S06 - Masses and Binary stars

Juraj Jonák Denis Mourard

Observatoire de la Côte d'Azur

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Binary

- binaries are unique space laboratories
- usually detected through spectroscopy
- mutual interaction $\rightarrow$
  - mass
  - physical separation

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- mutual interaction $\rightarrow$
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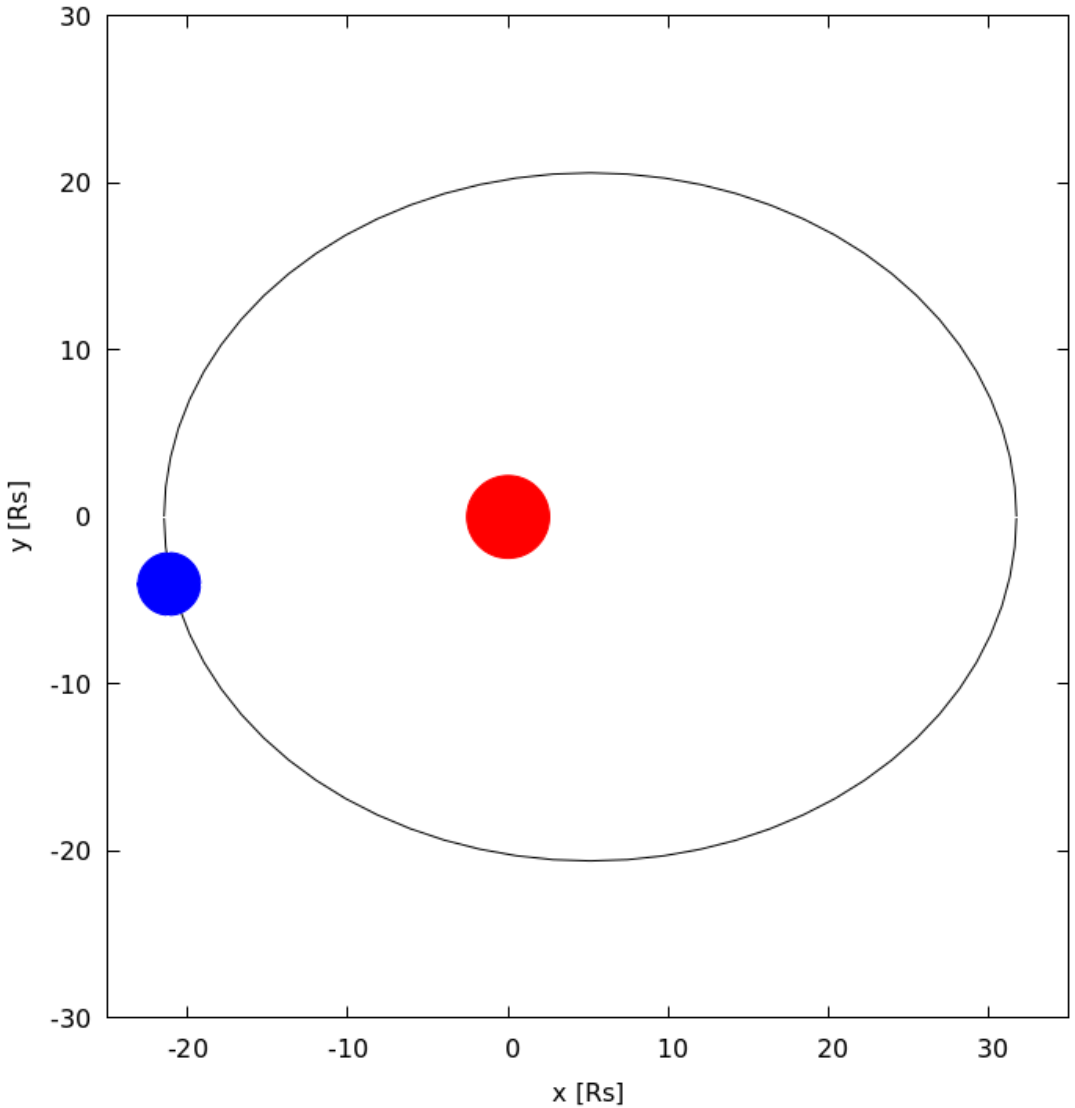
  - physical separation

- 54 targets
- reconstruct orbit by observing in multiple orbital phases
  - mass
  - distance

Orbital elements

- M_1 (1.42M$_\odot$)
- M_2 (1.42M$_\odot$)
- d (36 pc)
- a (26.6 R$_\odot$)
- e (0.19)
- T_0



Orbital elements

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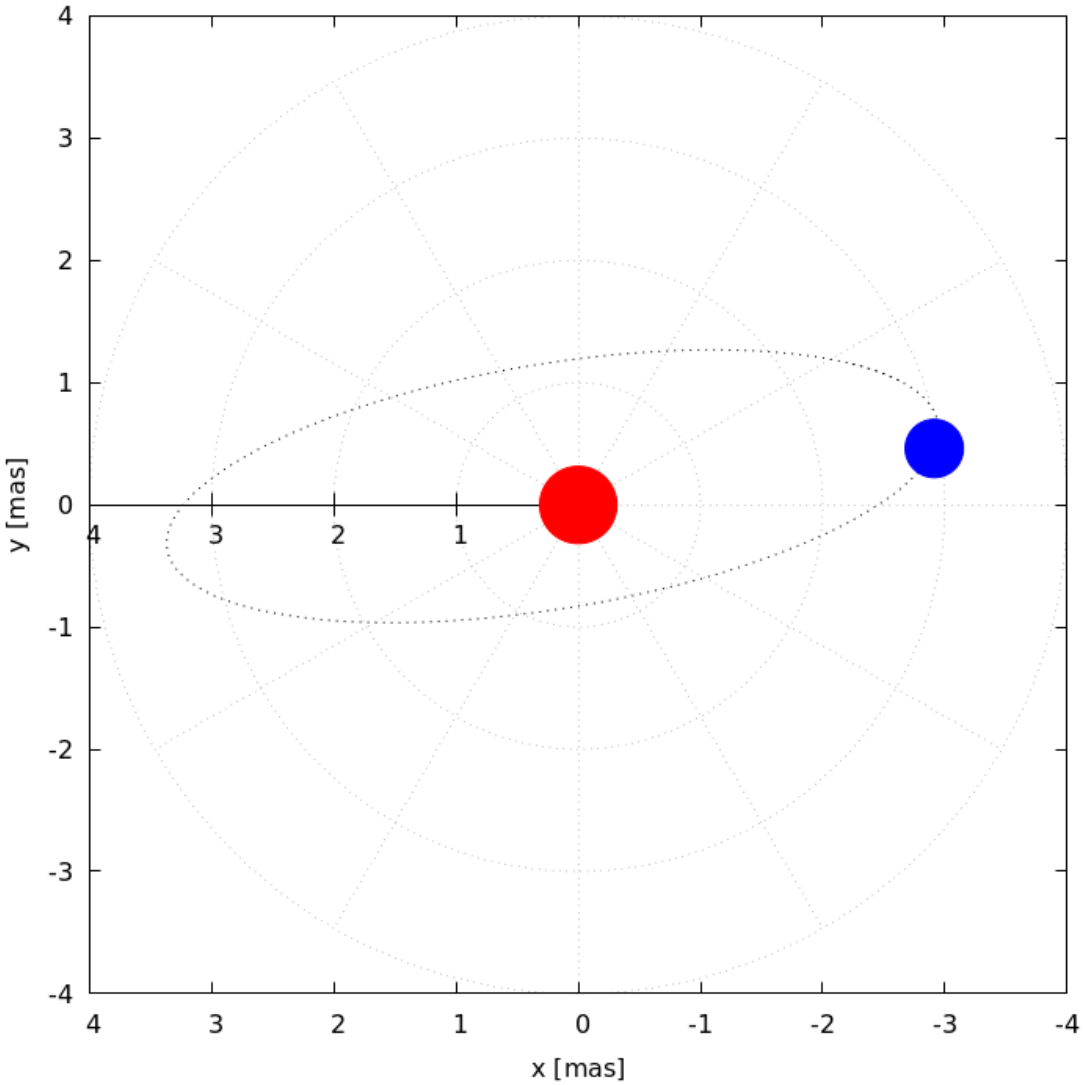
- M_2 (1.42M$_\odot$)
- d (36 pc)
- a (26.6 R$_\odot$)
- e (0.19)
- T_0
- i (108°)
- ω (289°)
- Ω (80°)
- d Boo
  m_V 4.9 mag



Parameter limits

- only detached, non-interacting SB2s with non-variable components
- $m_V < 8^{\mathrm{mag}}$
- DEC $> -30^{\circ}$

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- $m_V < 8^{\mathrm{mag}}$
- DEC $> -30^\circ$
- $f > 0.06$
- $\rho \in [0.15, 10]$ mas
- spectral type no later than G
- $M_2 > 0.1 M_\odot$
- $\rho/\theta_1 \in [2.5, 50]$

Available catalogues of eclipsing binaries

- inclination restricted to $\approx 90^\circ$
- light curve $\rightarrow$
  - radius
  - brightness

