Discovery of the Shortest-Period Ultracool Dwarf Binary

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Northwestern | CIERA
CENTER FOR INTERDISCIPLINARY EXPLORATION AND RESEARCH IN ASTROPHYSICS

W. M. KECK OBSERVATORY
On the summit of Mauna Kea, Island of Hawai‘i

Ultracool dwarfs are low-mass objects with temperature ≤ 3000 K

Credit: Robert Hurt

Short-period binaries are useful for calibrating theoretical models

www.eso.org

Credit: ESO/L. Calçada

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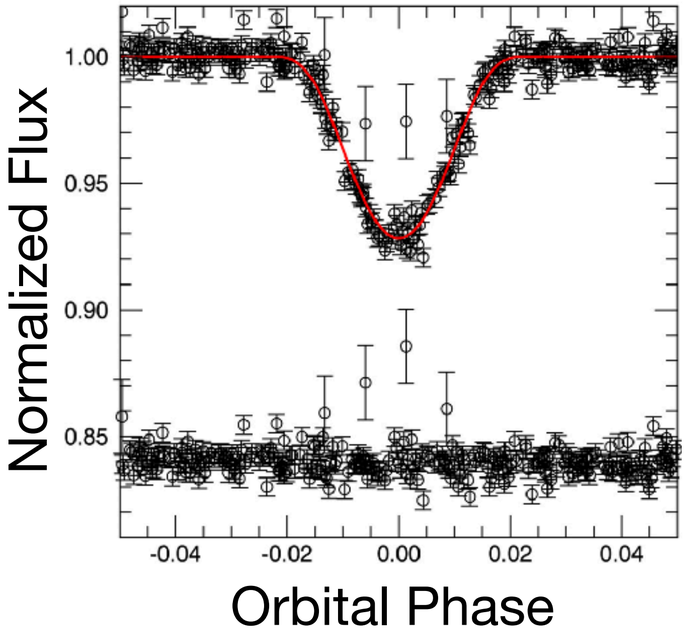
Only 3 short period ultracool dwarf binaries are known

SPEC J1510-2818AB
(Triaud et al. 2020)
Orbital period = 20.9 day

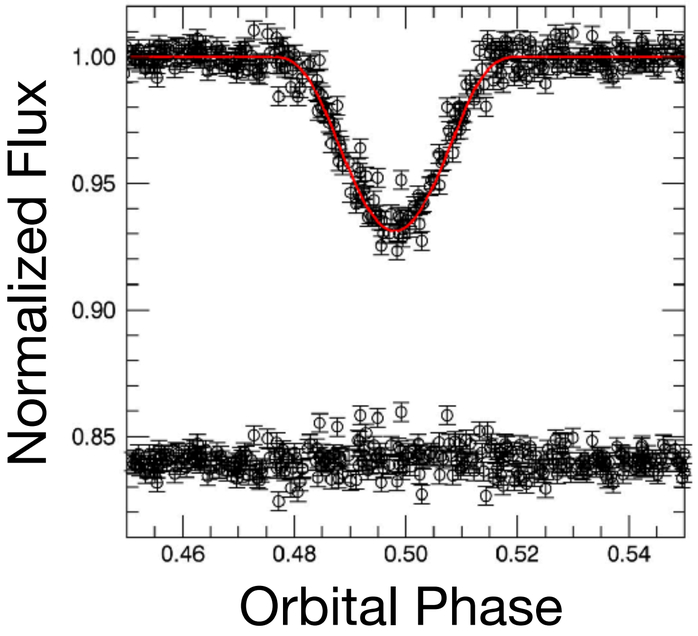
2MASS J0535-0546AB
(Stassun et al. 2006)
Orbital period = 9.8 day

