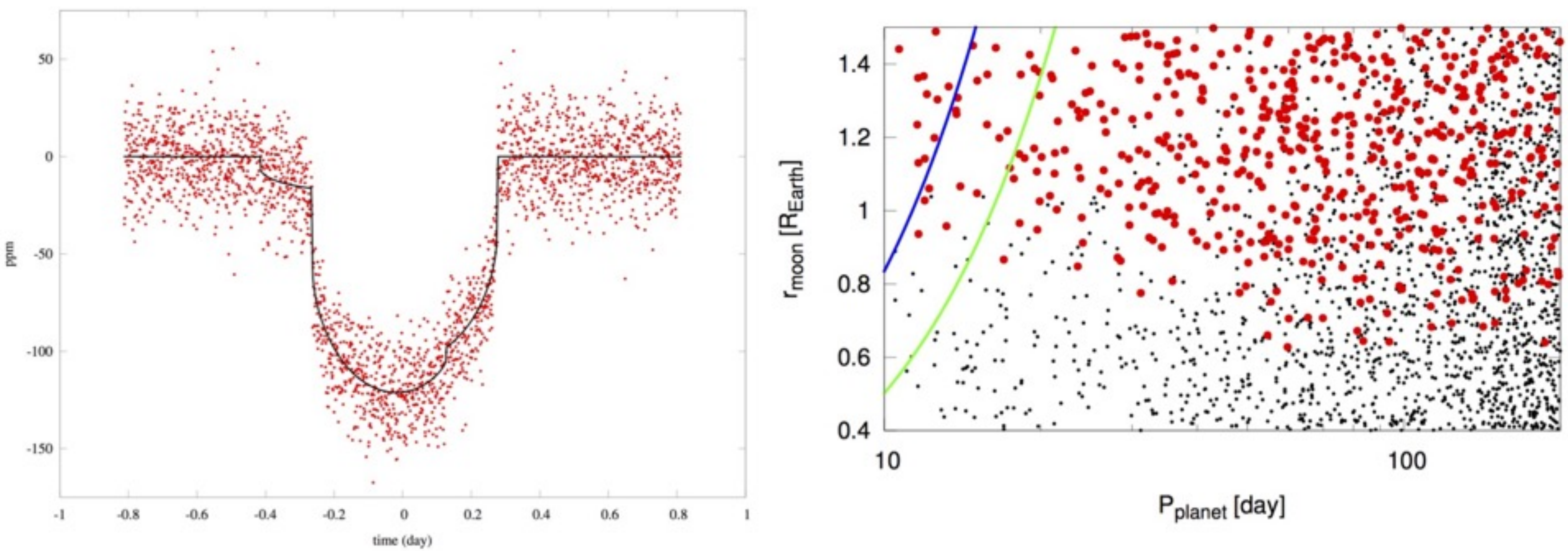


Figure 17 | ***Left panel*****—** *Transit of an Earth-size exoplanet plus a 0.4×smaller moon is simulated when the photometric precision is set to ~20 ppm (the solid curve shows the underlying theoretical model).* ***Right panel*****—** *Planet + moon systems have been generated with random planet periods and moon sizes (black dots). The blue and green curves show the 1- and 4.6-Gyr stability limits, respectively, of these systems (stable systems are on the right of the lines). The red dots are those systems for which the moon could be detected assuming* **CHEOPS** *observes five planetary transits.*

(Excerpt from the CHEOPS Red Book)

Folyamatban lévő munkák

Astronomy & Astrophysics manuscript no. transits
June 23, 2014

Observable transits of planets in the Solar System between 2015-2020

Gy. M. Szabó[1,2], A. E. Simon[2,3], Á. Dózsa[1], B. Csák[1], J. Kovács[1], L. L. Kiss[2,4]