Available catalogues of eclipsing binaries

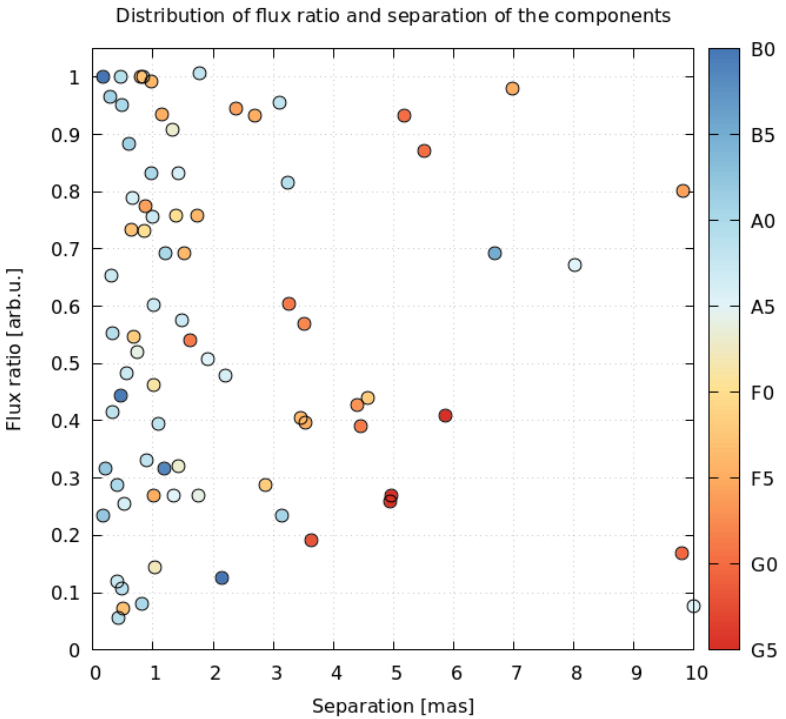
Source	#Total	#Suitable	#Selected
Graczyk+ 2019	81	13	13
Torres+ 2010	95	12	3
Eker+ 2014	257	24	9
Southworth 2015	198	21	2
Svechnikov+ 2004	350	24	9
		Total	36

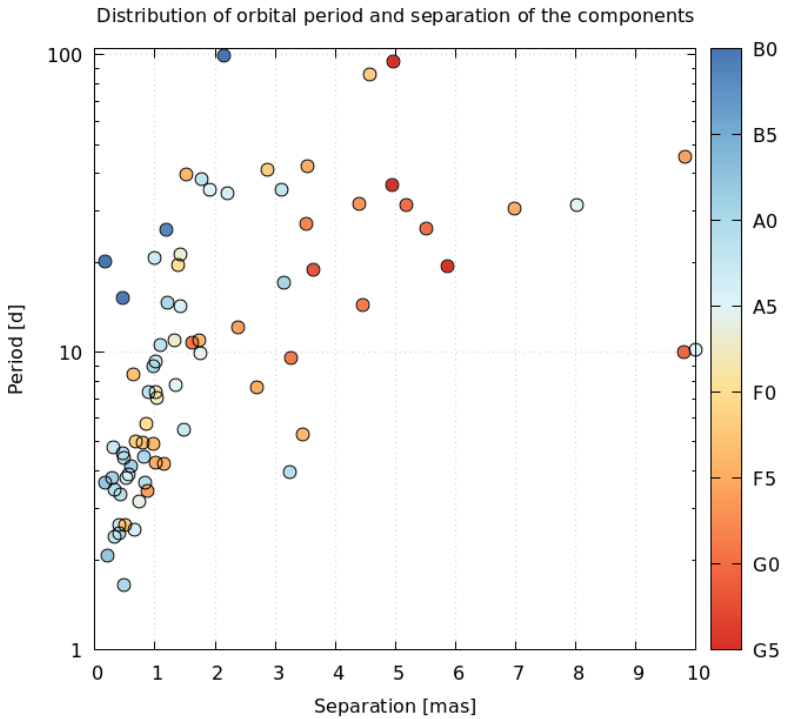
- not all necessary information
- $f \approx \frac{R_2}{R_1} \frac{\exp hk_B \lambda T_1}{\exp hk_B \lambda T_2}$

Catalogues of spectroscopic binaries SB9

- Pourbaix+ 2004 : SB9
  - over 4000 binaries
  - period, vel. amplitudes
  - to reduce the number
    1. simbad classification
    2. spectral type, m_V, DEC
    3. remove all SB1s
    4. $P < 1$ yr
    5. eliminating already checked objects
  - $\rightarrow \approx$ 200 targets
  - publications + applying conditions $\rightarrow$ 43

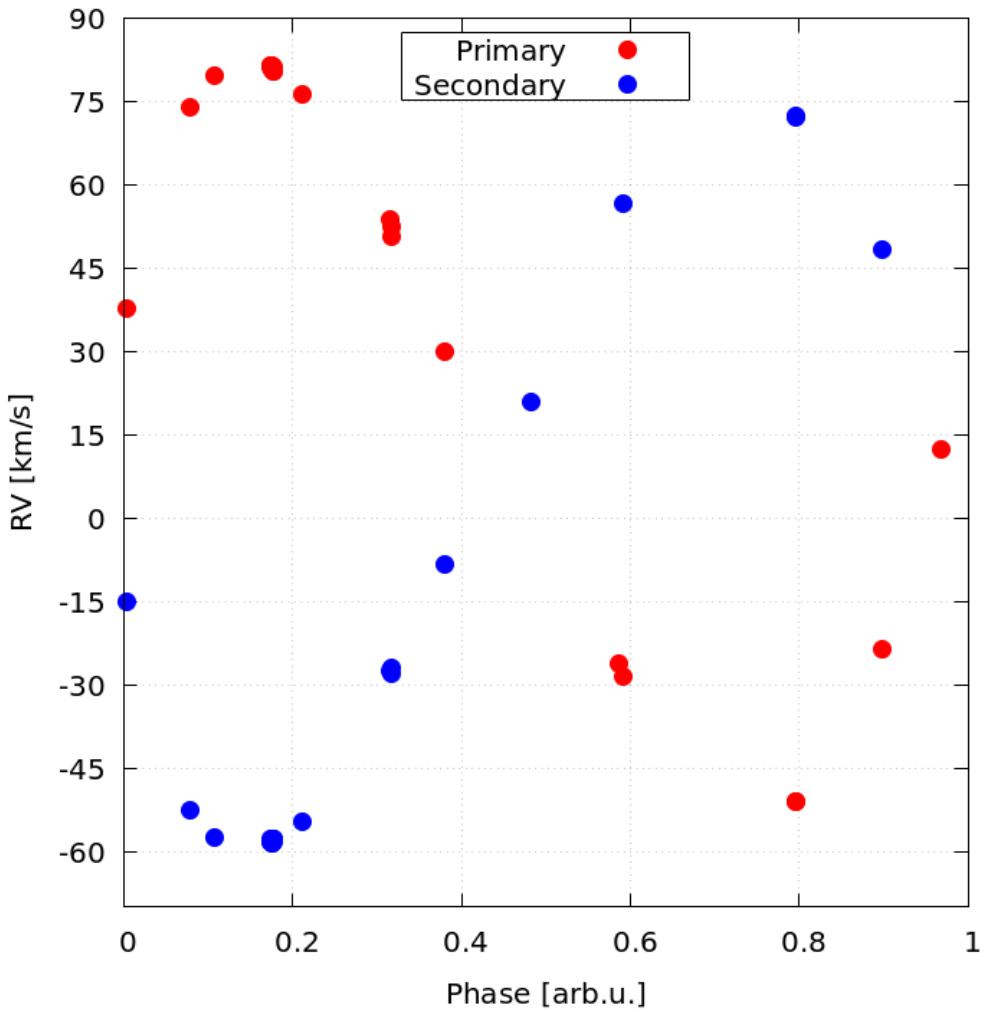
Selected targets





Radial velocities

M_1
M_2
d
T_0
a
e
i
ω
Ω



Radial velocities

M_1
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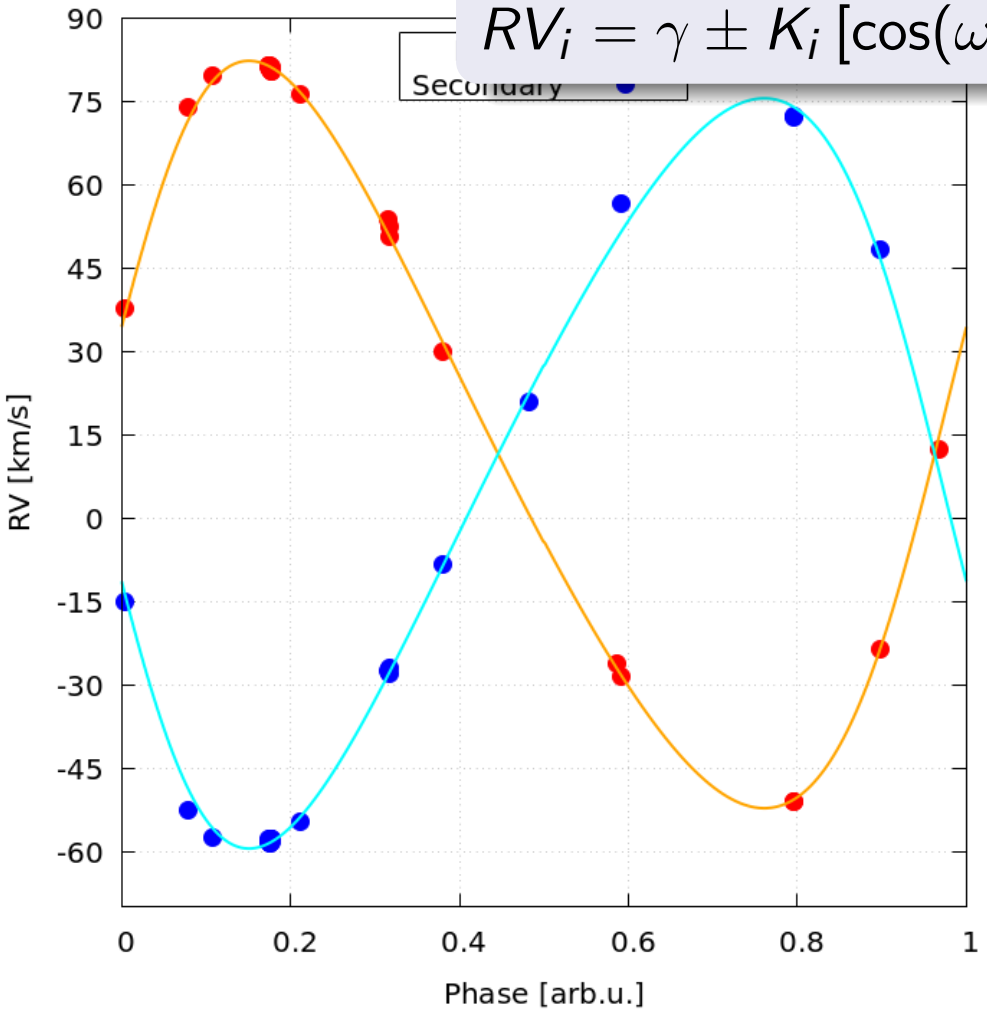
Ω

$$RV_i = \gamma \pm K_i \left[\cos(\omega + v(t; P, T0)) + e \cos \omega\right]$$