USCO J1616-2512
(Lodieu et al. 2015)
Orbital period = 2.8 day

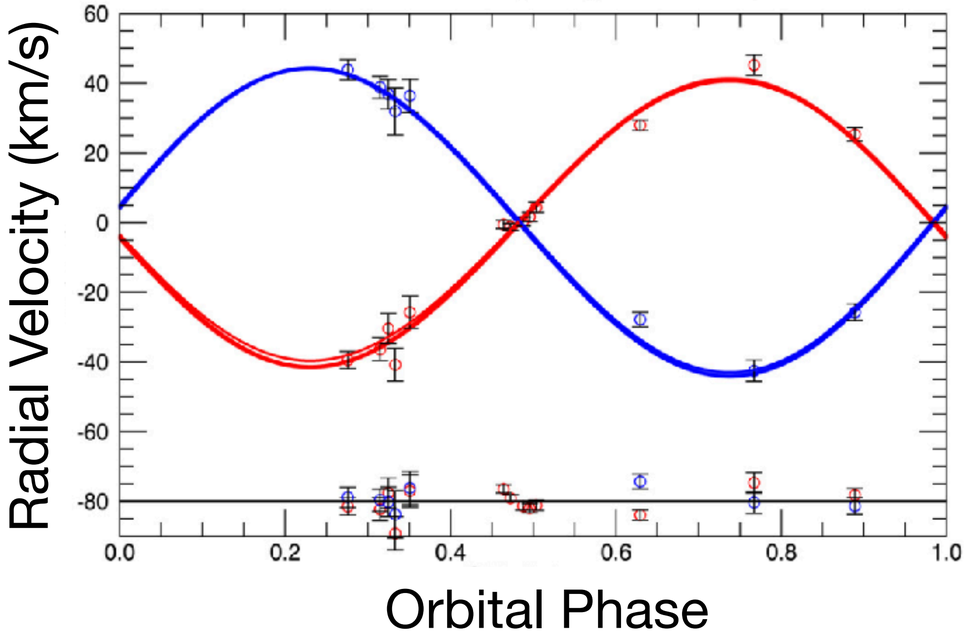
Primary Light Curve



Secondary Light Curve



Radial Velocity: primary and secondary

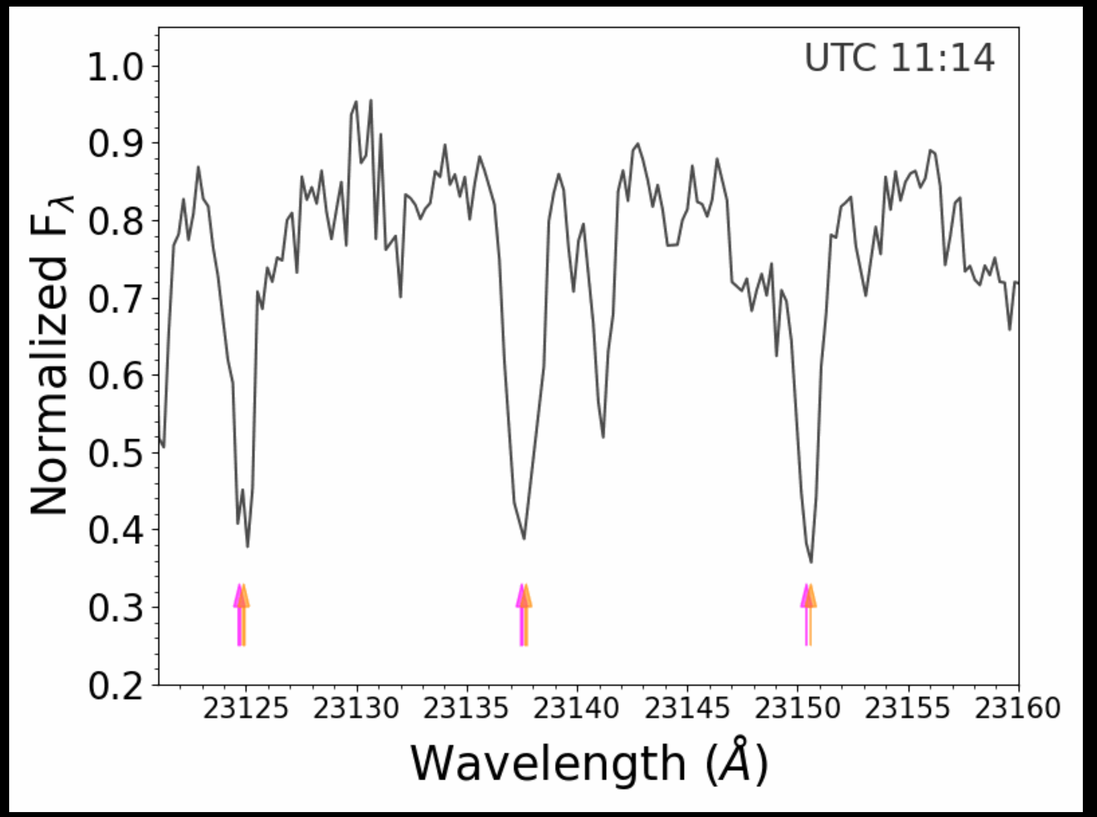


(Lodieu et al. 2015)

