Search for Exoplanets in steLLar streAms (SELLA)

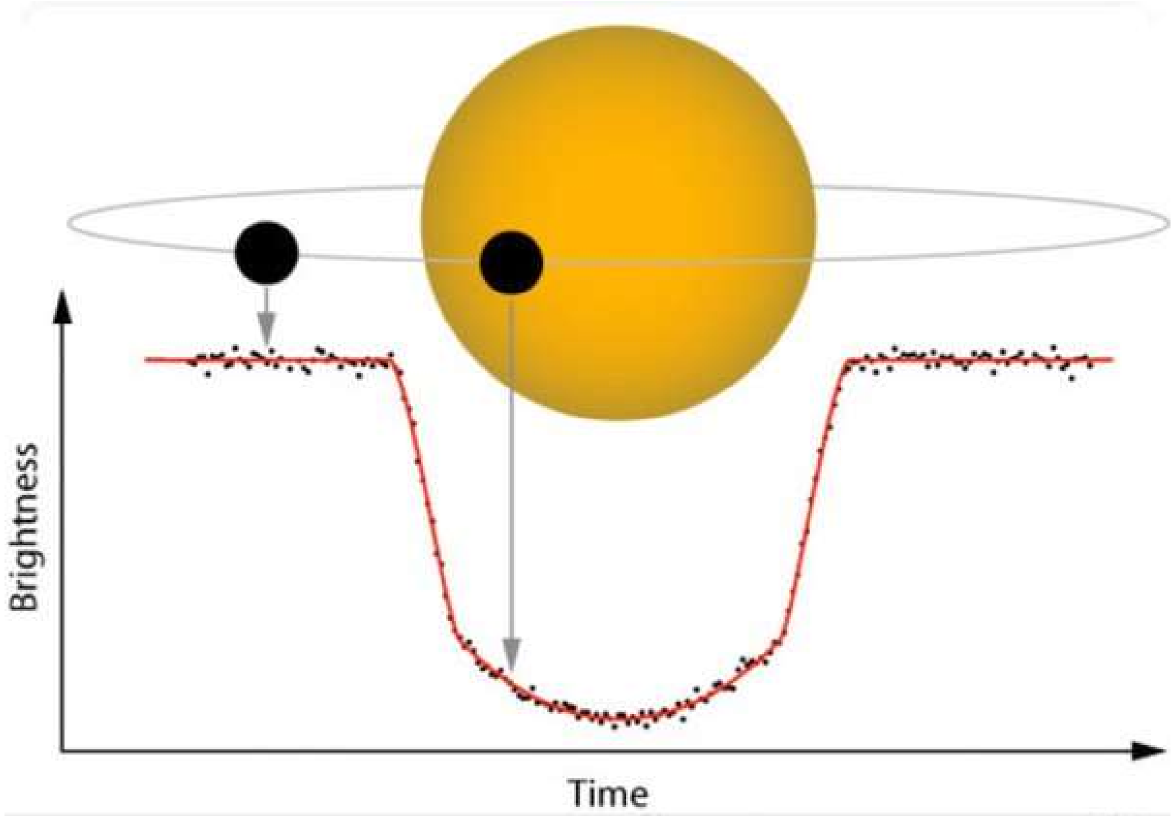
Enrique Díez Alonso, 07/05/2024

ICTEA
Instituto Universitario de Ciencias y Tecnologías Espaciales de Asturias

Universidad de Oviedo

- First exoplanet: 51 Pegasi –b (Mayor & Queloz, 1995), radial velocity method.

- First transiting exoplanet: HD 209458b (Charbonneau, 2000).



Monthly Notices of the ROYAL ASTRONOMICAL SOCIETY
MNRAS 476, L50–L54 (2018) doi:10.1093/mnrasl/sly040
Advance Access publication 2018 March 14

