WHEN STARS EVOLVE TOGETHER

DETECTION OF TIDAL SIGNATURES IN CLOSE BINARIES

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Presenting at

Stellar Intensity Interferometry Workshop 2025

13-17 Oct 2025, Research Campus Waischenfeld (Germany) of the Fraunhofer Society

Stellar Evolution in Close Binary Star System ?

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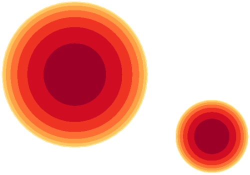
Measurement of Parameters Using Spherical Nature and Uniform Model.

Parameter Estimation: in Close Binaries



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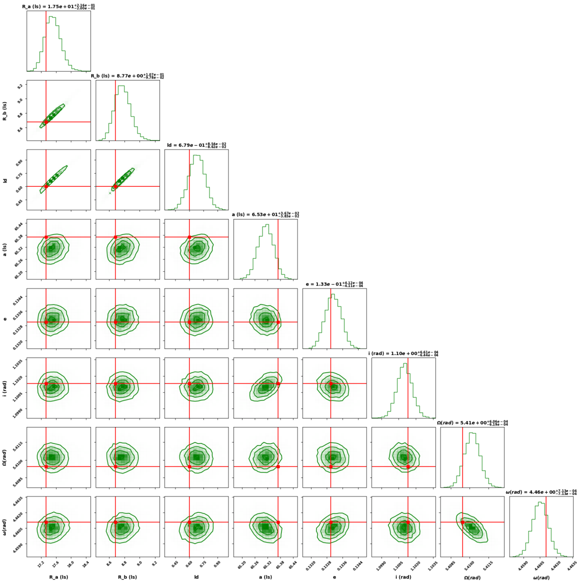

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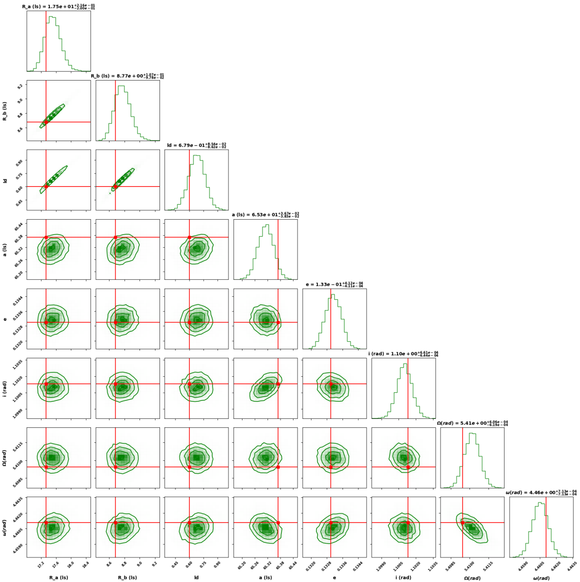

- The radii, orbit and linear limb-darkening coefficient was estimated.
- With simulation of Intensity Interferometry and using Bayesian Inference technique.

What if Spherical Nature and Uniform Model is Perturbed ?

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Estimation of Parameters Using Non-Uniform Model.

VERITAS Result: Deformed Shape of Star

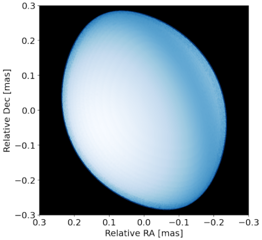
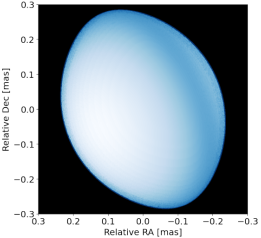


Figure 13. A synthetic photosphere for γ Cas with θ_{eq}=0.60 mas, Ω/Ω_{crit} =0.9888 and $\phi^* = 114°$ consistent with the best fit values to the VERITAS interferometry.

