Close substellar companions to hot subdwarf stars

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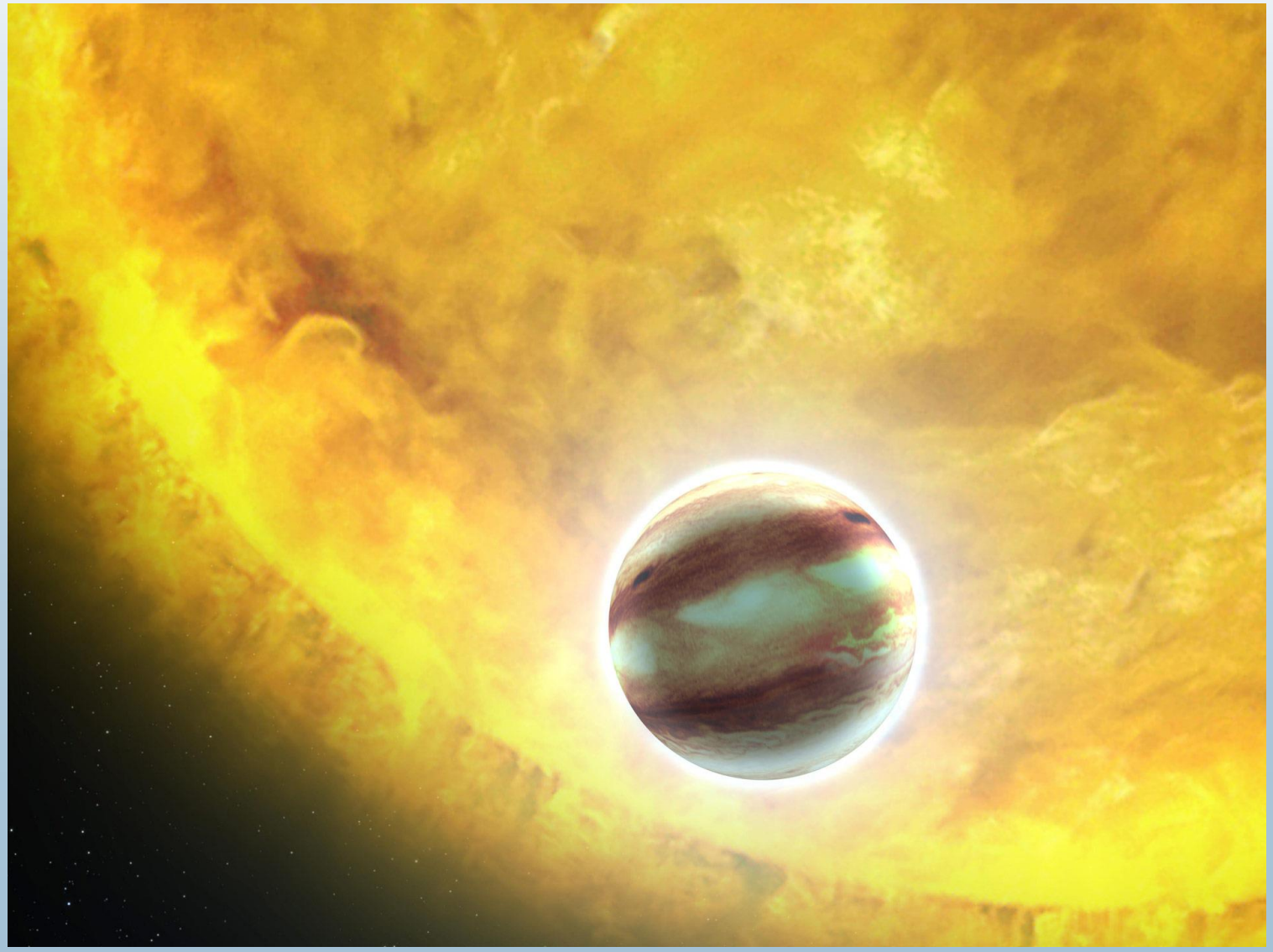
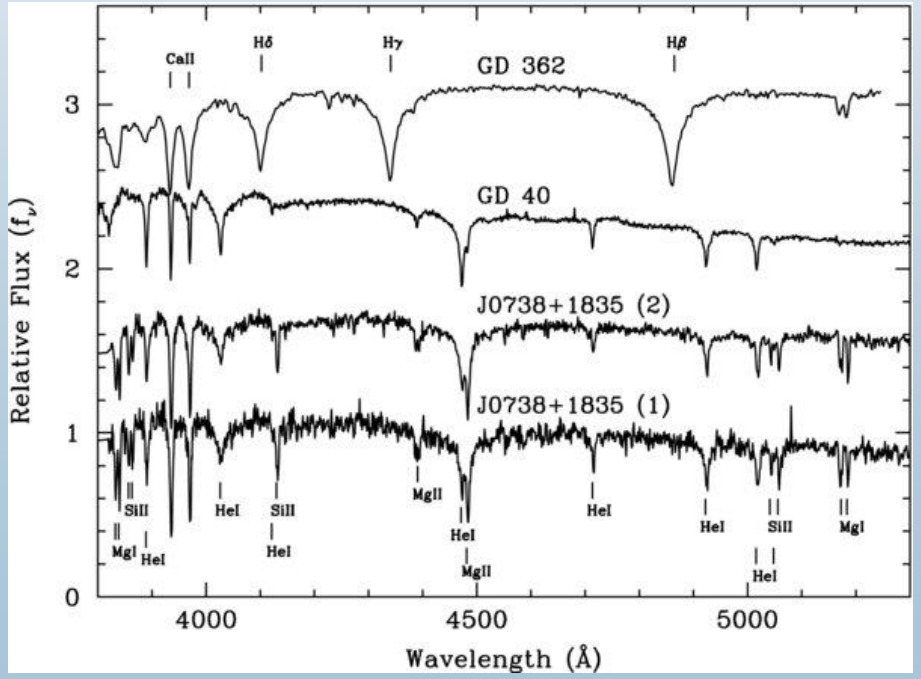
V. Schaffenroth (Tübingen), B. N. Barlow (High Point), T. Kupfer (Caltech), U. Heber (Bamberg), M. Vuckovic (Valparaiso), S. Casewell (Leicester), et al.

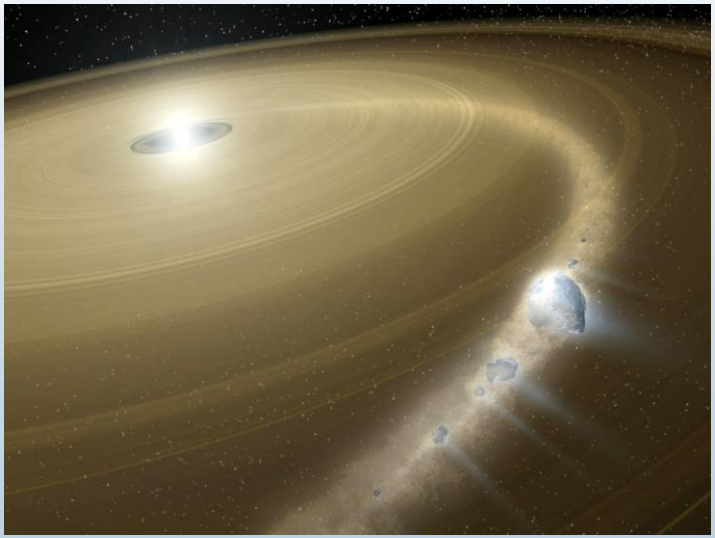
Star-planet interactions

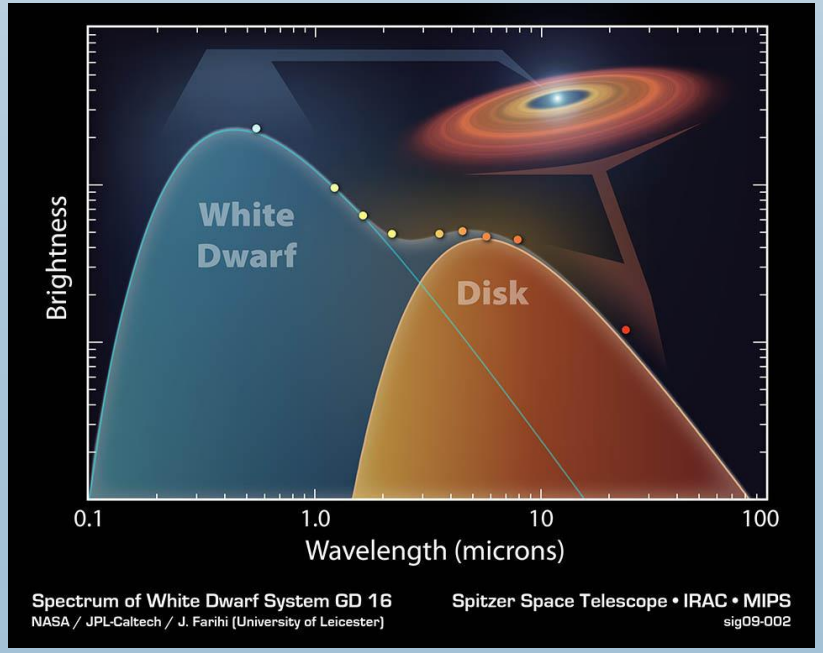


(NASA, ESA, and G. Bacon, STScI)