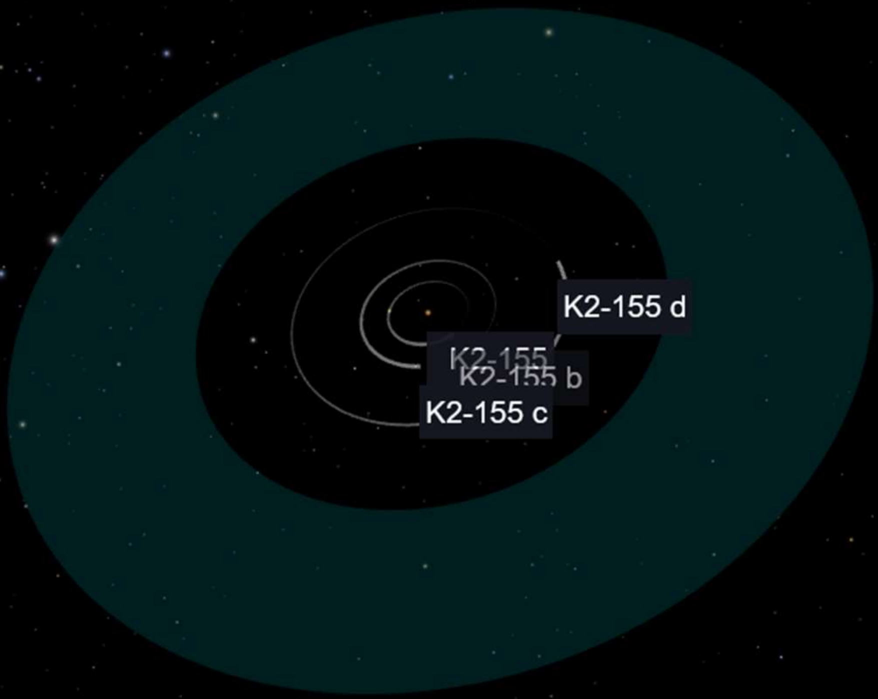
A system of three transiting super-Earths in a cool dwarf star

E. Díez Alonso,[1] S. L. Suárez Gómez,[1★] J. I. González Hernández,[2,3] A. Suárez Mascareño,[4] C. González Gutiérrez,[1] S. Velasco,[2,3] B. Toledo-Padrón,[2,3] E. J. de Cos Juez,[1★] and R. Rebolo[2,3,5]

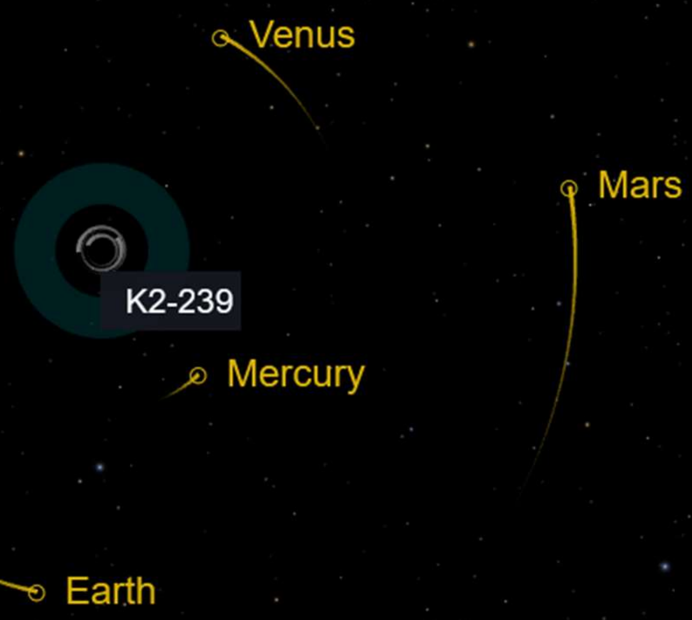
ROYAL ASTRONOMICAL SOCIETY
MNRAS 480, L1–L5 (2018) doi:10.1093/mnrasl/sly10
Advance Access publication 2018 June 06

Two planetary systems with transiting Earth-sized and super-Earth planets orbiting late-type dwarf stars

E. Díez Alonso,[1] J. I. González Hernández,[2,3] S. L. Suárez Gómez,[4] D. S. Aguado,[2] C. González Gutiérrez,[1] A. Suárez Mascareño,[5] A. Cabrera-Lavers,[2,6] J. González-Nuevo,[4] B. Toledo–Padrón,[2,3] J. Gracia,[7] F. J. de Cos Juez[1★] and R. Rebolo[2,3,8]



K2-155



K2-239 / K2-240


Monthly Notices of the ROYAL ASTRONOMICAL SOCIETY
MNRAS 489, 5928–5937 (2019) doi:10.1093/mnras/sty346
Advance Access publication 2018 December 24