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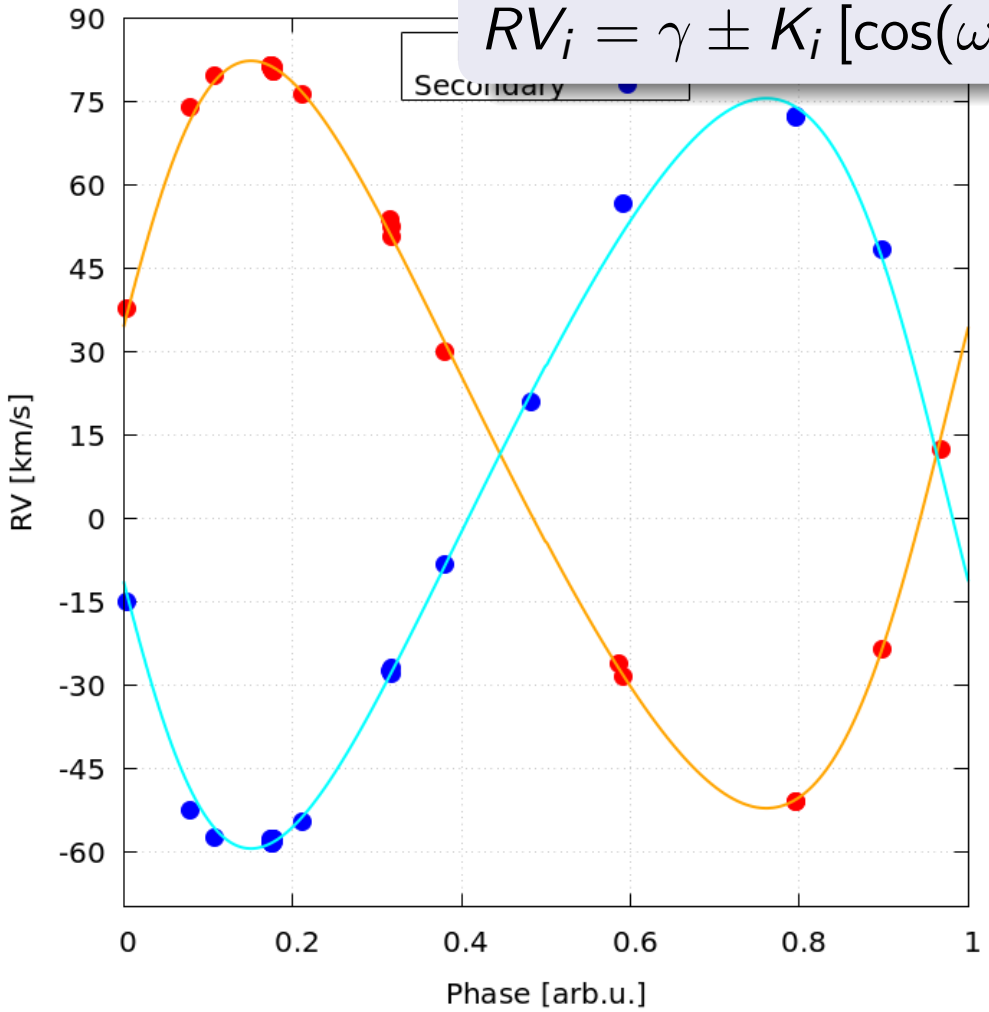
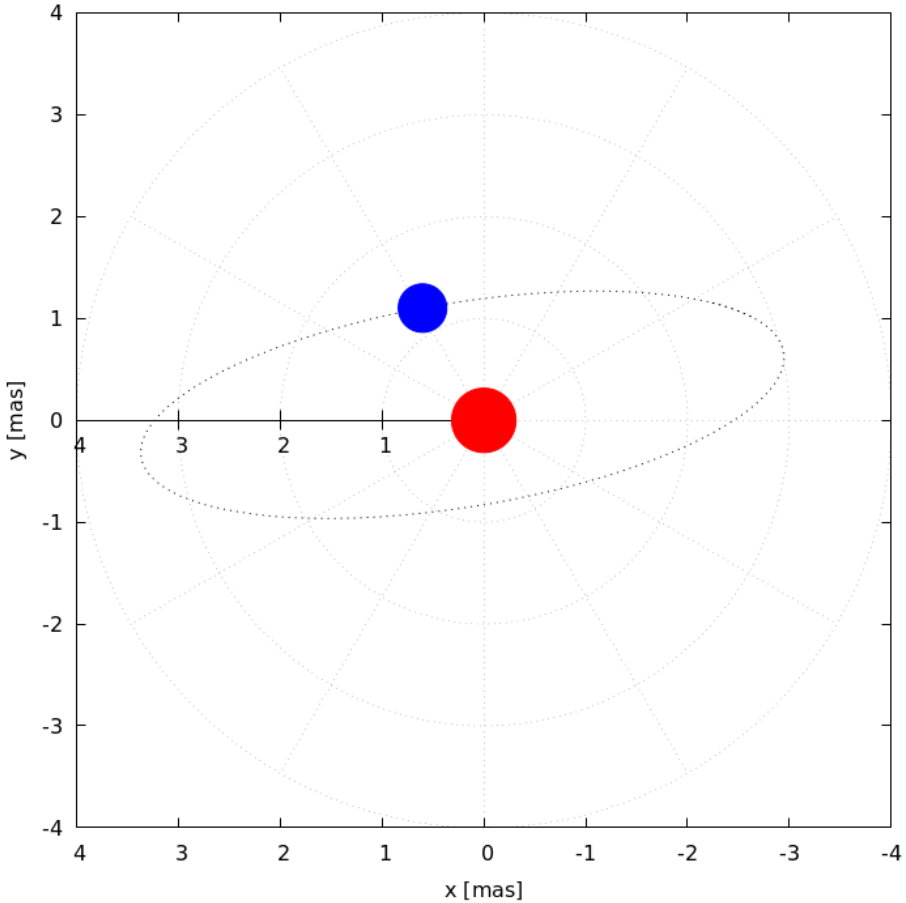
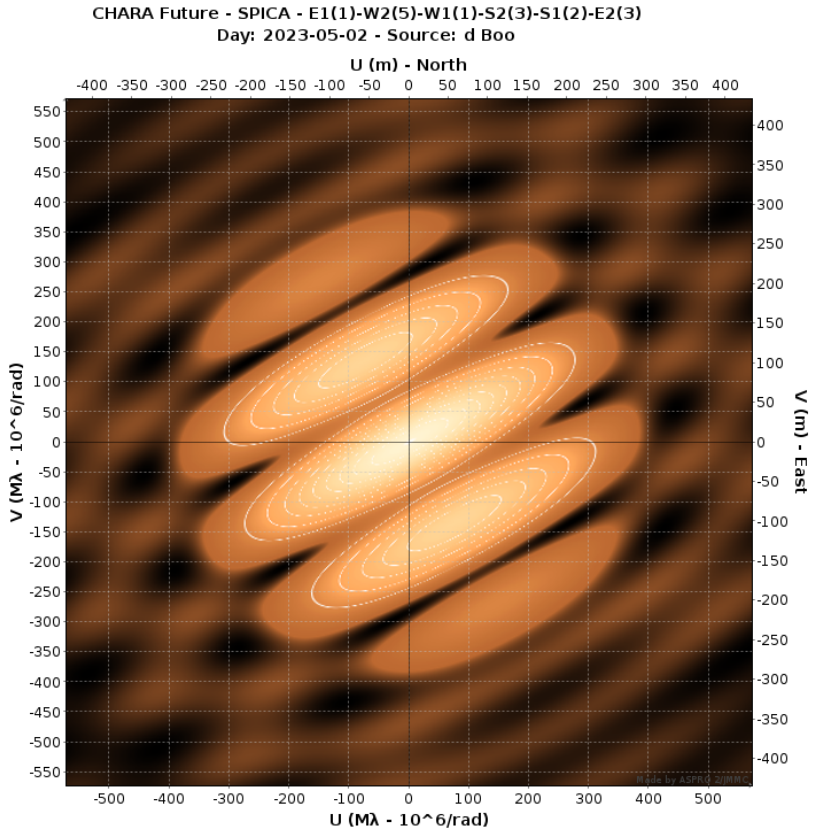