White dwarfs surrounded by debris

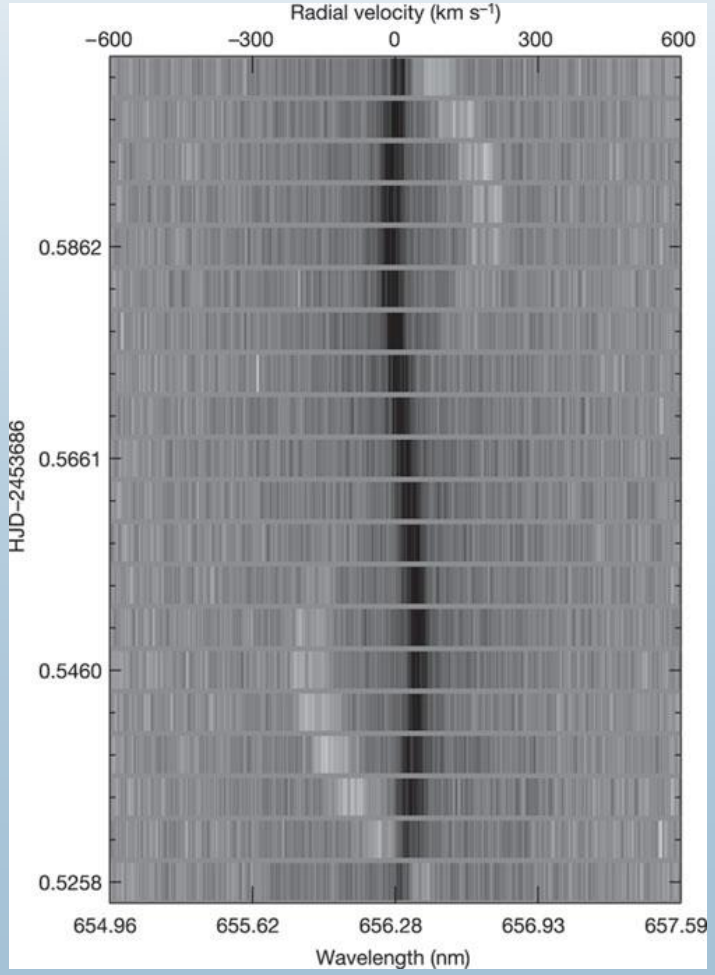




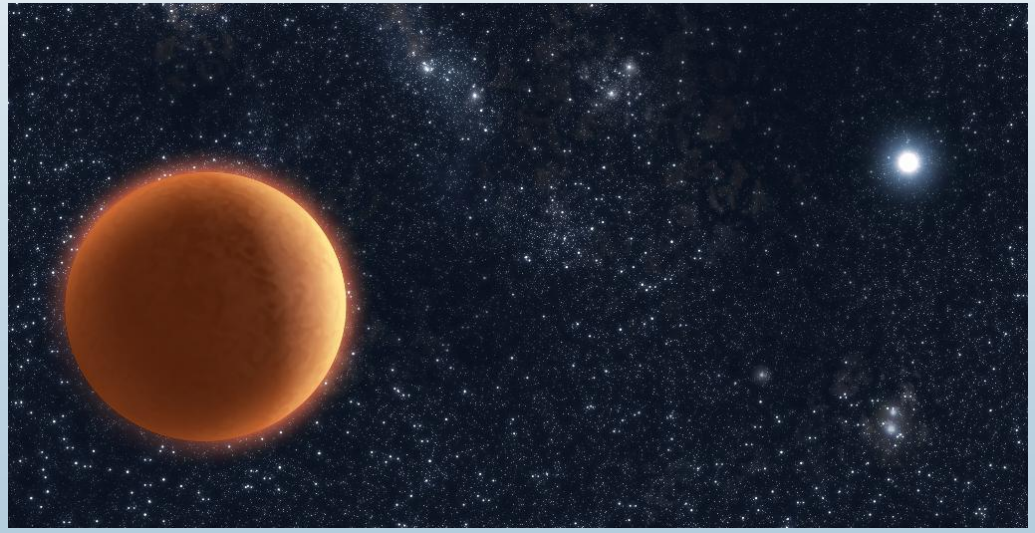


No planets (yet)!

Brown dwarfs can survive



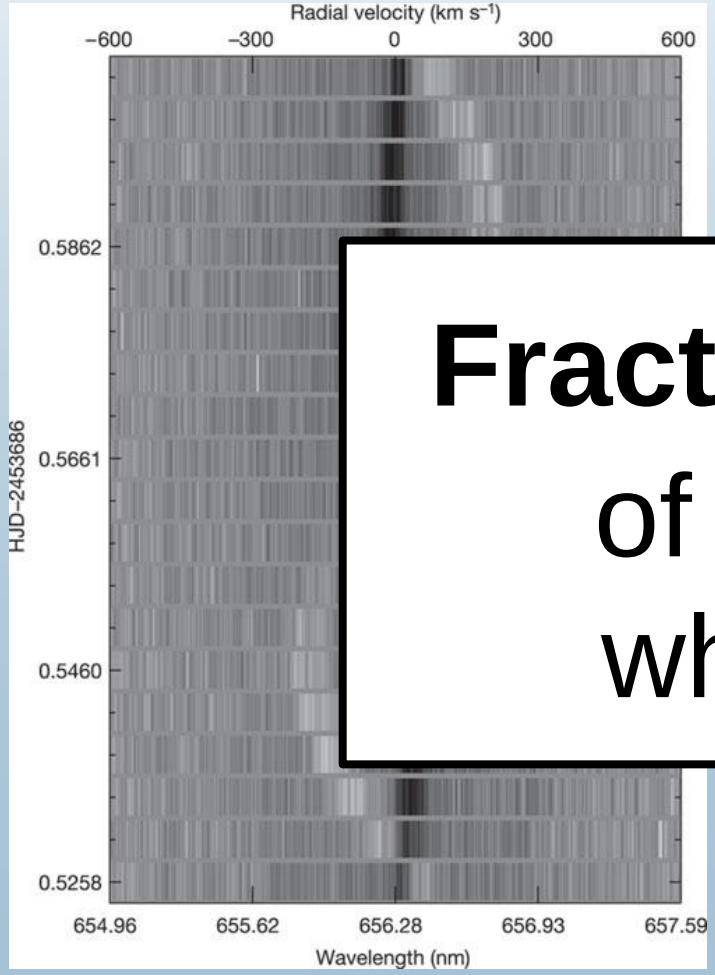
(Maxted et al. 2006)