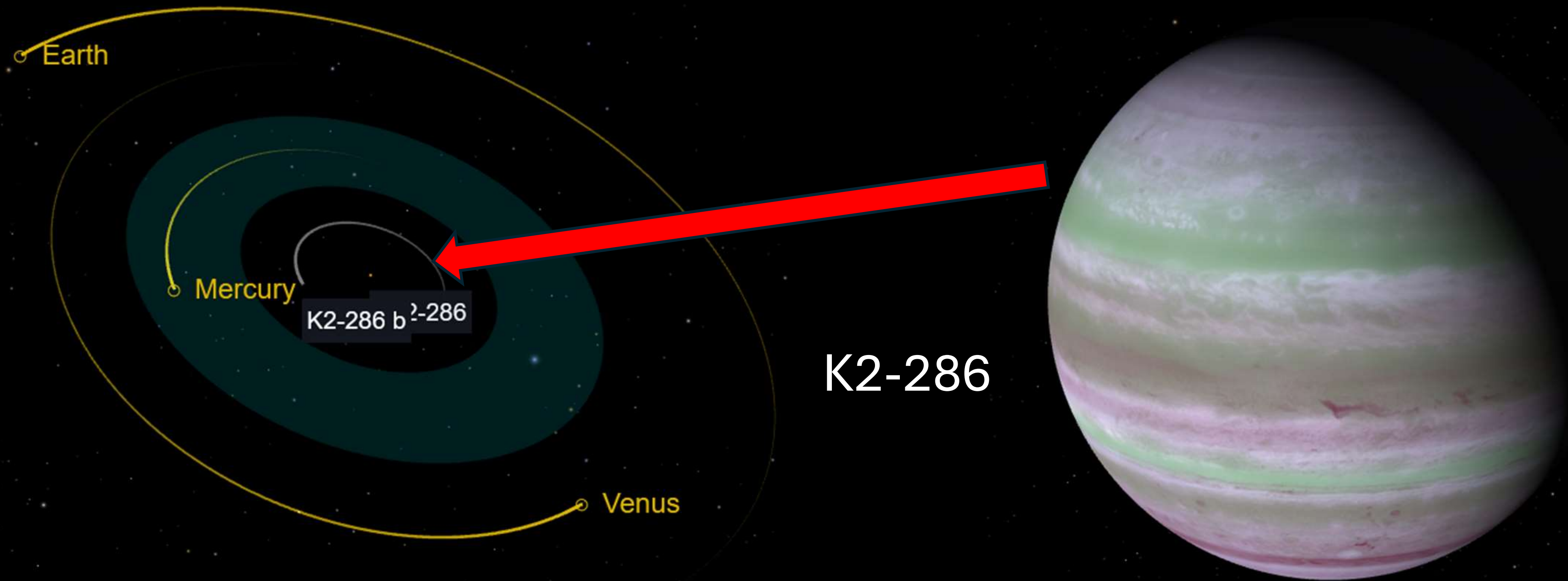
A transiting super-Earth close to the inner edge of the habitable zone of an M0 dwarf star