- ω
- e
- P, K_{12}
  $\rightarrow a \sin i$
  $\rightarrow M_{12} \sin^3 i$

Interferometry





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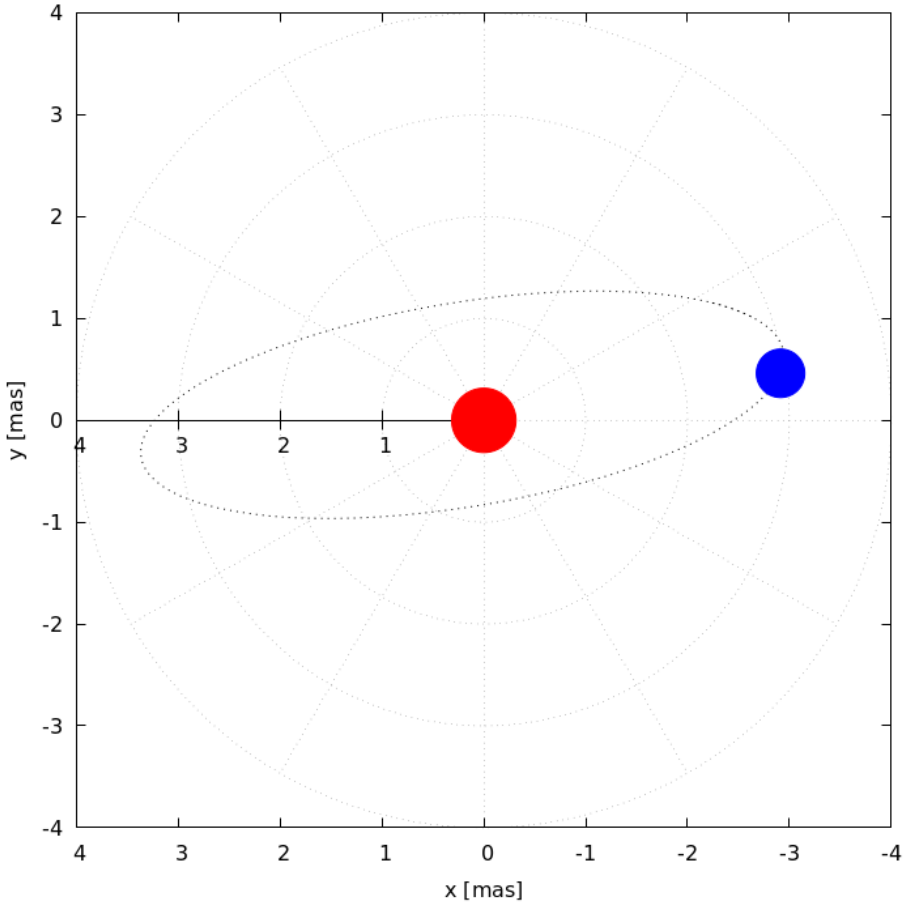

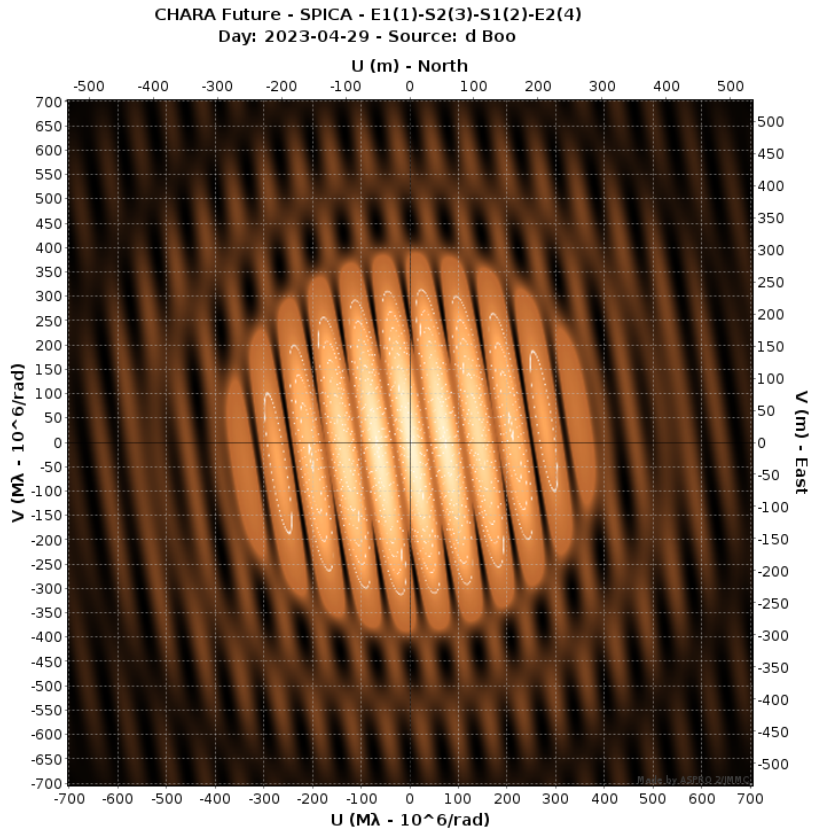

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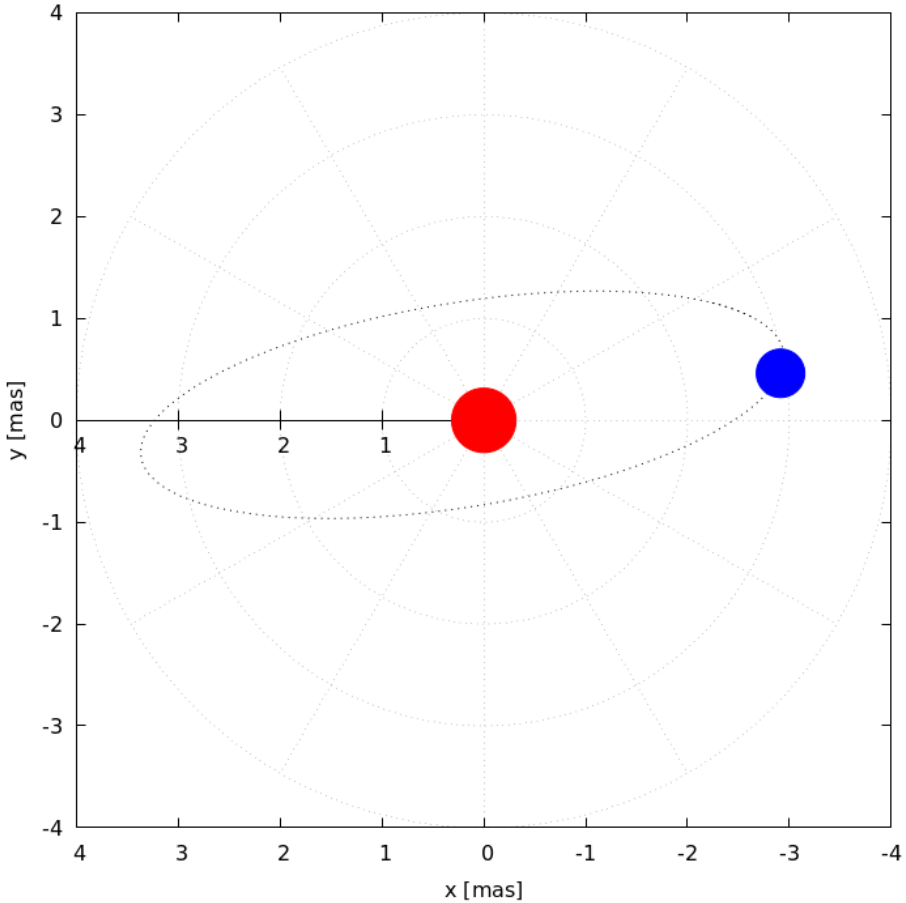