WD+BD, P=0.08 d

M_2 = 55 M_{Jup}

Brown dwarfs can survive

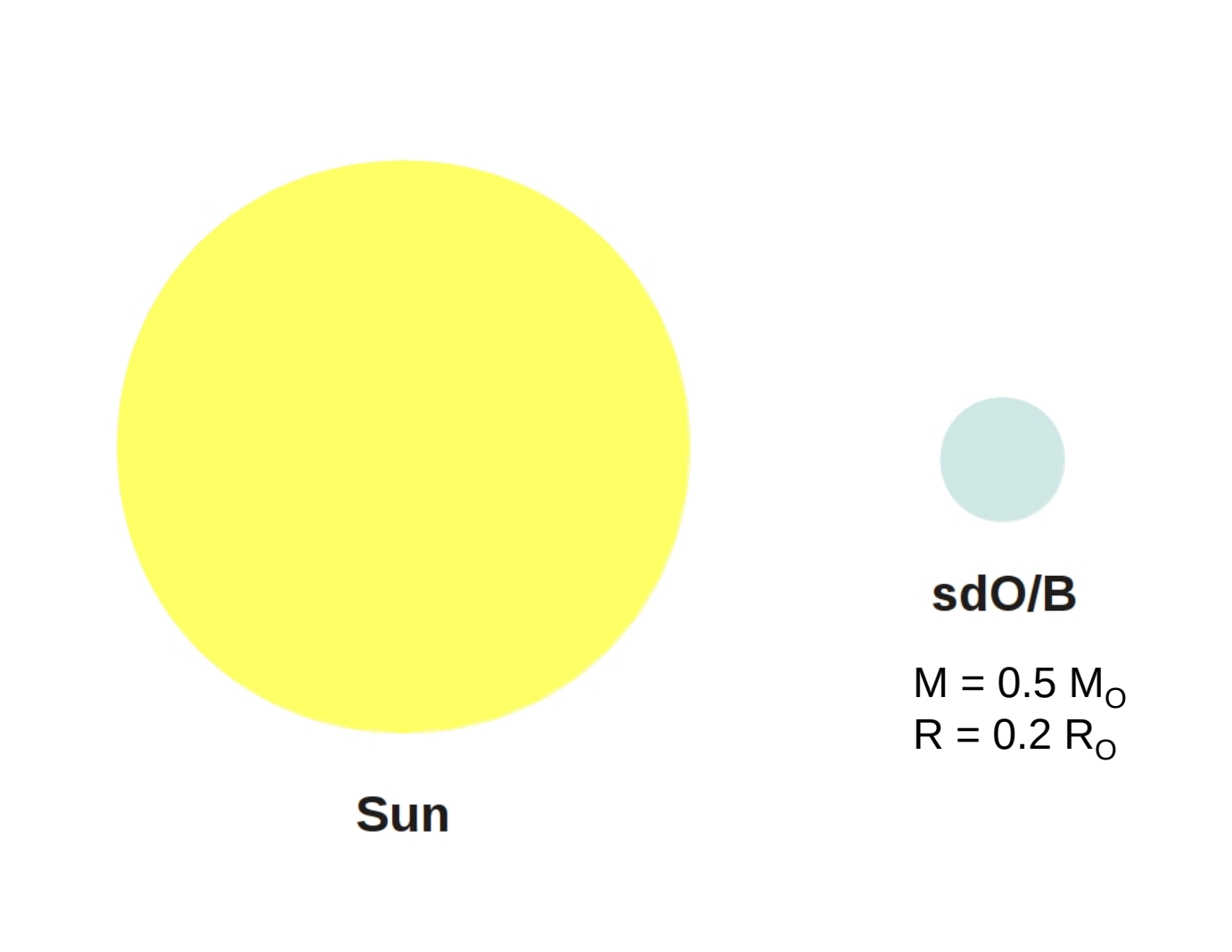


Fraction of >0.03%
of the known
white dwarfs

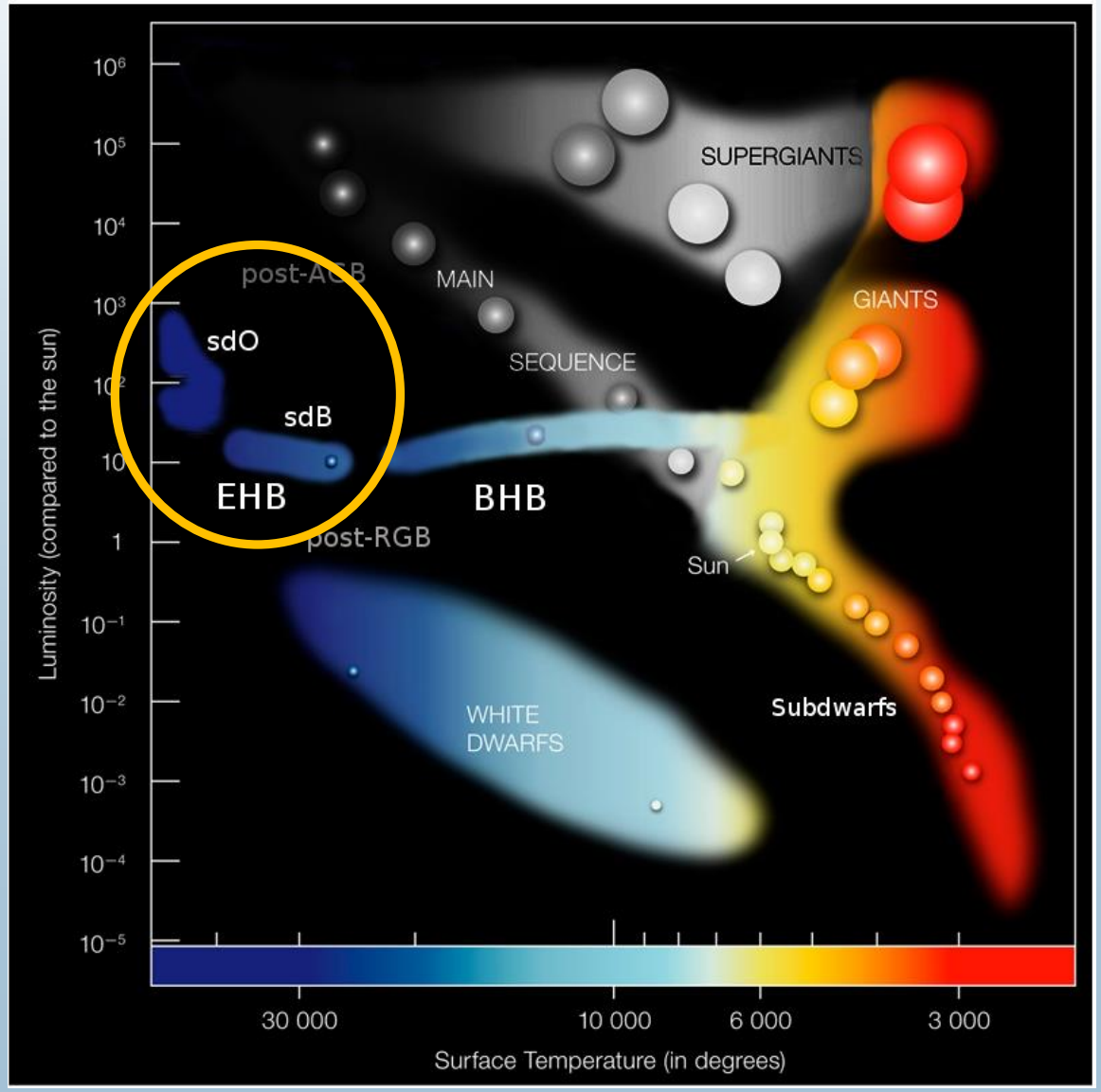
$M_2 = 55\ M_{Jup}$

(Maxted et al. 2006)

Hot subdwarfs - Small and hot

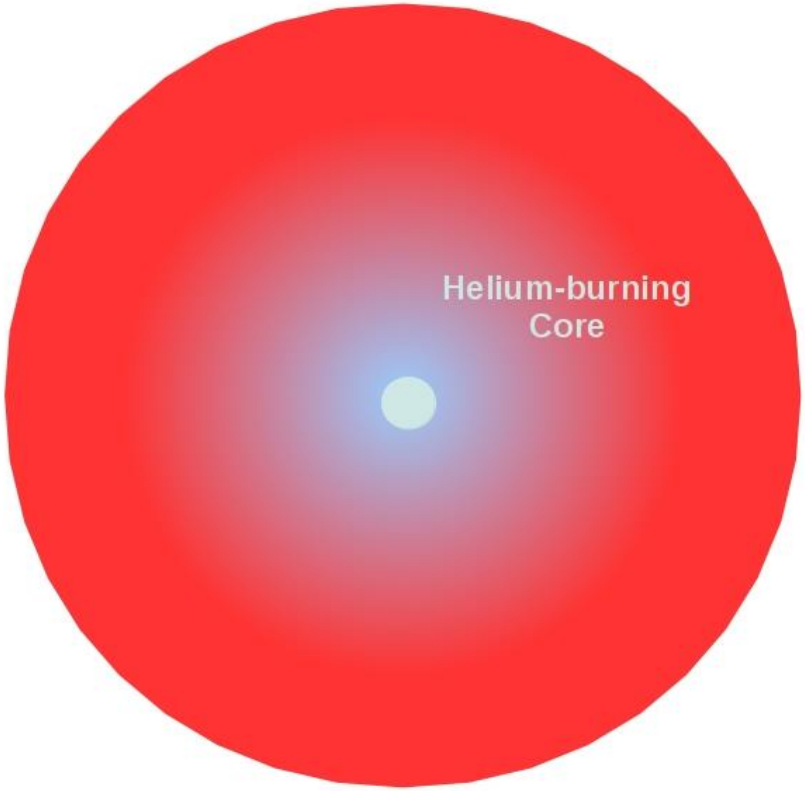


Not a normal phase of stellar evolution



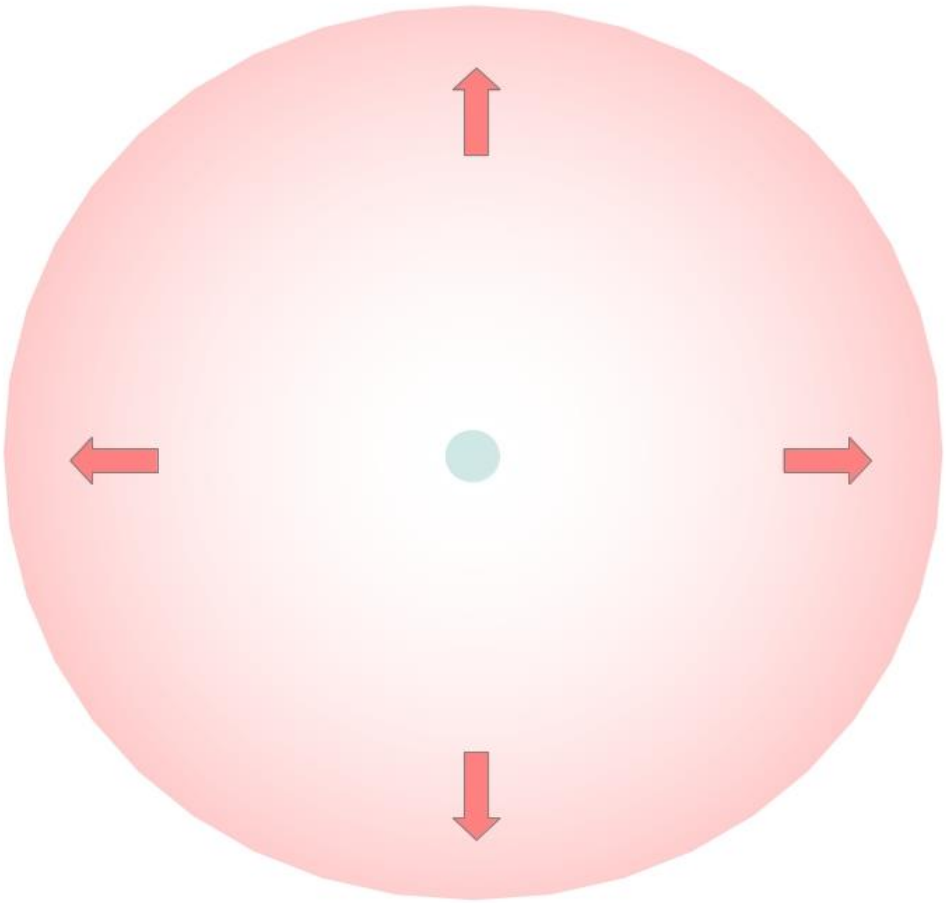
(ESO modified by Geier)