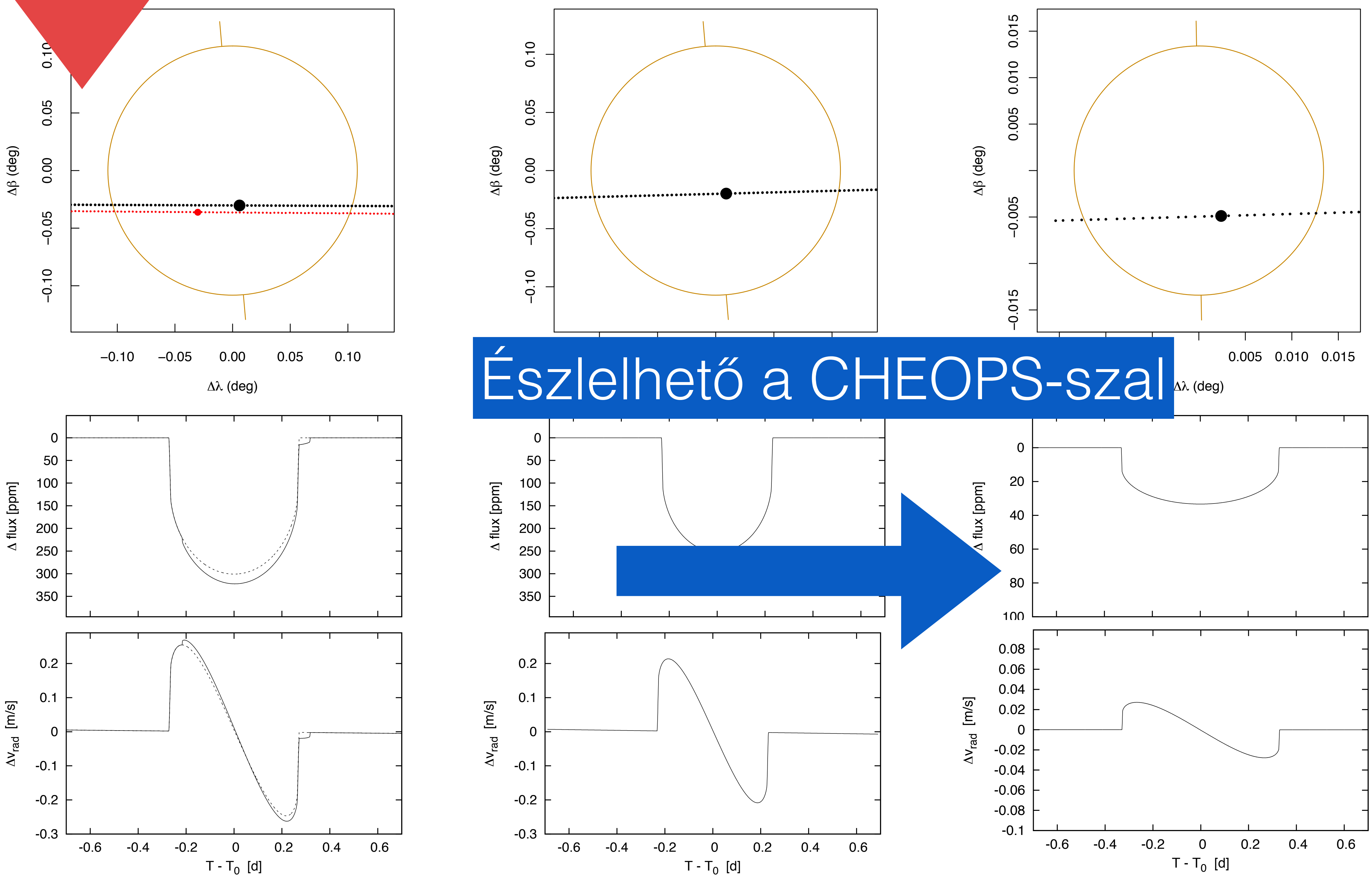
[1] ELTE Gothard Astrophysical Observatory, H-9704 Szombathely, Szent Imre herceg útja 112, Hungary
[2] Konkoly Observatory, MTA Research Centre for Astronomy and Earth Sciences, 1121 Budapest, Konkoly Th.M. út 15-17, Hungary
[3] Physikalisches Institut, Center for Space and Habitability, University of Berne, CH-3012 Bern, Sidlerstrasse 5
[4] Sydney Institute for Astronomy, School of Physics, University of Sydney, NSW 2006, Australia

ABSTRACT

Context. Solar System planets and moons can sometimes act as "a poor man's exo-Earth" or even exomoons when their transit in front of the Sun can be observed in the reflected light from a bright third body. These special geometric conditions can help testing the most sensitive instruments used in the quest for the smallest extrasolar bodies.
Aims. We compile a list of transits of Solar System planets that can be seen from various third bodies including the outer planets and the brightest asteroids. Acting as a kind of a mirror, these third bodies allow the detection of changes in solar irradiance and spectrum during the transit events. Observations of these events present a great opportunity to test the real limits of the currently existing astronomical instrumentation, the capability of detecting Earth-sized bodies around Sun-like stars and the transit distortions for objects that resemble the Earth-Moon system.
Methods. The NASA JPL Horizons ephemeris generator was used to calculate ephemerides of inner Solar System objects observed from outer ones. Observers were placed at all planets and the brightest asteroids, and we searched for possible transits of all planets orbiting inner orbits than the observer.
Results. We identified 3 major events between 2015-2020. One of them is a transit of the Earth-Moon system in 2015, reflected by asteroid Massalia, thus offering the opportunity to detect our Moon as if it were the first exomoon detection. In 2017, Vesta will reflect a transit of Venus. During the expected lifetime of the CHEOPS mission, a transit of Mars will be observed from Uranus, thus photometry of Uranus in those days will be an ideal test of CHEOPS's performance, and the accuracy of planet models. All reflecting bodies will be near the opposition point, offering excellent conditions for ground-based or near-Earth space observations.