- γ Cassiopeiae is a rapid Rotator
- Uniform and non-uniform model is applied to the observed data



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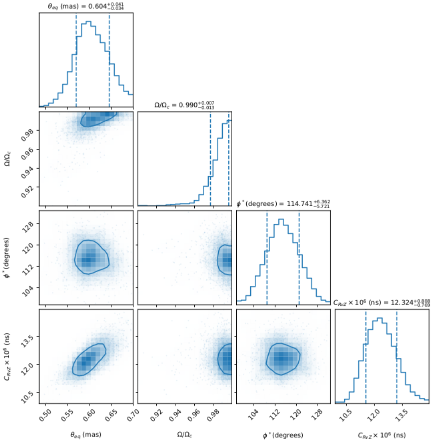

Figure 12. Best fit parameter distributions for the Roche-von Zeipel stellar model from fitting 1000 bootstrap samples with replacement from Table B1. The dashed lines show the 1σ lower bound error and the 1σ upper bound of each parameter: θ_{eq}, the equatorial angular diameter; Ω/Ω_c, fraction of the critical angular rotation rate; ϕ^* position angle of the visible rotation axis; and C_{RvZ}, the proportionality constant between the model squared visibilities and measured correlation peak integrals.

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Can this Effect Be Seen in Close Binaries?

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The Modeling of Stars using Stretching along their Orbit.

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The Modeling of Stars using Stretching along their Orbit.

Measurement of Love-Number of Stars along with Radii, and Orbit.

The Tidal Potential

- Total potential at point r on the source A, in presence of source B

$$U_a = -\frac{GM_a}{2R_a^3}(3R_a^2 - r^2) - \frac{GM_b}{d}\sum_{n=0}^{\infty}\left(\frac{r}{d}\right)^n P_n(Cos\phi)$$

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- n = 0 just add the potential and n = 1 introduces orbital acceleration in binary.
- The remaining term is responsible for tidal effects (Bulge shape)

$$U_{at} = -\frac{G\,M_b}{d}\sum_{n=2}^{\infty}\left(\frac{r}{d}\right)^n P_n(Cos\phi)$$

The Orbit of Binary

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$$T = \begin{bmatrix} 1+\alpha & 0 & 0 \\ 0 & 1-\beta & 0 \\ 0 & 0 & 1+\gamma \end{bmatrix} \mathsf{Z}(\omega+\phi)\ \mathsf{X}(\iota)\ \mathsf{Z}(\Omega)$$

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- If h_a is the radial love number for source A

$$\alpha = h_a \frac{U_{at}}{g} = -h_a \frac{r^4}{d^3}$$

$$\beta = h_a \frac{r^4}{2d^3} = -\alpha/2$$

I. Visibilities with Stretched Sources

- The visibilities in Cartesian Coordinates

$$V(u,v) = \int \int e^{\frac{2\pi i}{D}[ux+vy]} \, \Sigma(x,y) \, dx \, dy \tag{1}$$

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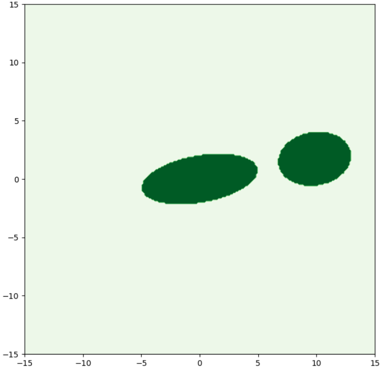
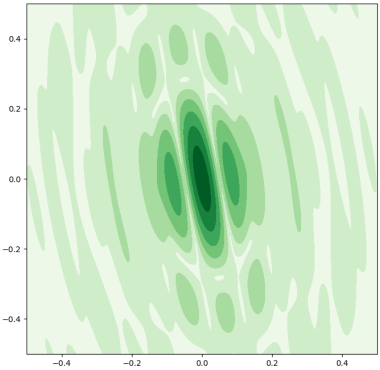
- There exist a relation between these equations

$$W(u,v) = K\, V(U,V) \tag{3}$$

Where K is a (constant) Jacobian between transformation of coordinates

Oblateness of Stars in Close Binaries





- Tidal interactions occur in presence of differential gravitational force.