Formation

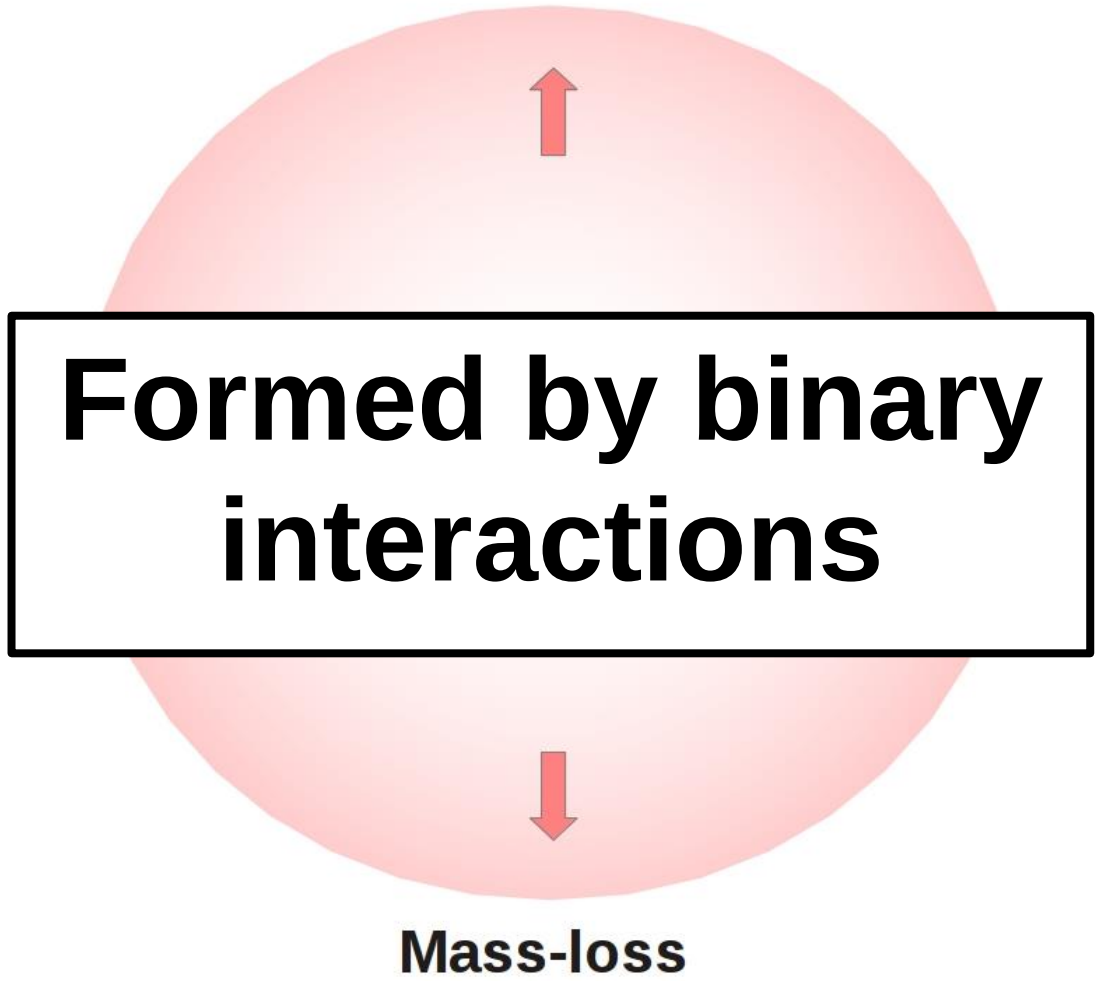


Red Giant

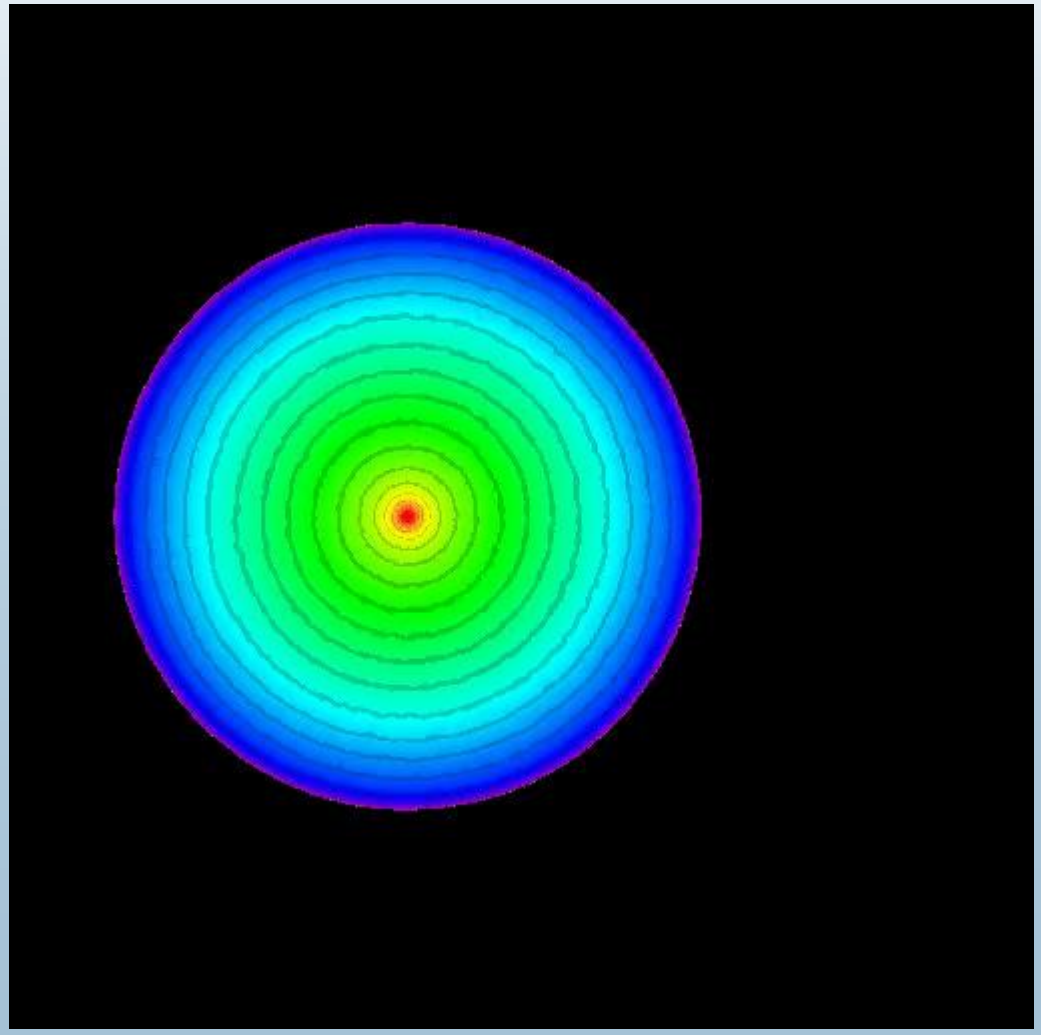
Stripped He-burning cores of red giants



Stripped He-burning cores of red giants



Common envelope ejection

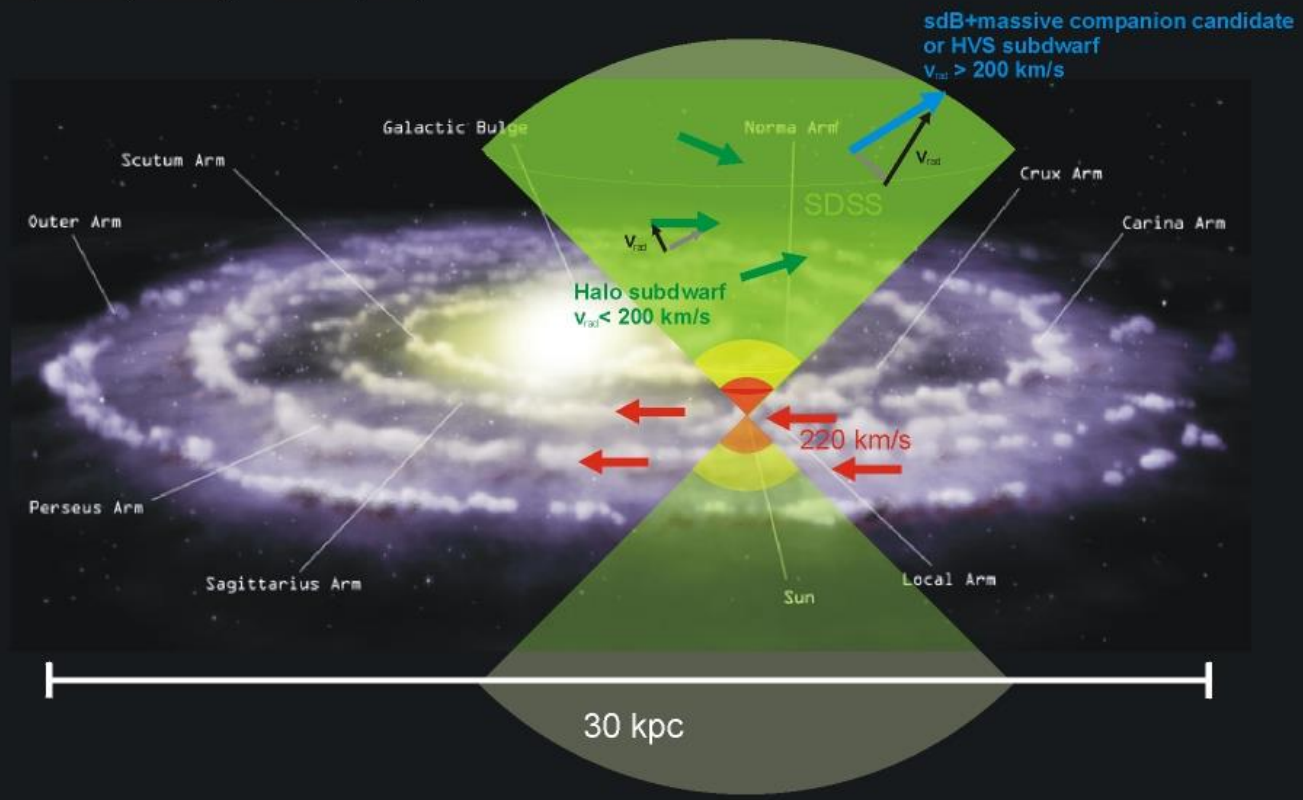


(Passy et al. 2012)

MUCHFUSS

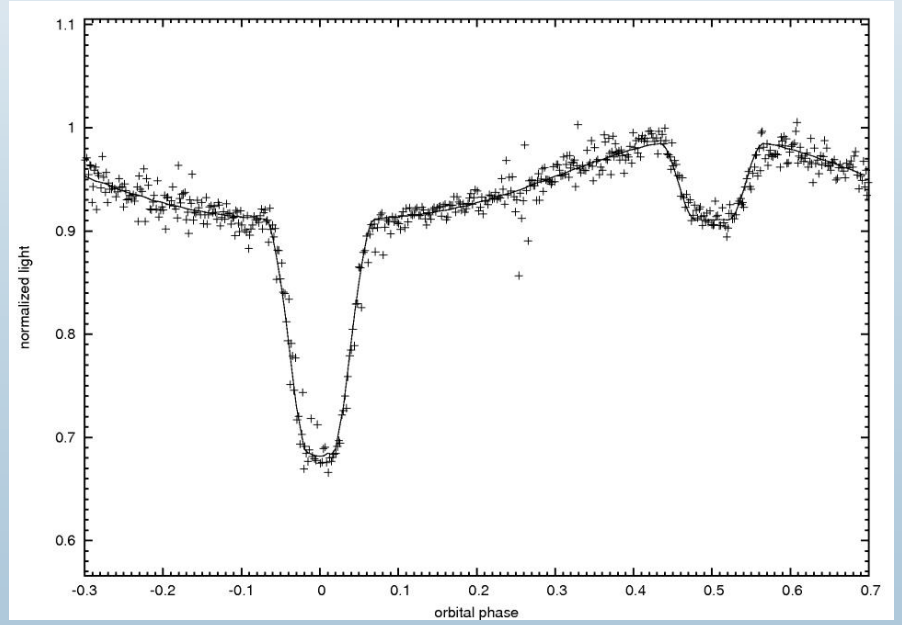
Massive **U**nseen **C**ompanions to **H**ot **F**aint **U**nderluminous **S**tars from **S**DSS

S. Geier (Bamberg), P. Maxted (Keele), U. Heber (Bamberg), A. Tillich (Bamberg),
H. Hirsch (Bamberg), B. Gänsicke (Warwick), R. Ostensen (Leuven), T. Marsh (Warwick),
R. Napiwotzki (Hatfield), B. Barlow (UNC)



(Geier et al. 2011, A&A, 530, 28; Geier et al. 2011, A&A, 526, 39; Geier et al. 2011, ApJ. 731, L22; Geier et al. 2012, AN, 333, 431; Geier et al. 2013, A&A, 554, 54; Østensen et al. 2013, A&A, 559, 35; Geier et al. 2014, A&A, 562, 95; Schaffenroth et al. 2014, A&A, 564, 98; Kupfer et al. 2015, A&A, 576, 44; Geier et al. 2015, A&A, 577,26; Reindl et al. 2016, A&A, 587, 101; Schaffenroth et al. 2017, A&A, submitted)