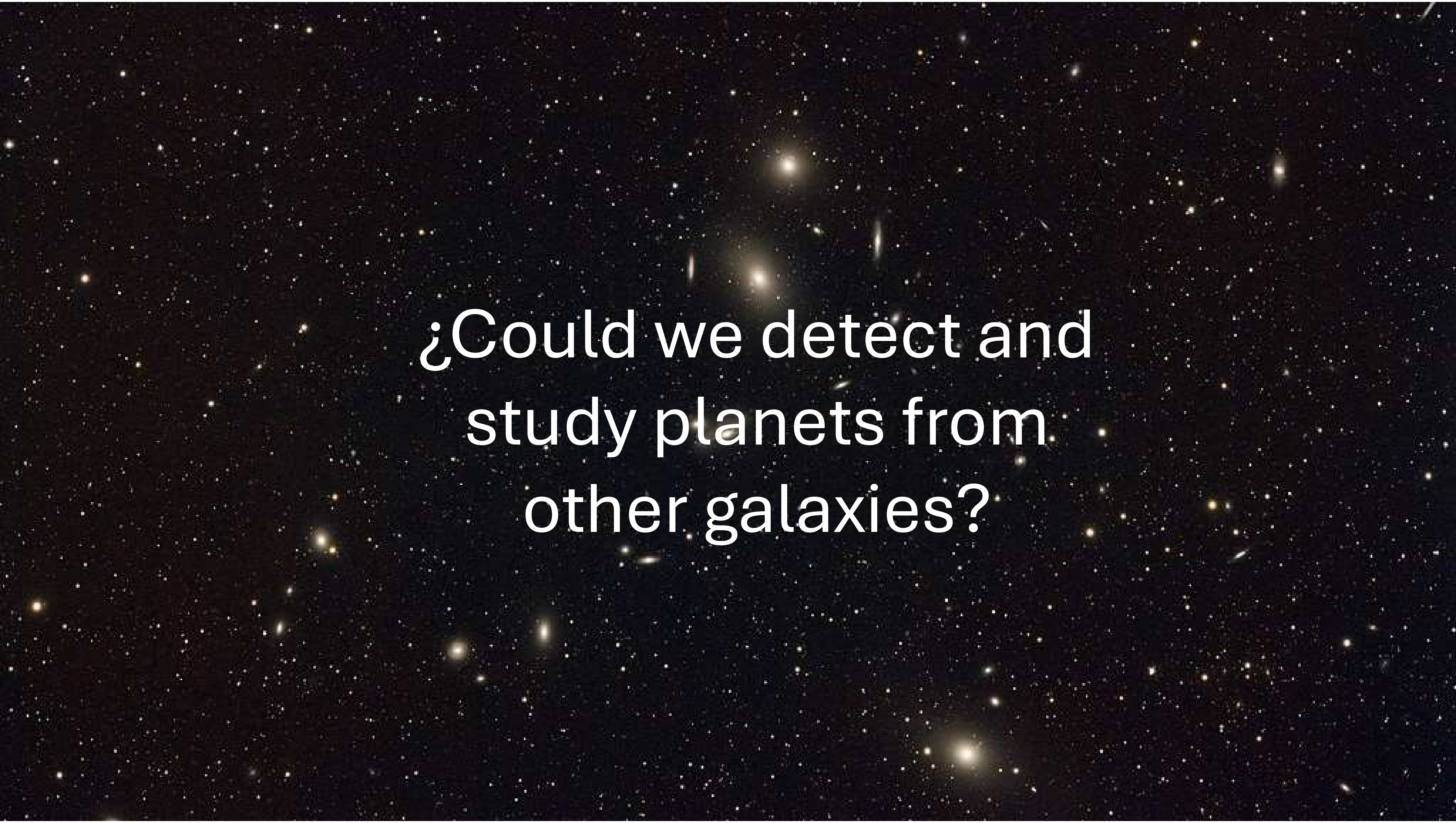
E. Díez Alonso,[1★] J. I. González Hernández,[2,3] B. Toledo-Padrón,[2,3] S. L. Suárez Gómez,[4] A. Suárez Mascareño,[5] D. S. Aguado,[2] C. González Gutiérrez,[1] A. Cabrera-Lavers,[2,6] J. Carballido-Landeira,[4] L. Bonavera,[4] F. J. de Cos Juez,[1★] and R. Rebolo[2,3,7]


Monthly Notices of the ROYAL ASTRONOMICAL SOCIETY
MNRAS 509, 1075–1095 (2022) https://doi.org/10.1093/mnras/stab2669
Advance Access publication 2021 September 22

The K2-OjOS Project: New and revisited planets and candidates in *K2* campaigns 5, 16, & 18

A. Castro-González,[1★] E. Díez Alonso,[1] J. Menéndez Blanco,[1] J. Livingston,[2] J. P. de Leon,[2] J. Lillo-Box,[3] J. Korth,[4] S. Fernández Menéndez,[1] J. M. Recio,[5] F. Izquierdo-Ruiz,[6] A. Coya Lozano,[7] F. García de la Cuesta,[7] N. Gómez Hernández,[7] J. R. Vidal Blanco,[7] R. Hevia Díaz,[7] R. Pardo Silva,[7] S. Pérez Acevedo,[7] J. Polancos Ruiz,[7] P. Padilla Tijerín,[7] D. Vázquez García,[7] S. L. Suárez Gómez,[1] F. García Riesgo,[1] C. González Gutiérrez,[1] L. Bonavera,[1] J. González-Nuevo,[1] C. Rodríguez Pereira,[1] F. Sánchez Lasheras,[1] M. L. Sánchez Rodríguez,[1] R. Muñiz,[1] J. D. Santos Rodríguez[1] and F. J. de Cos Juez[1]




¿Could we detect and
study planets from
other galaxies?

