The 7th Sino-Thai Symposium on High Energy Physics, Astrophysics, Materials Science and Beyond

2026年10月11日至15日
Guilin, Guangxi

Searching for and Studying Multi-star Systems

Liying Zhu

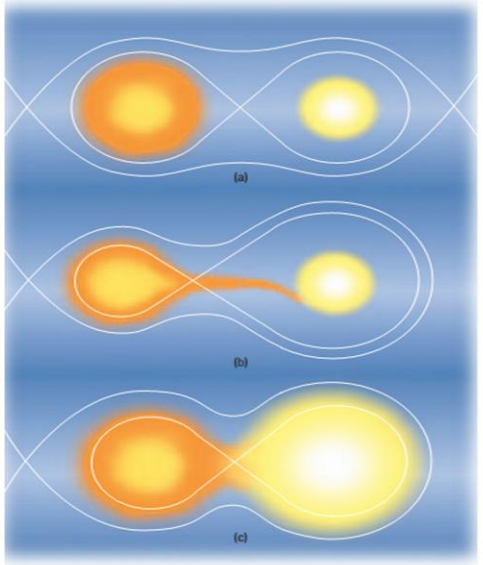
Yunnan Observatories, Chinese Academy of Sciences

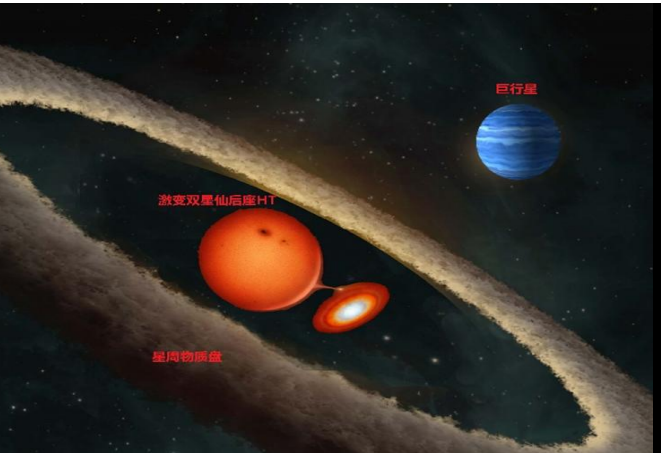
Collaborators: Shengbang Qian, Boonrucksar Soonthornthum, Ergang Zhao, Fangbing Meng, Wenxu Lin, Linjia Li, Nianping Liu and Xiao Zhou

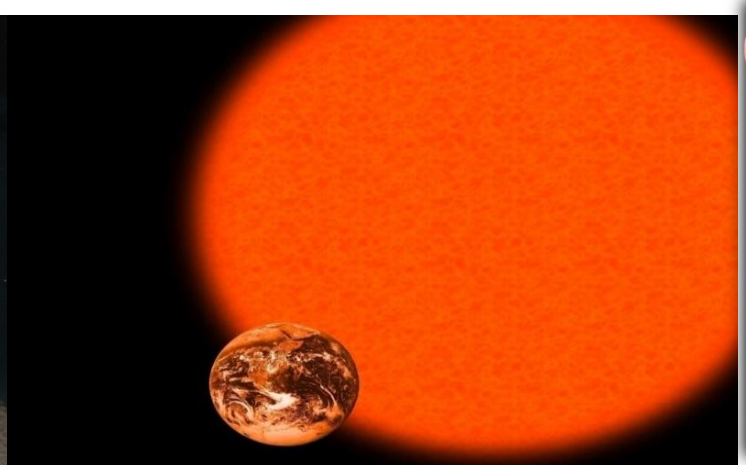


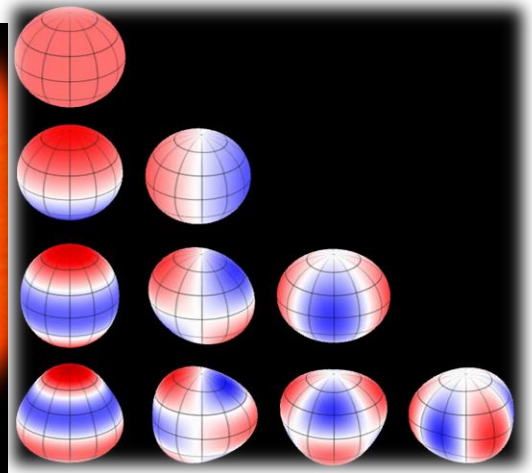
OUTLINE

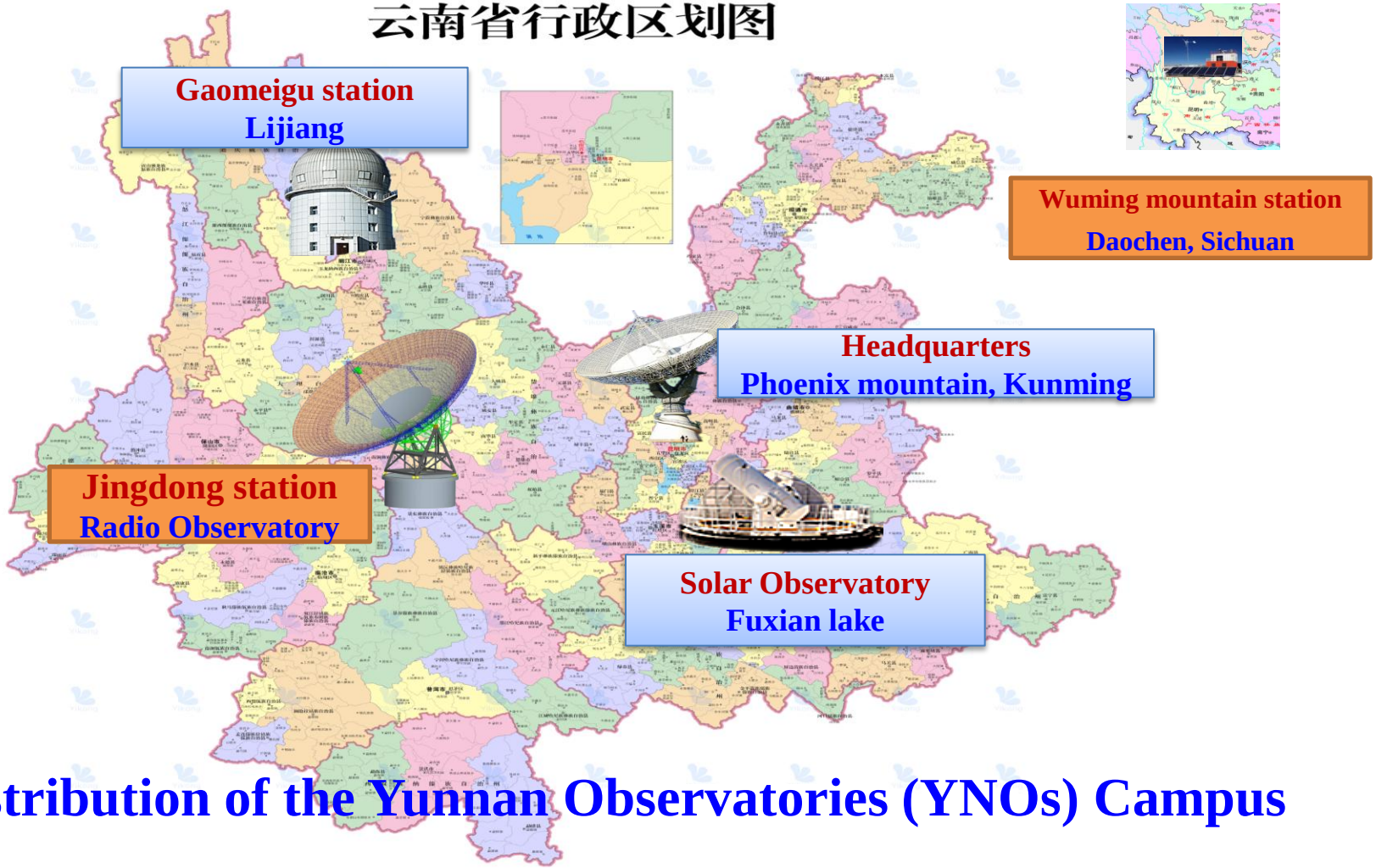
- **Brief introduction of YNOs**
- **Sino-Thai collaboration on astrophysics**
- **Recent achievements on multiple star Systems**











The distribution of the Yunnan Observatories (YNOs) Campus

Gaomeigu station, Lijiang

Telescopes:

2.4-m telescope

1.8-m telescope

1.6-m telescope

70-cm telescope

60-cm telescope

45-cm telescope

……









3.2-m vacuum coating machine

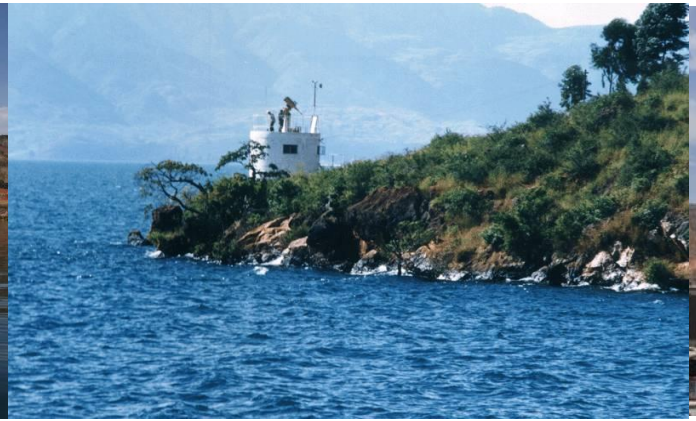






Solar observatory at Fu Xian lake









A radio observatory is now constructing in Jingdong county of Yunnan Province





A 120-m radio telescope: the world's largest fully steerable radio telescope

Wuming mountain station

Daochen, Sichuan

Station No.	Location	Altitude	Start Date
1	100°04′12″ E, 29°09′01″ N	4680 m	Oct. 2014
2	100°06′32″ E, 29°06′25″ N	4780 m	Dec. 2015



























Vice Dean of School of Physics and Astronomy, Yunnan University

- ✓ The Department of Astronomy at Yunnan University was established in 2013, making it the fifth university department of its kind in China.
- ✓ 1.6-m telescope Multi-channel Photometric Survey Telescope
- ✓ 1-meter telescope in Astronomical Observatory of Yunnan University
- ✓ 50-cm telescope array









Signing of the MOU

- The initial MOU between NARIT and YNOs was signed in Kunming in 2007.
- In 2015, CAS President Bai Chunli and the Minister of Science and Technology of Thailand witnessed the renewal of MOU in Bangkok and also **signed an agreement to jointly establish a cooperative research center between the two sides**








Sino-Thai Symposium on High Energy Physics, Astr
Nakhon Ratchasima, Thailand, July 30 – Au