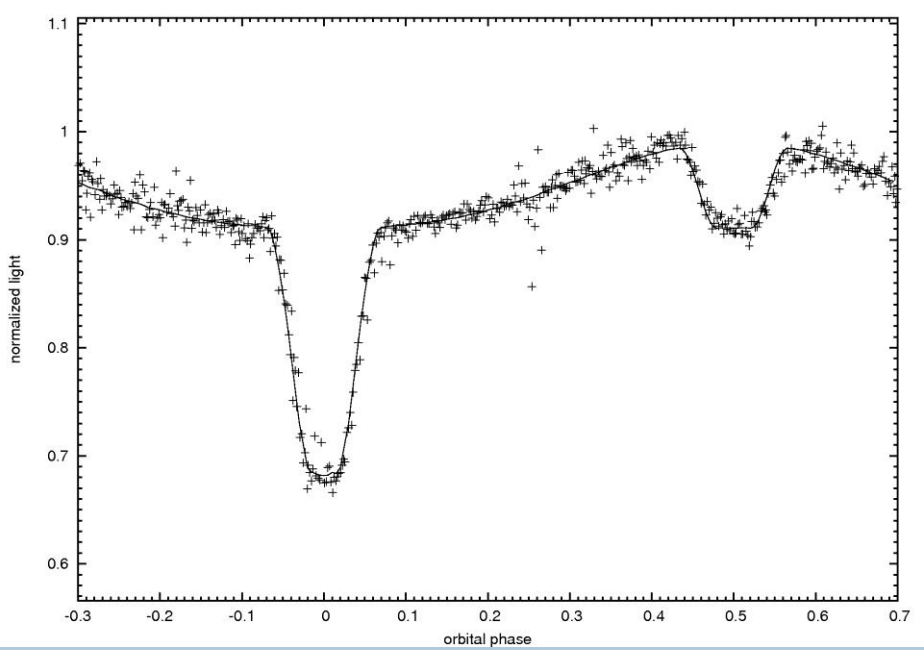
Eclipsing sdB binaries (HW Vir type)



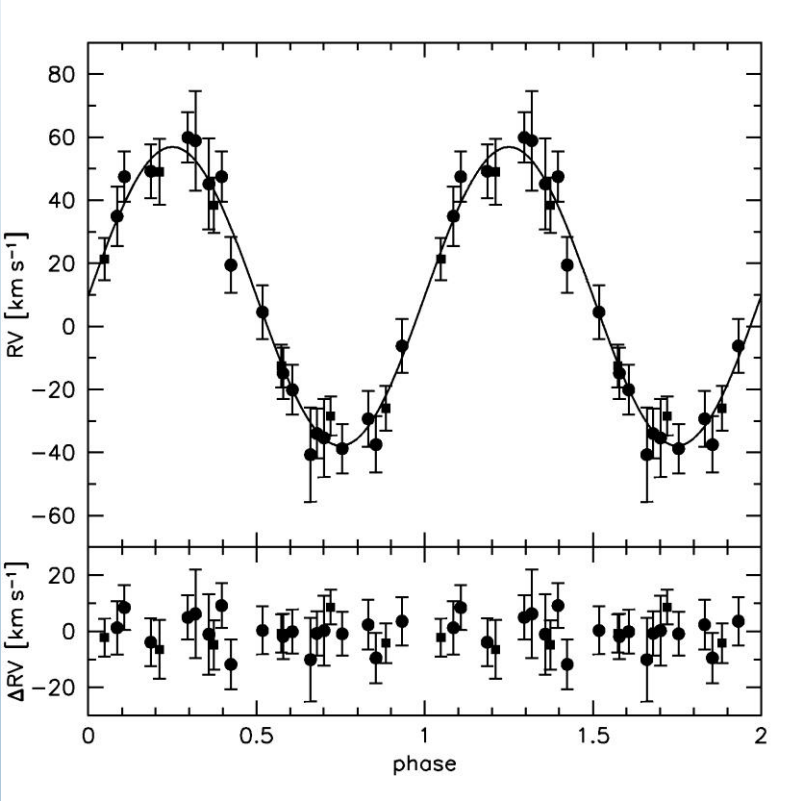
(Geier et al. 2011, ApJ, 731, L22)

Reflection effect (+ eclipses) → **Cool low-mass companion (e.g. M-star)**

Substellar companions



(Geier et al. 2011, ApJ, 731, L22)