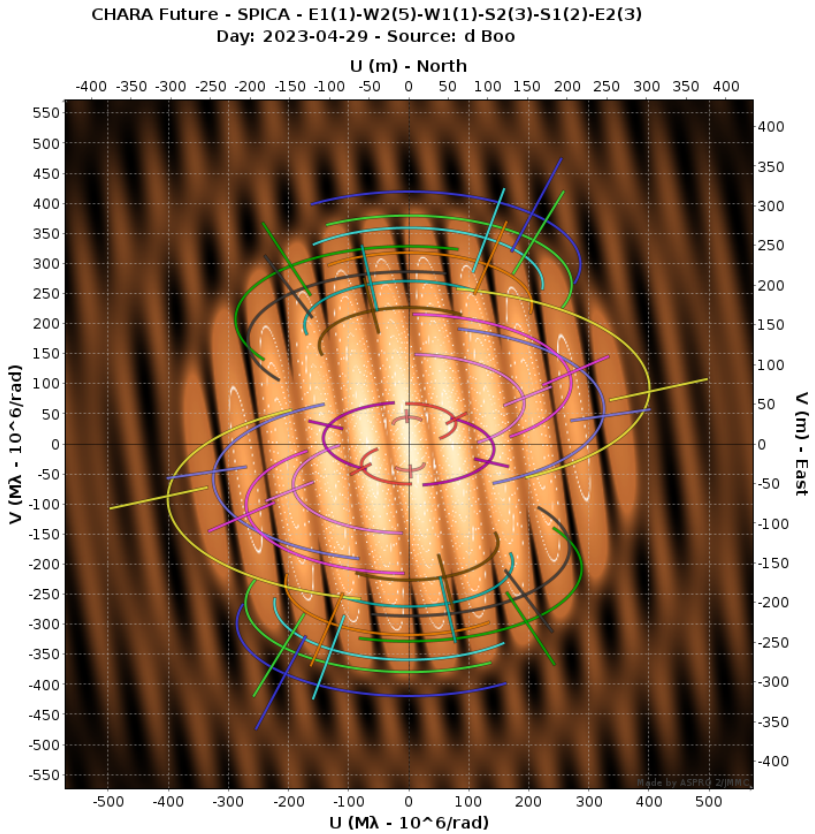

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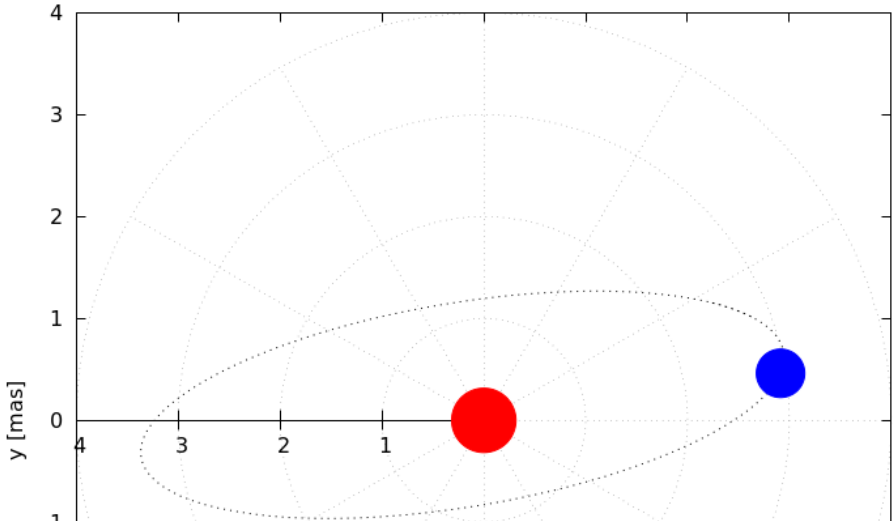
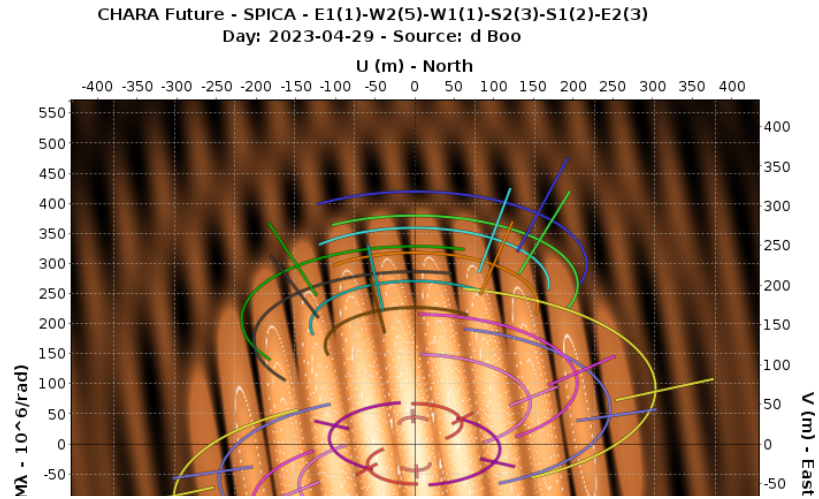
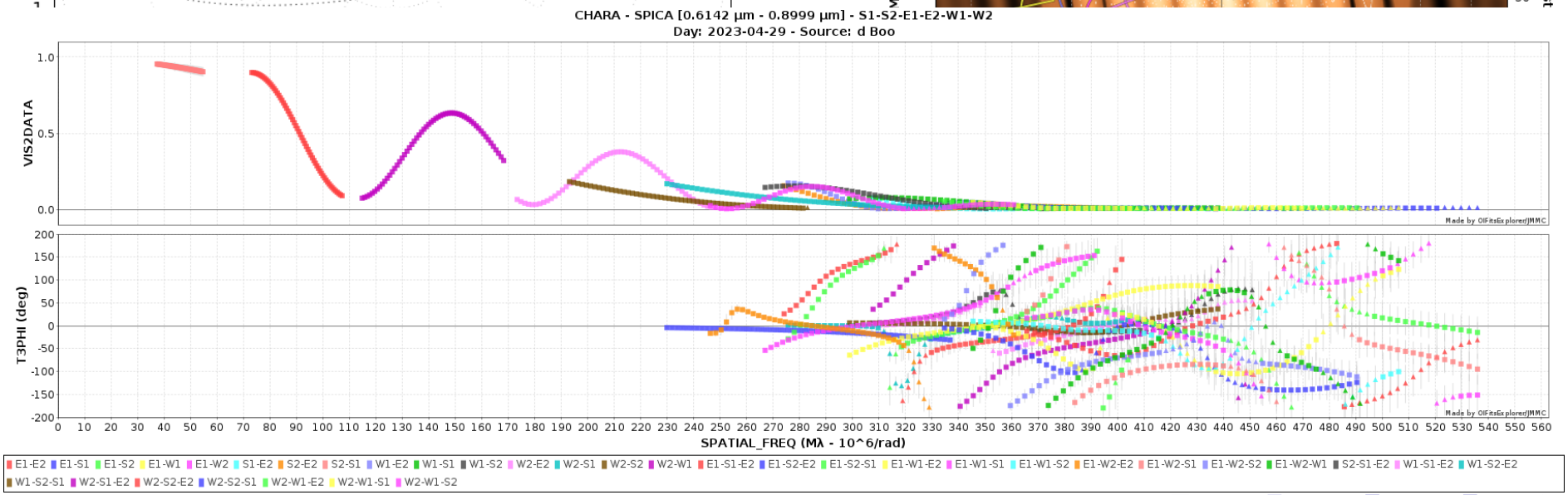
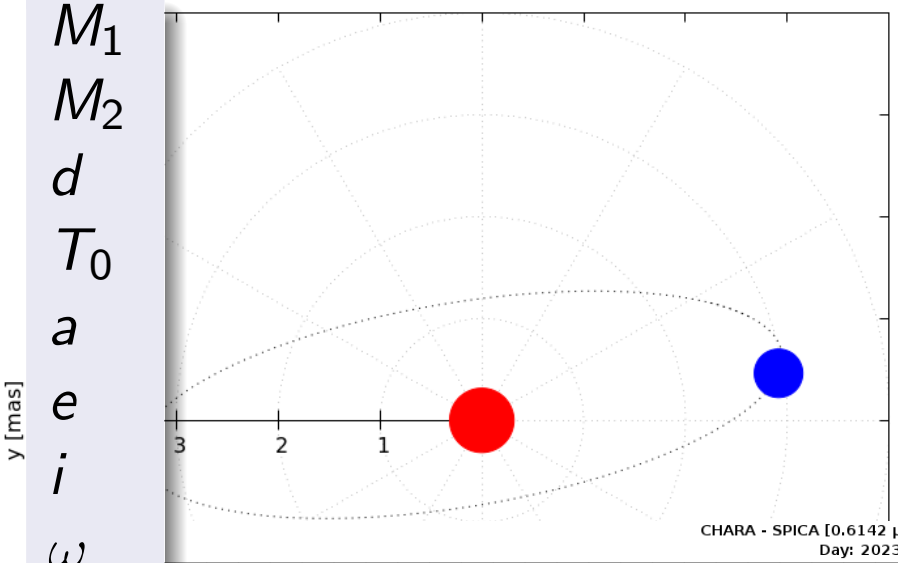