NARIT





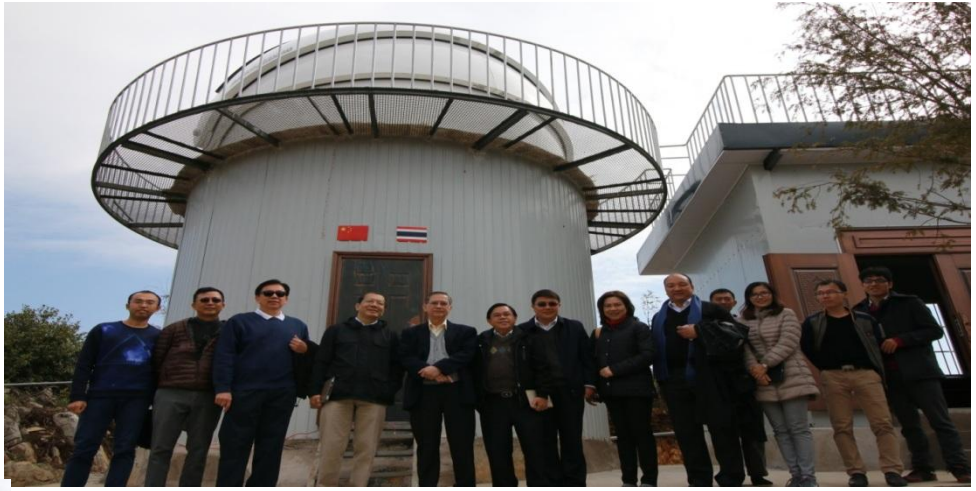

The First Sino-Thai Research Project Meeting

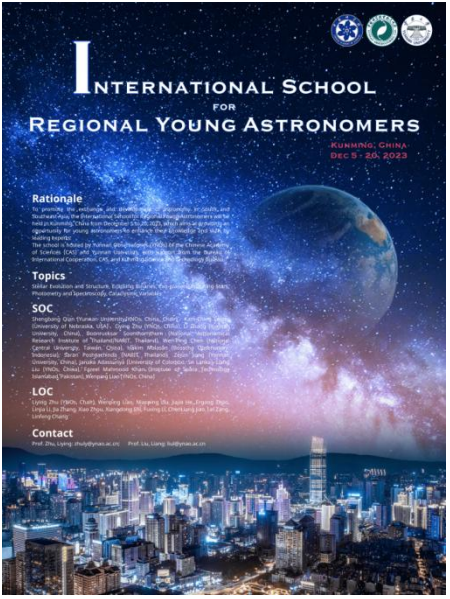

หอดูดาวมหาวิทยาลัยราชภัฏเชียง


between YNAO and NARIT



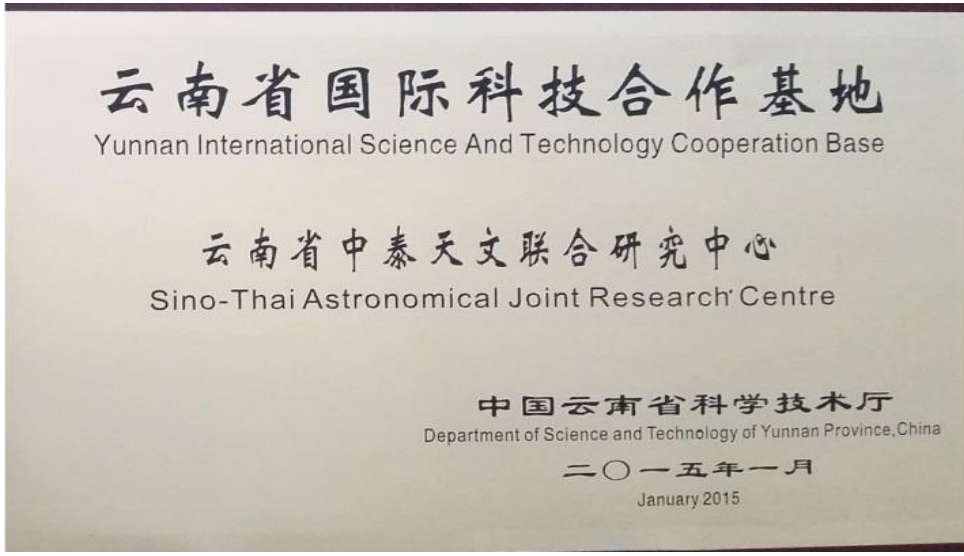
- **Establish the Sino-Thai Joint Astronomical Research Center**
- **Construct the Sino-Thai 70cm Telescope**
- **Train regional young astronomers**











Main topic:

Variable stars

cooperated to publish

more than 80 SCI papers

The Astrophysical Journal Letters, 798:L42 (4pp), 2015 January 10 doi:10.1088/2041-8205/798/2/L42
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SDSS J001641-000925: THE FIRST STABLE RED DWARF CONTACT BINARY WITH A CLOSE-IN STELLAR COMPANION

S.-B. Qian[1,2,3], L.-Q. Jiang[1,2,3], E. Fernández Latús[4,5,7], B. Soonthornthum[6], L.-Y. Zhu[1,2,3], E. G. Zhao[1,2], J.-J. He[1,2], W.-P. Liao[1,2], J.-J. Wang[1,2,3], L. Liu[1,2,3], S. Rattanasoon[6], S. Aukkaravittayapun[6], X. Zhou[1,2,3], and N. P. Liu[1,2]
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Received 2014 October 20; accepted 2014 December 16; published 2015 January 6

ABSTRACT

SDSS J001641-000925 is the first red dwarf contact binary star with an orbital period of 0.19856 days that is one of the shortest known periods among M-dwarf binary systems. The orbital period was detected to be decreasing rapidly at a rate of $\dot{P} \sim$ [illegible] yr^{-1}. This indicated that SDSS J001641-000925 was undergoing coalescence via a dynamical

The Astronomical Journal, 129:2806–2814, 2005 June
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DEEP, LOW MASS RATIO OVERCONTACT BINARIES. II. IK PERSEI

L.-Y. Zhu,[1,2,3] S.-B. Qian,[1,2] B. Soonthornthum,[4] and Y.-G. Yang[1,2,3]
Received 2004 November 8; accepted 2005 March 10

ABSTRACT

BV photometric light curves of the eclipsing binary IK Per were obtained during three nights in 2002 December. The photometric elements were computed using the Wilson-Devinney code. The results reveal that IK Per is an A-type overcontact binary system with a low mass ratio of $q = 0.17$ and a large degree of overcontact of 60%. The asymmetry of the light curves (i.e., the O'Connell effect) is explained by spot models. The observed long-term orbital period decrease [$dP/dt = -(2.5 \pm 0.09) \times 10^{-7}$ days yr^{-1}] is probably influenced by the presence of a third body in the system. The low mass ratio, high degree of overcontact, and secular orbital decrease all indicate that the situation of IK Per resembles those of FG Hya, GR Vir, and AW UMa. Because of the decrease of their orbital periods, the shrinking of the inner and outer critical Roche lobes will lead the common envelopes to overlap more,

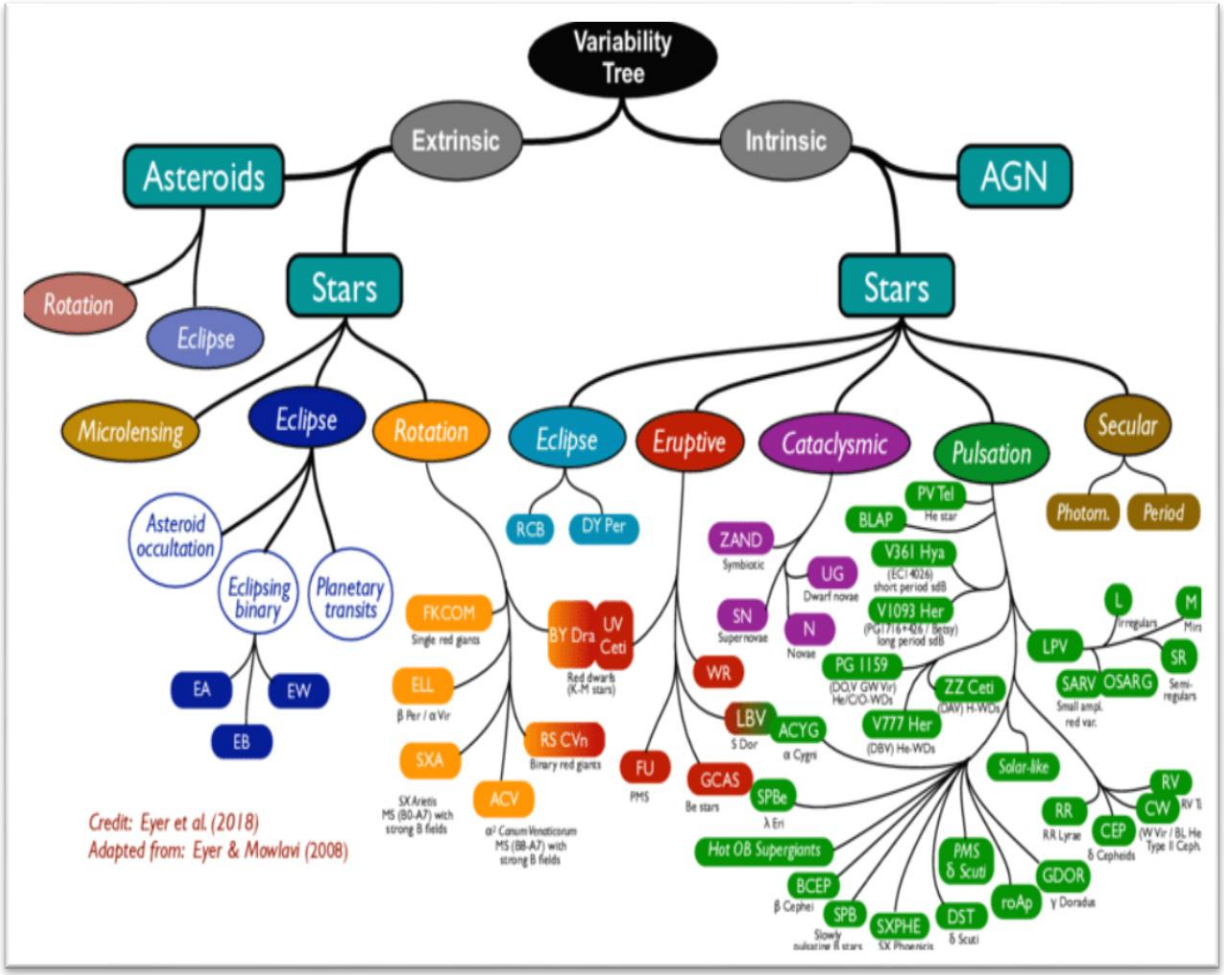
The Astrophysical Journal Letters, 871:L10 (6pp), 2019 January 20 https://doi.org/10.3847/2041-8213/aafc2e
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Two Massive Twins in a Deep-contact Binary with a Black Hole Candidate

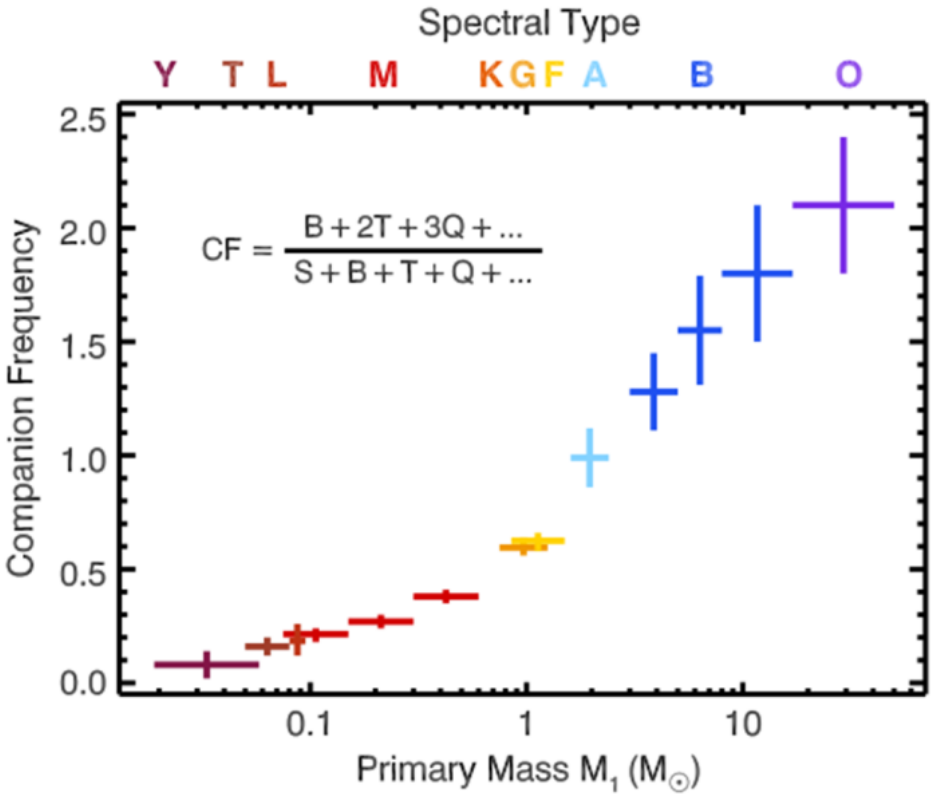
Zhao Er-gang[1,2,3], Qian Sheng-bang[1,2,3,4], Boonrucksar Soonthornthum[5], Saran Poshyachinda[5], Zhou Xiao[1,2,3,5], Thawicharat Sarotsakulchai[5], Zhang Jia[1,2,3], and Liao Wen-ping[1,2,3]
[1] Yunnan Observatories, Chinese Academy of Sciences(CAS), P.O. Box 110, 650216 Kunming, People's Republic of China; zergang@ynao.ac.cn
[2] Key Laboratory of the Structure and Evolution of Celestial Objects, CAS, Kunming 650216, People's Republic of China
[3] Center for Astronomical Mega-Science, CAS, 20A Datun Road, Chaoyang District, Beijing, 100012, People's Republic of China
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[5] National Astronomical Research Institute of Thailand, Ministry of Science and Technology, BangKok, Thailand
Received 2018 August 24; revised 2018 December 24; accepted 2019 January 4; published 2019 January 22