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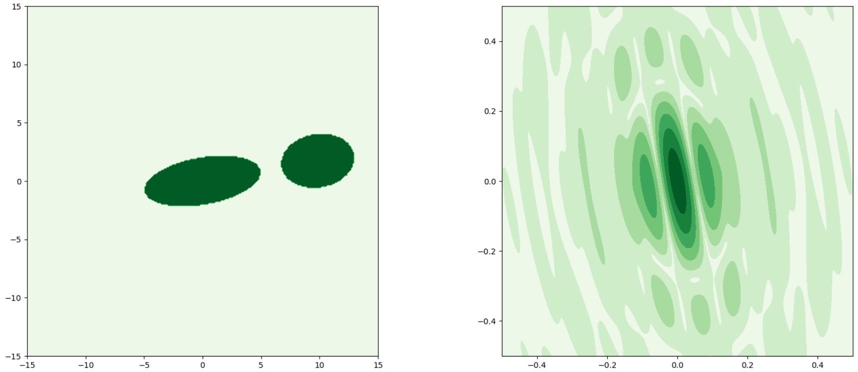

- Tidal interactions occur in presence of differential gravitational force.
- The visibility will be affected on observational plane.

The Selection of Baselines on Observational Plane ?

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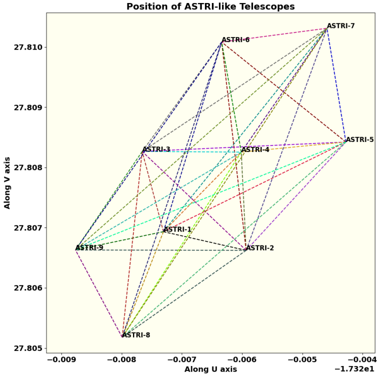
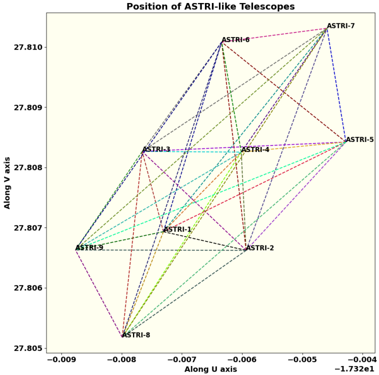
Signal and Estimation of Parameters.

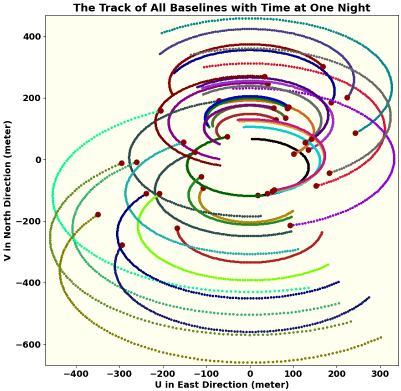
The Simulation of CTA Array as II



- Mimic the existing or upcoming CTA in the World

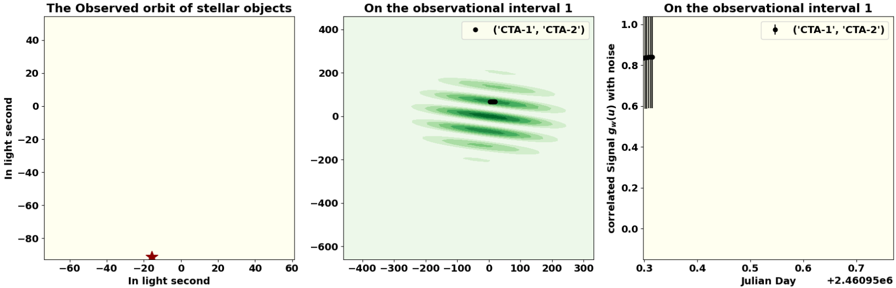
The Simulation of CTA Array as II





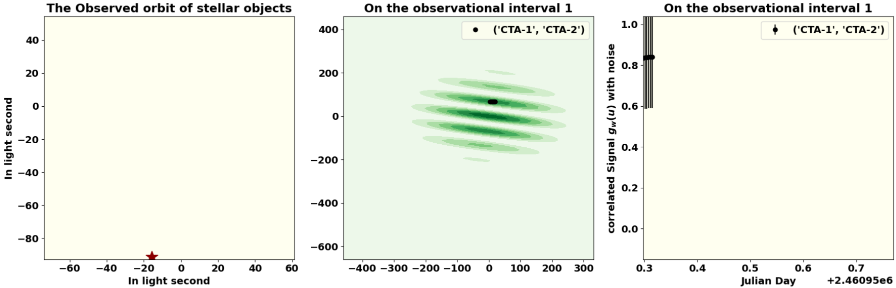
- Mimic the existing or upcoming CTA in the World
- It covers maximum observational plane for better SNR.