J08205+0008

K = 47 km/s

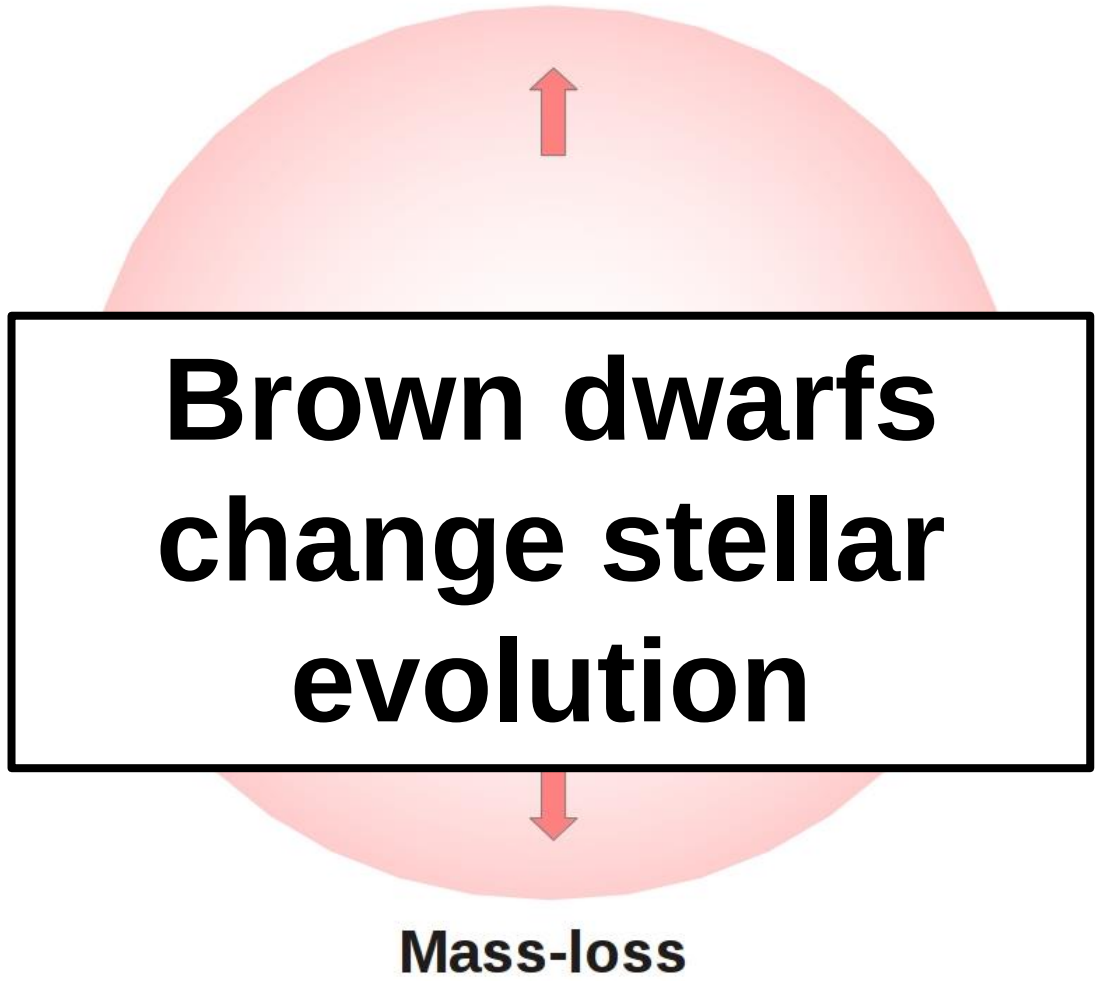
P = 0.096 d

M_2 = 47-70 M_{Jup}

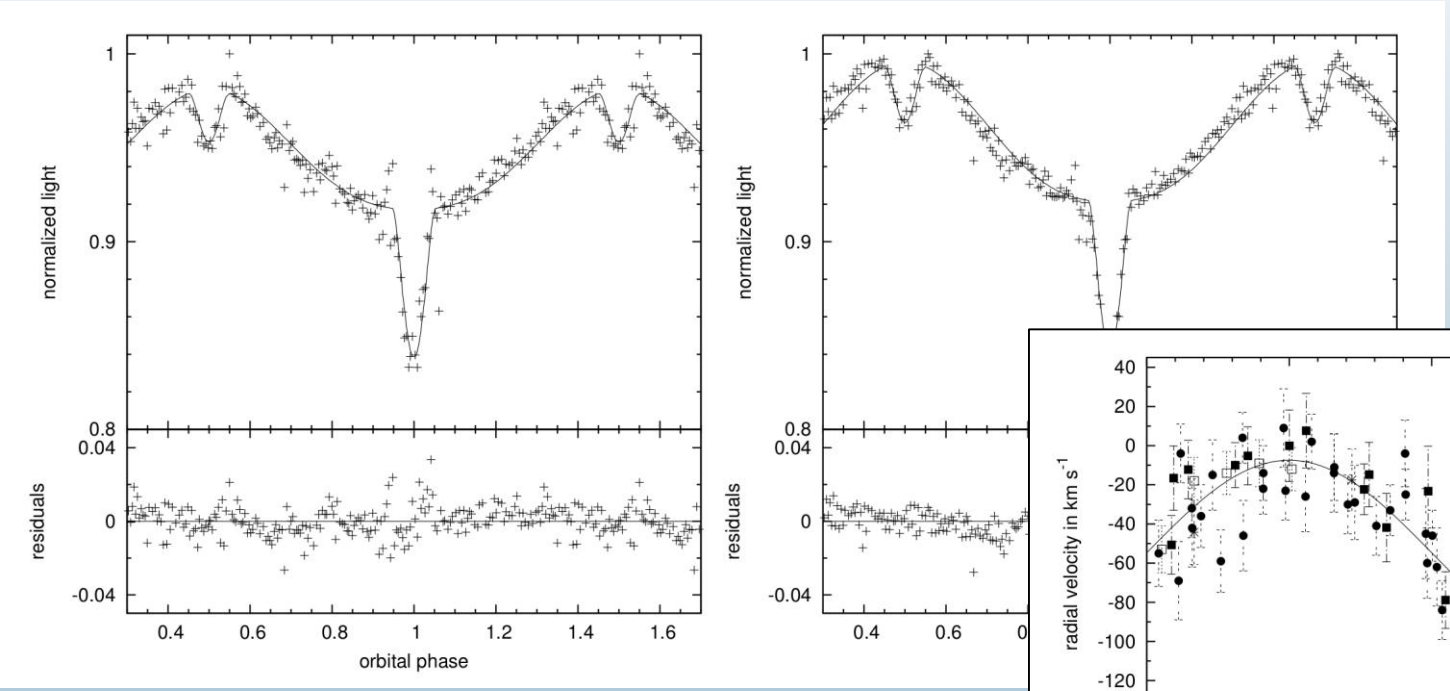
Brown dwarf companion

New XSHOOTER spectra taken in February 2017

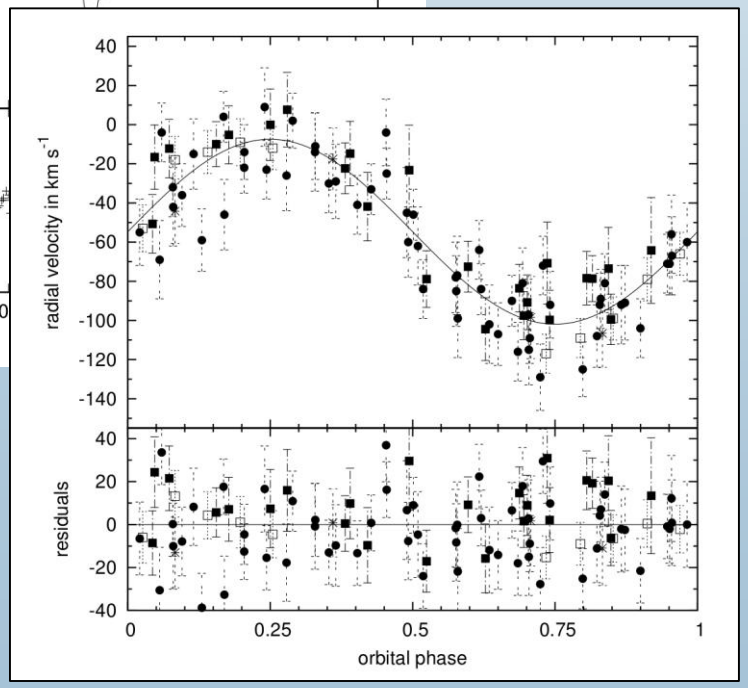
Stripped He-burning cores of red giants



Substellar companions



(Schaffenroth et al. 2014, A&A, 564, 98)



J16225+4730

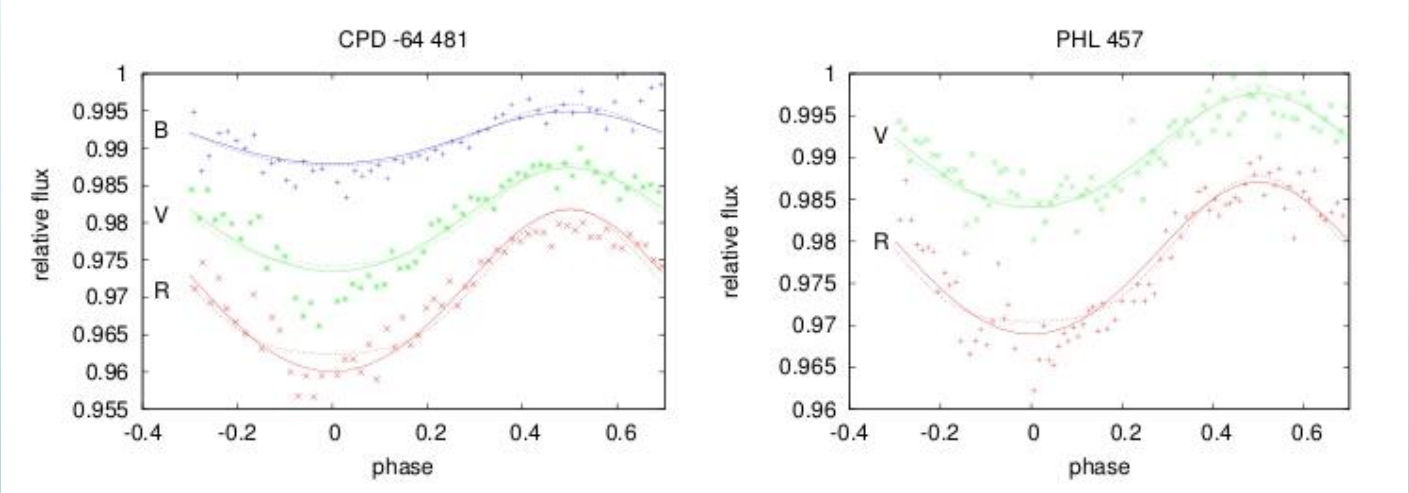
K = 47 km/s

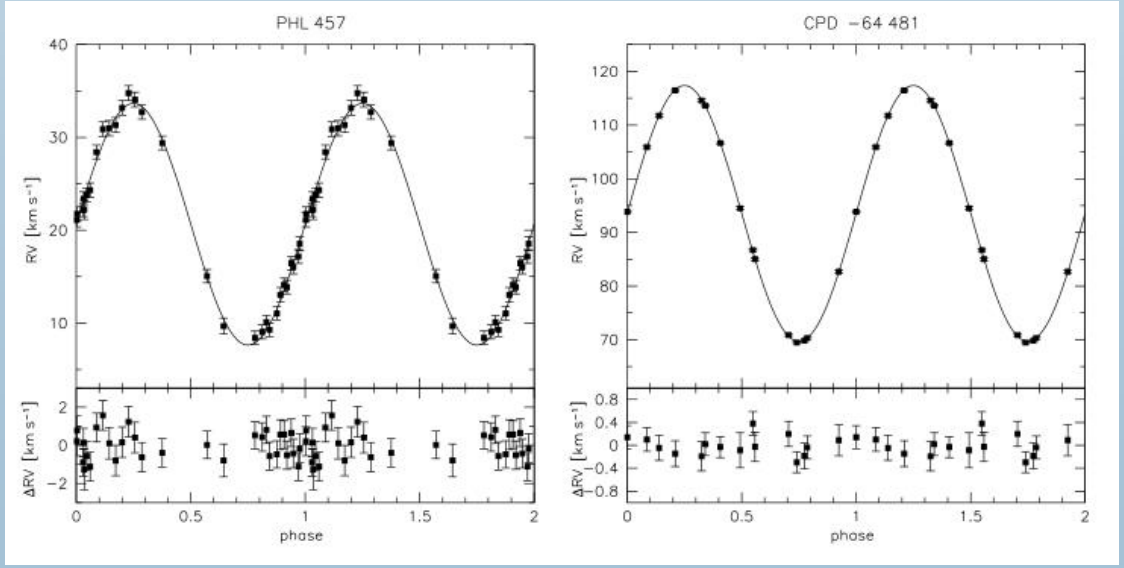
P = 0.0697 d

$M_2 = 67\ M_{Jup}$

Brown dwarf companion

Substellar companions





(Schaffenroth et al. 2014, A&A, 570, 70)