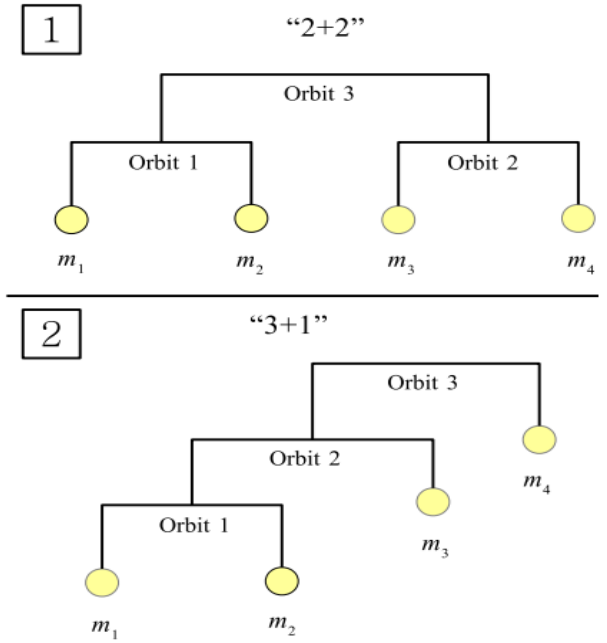
Abstract

New light curves in *B*, *V*, *R*, and *I* bands for the B-type contact binary V593 Cen were obtained, and another *V*-band light curve was collected from All Sky Automated Survey data. We analyzed these two sets of light curves using the

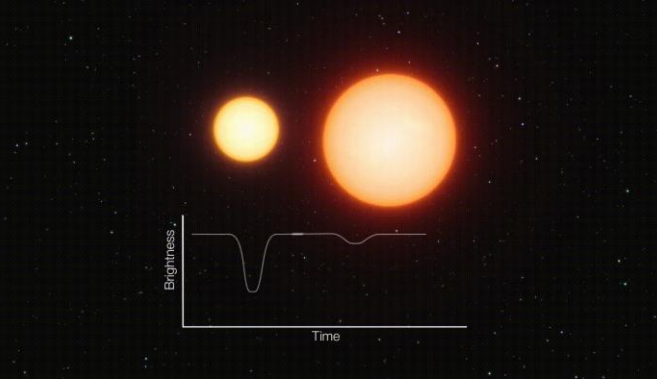


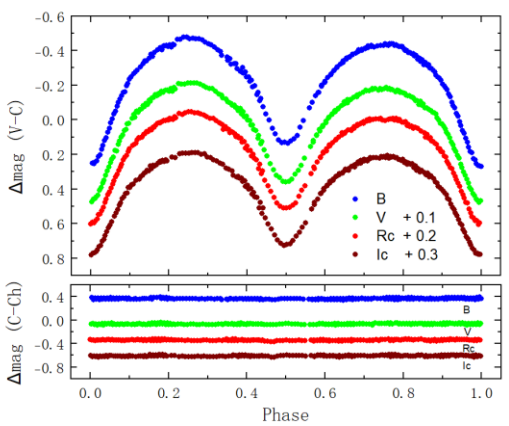
Multiplicity Dependence on Spectral Type

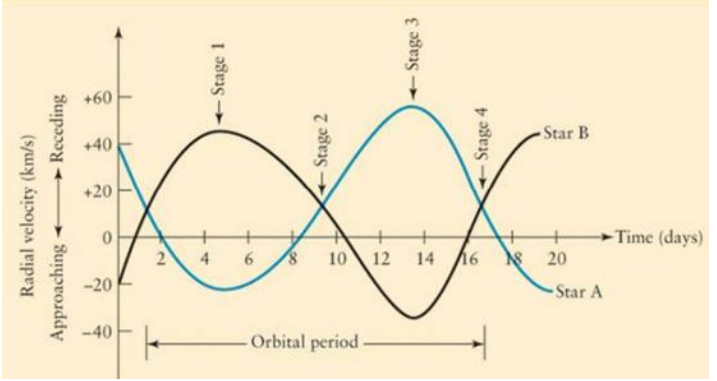




Stella S. R. Offner, et al (2022)



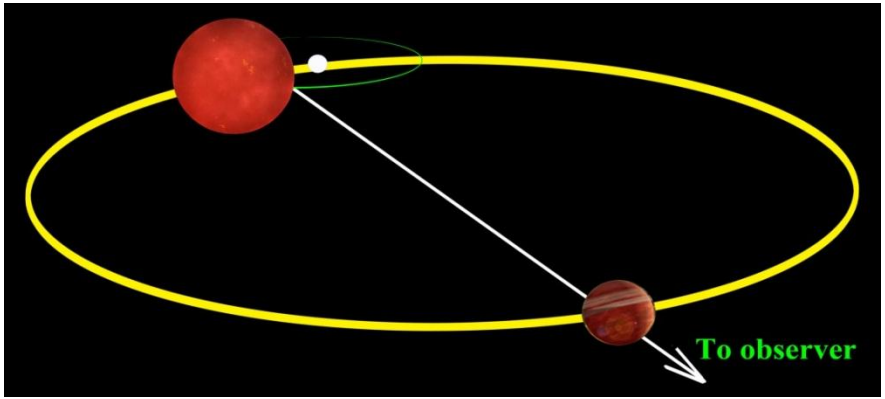


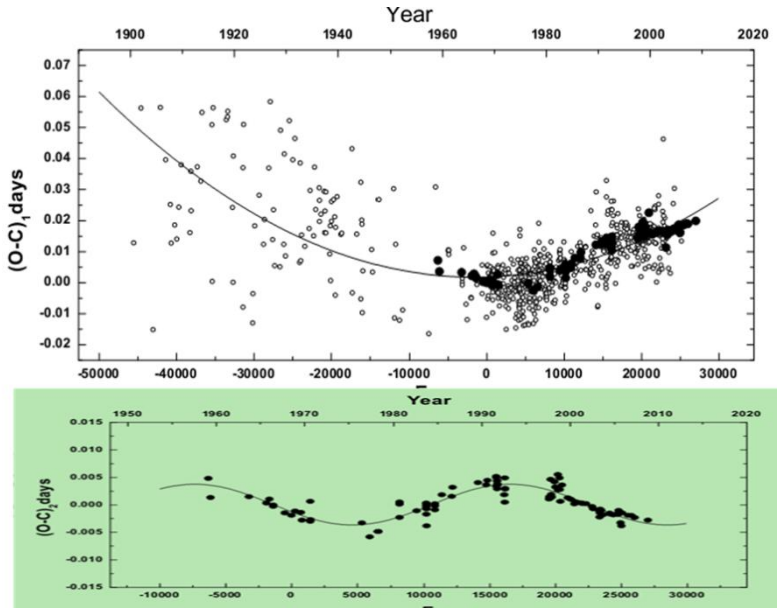


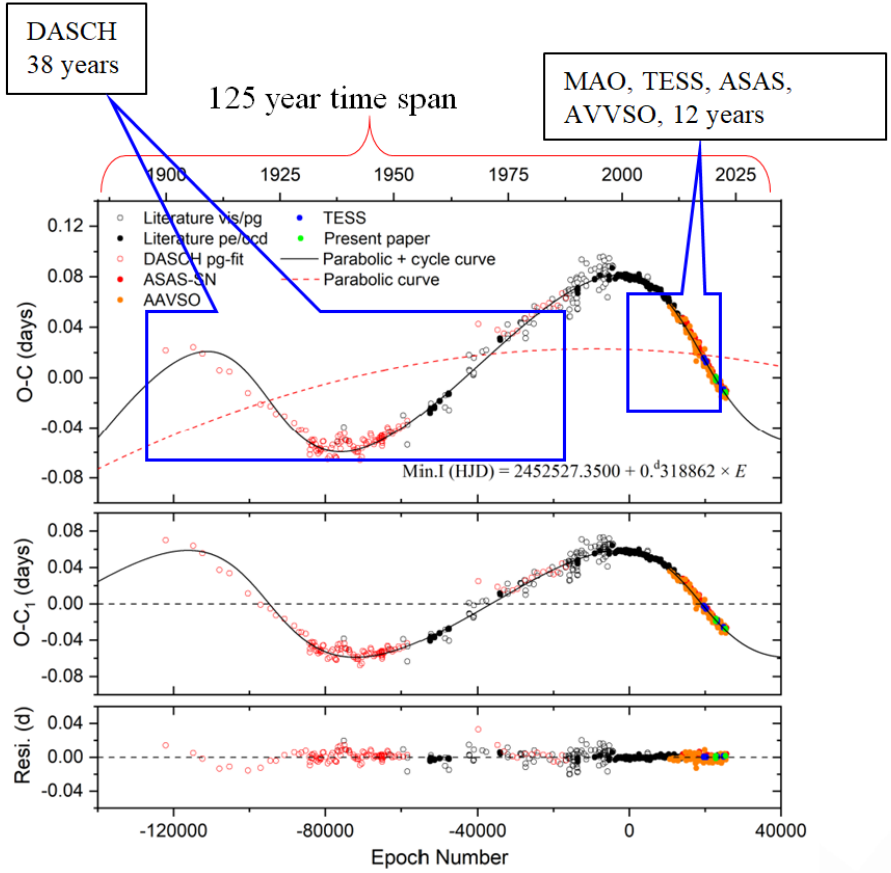
The scheme of directly derivable entities for EBs

	Only LC	Only RV SB1	Only RV SB2	LC RV SB1	LC RV SB2	Only $O-C$ LITE	Only $O-C$ Apsid.	Astrom.	LITE + Astrom.	LITE Apsid. Astrom.
$a_1 \sin i$ or $a_2 \sin i$		✓	✓	✓	✓					
$a \sin i$, $a_1 \sin i$, $a_2 \sin i$, $M_1 \sin^3 i$, $M_2 \sin^3 i$			✓		✓					
a, a_1, a_2, M_1, M_2, R_1, R_2, $\mathcal{L}_1$, $\mathcal{L}_2$, d				(✓)	✓					
P, e, ω, $(\dot{\omega})$	✓	✓	✓	✓	✓		✓			✓
γ		✓	✓	✓	✓					
q	(✓)		✓	(✓)	✓					
i, $\frac{R_1}{a}$, $\frac{R_2}{a}$, L_1/L_2, g_1, g_2, A_1, A_2, F_1, F_2, x_1, x_2, l_3	✓			✓	✓					
T_2	✓	?	?	✓	✓					
JD_0, P	✓	✓	✓	✓	✓	✓	✓		✓	✓
p_3, T_0, A_3, ω_3, e_3, $f(M_3)$, $M_{3,min}$						✓			✓	✓
p_3, T_0, ω_3, e_3, i_3, Ω_3, a_3''								✓	✓	✓
M_3, D									✓	✓

