Inferring properties of stellar systems via astrometric monitoring

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Keywords: Alpha Centauri, Astrometry, Exoplanets, Stellar activity, Star spots, TOLIMAN

Astrometric Jitter of the Sun

- Astrometry is the best bet for detecting a nearby Earth twin.
- The astrometric signal precision is fundamentally limited by stellar activity, the magnitude of which is yet to be measured directly with estimates varying by several orders of magnitude.
- Using the PSPT instrument at MLSO, we use over 60k photos over a period of ten years spanning one solar cycle to measure the photometric noise of the Sun.
- We show that in Red and Blue bands, the photometric jitter varies from **0.05-0.2 milli stellar radii**, and in the K band, varies from **0.5-3.5 milli stellar radii**, over a solar cycle. This is about 1.2-4.5x smaller than the expected astrometric signal of an Earth-like planet around Alpha Centauri A
- To calibrate these measurements, we created sunspot simulations to validate the data to ensure there were no instrumental or instrumental systematics contaminating the data.

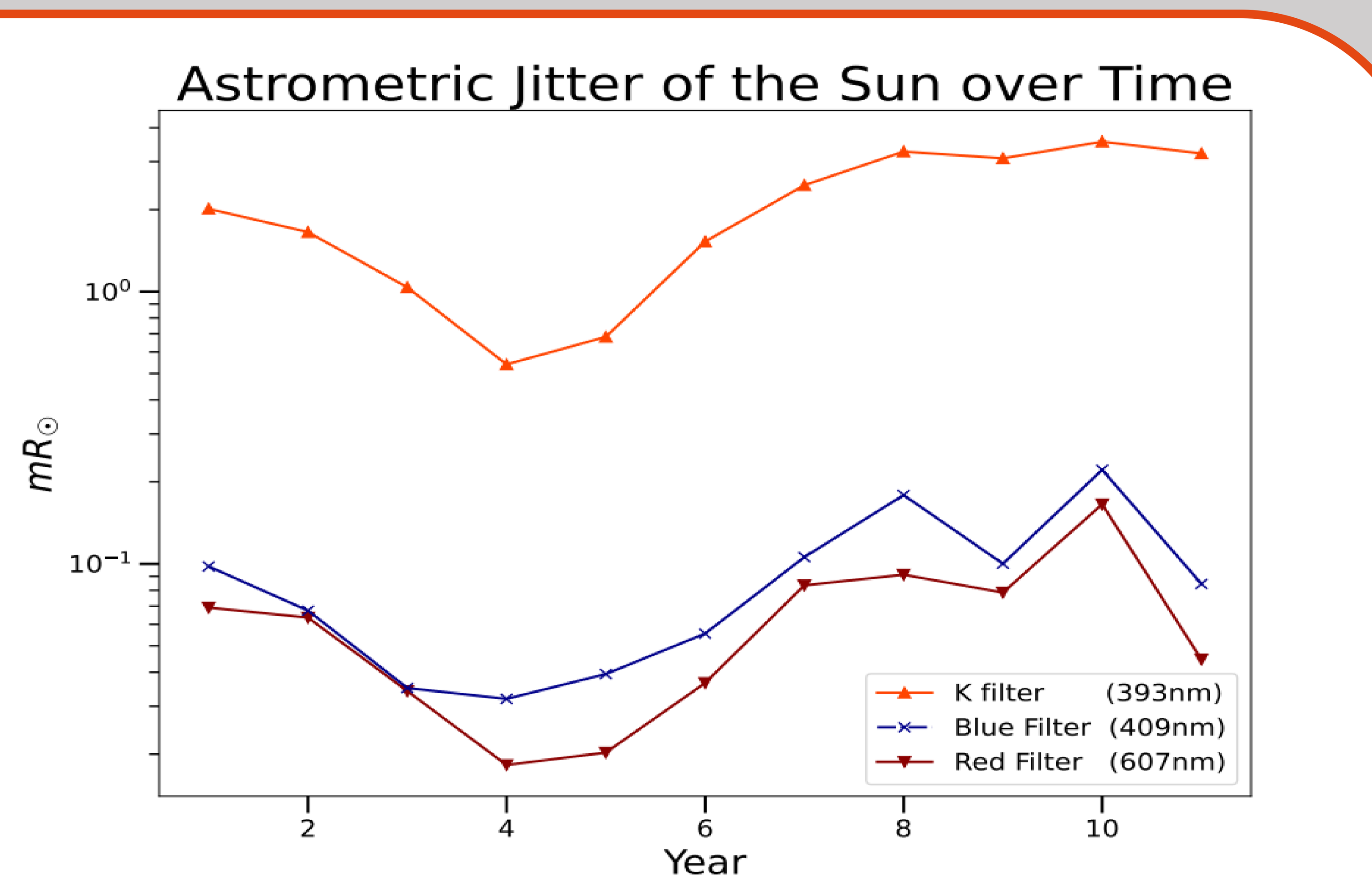


Figure 1:
The astrometric jitter of the Sun in three different wavelengths due to photometric variation over one solar cycle.