The M9 dwarf LP 413-53 has a *significant* RV variation OVER TWO HOURS OF OBSERVATIONS with Keck/NIRSPEC

Secondary

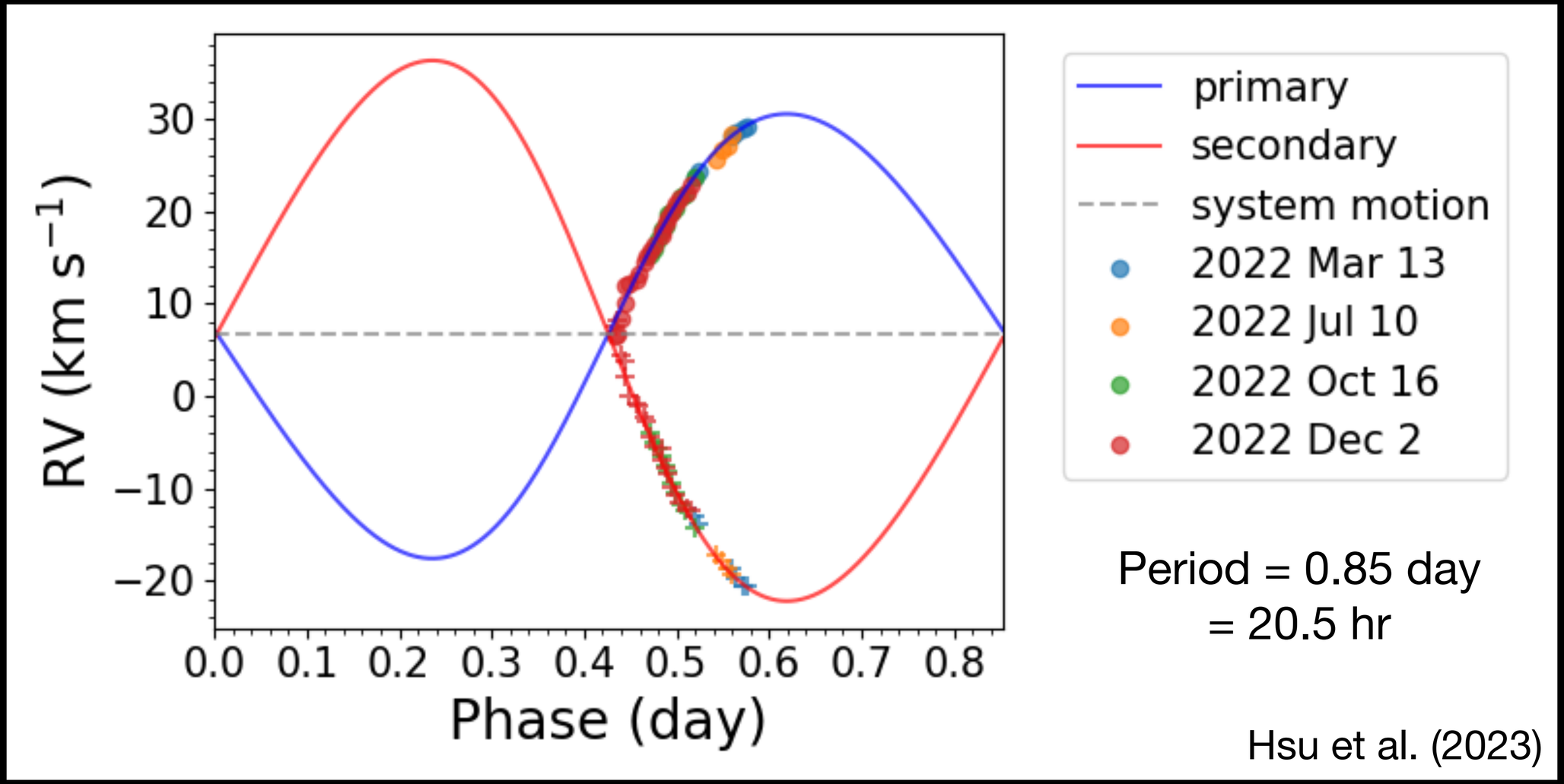
Primary



Credit: Keck Observatory

Hsu et al. (2023)

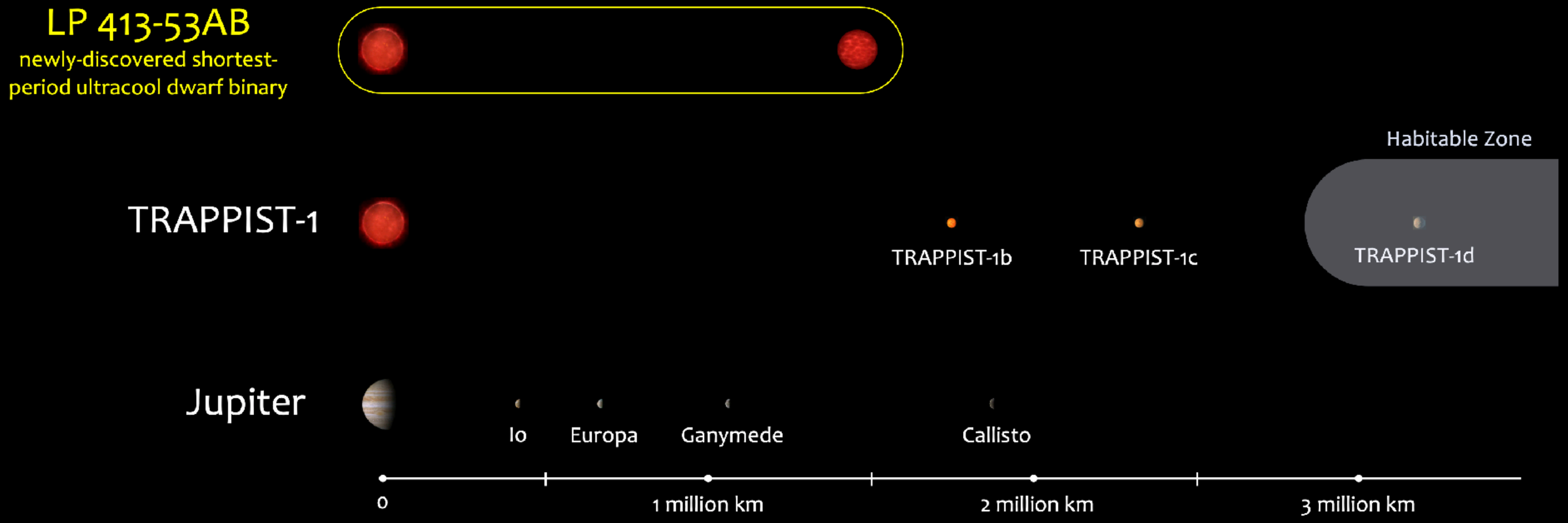
LP 413-53AB is the shortest-period UCD binary



Period = 0.85 day
= 20.5 hr

Hsu et al. (2023)

LP 413-53AB's separation is similar to the TRAPPIST-1 planet and Jupiter satellite systems