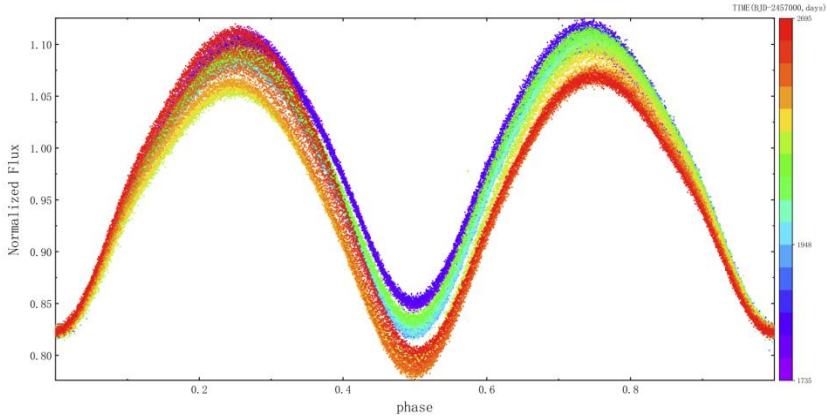
DASCH（Digital Access to a Sky Century @ Harvard）

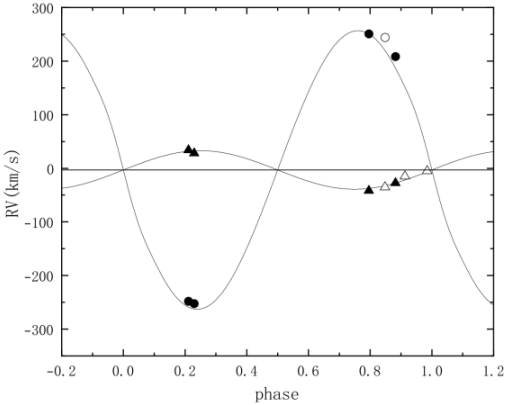


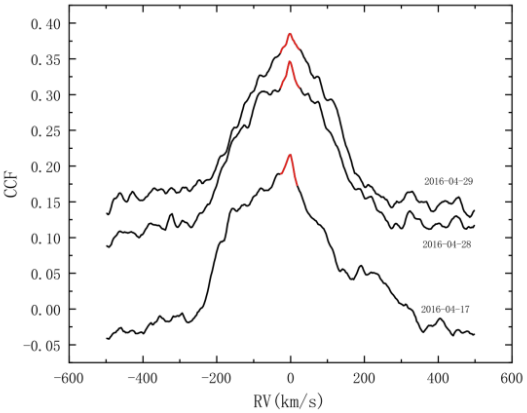


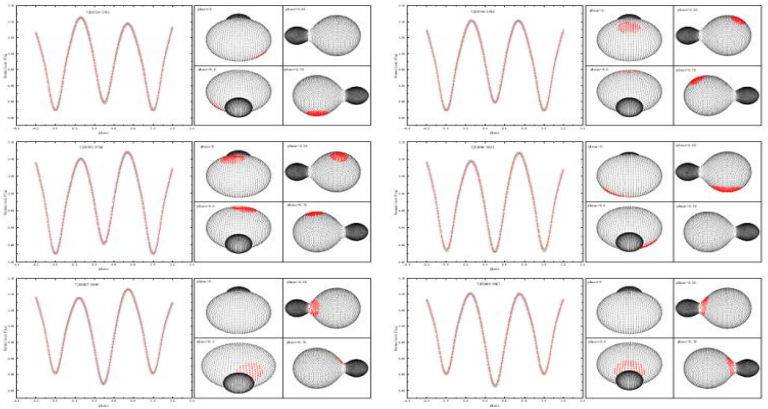


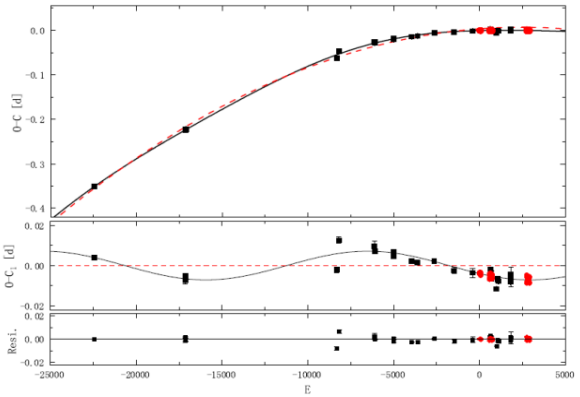
Hierarchical triple systems: NY Boo q=0.14; f=73%; (LC + RV + LTTE+ L3)

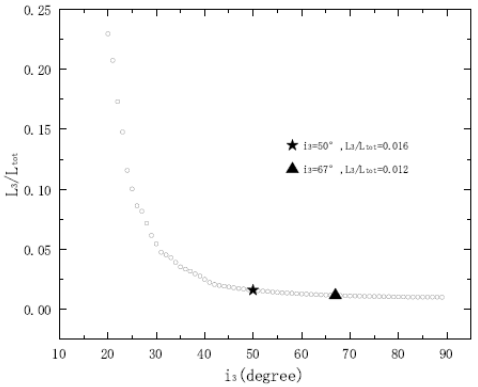








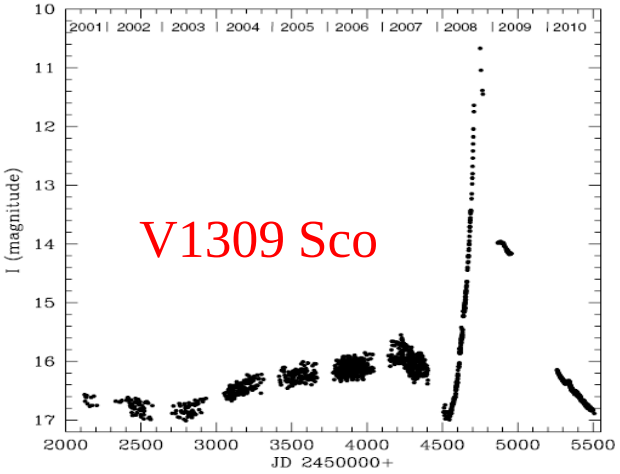


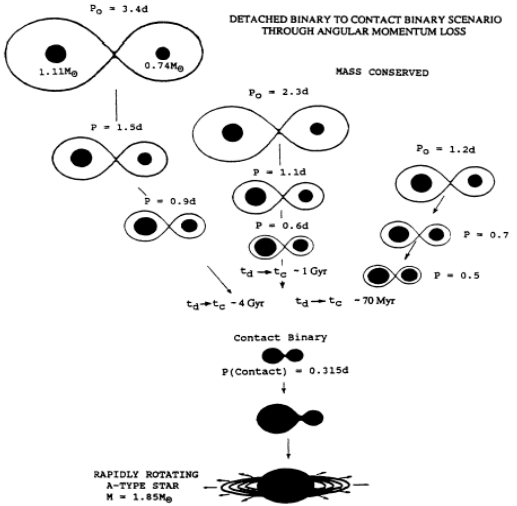


Meng Zhu et al., 2023ApJ...954..111

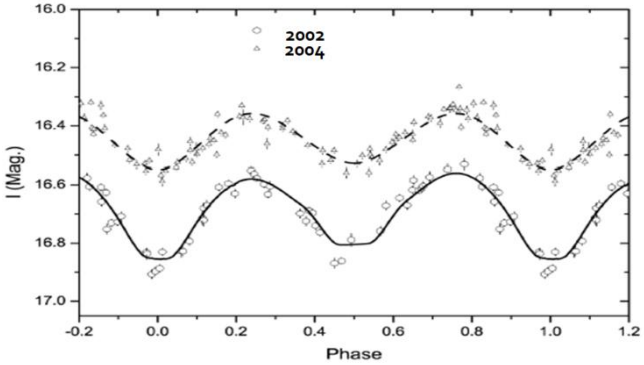
Contact binary towards merger

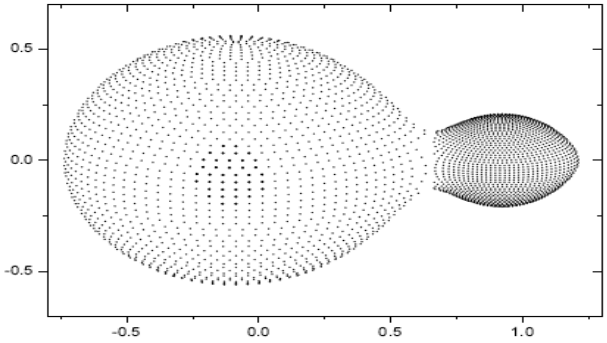
- **V1309 Sco： luminous red nova，first observed and confirmed case of a stellar merger.**
- **Progenitor: contact binary star system: f=90%， q~0.094**





Bradstreet, D. H. & Guinan, E. F., 1994

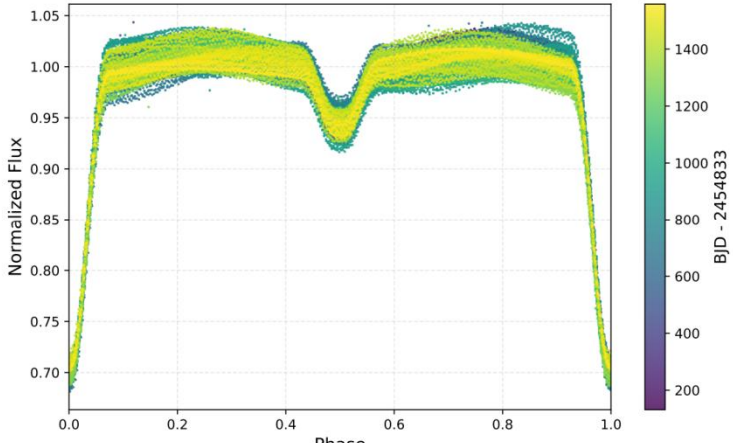


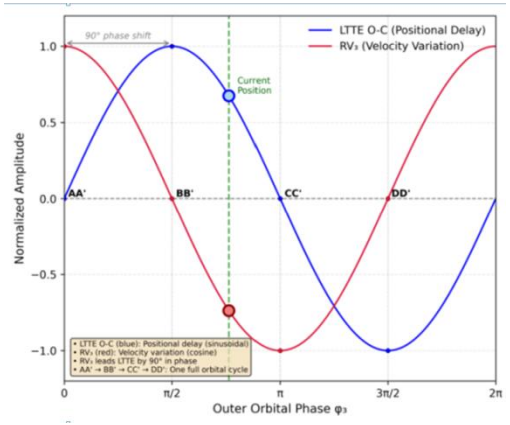


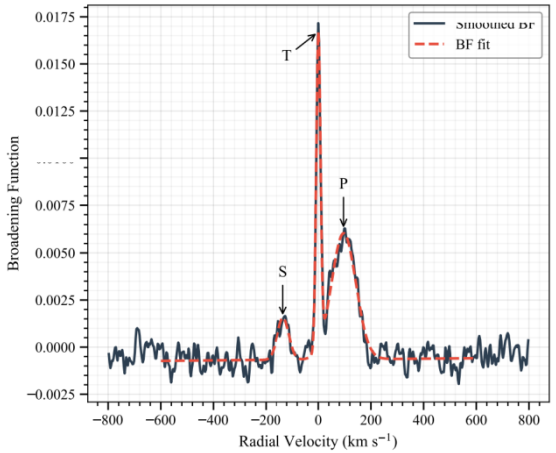


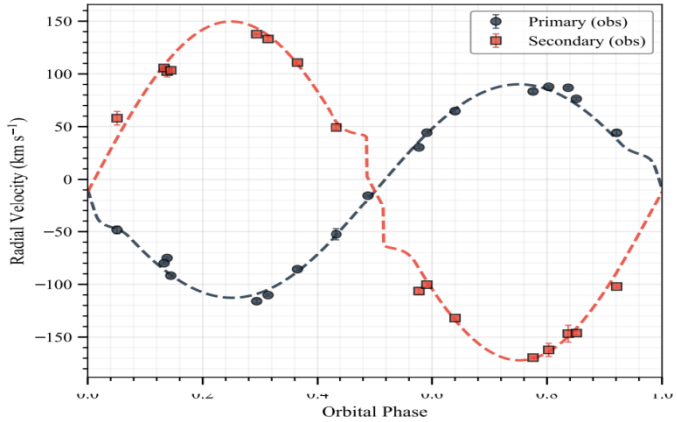
Tylenda et al., 2011, Zhu et al.,2016

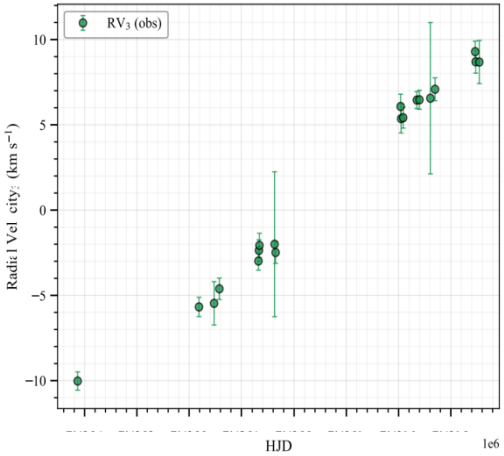
KIC6464285(LC + RV + LTTE+ RV3)