Észlelhető a MOST-tal

Transit of	From	Date	Ingress (UT)	Egress (UT)	R	Δ	Θ/Θ_{Sun}	β	λ
Ear	Massalia	2015 Apr 20	03:37	16:10	2.463	1.460	1.54%	0.140	5.2
Mo	Massalia	2015 Apr 20	04:57	17:30	2.463	1.460	0.42%	0.168	5.4
Ven	Vesta	2017 Feb 16	10:58	19:55	2.484	1.765	1.41%	0.093	6.3
Mar	Uranus	2018 Dec 13/14	14:47	03:09	19.864	18.431	0.52%	0.187	3.0



Astronomy & Astrophysics manuscript no. bisector
November 20, 2014

Bisector analysis of transit light curves:

A model-independent diagnostic for asymmetric distortions

A. E. Simon[1,2,3], G. Hodosán[4,5], Gy. M. Szabó[2,3], D. Swoboda[1], Y. Alibert[1], L. L. Kiss[2,3,6]

[1] Physikalisches Institut, Center for Space and Habitability, University of Berne, CH-3012 Bern, Sidlerstrasse 5,
[2] Research Centre for Astronomy and Earth Sciences, Hungarian Academy of Sciences, Konkoly-Thege Miklós út 15-17, H-1121 Budapest, Hungary
[3] Gothard Astrophysical Observatory and Multidisciplinary Research Center of Loránd Eötvös University, H-9700 Szombathely, Szent Imre herceg u. 112., Hungary
[4] SUPA, School of Physics and Astronomy, University of St Andrews, St Andrews, KY16 9SS, United Kingdom
[5] Eötvös Loránd University, Pázmány Péter sétány 1/A, H-1117 Budapest, Hungary
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Received —-; accepted —-

ABSTRACT

Context. Transit light curves of exoplanets can be distorted by various astrophysical phenomena, such as stellar rotation, extended starspots, or even exomoons. The extent and time-variability of the light curve anomalies are good indicators of the physical causes.
Aims. In this paper we introduce a new method with which we are able to detect and characterize distortions of the transit light curves. We apply this technique to selected Kepler planets and candidates to determine their transit anomalies and identify the origin of light curve asymmetry in some cases. We also discuss briefly the detectability of such anomalies by the forthcoming CHEOPS space telescope
Methods. We calculated the averaged line bisector of the transit light curves determining the bisector points with increasing flux levels from the core to the top of the transit. To decide if the shape of the bisector is caused only by statistical uncertainties we perform detailed bootstrap analysis in each case.
Results. We have analyzed 99 planet candidates from the second Kepler data release (Batalha et al. 2013), predominantly hot Jupiters with a mean orbital period of 5.64 days. 15 of the studied systems have been found to show noticeable shape asymmetry. The most remarkable cases include Kepler-13Ab, Kepler-63, HAT-P-7, KOI-75, KOI-319, KOI-368. For Kepler-63, we also found time-variability in the bisector shape, with a period of 37.16 days. This may arise from evolution of a spot-crossing events, although other possibilities cannot be excluded either.
Conclusions. The presented bisector analysis is a model-independent technique for a fast identification of anomalous transit light curves. Detailed modelling can then be used to decipher the actual astrophysical phenomena.