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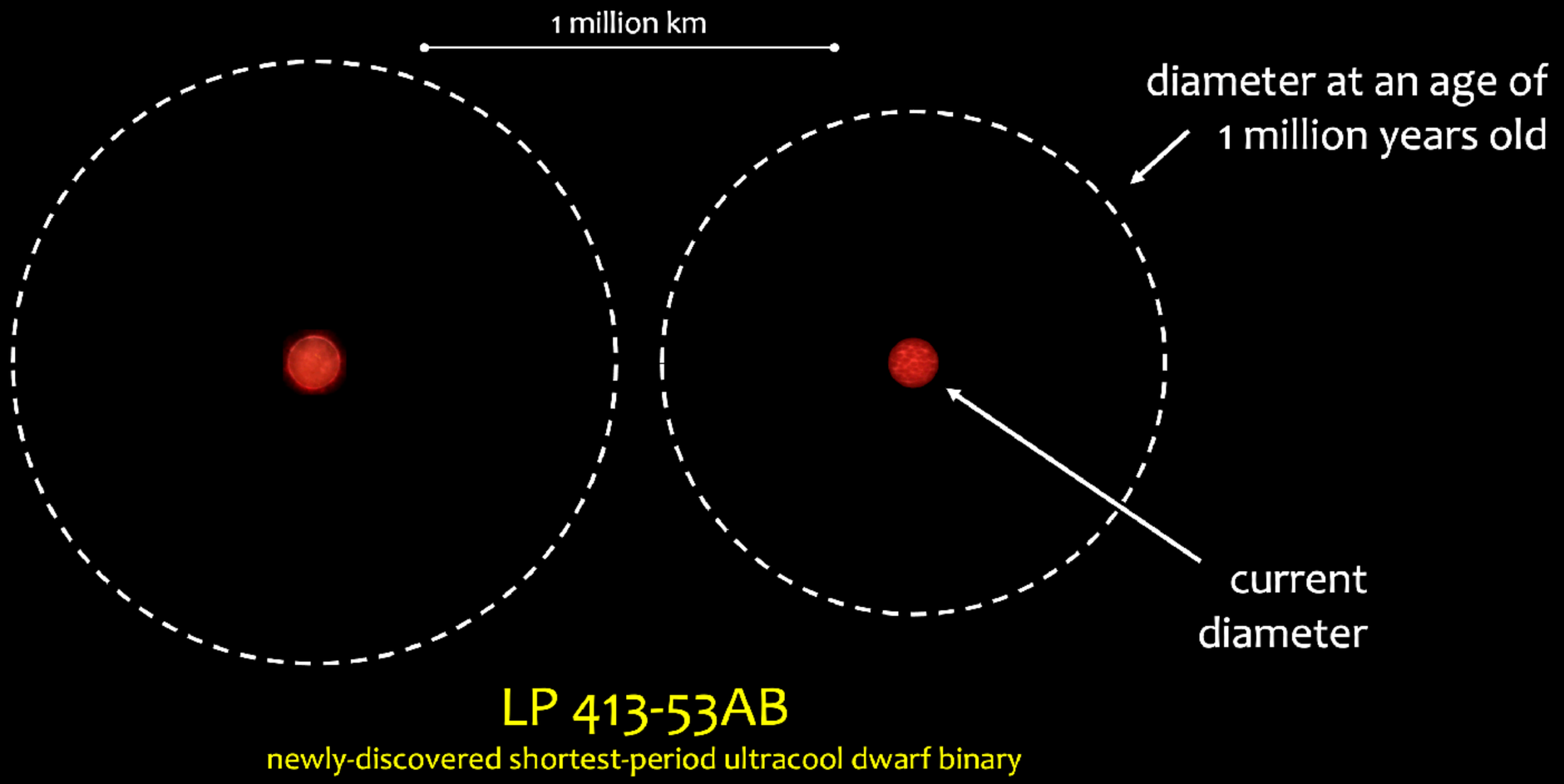