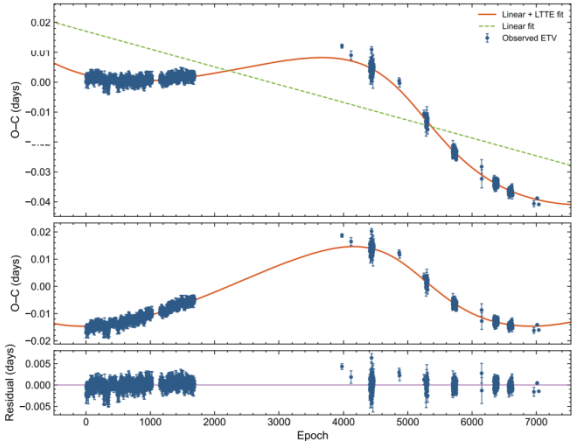






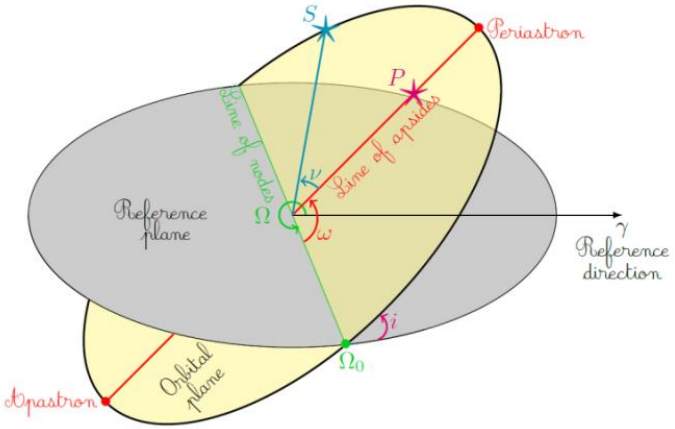


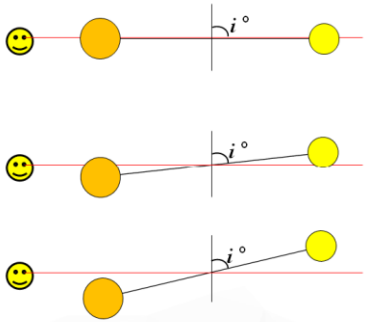


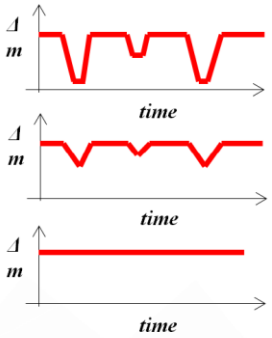


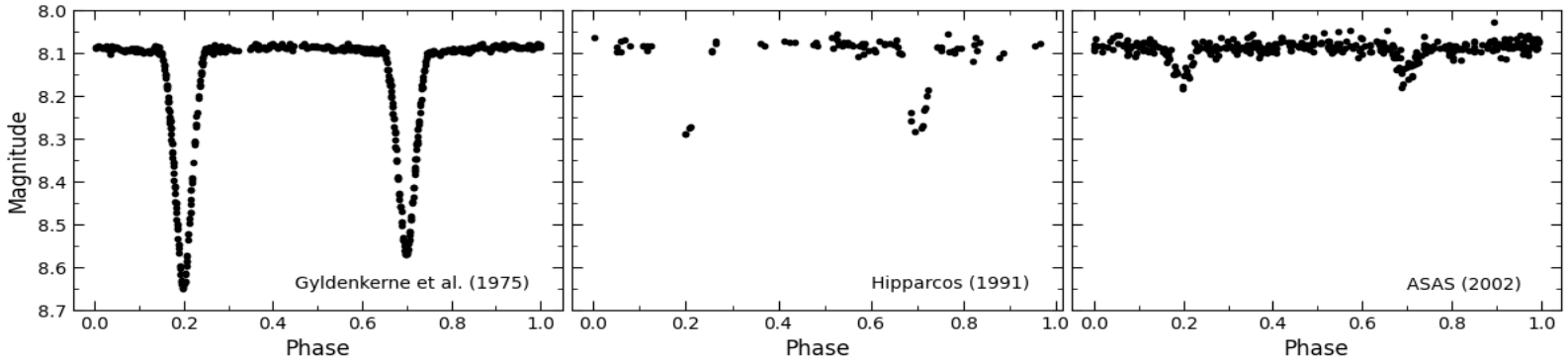
Meng Zhu et al., 2026ApJ...1003..133

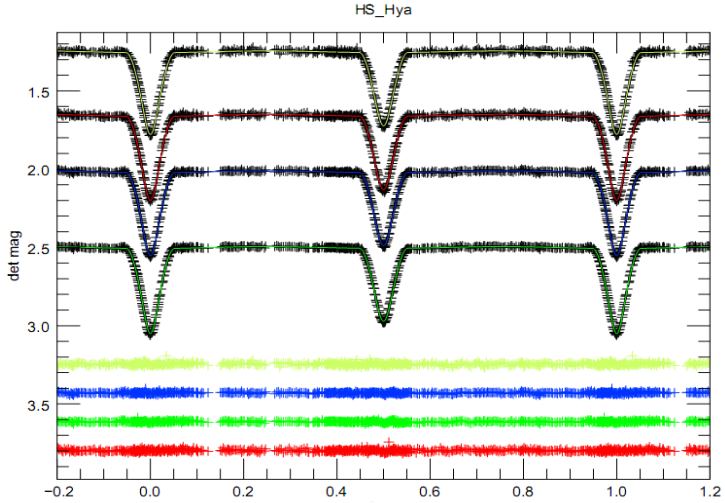
Nodal line precession by a tertiary companion