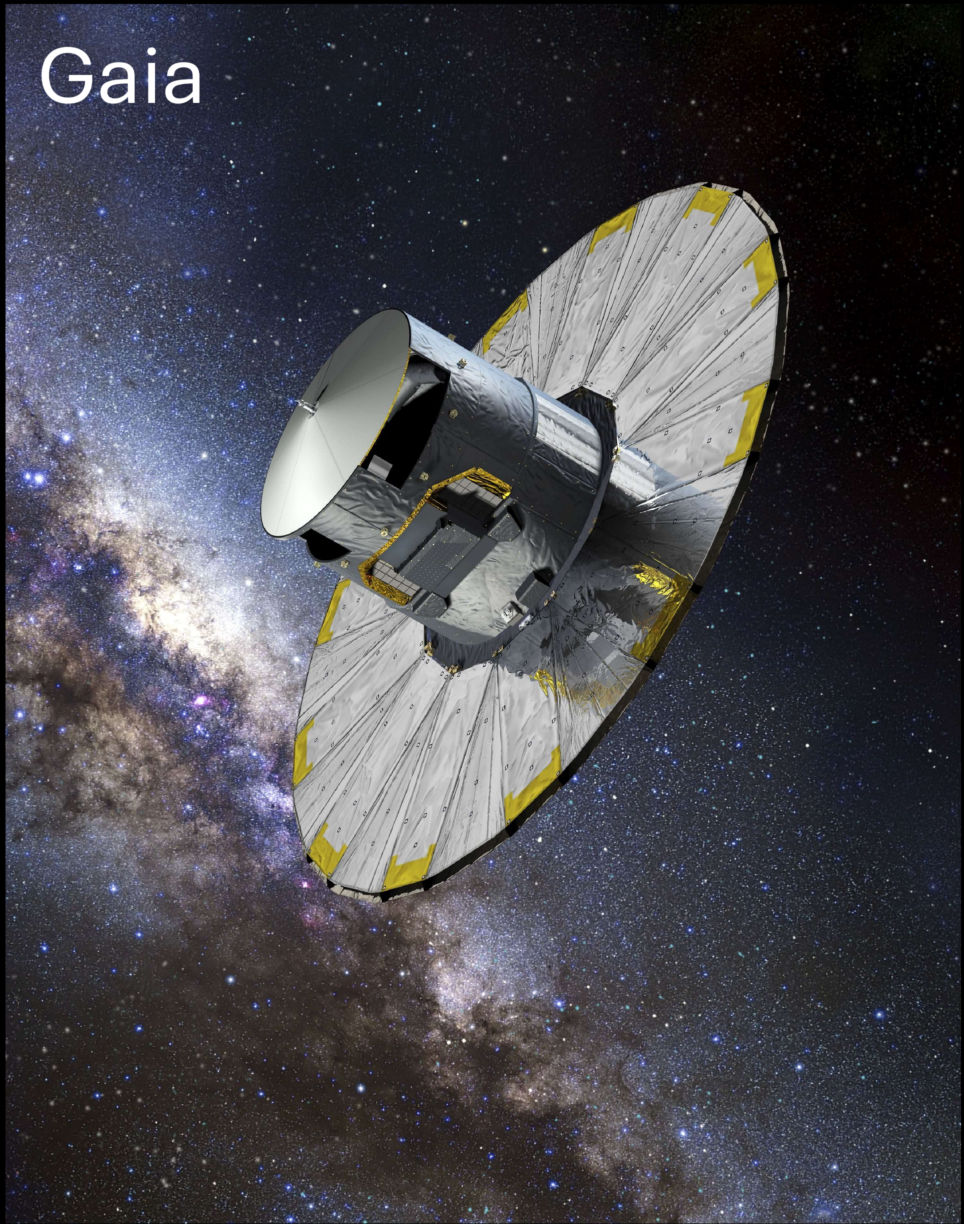
Stellar streams

NGC 5907

SELLA

- In this work we aim to detect and characterize exoplanets orbiting members of *stellar streams*, which are structures in the Galaxy composed of stars with similar dynamic and chemical properties, and with galactic or extragalactic origin.

- With current facilities, the detection of exoplanets in extragalactic stellar streams, resulting from merger events, could be the only way to study in detail exoplanets formed outside the Milky Way. This could help to understand better the impact of the merger events in the planetary systems of these stars, and also to compare their planetary properties and statistics with the ones from the Milky Way.