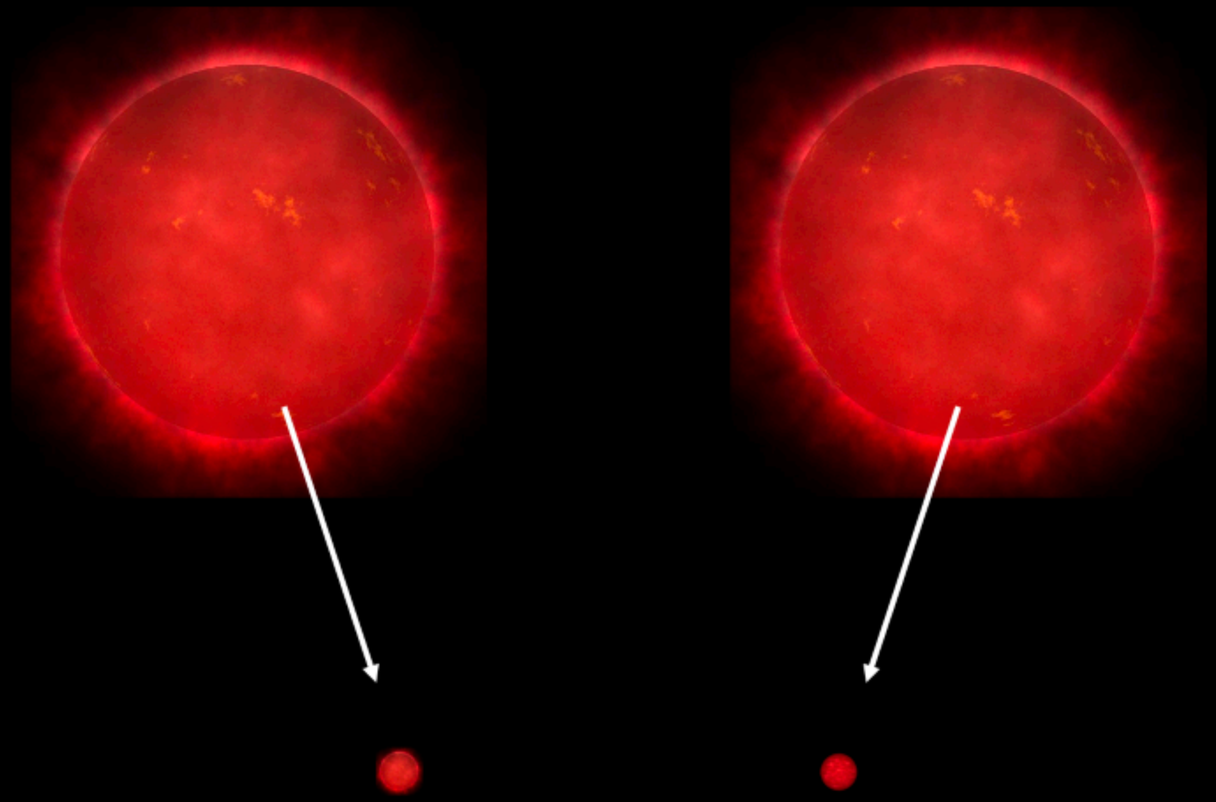
How did they evolve to its current configuration?