CPD -64 481

P = 0.277 d

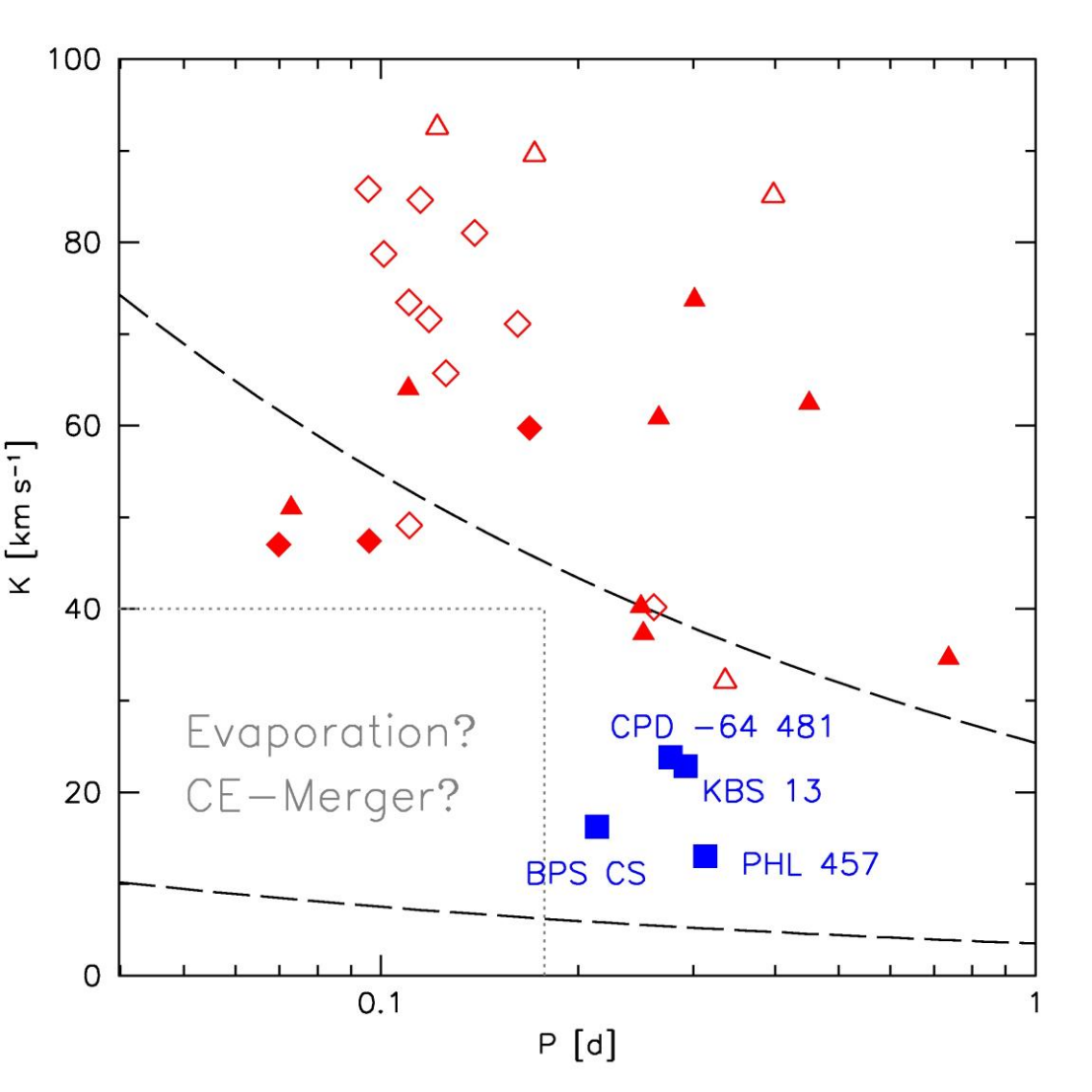
$M_2 > 50\ M_{Jup}$

PHL 457

P = 0.31 d

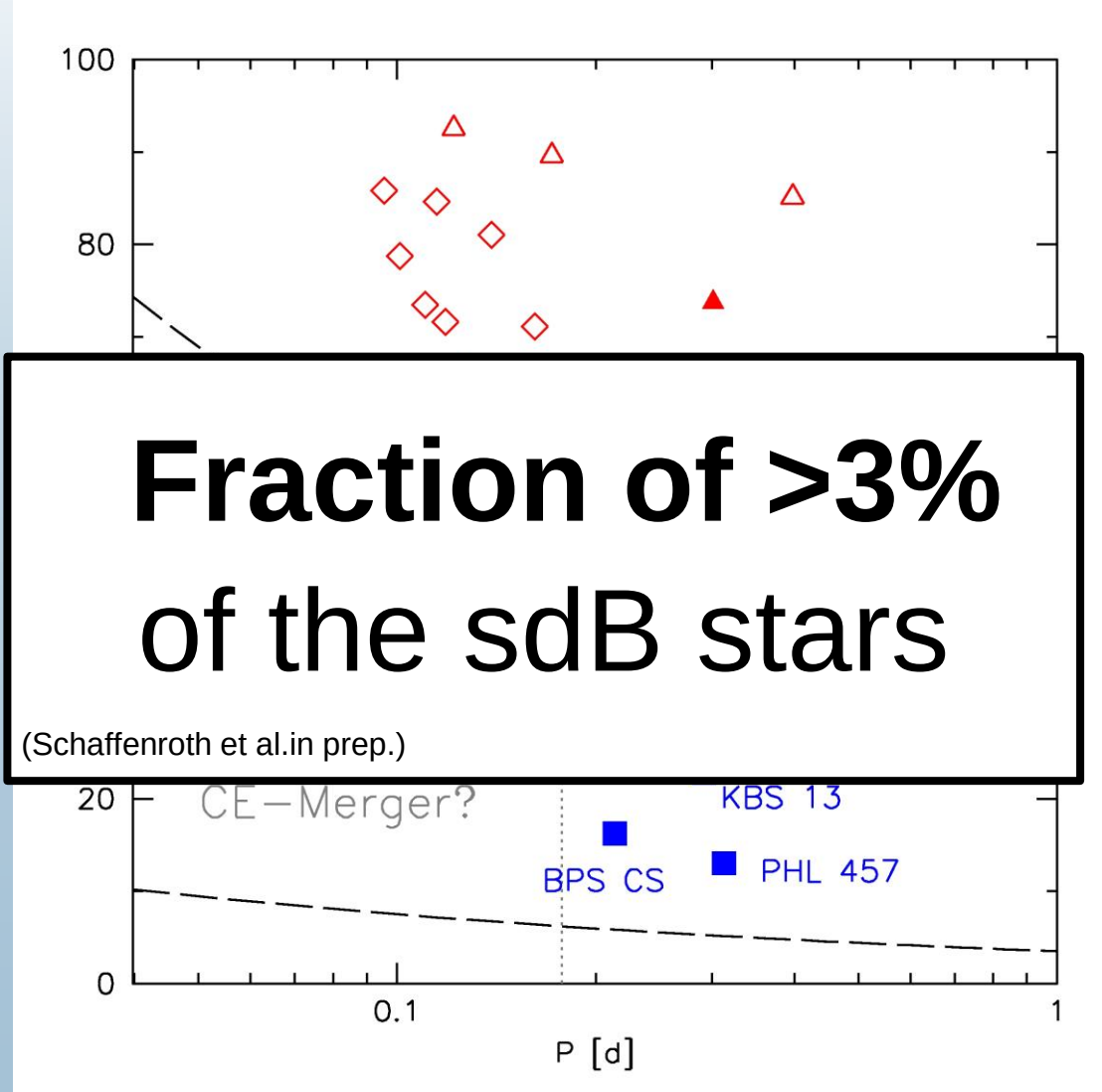
$M_2 > 28\ M_{Jup}$

Substellar companions



(Schaffenroth et al. 2014, A&A, 570, 70)

Substellar companions



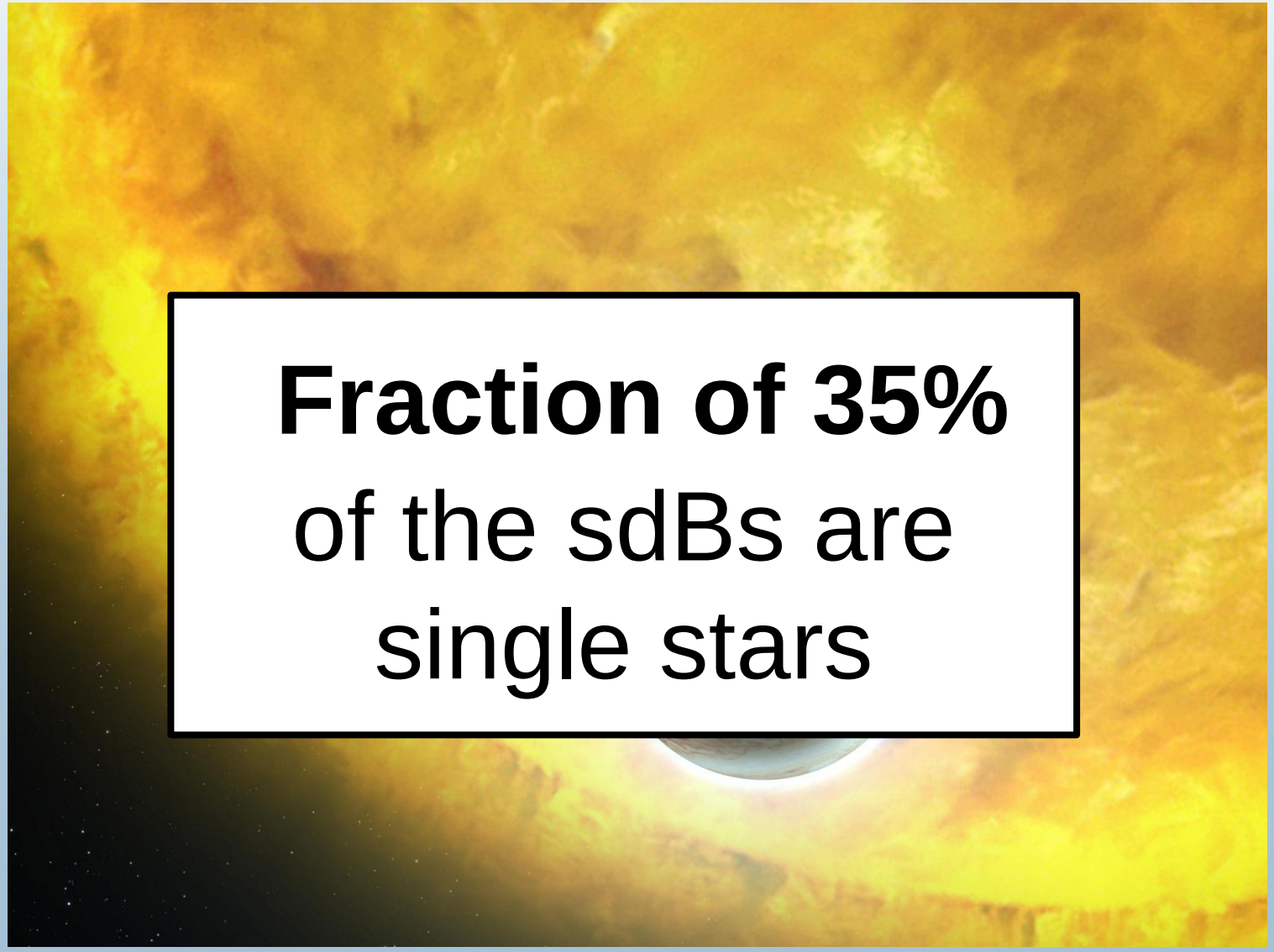
Fraction of >3%

of the sdB stars

(Schaffenroth et al.in prep.)

(Schaffenroth et al. 2014, A&A, 570, 70)

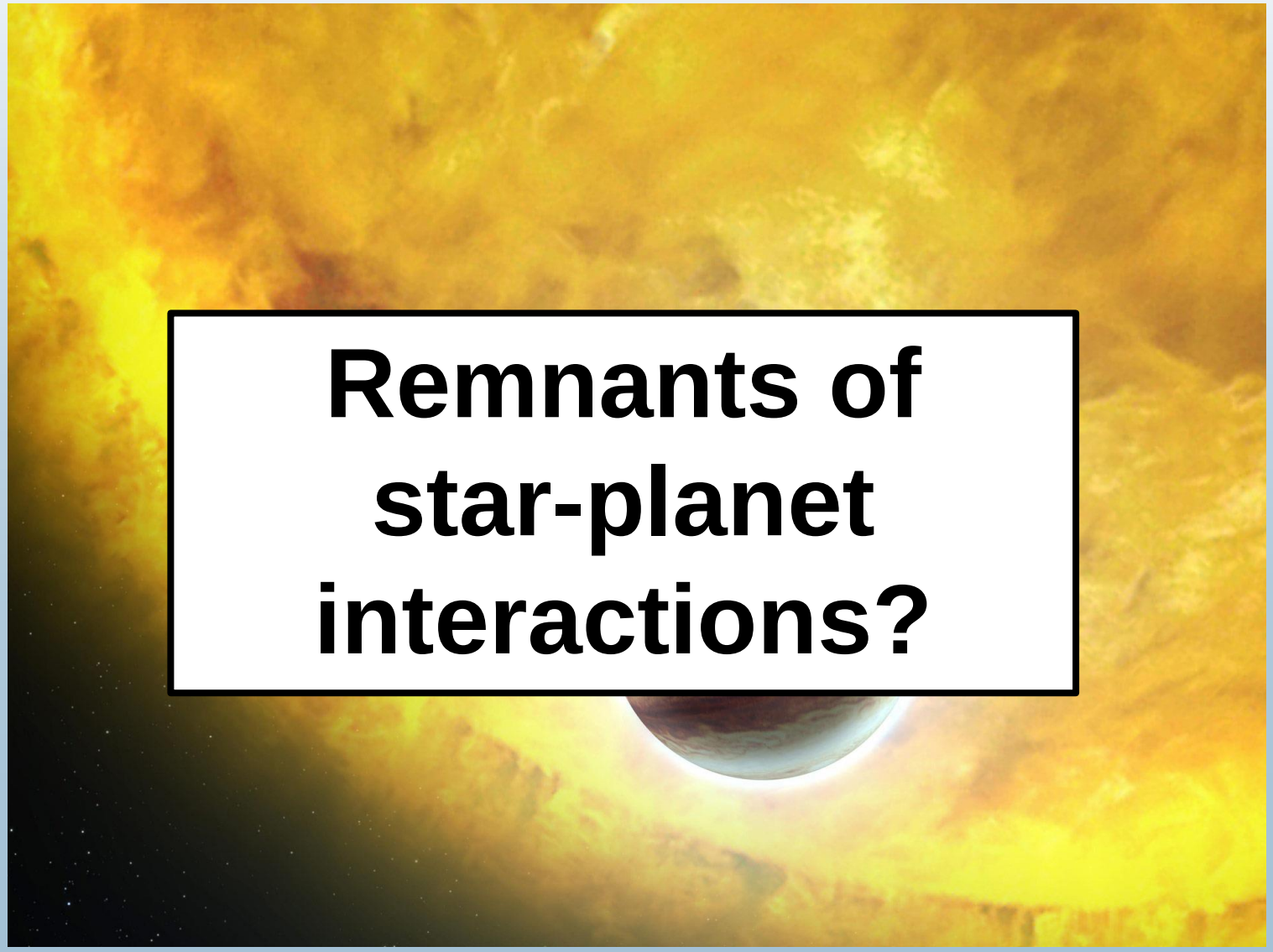
Hot subdwarfs & Planets?