The Signal with Time



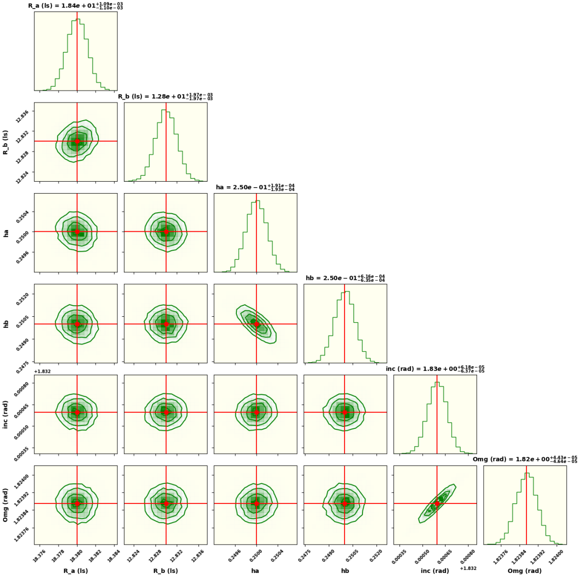
- Epsilon Lupi a close binary star system with ≈ 4 days orbit.

The Signal with Time



- Epsilon Lupi a close binary star system with $\approx$ 4 days orbit.
- 4 night of observation return total number of SNR = 1744725.

The Estimation of Love Number



- The love number is estimated.

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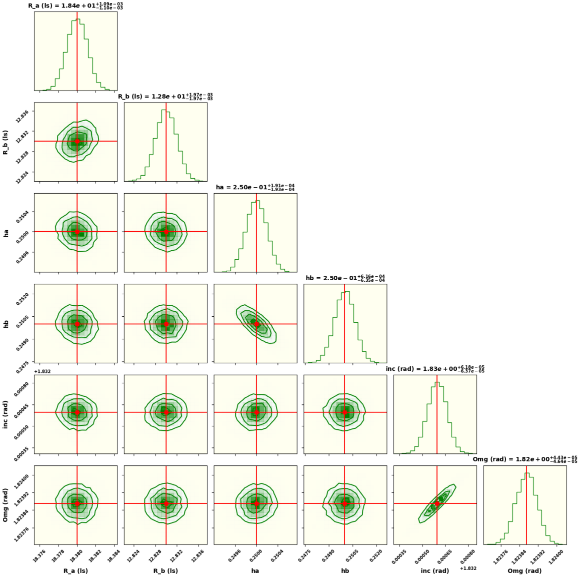

- The love number is estimated.
- Along with other parameters.

The Oblateness of Stars Introduces Non-uniform Brightness ?

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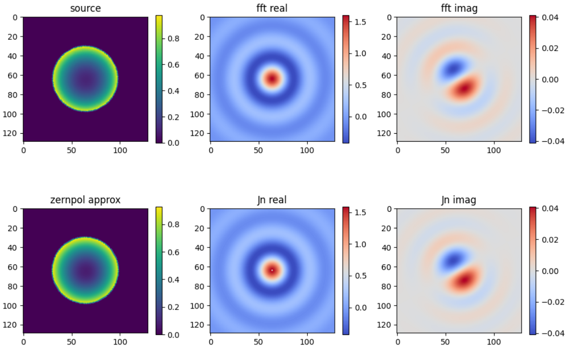
II. Including Gravity Darkening in the model.



- Stretching will also include non-uniform brightness distribution.

Looking for.....

??!!

Thank You!!