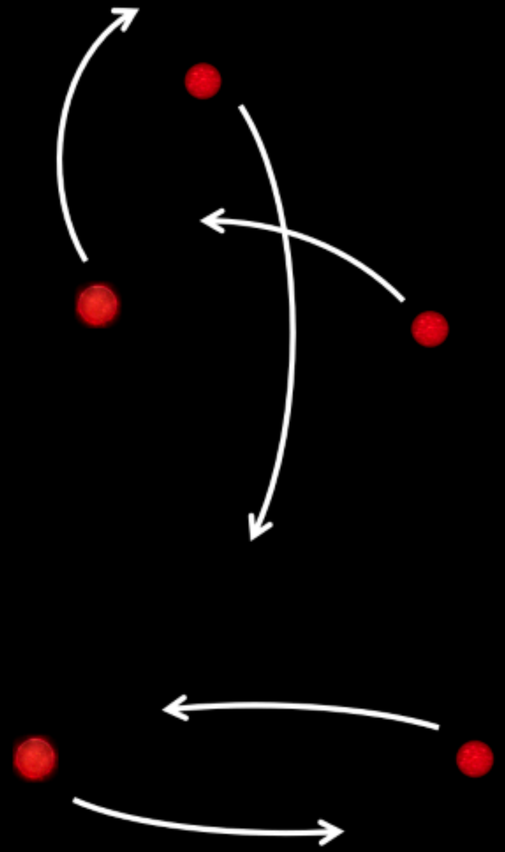


It may have formed by orbital evolution or by scattering out a third star

orbital evolution



three-body interaction



Key Results

- LP 413-53AB is the shortest-period ultracool dwarf binary known (20.5 hr = 0.85 day)
- Its tight separation likely prevented the formation of habitable exoplanets
- It may have formed by orbital evolution or by scattering out a third star
- Eclipse measurements have not yet been made - stay tuned!