Fraction of 35%
of the sdBs are
single stars

(NASA, ESA, and G. Bacon, STScI)

Hot subdwarfs & Planets?



(NASA, ESA, and G. Bacon, STScI)

Hot subdwarfs & Planets?

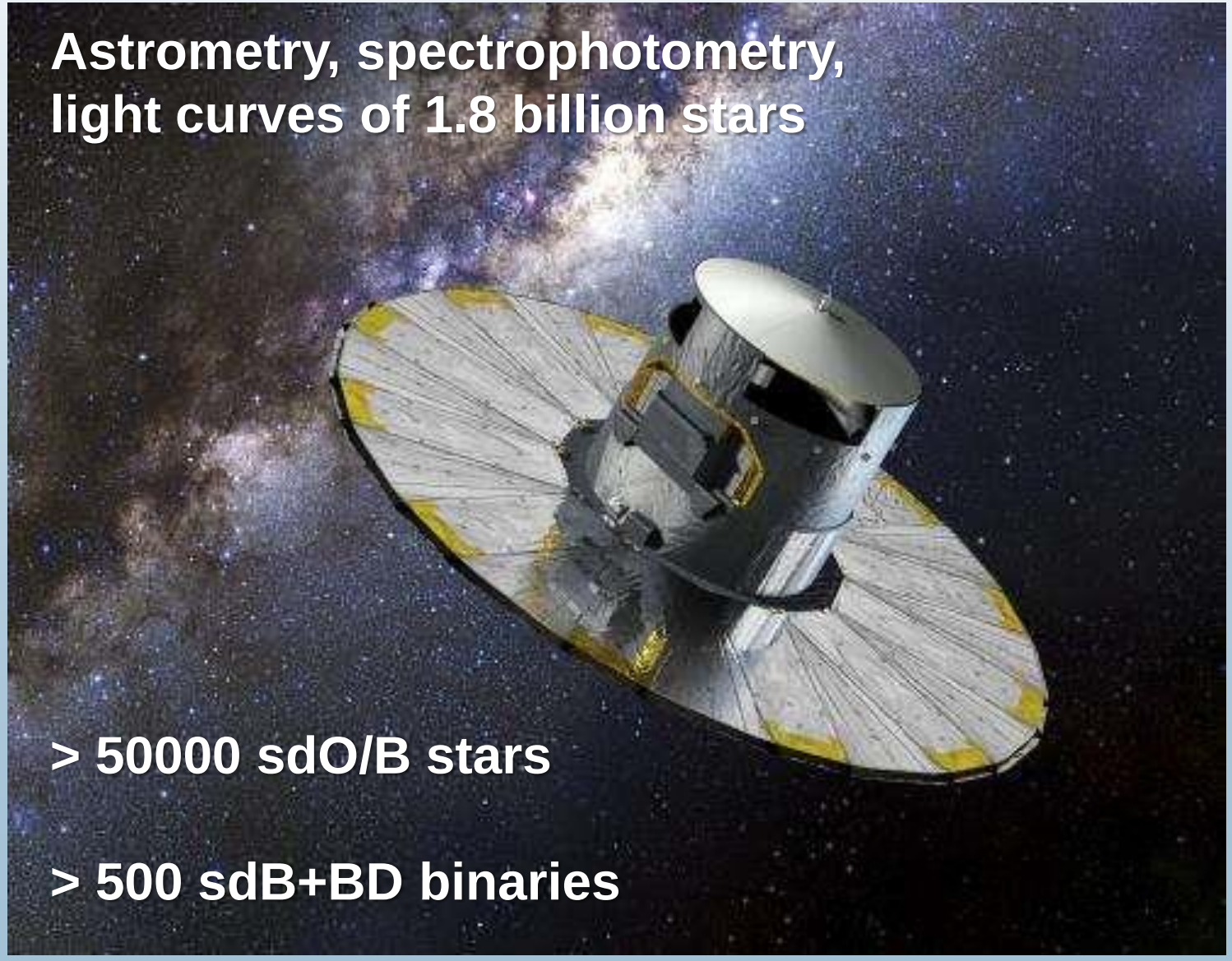
(NASA, ESA, and G. Bacon, STScI)

Data mining: New sdO/B catalogue

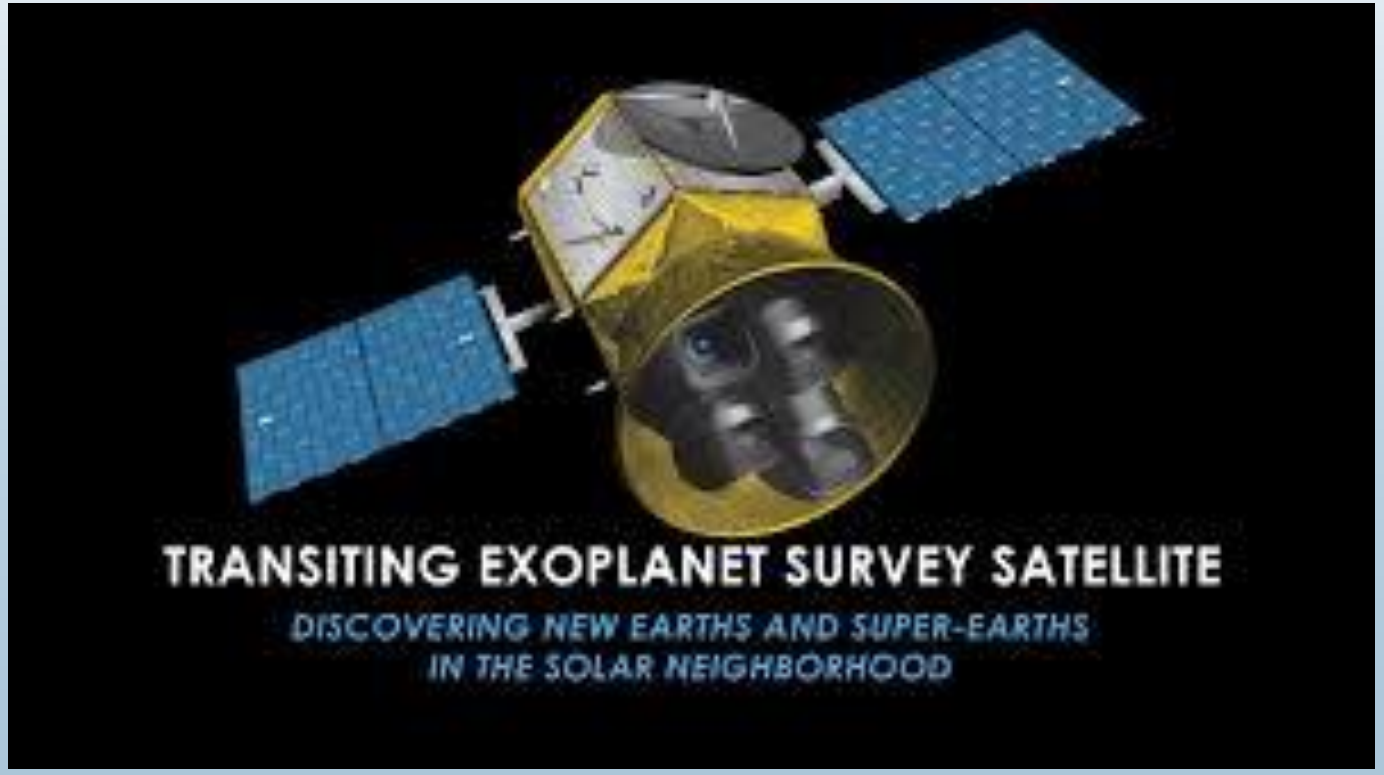
5613 unique sources (Geier et al. 2017, A&A, in press)

- Compilation of all known larger samples of sdOBs
  (sdOB database, GALEX, LAMOST, FBS, SDSS DR12 …)
- Multi-band photometry (GALEX, GSC, APASS, SDSS, VST, VISTA, UKIDSS, 2MASS, WISE)
- Proper motions (USNO-B1.0, SDSS, PPMXL, UCAC4, SPM4, APOP)
- Lightcurves checked for variability (SWASP, CRTS, PTF)
  >**40 variable stars found: 8 new HW Vir systems**
  (Kupfer et al. in prep.)
- 1500 sdO/Bs with atmospheric parameters, radial velocities and spectroscopic distances (MUCHFUSS, SPY, HE, HS, GALEX)

Hot subdwarfs & Gaia mission (2017-2022)

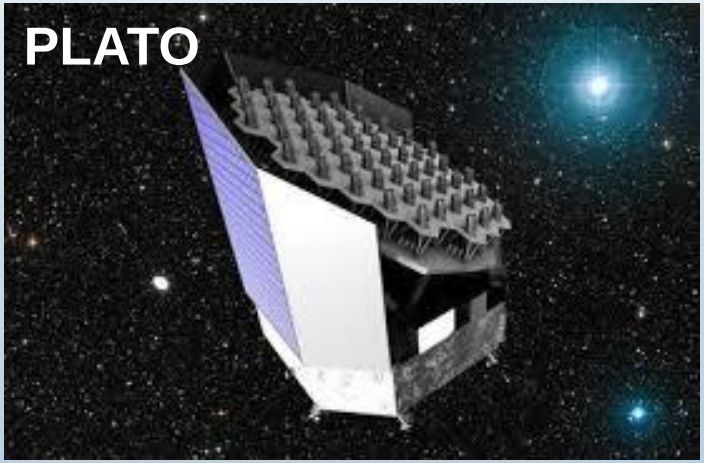


Hot subdwarfs & TESS (2018-2020)



Light curves of >1500 bright sdO/Bs
27 d duration, short-cadence

Hot subdwarfs & PLATO, LSST, WFIRST (mid 2020s)



Light curves, light curves, light curves …

Eclipsing Reflection Effect Binaries from the OGLE Survey

V. Schaffenroth, B. N. Barlow, S. Geier,
M. Vuckovic, U. Heber, S. Dreizler, T. R. Marsh,
D. Kilkenny, E. M. Green

Thank you!

Interested in working with us? Ask Veronika and me!