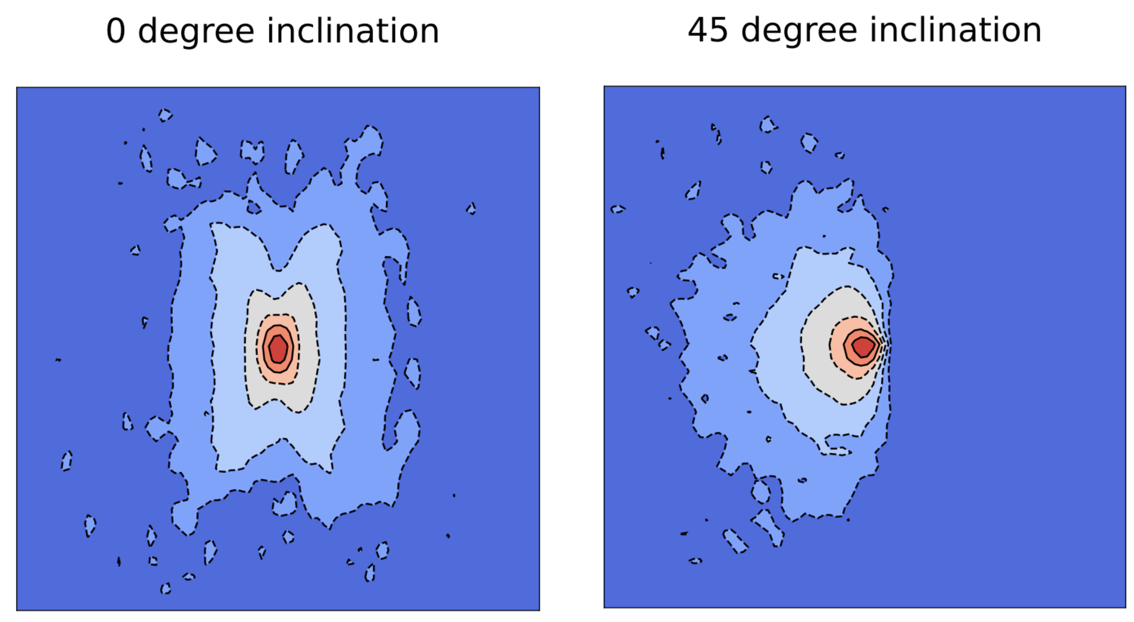


Figure 2:
A qualitative representation of the probability of the position of the photometric centre of a star at two different stellar inclinations. Redder means a higher probability.

Starspot simulations

- We note that the photometric jitter due to starspots create distinct patterns which change as a function of spot location and stellar inclination.
- Using the UNSW Katana computing cluster, we ran the simulations thousands of times with different parameter sets and found that these patterns consistently showed up. Therefore, we can use this information to infer the inclination.

Retrieving Stellar inclination

- We hypothesise that by astrometrically monitoring nearby stars for a long enough time period during periods of high stellar activity, we can recover the stellar inclination
- Using the upcoming TOLIMAN telescope mission as a baseline, we used Bayesian modelling to demonstrate that, under good conditions*, we may be able to recover the stellar inclination of Alpha Centauri A&B to **within several degrees.**
- ***** *If you are curious what these are, ask me! Contact details below ☺*