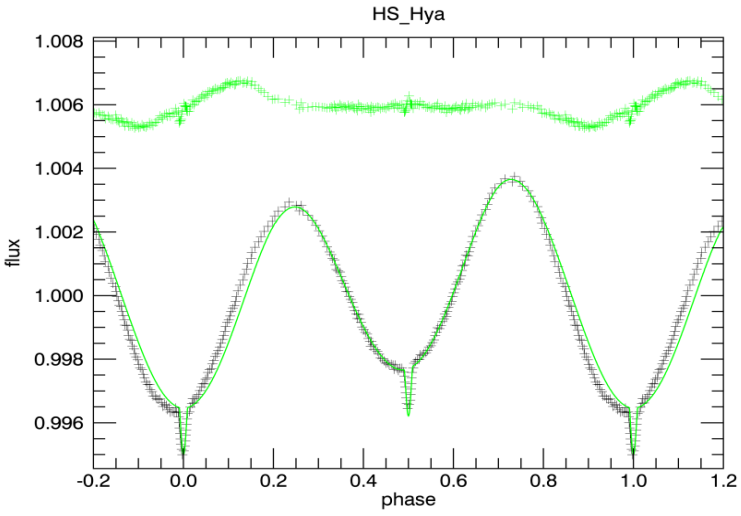


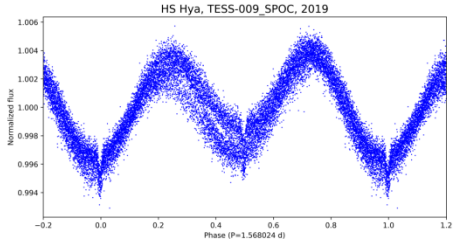


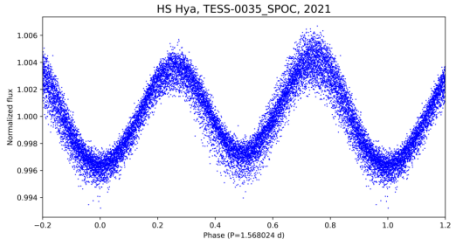


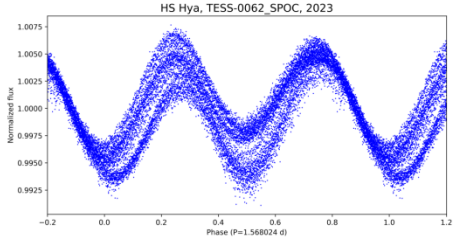


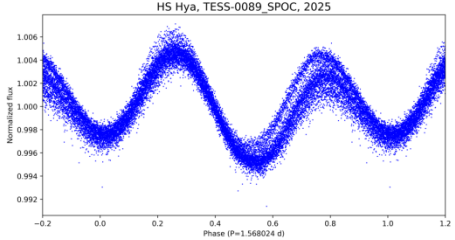


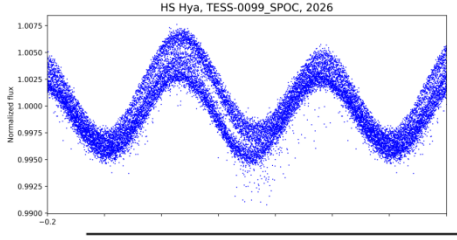


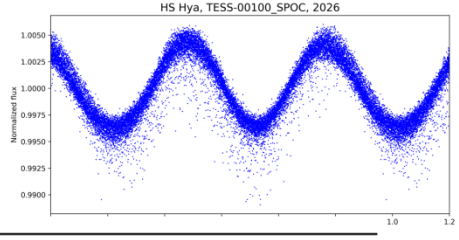






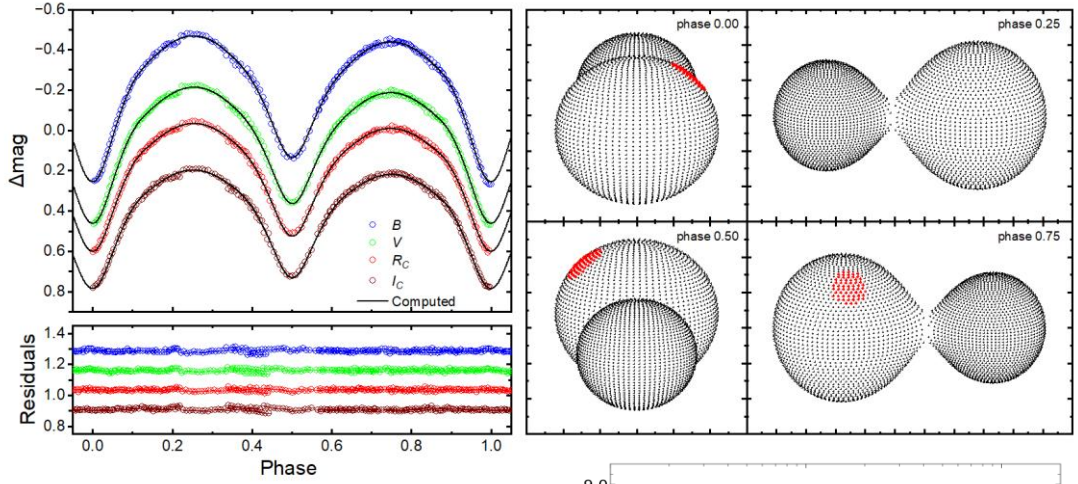


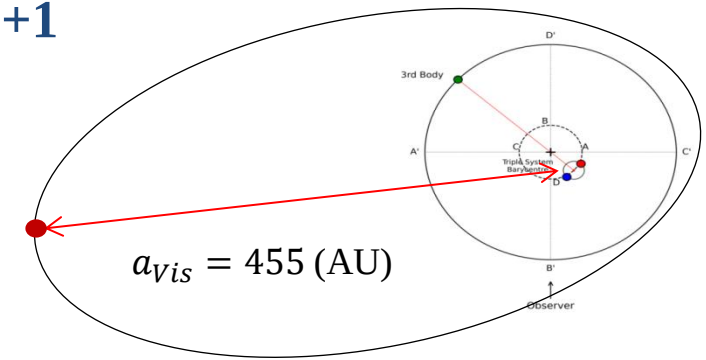


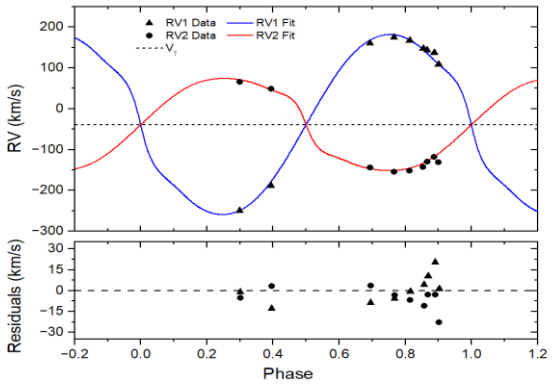


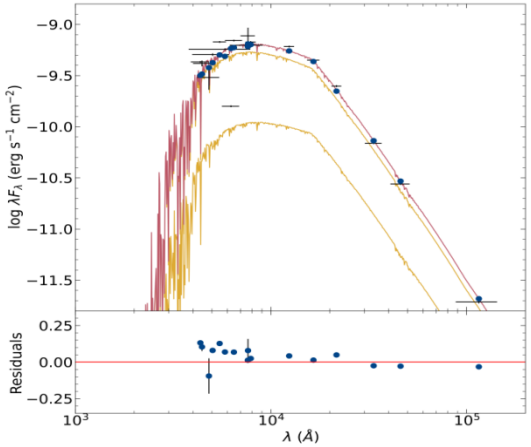
Year	Dataset	i (deg)
Strohmeier et al. (1965)	1964	88.9 ± 1.1
Gyldenkerne et al. (1975)	1972	85.56 ± 0.15
Zasche et al. (2012) Hipparcos	1991	79.55 ± 0.24
Zasche et al. (2012) ASAS (epoch 1)	2002	76.06 ± 0.21
Zasche et al. (2012) ASAS (epoch 2)	2005	74.87 ± 0.34
Zasche et al. (2012) ASAS (epoch 3)	2008	74.19 ± 0.48
Matekov et al. (2023a) TESS (Sector-09)	2019	73.1 ± 0.1

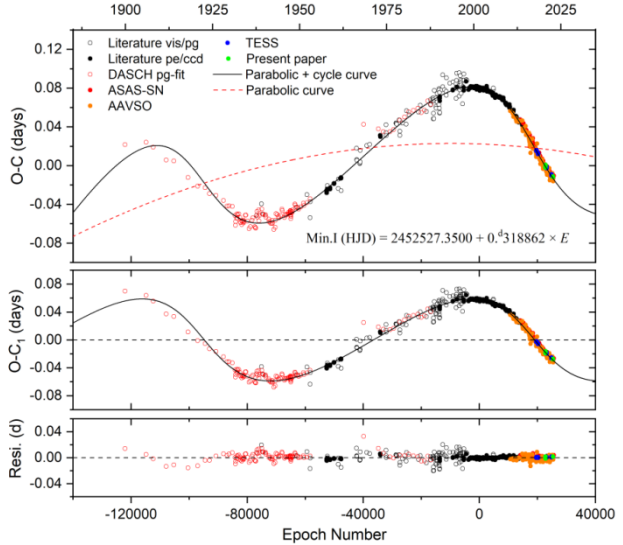
Hierarchical quadruple star system: CW Cas 2+1+1





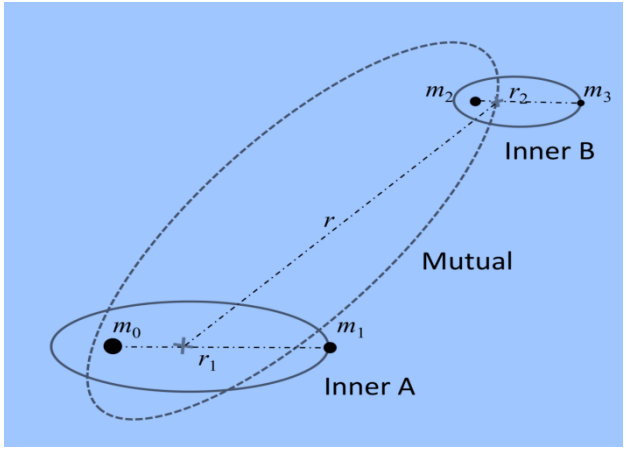


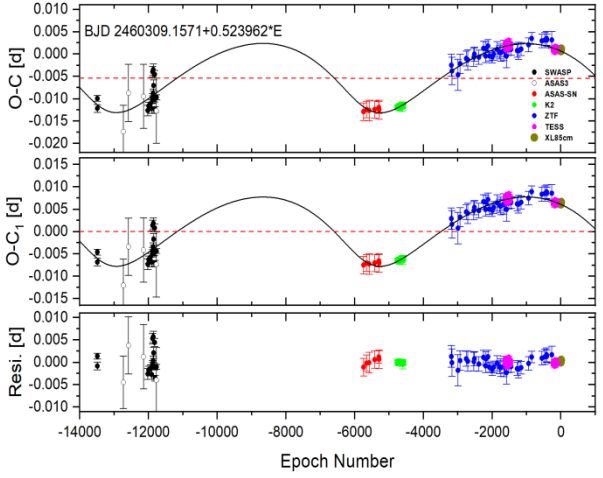


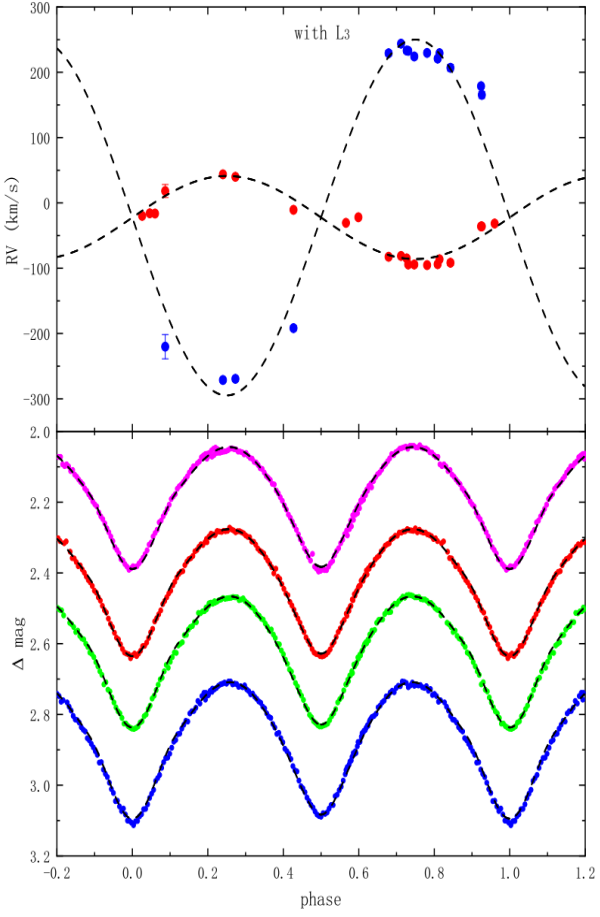


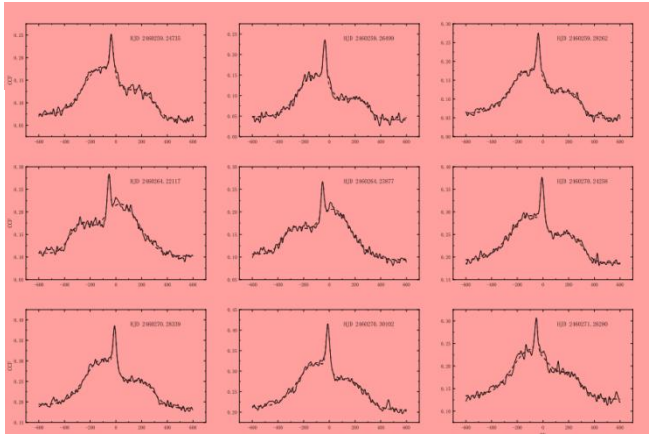
Matekov, Zhu et al.,2026ApJ...999..39

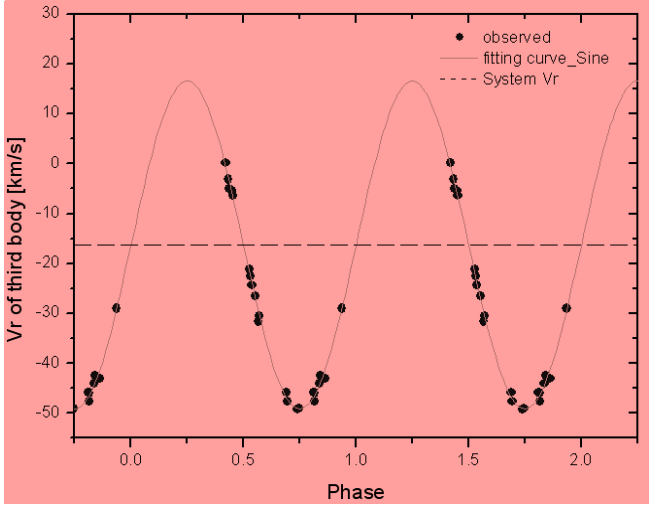
Quadruple 2+2 System





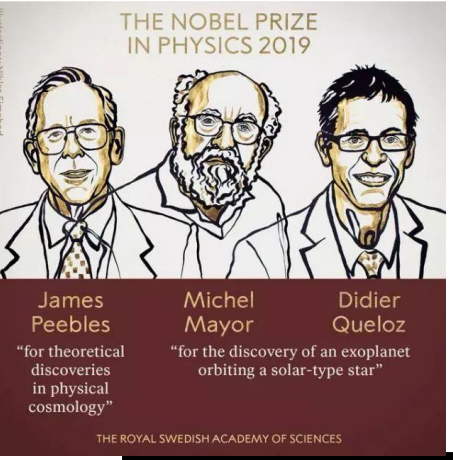




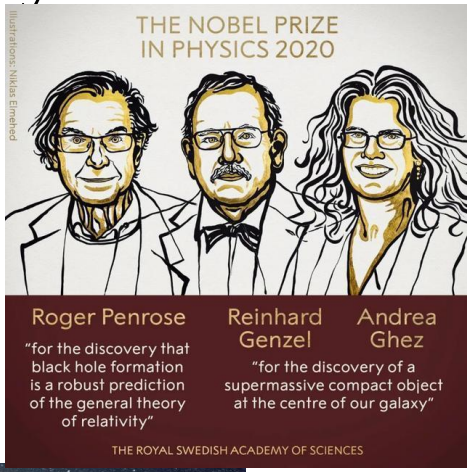


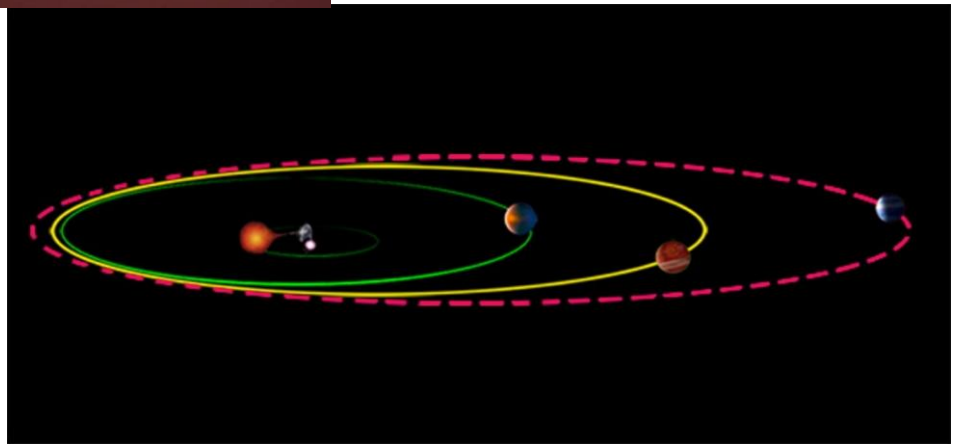
Zhu et al., 2026 prep.