Thank you! What are your Questions?

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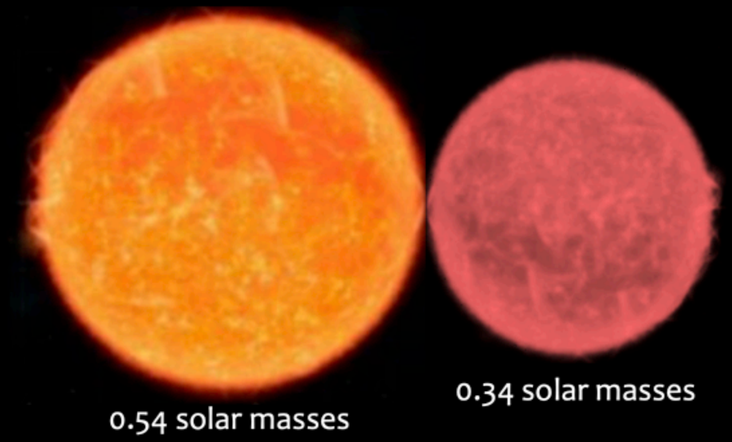
LP 413-53AB's separation is similar to other short-period (higher-mass) binaries

SDSS J0016-0009AB
short-period contact binary

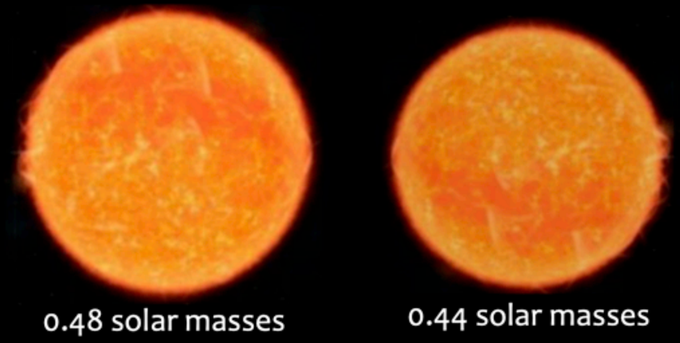


orbit period:
4.8 hours

LP 413-53AB