Gaia


TESS

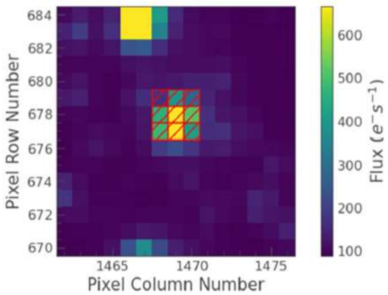
Arcturus stream member selection

- Using TOPCAT [1], which is a tool designed to work with astronomical databases, and *Gaia DR2* [2] data, we searched for stellar members of the *Arcturus stream* based on their kinematics.
- The members of the *Arcturus stream* have a galactic V velocity component at ~ *–100 km/s* [3]. We focus on galactic latitude *(b)* in the ranges $-90^{o} < b < -30^{o}$ and $30^{o} < b < 90^{o}$, in order to discard stars located in crowded fields of the Galactic disk, and with $G_{mag}<14$, as we use *TESS* [4] light curves and its photometric accuracy decreases considerably above this limit.
- After searching for planetary candidates, we also filtered the systems with other common parameters of stellar members of the Arcturus stream; more specifically *[Fe/H], age,* J_r *and* L_z.

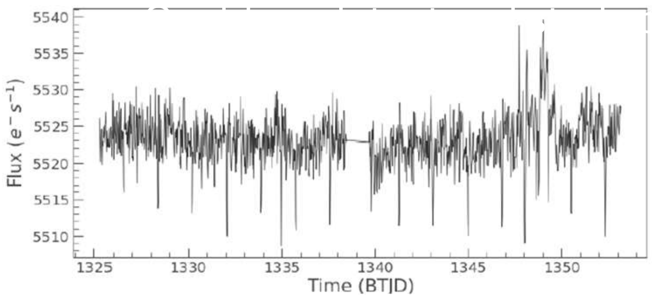
Planetary candidate search

- With *TESScut* [5], we obtained *TESS* sectors where the previously found stars were observed and their light curves from *TESS Full Frame Images (FFI)* with *Lightkurve* [6]. Each *light curve* was analyzed with the *Box Least Squares (BLS)* algorithm [7] in order to detect transit- like signals.