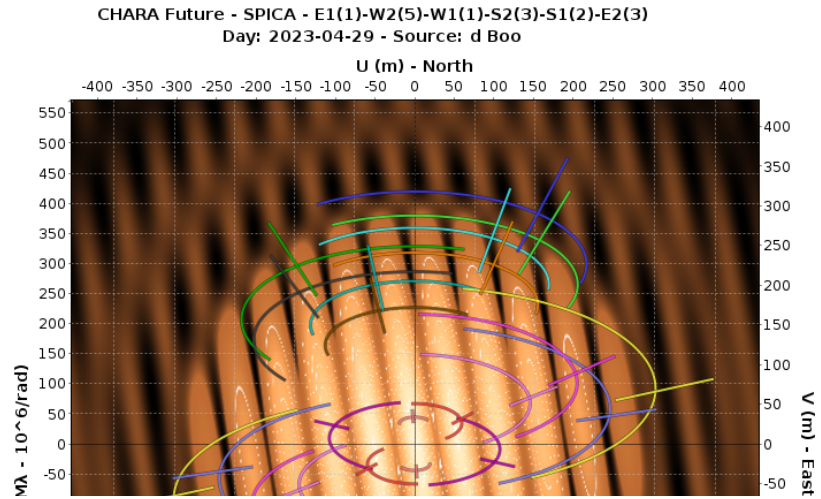


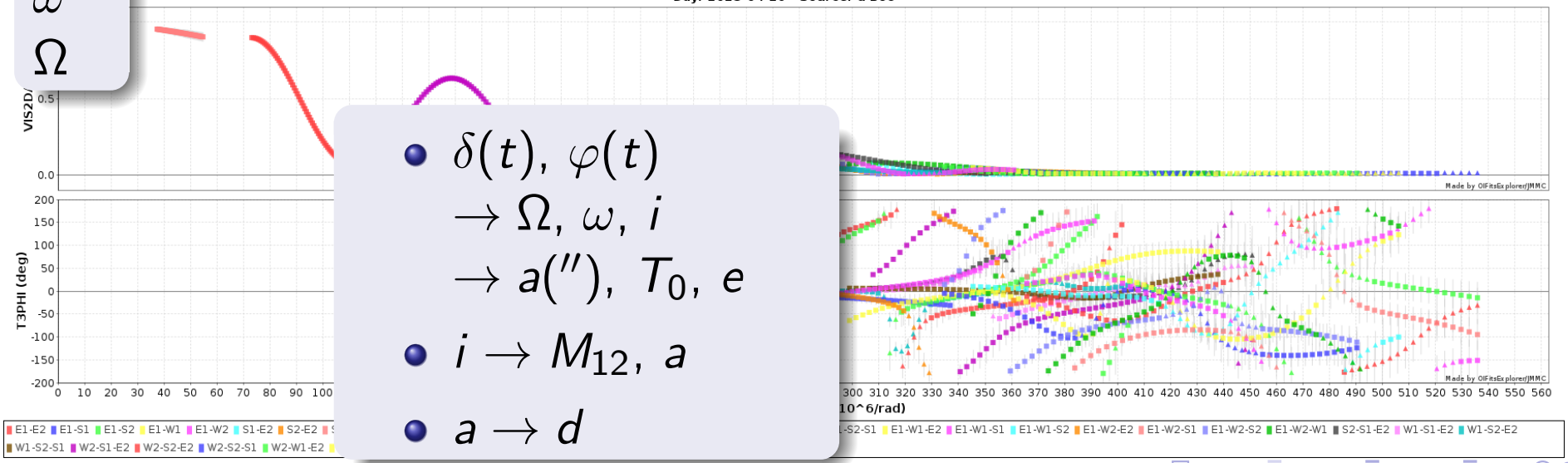


Interferometry

M_1
M_2
d
T_0
a
e
i
ω
Ω





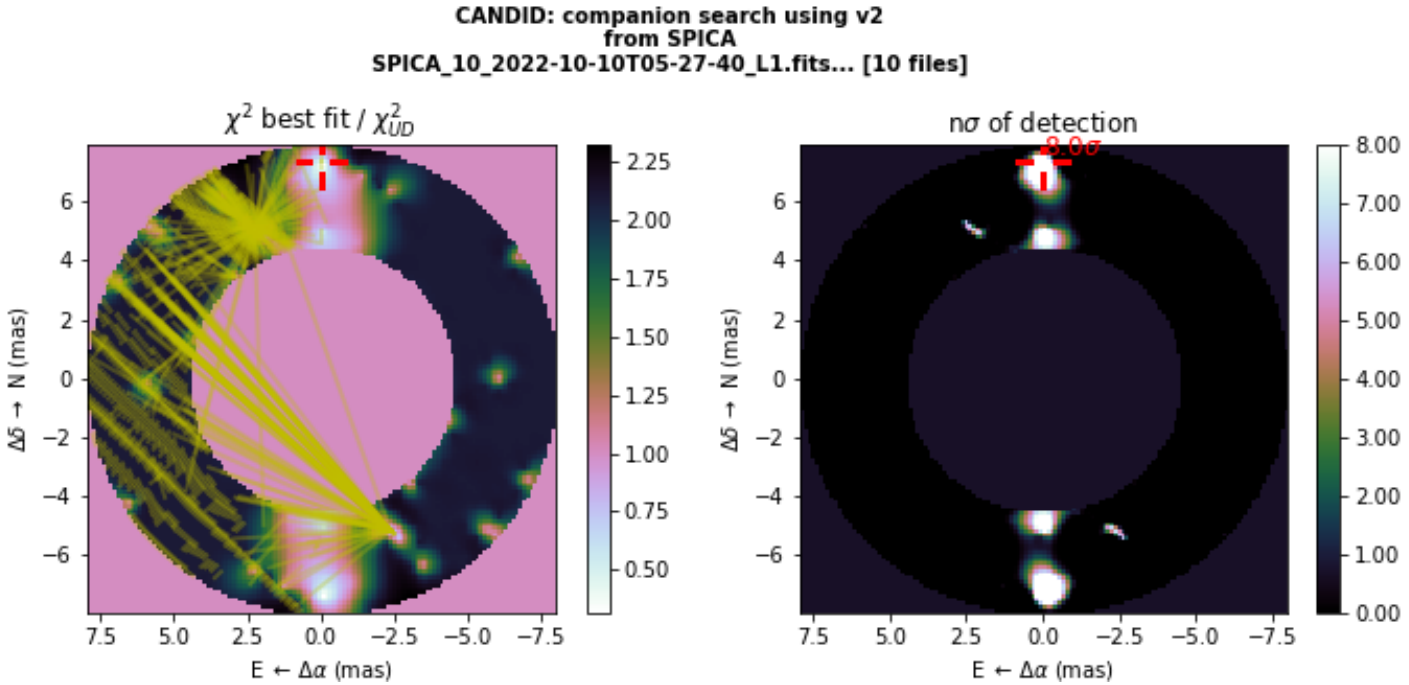


- $\delta(t)$, $\varphi(t)$
  $\rightarrow \Omega$, ω, i
  $\rightarrow a('')$, T_0, e
- $i \rightarrow M_{12}$, a
- $a \rightarrow d$

Modeling tools

[C]ompanion [A]nalysis and [N]on-[D]etection in [I]nterferometric [D]ata Gallenne+ 2015

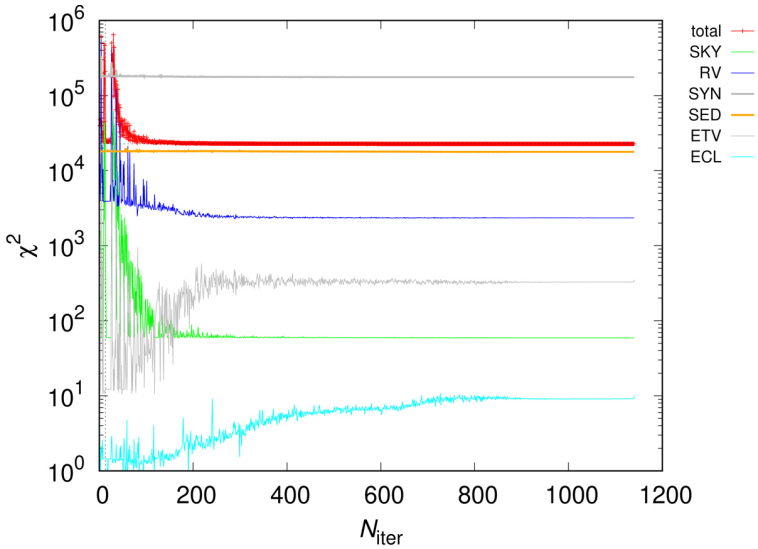
- $V^2 \rightarrow (\delta, \varphi)$
- systematic search for companions in OIFITS data



Modeling tools

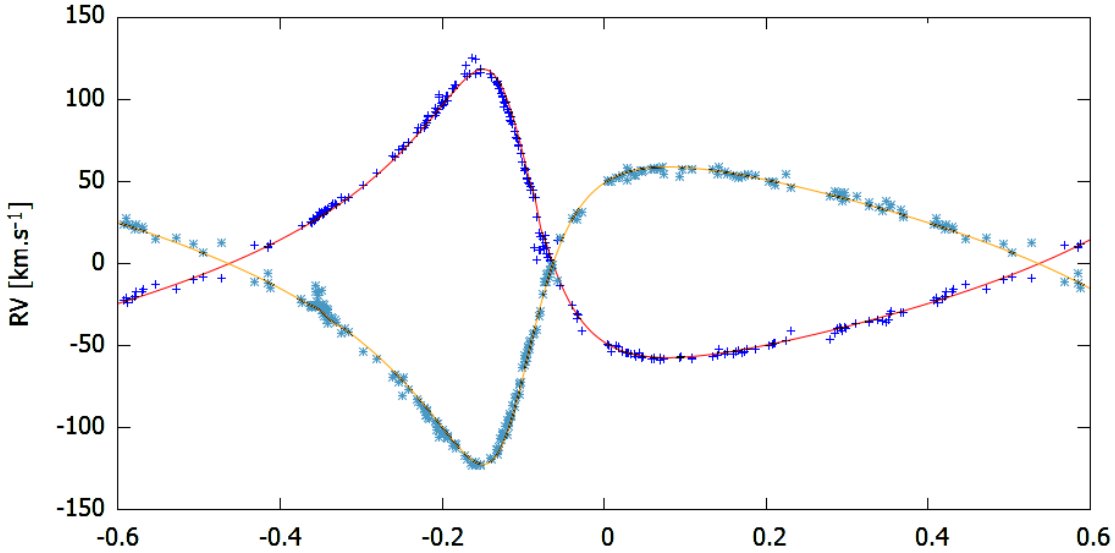
XiTau [Brož 2017, Nemravová+ 2016, Oplištilová+ 2023]

- Nbody simulator
- integration of Newton's equations + additional sources
- simultaneous optimization of
  - RVs
  - V^2
  - CPs
  - spectra
  - minima timings
  - SED
  - astrometry



Additional data

- spectroscopy
  - spectra (preferably red) $R > 10\,000$
  - radial velocity measurements



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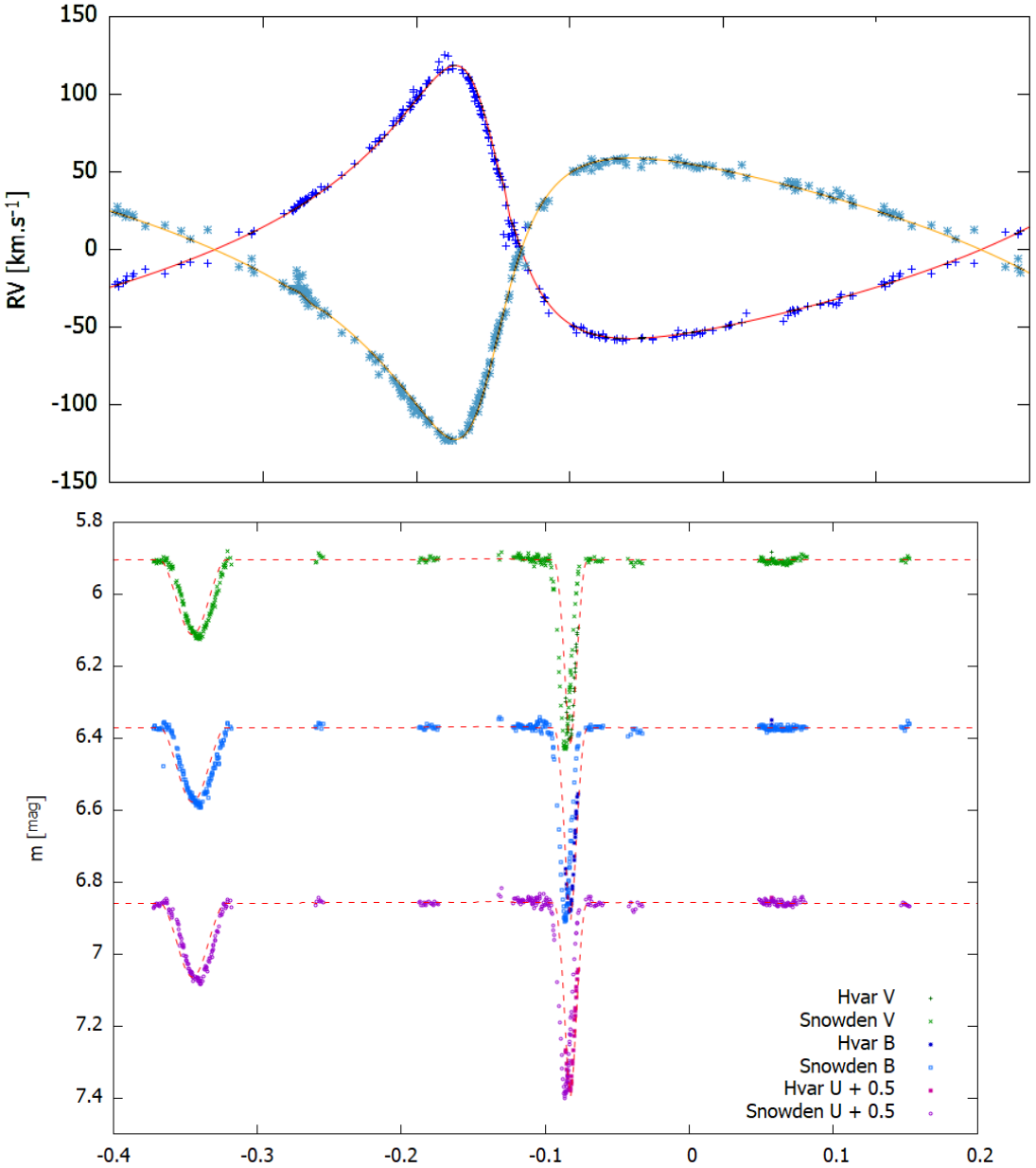
  - spectra (preferably red) $R > 10\,000$
  - radial velocity measurements
- photometry
  - light curves
  - minima timings
  - SED