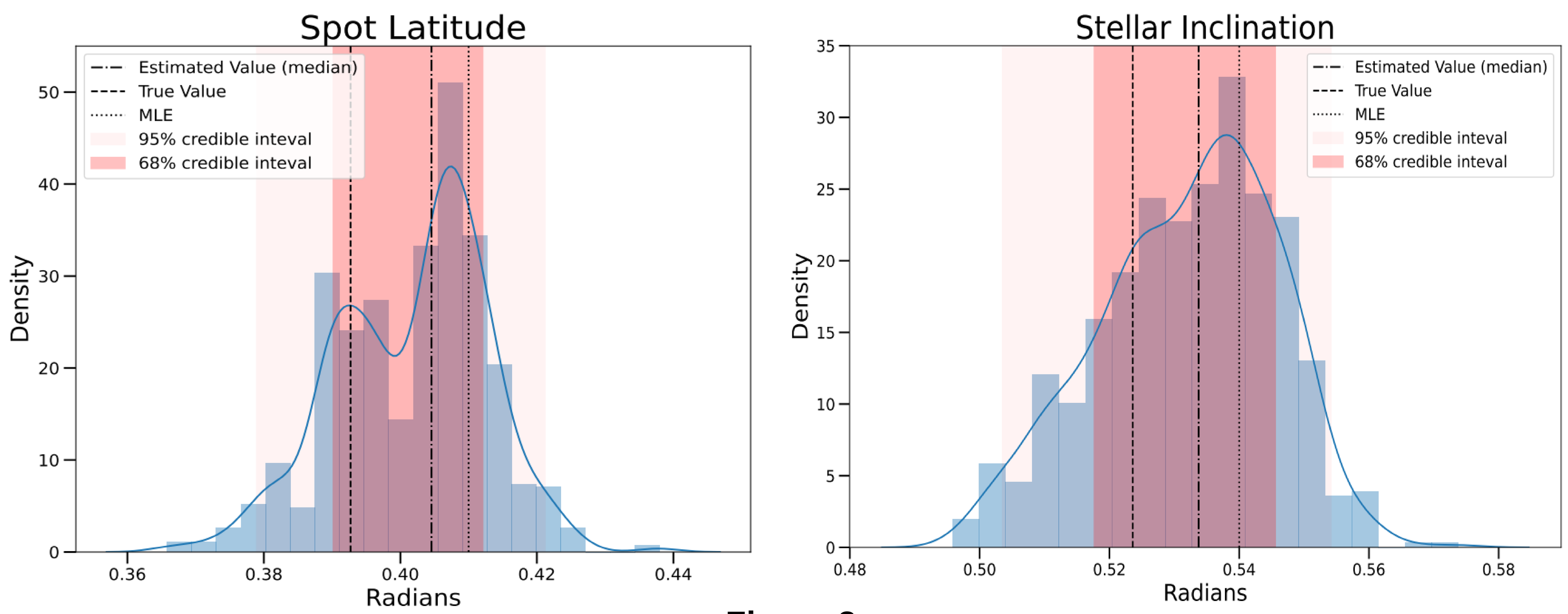
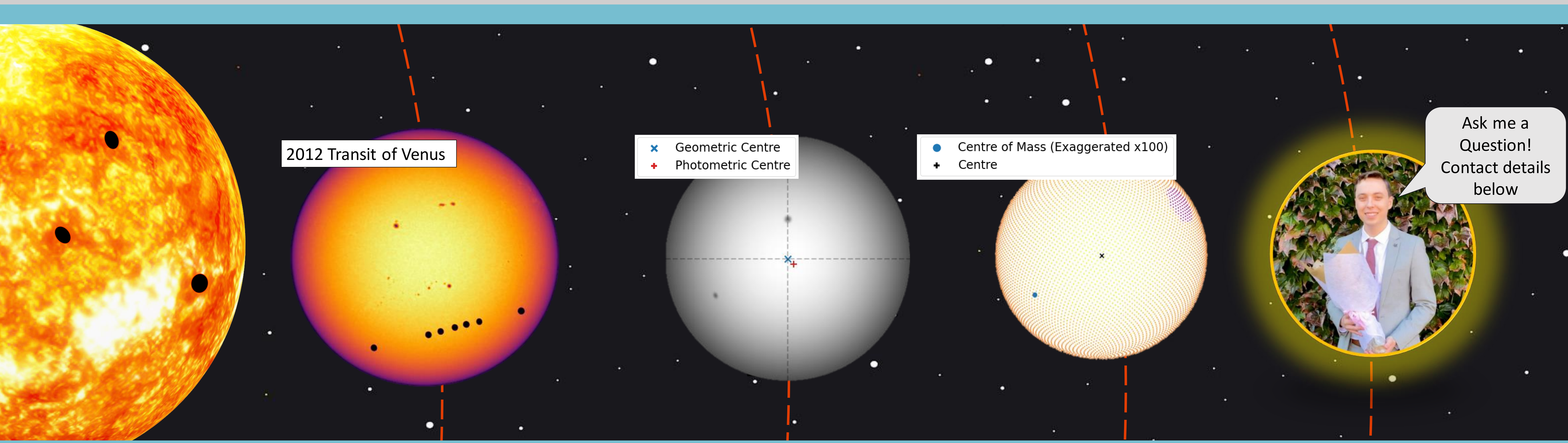


Figure 3:
A Bayesian posterior of stellar parameters based on simulated observations. Note that the priors were very non-prescriptive with the Spot Latitude prior spanning [$-\pi/2$, $\pi/2$], and Stellar Inclination spanning [0, $\pi/2$]. This demonstrates that with good conditions, we can restrict stellar inclination significantly.



To conclude, we have for the first time measure the astrometric jitter of the Sun, and we have demonstrated the feasibility of measuring the inclination of nearby stars with upcoming astrometric missions.

Have questions?
Contact me here -->

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