newly-discovered shortest-period
ultracool dwarf binary

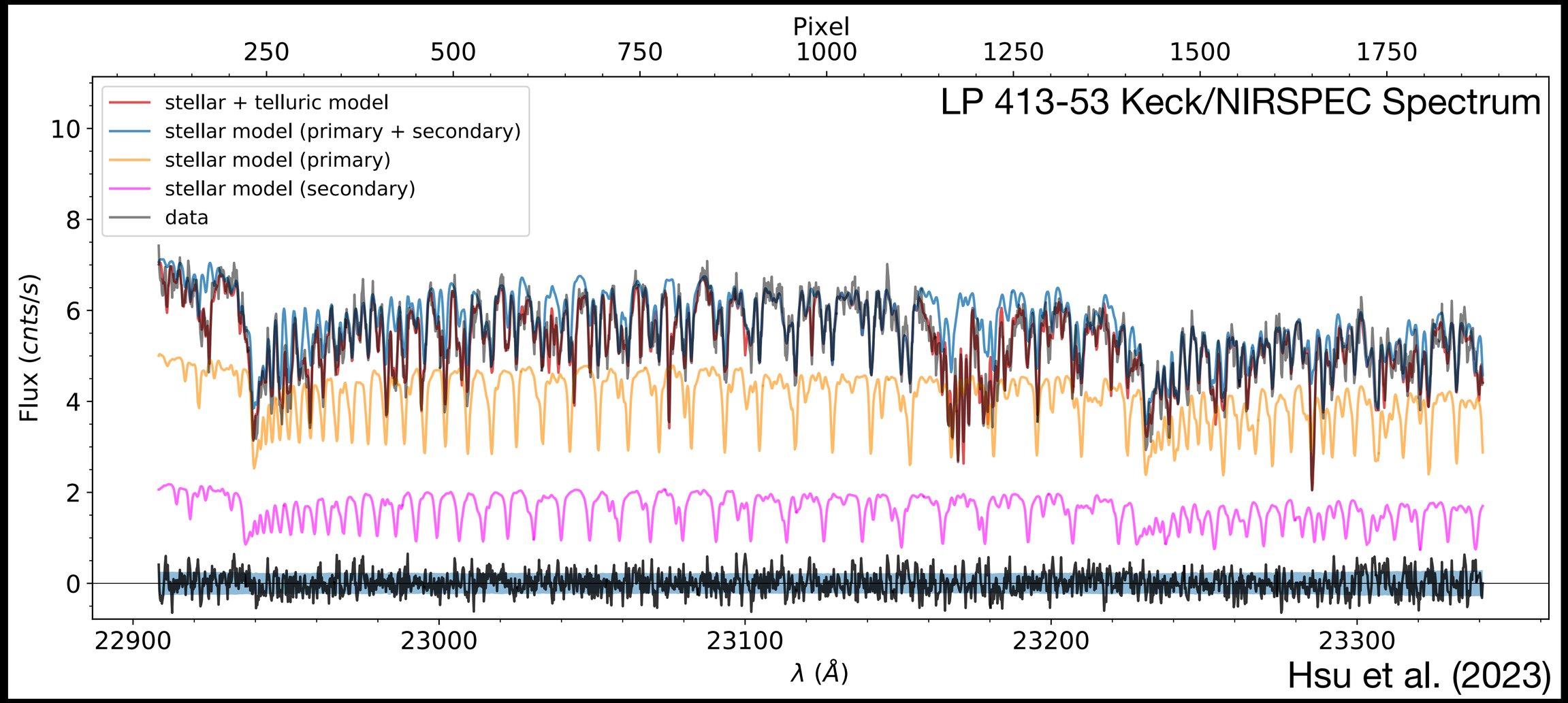
orbit period:
20.5 hours

2MASS J1155+3544AB
short-period detached stellar binary

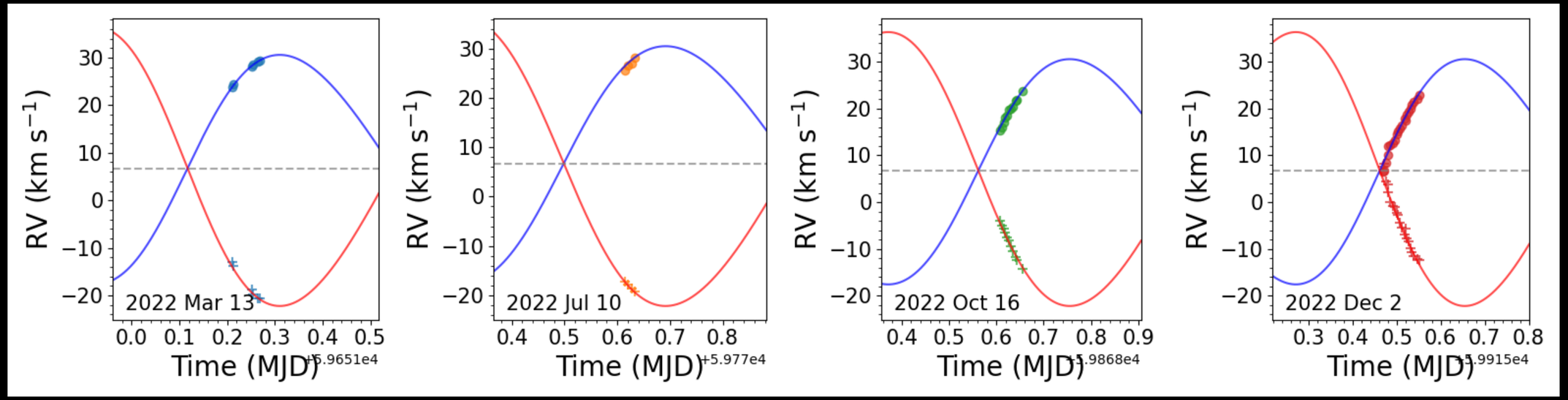


orbit period:
4.8 hours

LP 413-53 shows double-lined in Keck/NIRSPEC spectra



RV time series per epoch



Hsu et al. (2023)