Additional data

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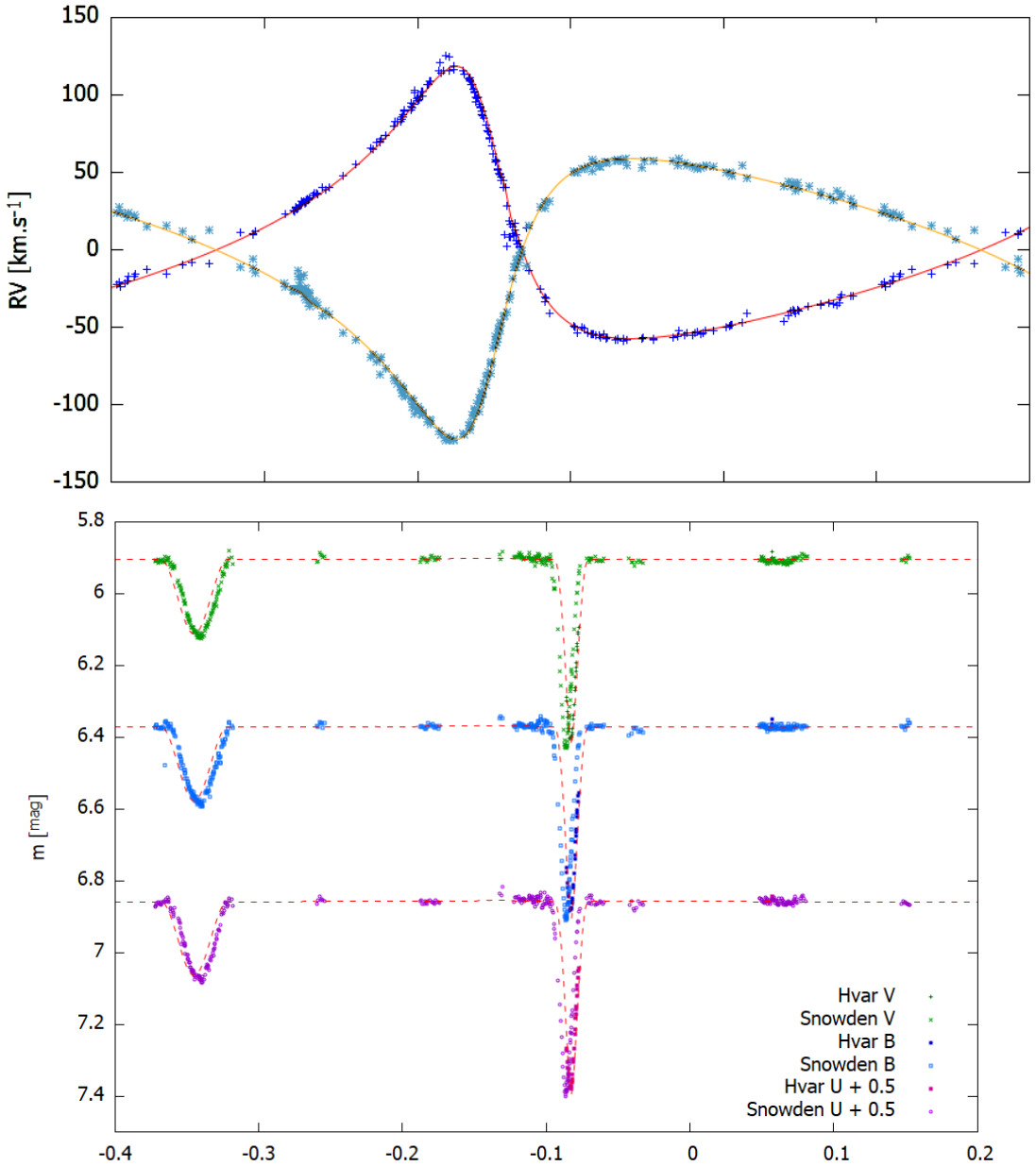
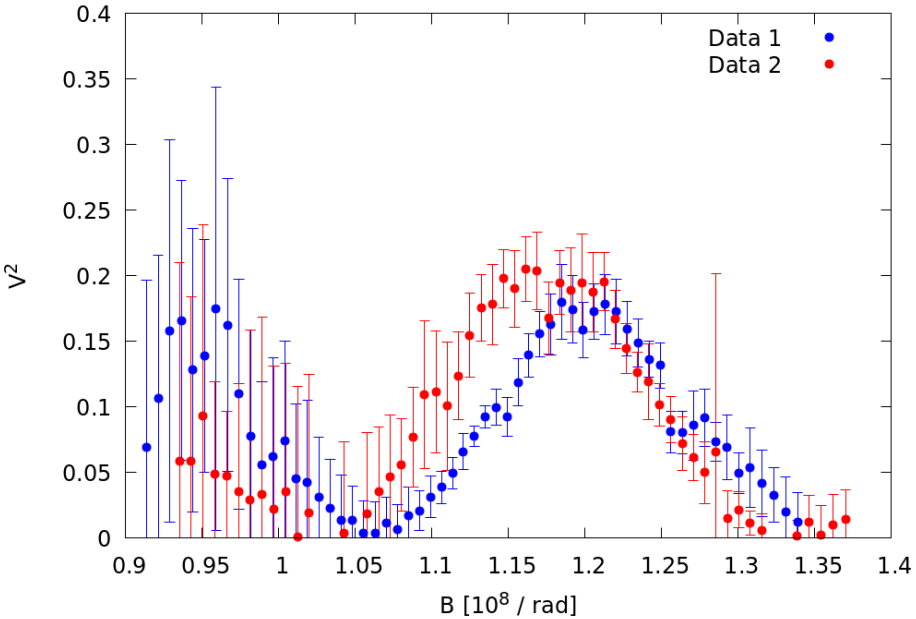
- previous interferometry



Data: β Tri

- observed on Oct 10 2022
- W1 and W2
- uncalibrated data



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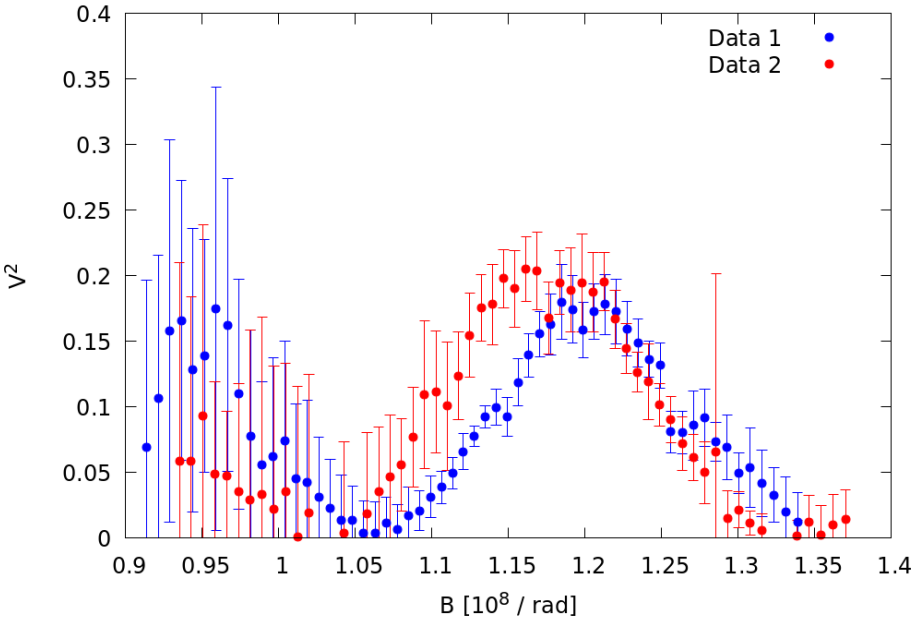