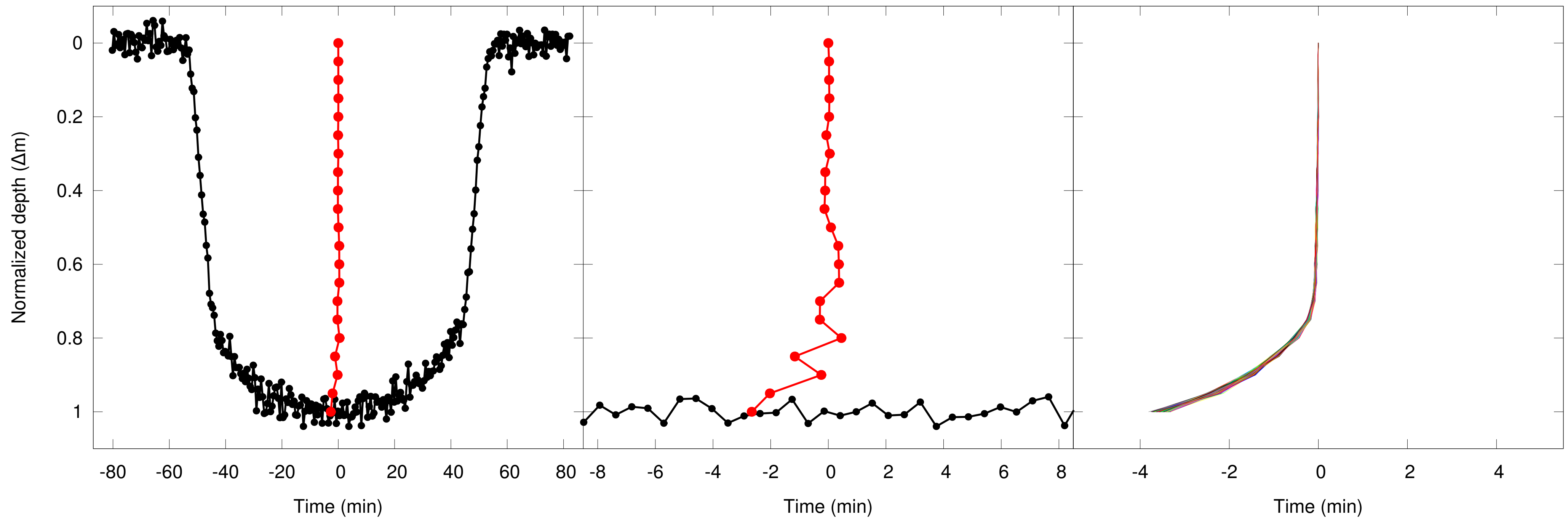

Fig. 1. The light curve and line bisector of Kepler-13Ab. In the left panel we show an individual transit and its line bisector. In the middle panel we show a zoom to the profile to better display the asymmetry of an individual line bisector. In the right panel the averaged line bisector (thick black line) of Kepler-13Ab and the bisectors (thin color lines) of the bootstrapped light curve.