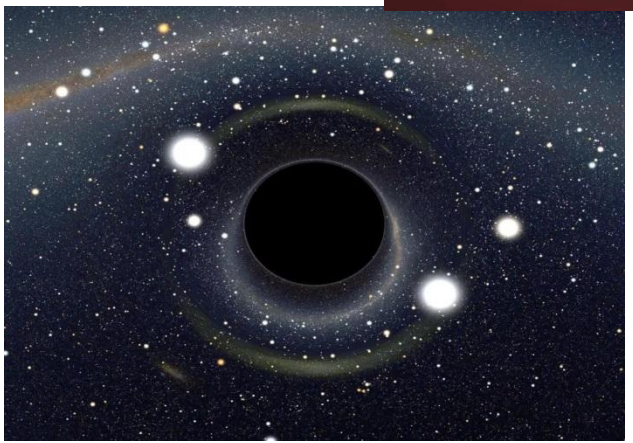
The detection of **black holes and exoplanets** is currently one of the frontier hot topics in today's astrophysics



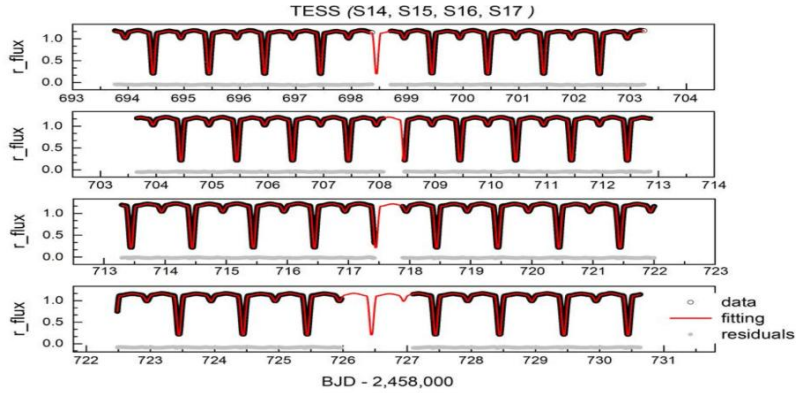
- According to theoretical predictions, there could be hundreds of millions of stellar-mass black holes in the Milky Way galaxy, but fewer than a hundred have been discovered so far.
- Most exoplanets discovered to date orbit around single stars, with very few orbiting binary stars; Moreover, exoplanets orbiting early type stars are also rare systems.

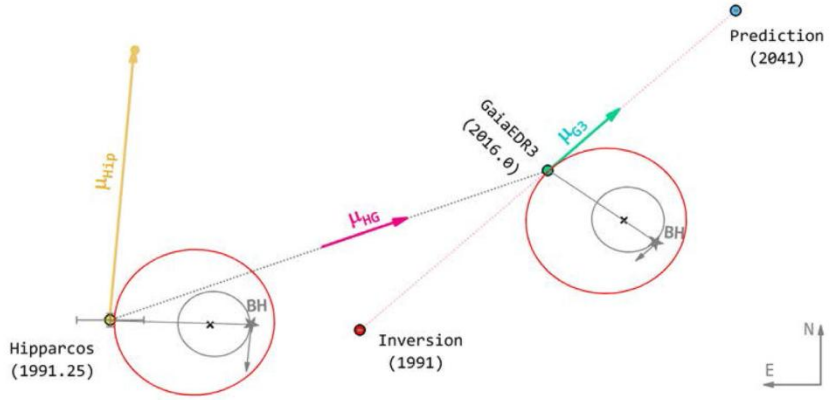


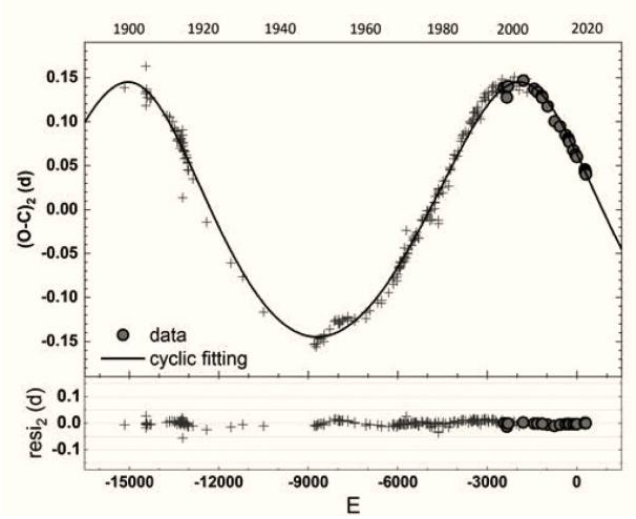


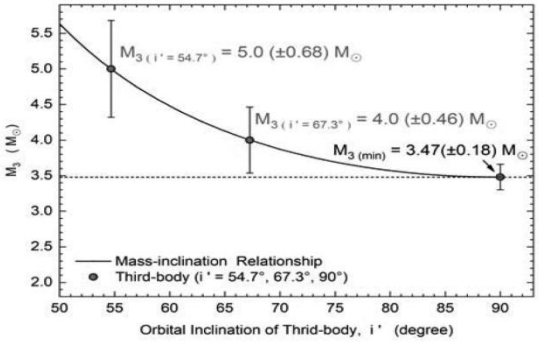


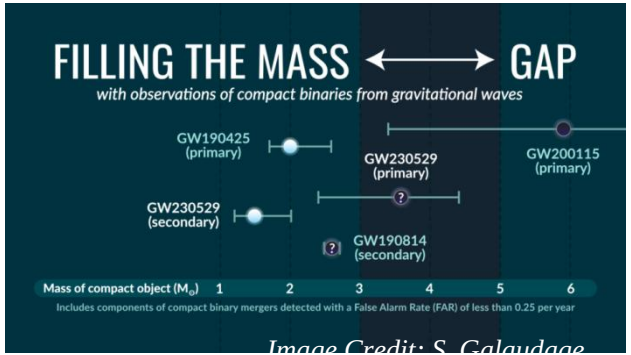
RR Dra — Algol + BH





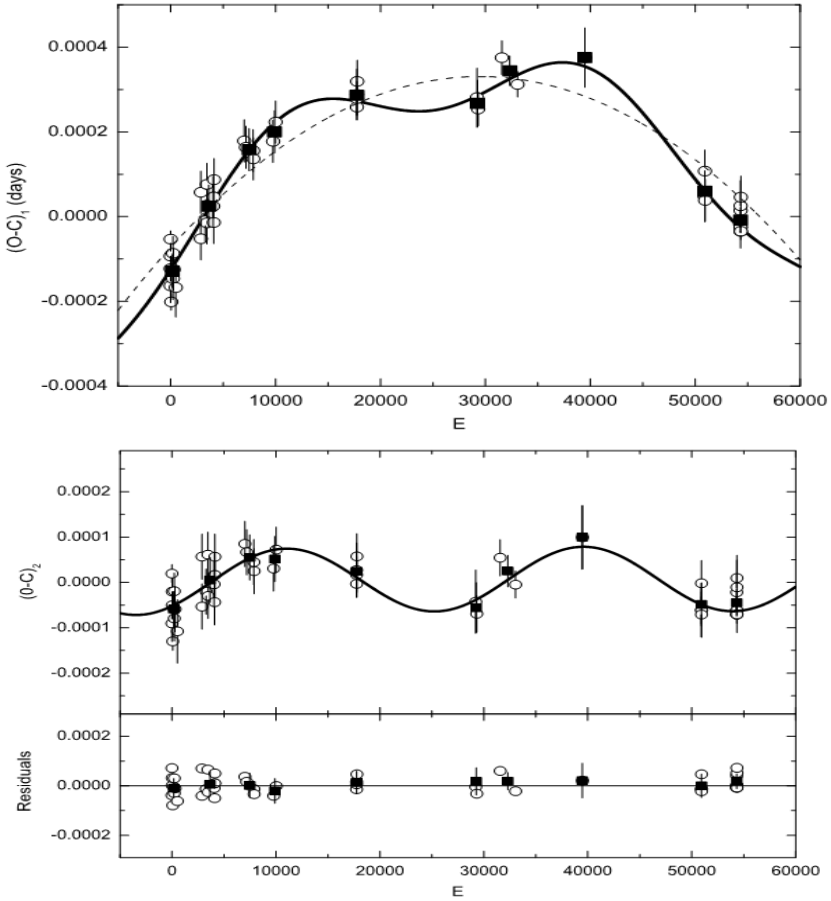


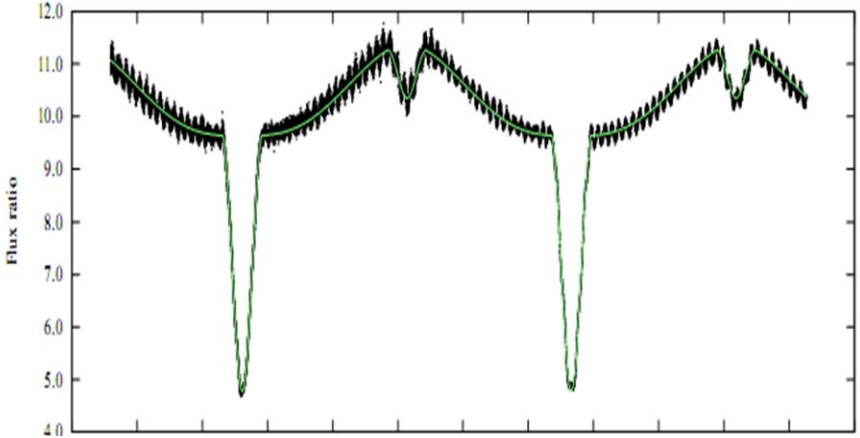




Wang and Zhu 2021MNRAS.507.2804

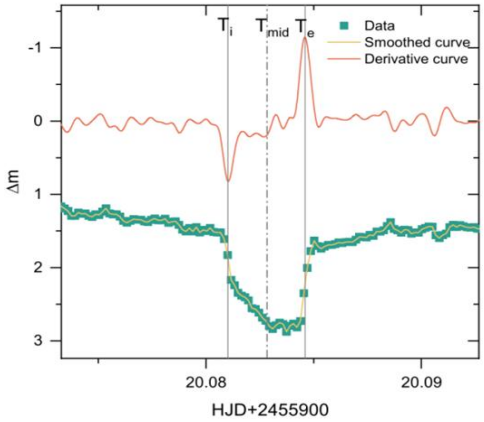
CIRCUMBINARY PLANETS:NY Vir—Pulsating HW Vir like