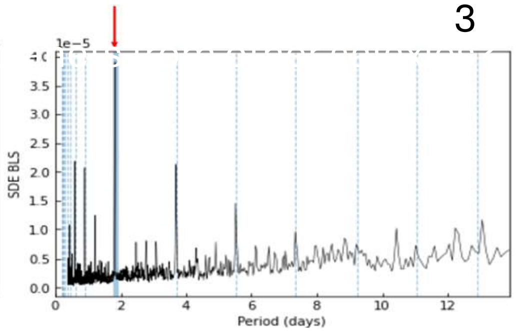
1



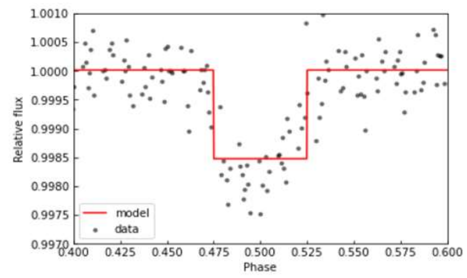
2



3



4



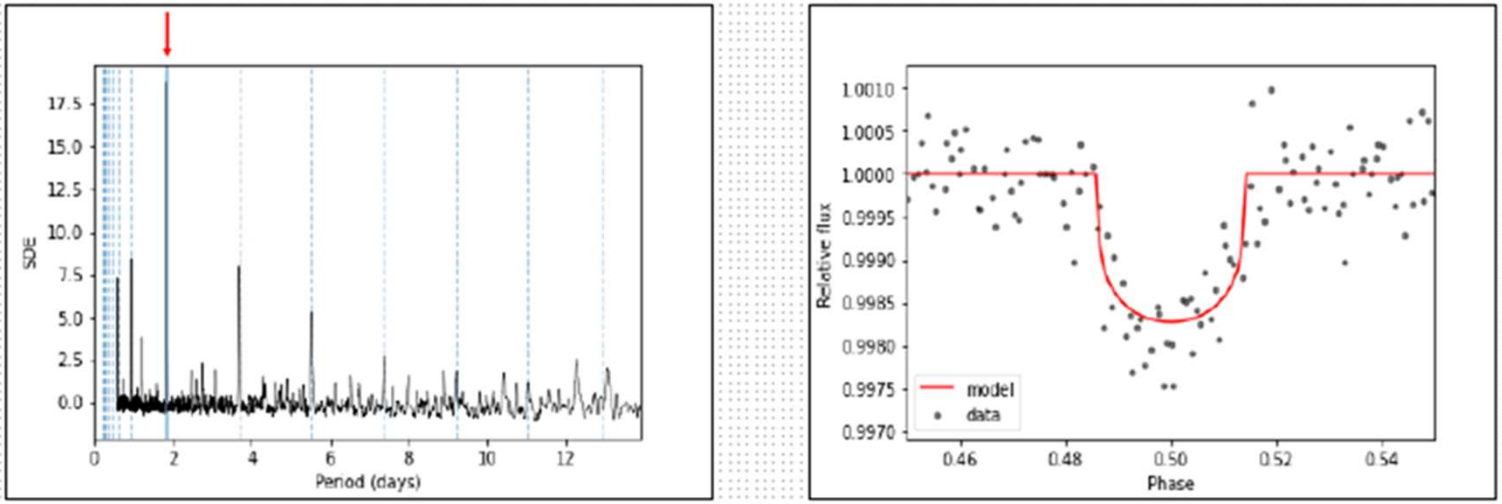
Target Pixel File (TPF) with the selected mask (1); Light curve of the candidate (2); *Signal Detection Efficiency (SDE)* periodogram (which shows the most probable value of the orbital period) (3) and *phase-folded detrended light curve*, which shows the light curve without the *long-term trend* phased with the orbital period (in black) and the BLS square model (in red) (4).

Transit analysis & Results

- The transit analysis of each possible planetary candidate detected with *BLS* was carried out with *Transit Least Squares (TLS)* [8], a more efficient periodogram-like tool which models the transit shape starting from the *Mandel & Agol* [9] theoretical models. *TLS* needs to be applied to the detrended light curves, so we used *Wotan* [10] in order to remove all the *long-term trends* of the light curves.

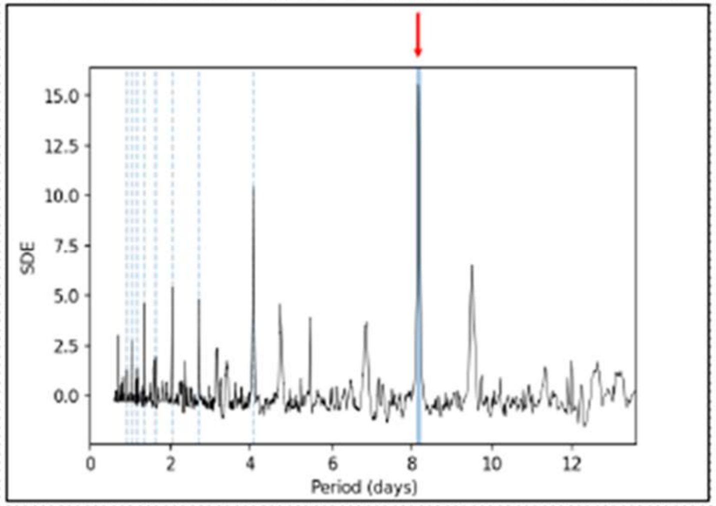
- In the next slides we present results for three candidates. Left panels: *Signal Detection Efficiency (SDE)* periodogram which shows the most probable orbital period of the planetary candidate. Central panels: phase-folded light curve with the computed transit model. Right panels: orbital period, planet-to- star radius ratio (R_p/R_*) and the *signal-to-noise ratio (SNR)*.