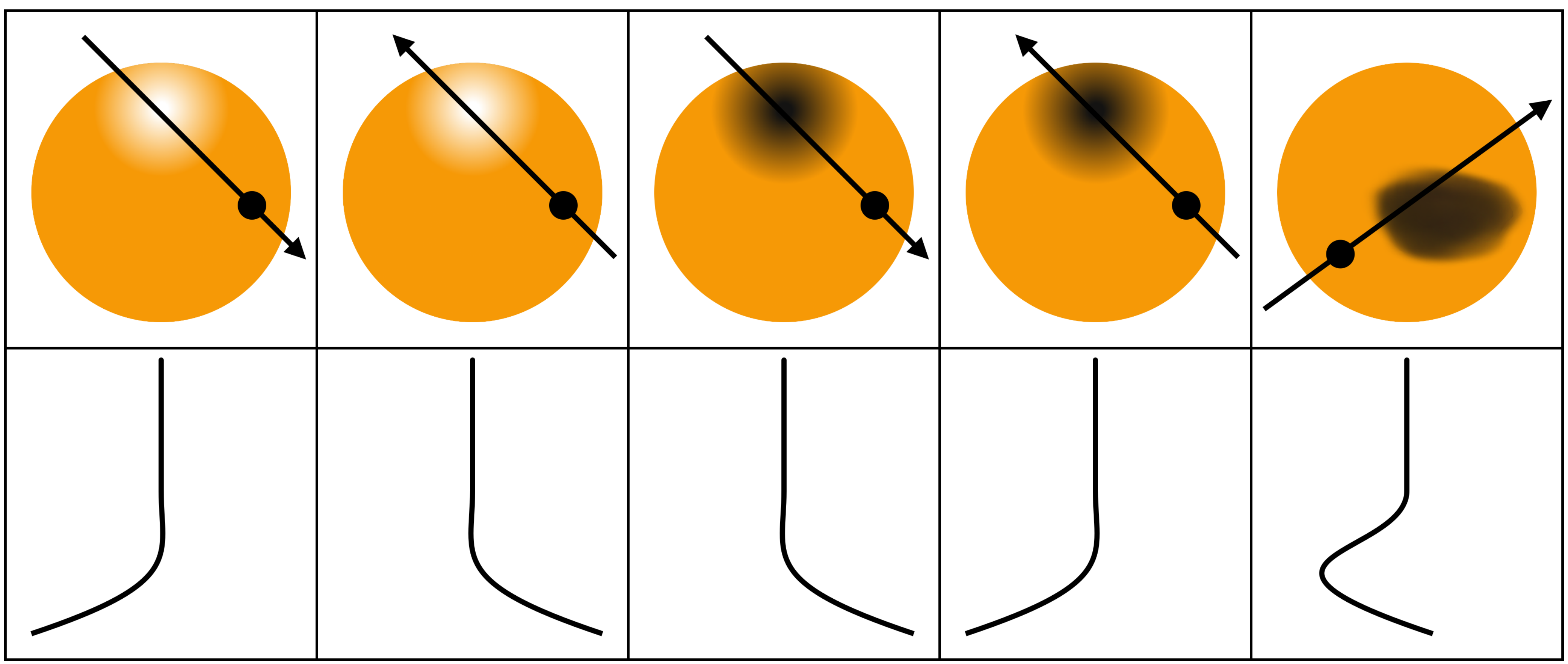

Fig. 2. Schematic representation of the various cases of orbital orientation and stellar surface brightness distribution (top row) and the corresponding line bisectors (bottom row).

Astronomy & Astrophysics manuscript no. cheops_exomoon
November 21, 2014

CHEOPS performance for exomoons

The detectability of exomoons by using optimal decision algorithm

A. E. Simon[1,2,3], Gy. M. Szabó[2,3], A. Fortier[1], L. L. Kiss[2,4], W. Benz[1]

[1] Physikalisches Institut, Center for Space and Habitability, University of Berne, CH-3012 Bern, Sidlerstrasse 5,
[2] Konkoly Observatory, Research Centre for Astronomy and Earth Sciences, Hungarian Academy of Sciences, H-1121 Budapest, Konkoly Thege. Miklós. út 15-17.
[3] Gothard Astrophysical Observatory and Multidisciplinary Research Center of Loránd Eötvös University, H-9700 Szombathely, Szent Imre herceg u. 112.
[4] Sydney Institute for Astronomy, School of Physics, University of Sydney, NSW 2006, Australia

Received Month Day, —-; accepted Month Day, —-

ABSTRACT

Context. Many attempts has already been made for detecting exomoons around transiting exoplanet but the first confirmed discovery is still pending. The even more precise instruments, the new space telescopes and the newly developed techniques provide us new opportunities and get even closer the first successful discovery.
Aims. In this paper we focus on the forthcoming *CHaraterising ExOPlanet Satellite (CHEOPS)*, calculate the possibility of an exomoon detection for different planet-moon configuration, explore the most efficient way for such a observation and last but not least estimate the cost of observing time.
Methods. Our study based on calculating variations of the central time of the transit, especially computing PTVs (photocentric transit timing variation, Szabó et al, 2006) in simulated CHEOPS data. We analyzed transit observation sets for different star-planet-moon scenarios and performed bootstrapping analysis to determine their detection statistics.
Results. The simulations with CHEOPS-quality data showed that the detection limit is about Earth-sized moon with 80% probability if the planet larger than the Neptune. For such a detection at least one period of the PTV and minimum 5-6 transit observation is needed. We have also non-zero chance in the case of smaller moon, but the detection statistics worsens rapidly.
Conclusions. After the CoRoT and Kepler spacecraft CHEOPS will be the next generation space telescope that will observe exoplanetary transits. Although its mirror's diameter is 1/3 of the Kepler's one it will have more precise CCD and larger sampling rate, therefore the detection limit for an exomoon can be the same as or better, which make it competitive in searching for exomoons.

Key words. planetary systems – stars: binaries: eclipsing – techniques: photometric

Lendület tapasztalatok (2014)

- Az MTA (elnökének) kiemelt prioritású projektje...
- ...ennek megfelelően rugalmas ügykezelés (pl. átcsoportosítások)
- Igen pozitív média- és politikai fogadtatás

Lendület tapasztalatok (2014)

Ugyanakkor:

- Az ország hazacsábító ereje rég nem látott mélységekben **(IGAZ)**
- A Lendület-programtól független és azzal összemérhető pályázati pénz megszerzése szinte reménytelennek tűnik (ezért sokan bele se vágnak) **(IGAZ)**
- Hosszú távon fenntarthatatlan a jelenlegi séma finanszírozása (t.i. lenniük kell sikertelen projekteknek is, akik kihullanak 3-5 év után - az eddigi sikerkommunikáció után nehéznek tűnik) **(SIKERÜLT KIDOLGOZNI)**
- Nem látszik még az állandósulás mikéntje **(DE IGEN)**
- 2014-tól új akadémiai elnök: elképzelhető-e, hogy a Lendület-program túléli a vezetőváltást? **(IGEN)**


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