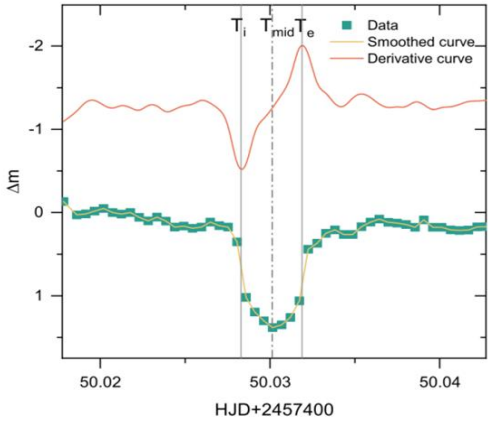


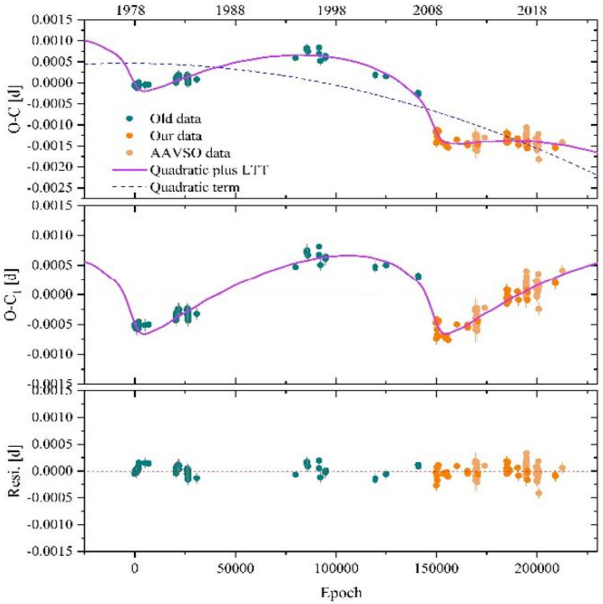


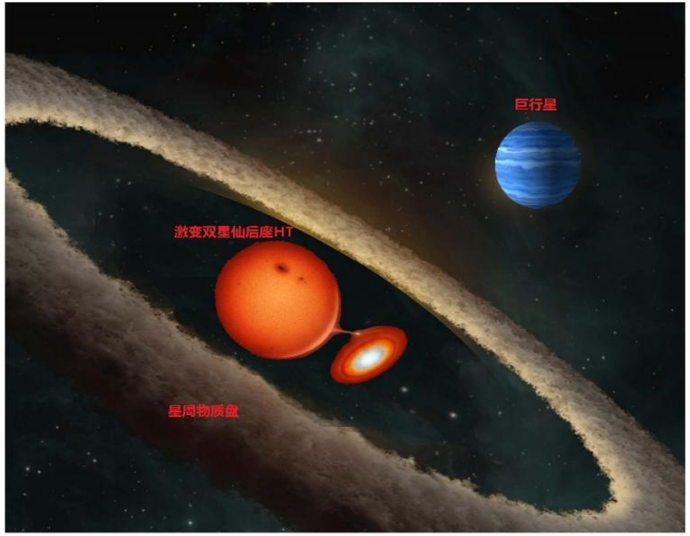
- **Planet**
- **P_3=7.9 years**
- **$M_3 \sin i_3 = 2.3 M_{Jup}$**
- **$a_3 \sin i_3 = 3.3$AU**

Qian et al., ApJ, 745, L23 (2012)



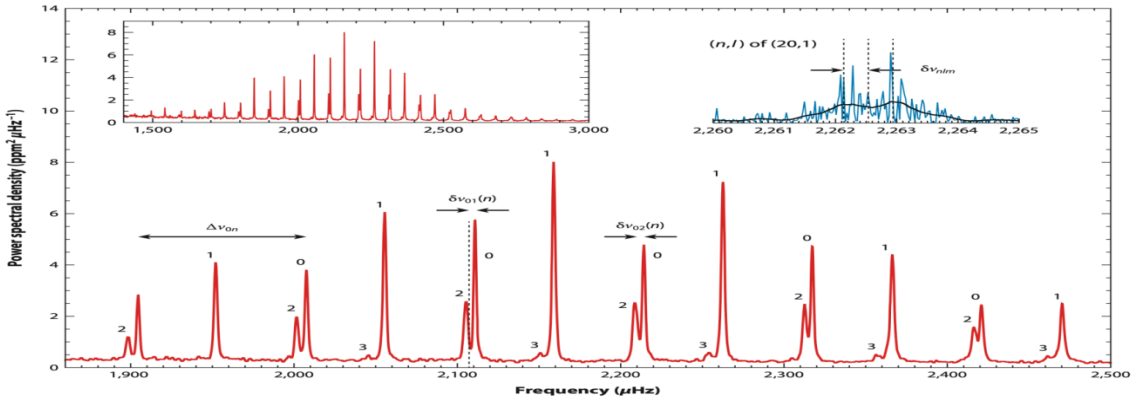






Han, Qian et al., 2023ApJ...953...63

Solar-like Oscillation



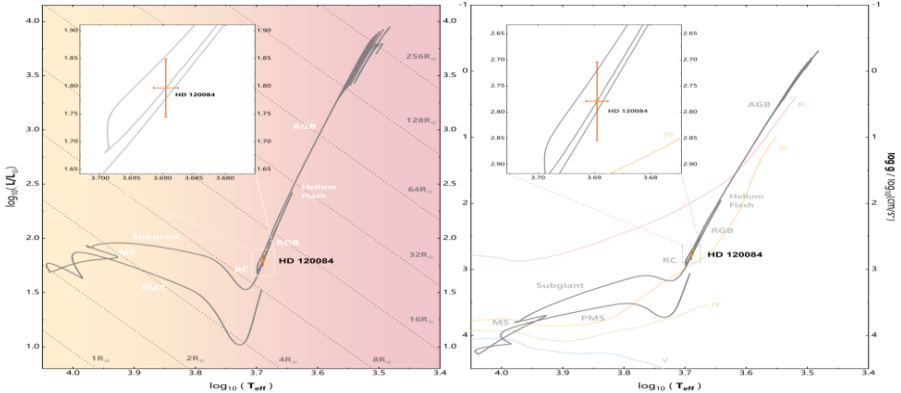
$$\left(\frac{R}{R_\odot}\right) \simeq \left(\frac{\nu_{\max}}{\nu_{\max,\odot}}\right)\left(\frac{\langle\Delta\nu_{nl}\rangle}{\langle\Delta\nu_{nl}\rangle_\odot}\right)^{-2}\left(\frac{T_{\rm eff}}{T_{\rm eff,\odot}}\right)^{0.5},$$

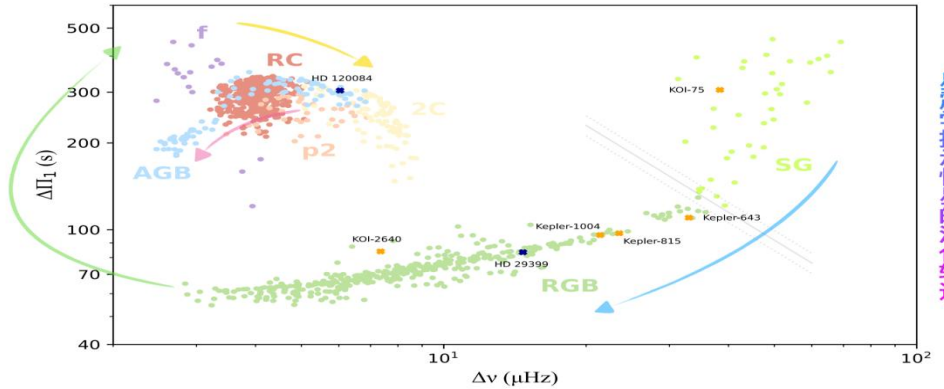
$$\left(\frac{M}{M_\odot}\right) \simeq \left(\frac{\nu_{\max}}{\nu_{\max,\odot}}\right)^{3}\left(\frac{\langle\Delta\nu_{nl}\rangle}{\langle\Delta\nu_{nl}\rangle_\odot}\right)^{-4}\left(\frac{T_{\rm eff}}{T_{\rm eff,\odot}}\right)^{1.5},$$

$$\left(\frac{\rho}{\rho_\odot}\right) \simeq \left(\frac{\langle\Delta\nu_{nl}\rangle}{\langle\Delta\nu_{nl}\rangle_\odot}\right)^{2},$$

$$\left(\frac{g}{g_\odot}\right) \simeq \left(\frac{\nu_{\max}}{\nu_{\max,\odot}}\right)\left(\frac{T_{\rm eff}}{T_{\rm eff,\odot}}\right)^{0.5}.$$

Chaplin, William J., and Andrea Miglio. ARAA 51.1 (2013): 353-392.





星震学揭示恒星的演化轨迹

Lin, Qian Zhu et al.,2024ApJ...971L..502025ApJ...978...24；2025ApJ...980..174；2025ApJS..279...31

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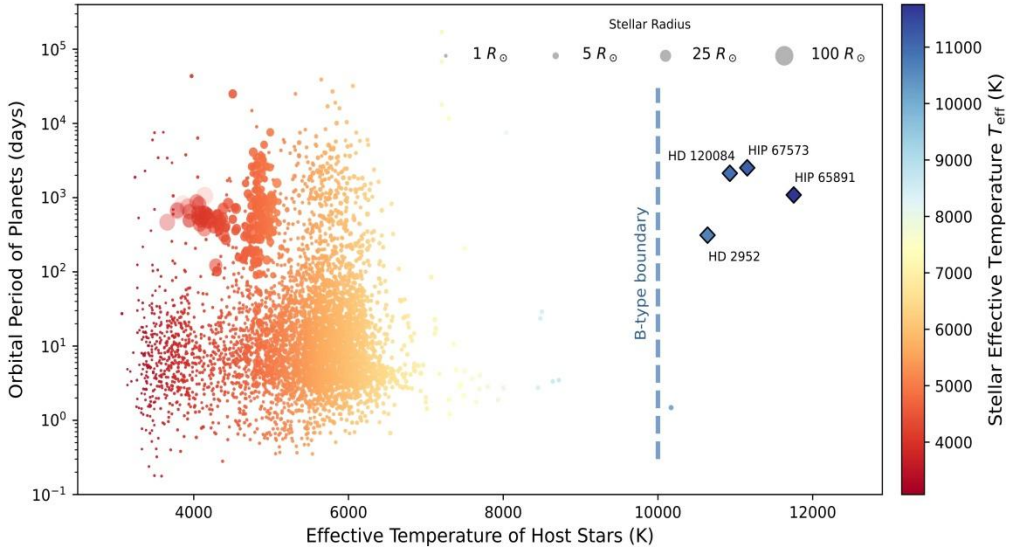
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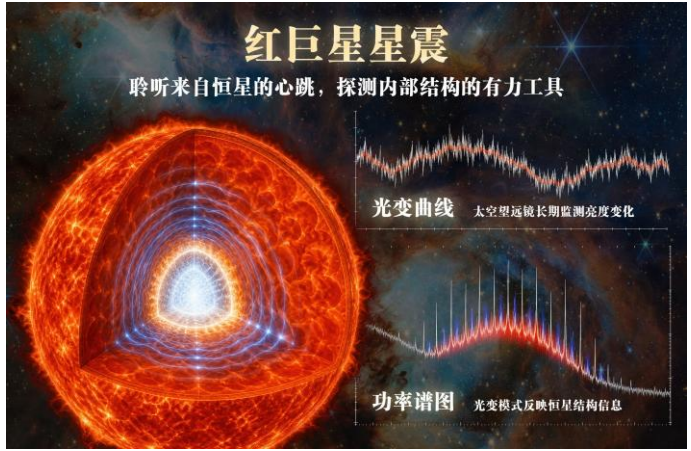
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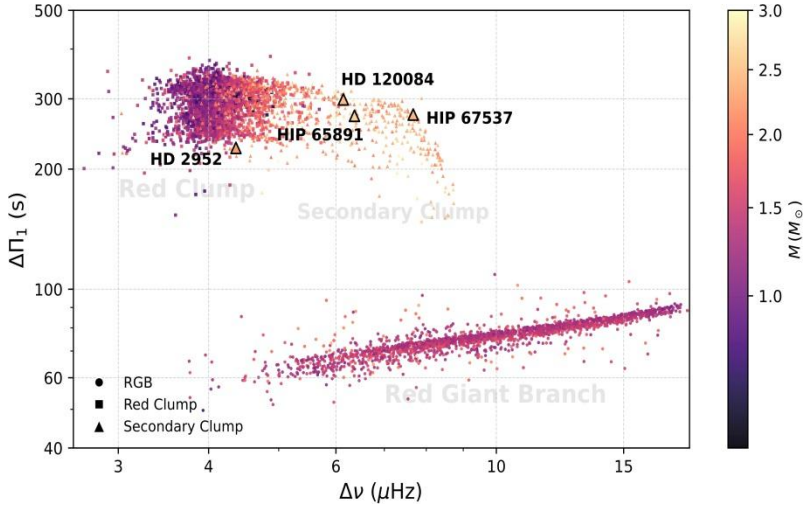
B-type host stars revealed by exoplanets around massive secondary-clump giant stars

Wen-Xu Lin, Sheng-Bang Qian ✉, Qi-Bin Sun, Li-Ying Zhu, Wen-Ping Liao, Ting Li, Fu-Xing Li, Liang Liu, Xiang-Dong Shi, LinJia Li, Ergang Zhao, Huiting Zhang, Ping Li, Jing Li & Ming Lian

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