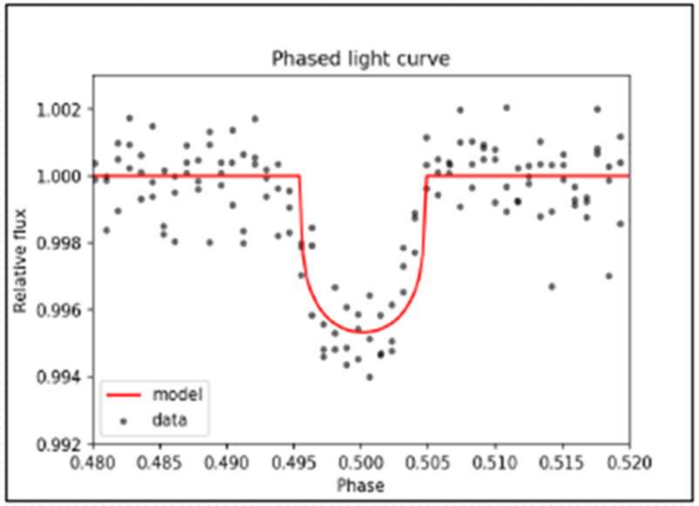
Candidate 1



Parameter	Value
P (d)	1.843 ± 0.005
R_p/R_*	0.062 ± 0.003
SNR	19.46

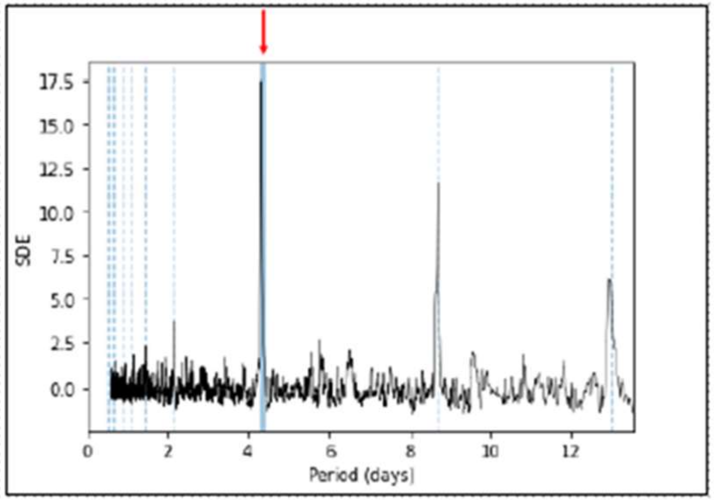
Candidate 2

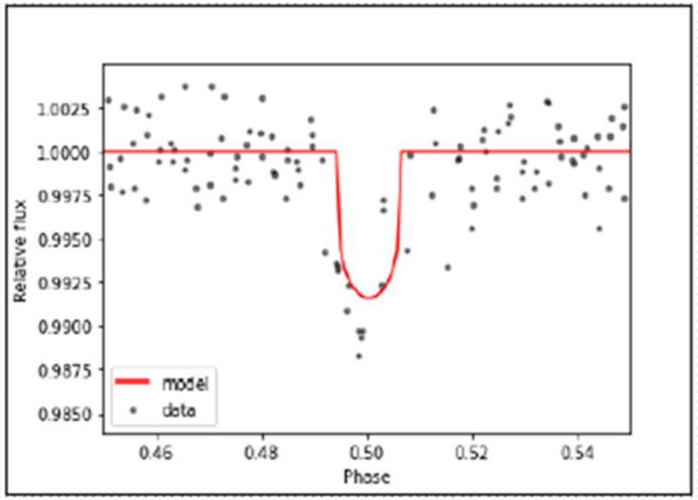




Parameter	Value
P (d)	8.1642 ± 0.0004
R_p/R_*	0.079 ± 0.008
SNR	14.57

Candidate 3





Parameter	Value
P (d)	4.34 ± 0.02
R_p/R_*	0.082 ± 0.006
SNR	12.45

References

[1] Taylor M. B., 2005, in Shopbell P., Britton M., Ebert R., eds, Astronomical Society of the Pacific Conference Series Vol. 347, Astronomica Data Analysis Software and Systems XIV. p. 29

[2] Gaia Collaboration et al., 2018, A&A, 616, A1

[3] O. J. Eggen 1971 PASP 83 271

[4] Ricker G. R., et al., 2014, Journal of Astronomical Telescopes, Instruments, and Systems, 1, 1

[5] Brasseur C. E., Phillip C., Fleming S. W., Mullally S. E., White R. L., 2019, Astrocut: Tools for creating cutouts of TESS images (ascl:1905.007)

[6] Lightkurve Collaboration et al., 2018, Lightkurve: Kepler and TESS time series analysis in Python, Astrophysics Source Code Library (ascl:1812.013)

[7] Kovács G., Zucker S., Mazeh T., 2016, BLS: Box-fitting Least Squares (ascl:1607.008)

[8] Hippke M., Heller R., 2019, A&A, 623, A39

[9] Mandel K., Agol E., 2002, ApJ, 580, L171

[10] Hippke M., David T. J., Mulders G. D., Heller R., 2019, AJ, 158, 143

[11] Nordström B., et al., 2004, A&A, 418, 989ç[12] Ženovien˙e R., Tautvaišien˙e G., Nordström B., Stonkut˙e E., 2014, A&A, 563, A53