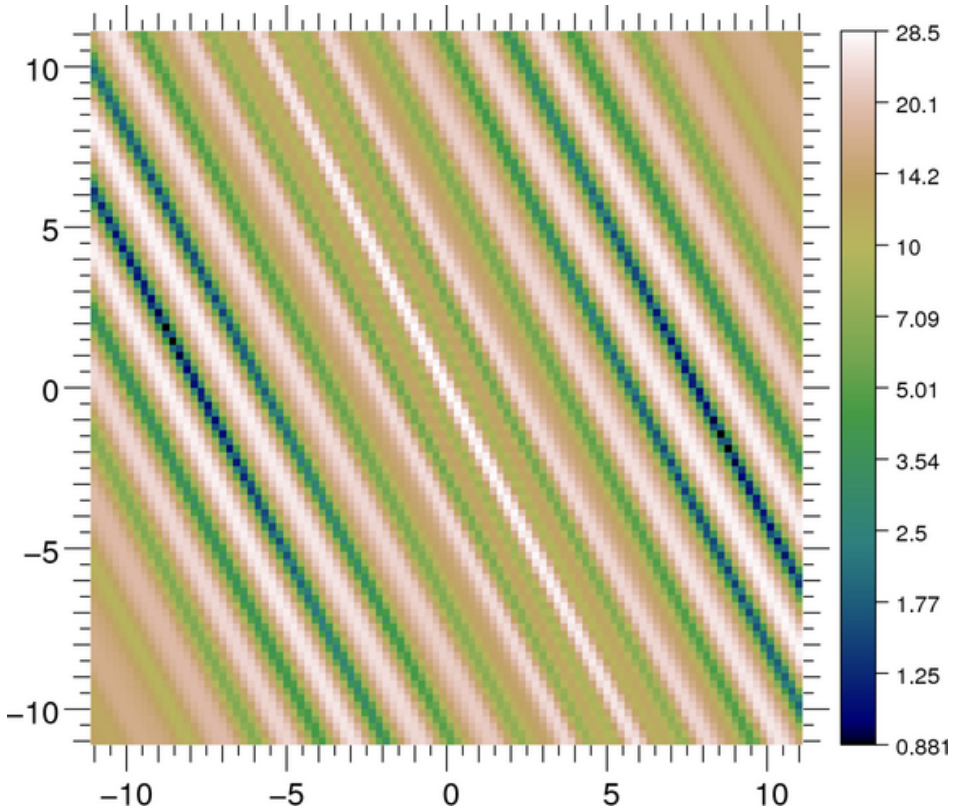

- LitPRO

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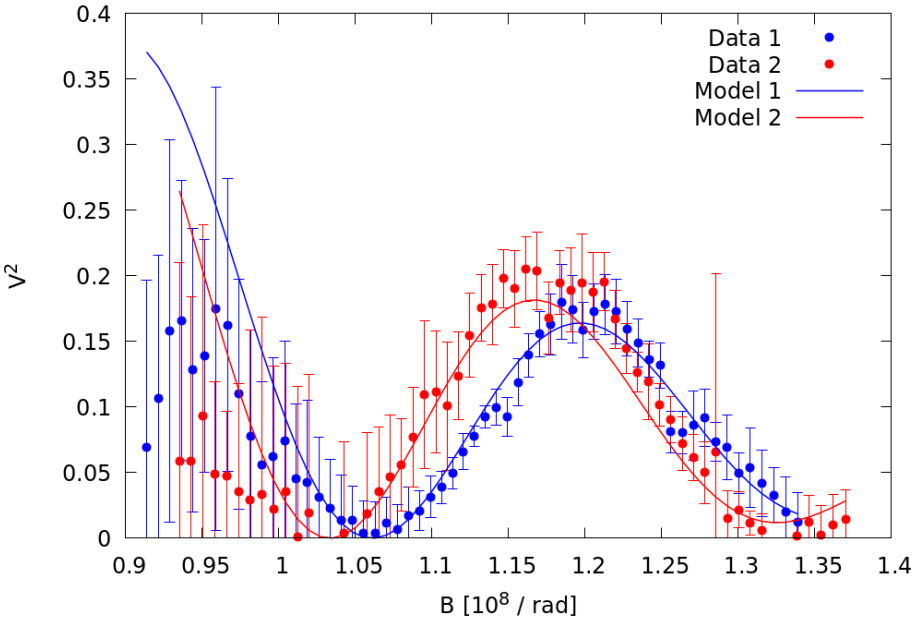

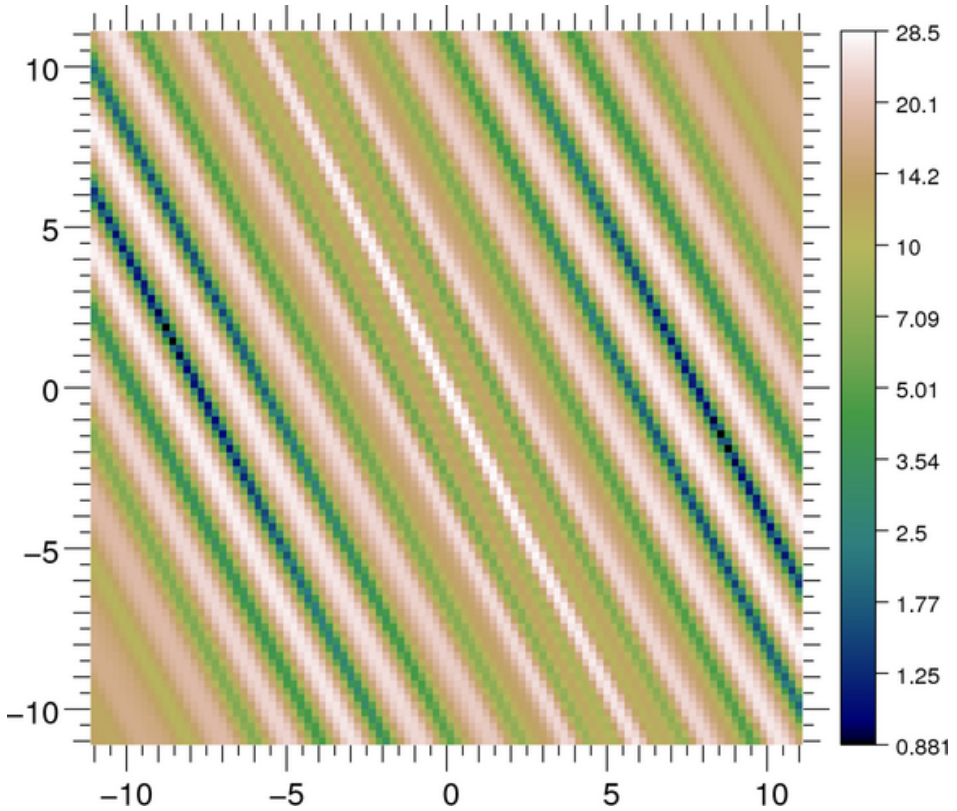

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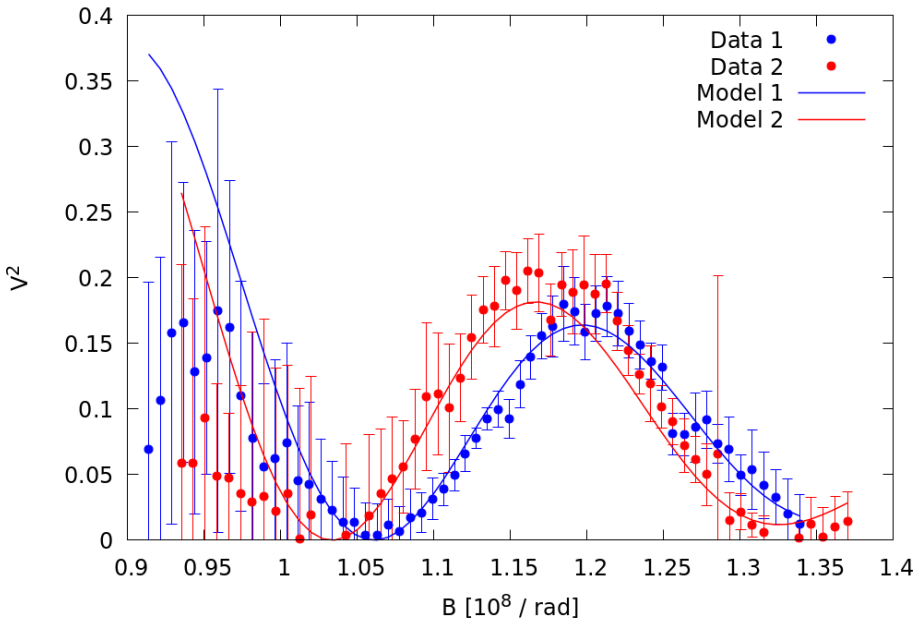

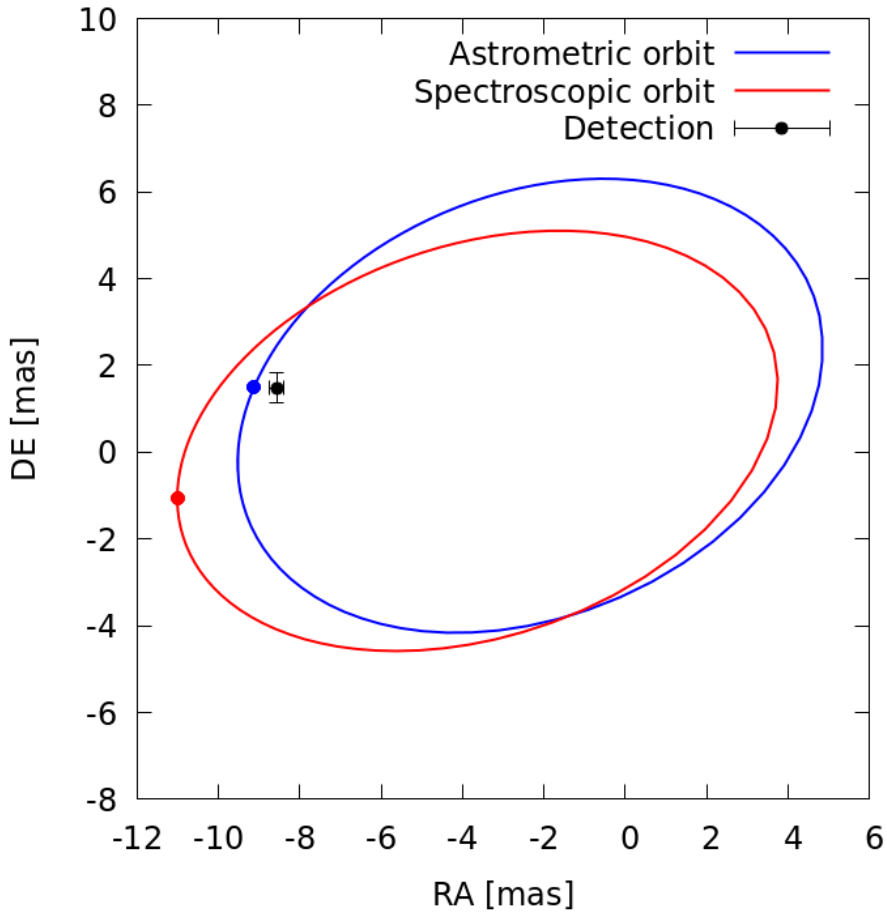

- Hummel+ 1995