



# Independent Verification of Transiting Planet TOI-201 c with Hipparcos-Gaia Astrometry



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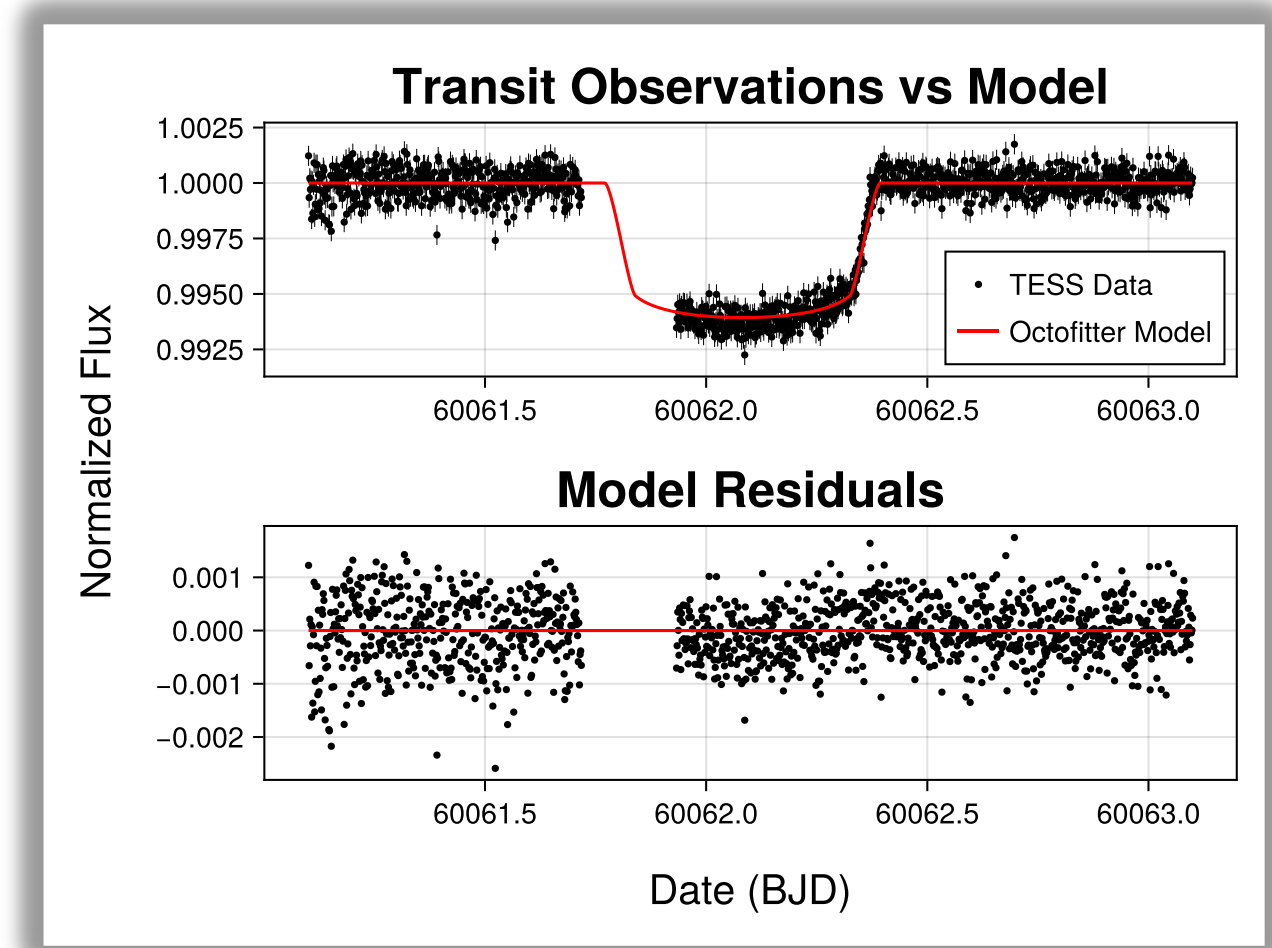
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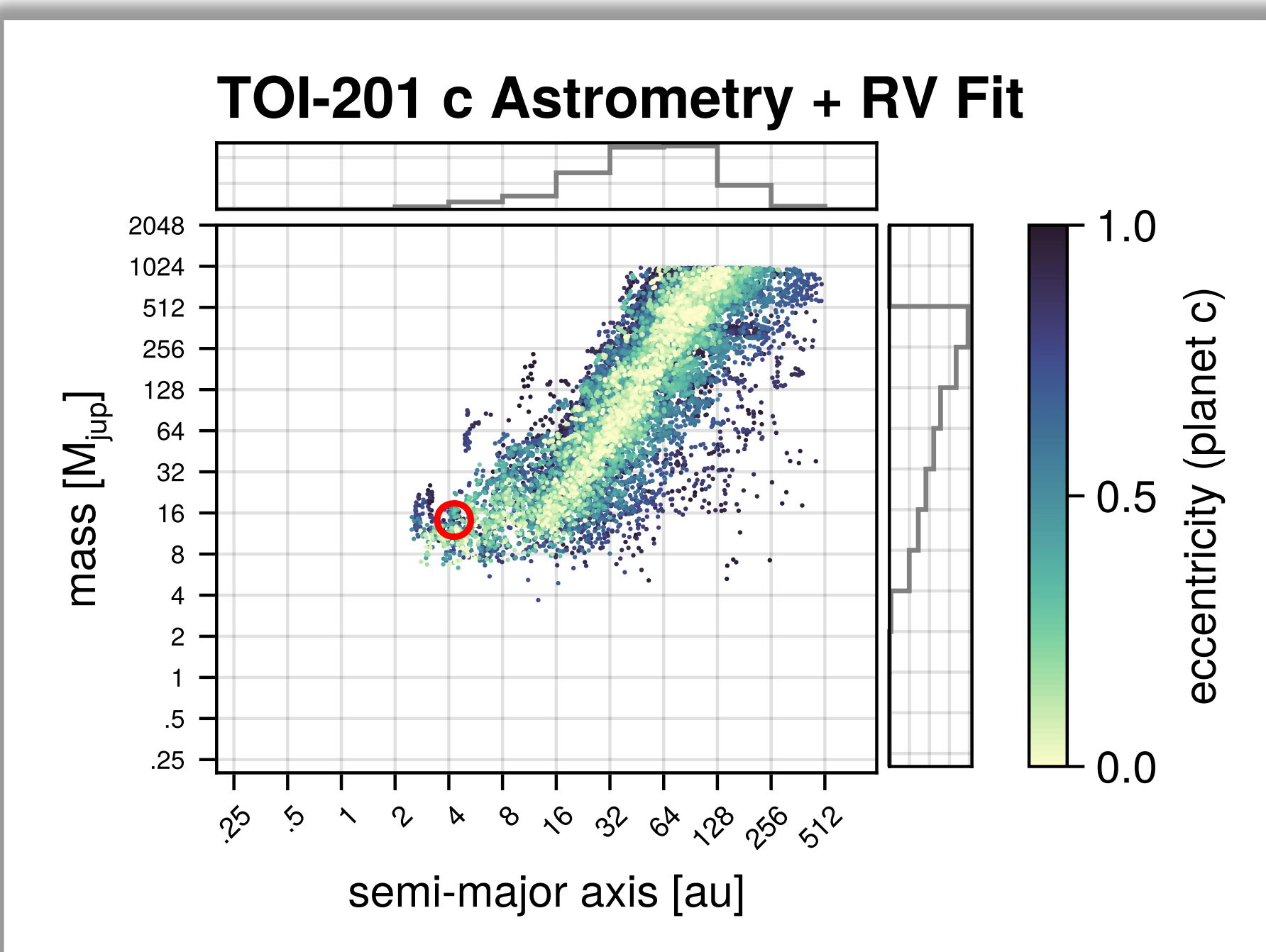
## TOI-201 b and c

TESS Object of Interest 201 is a young, active star identified as a candidate host, with follow up analysis confirming the presence of a warm giant planet, TOI-201 b on a  $\sim 53$ -day orbit<sup>1</sup>. Later analysis of transit timing variations and a  $\sim 15$ -hour transit in the TESS photometry led to the detection of outer planet TOI-201 c, with a  $\sim 2800$ -day period<sup>2</sup>. To the right is the TESS light curve modeled with the Bayesian inference code Octofitter<sup>3</sup>.



## The G23H Catalog

The G23H catalog is a new catalog<sup>4</sup> of Gaia DR3 reference frame-calibrated DR2 proper motions and DR3-DR2 scaled position differences, combined with the Hipparcos-Gaia Catalog of Accelerations, Hipparcos intermediate astrometric data, Gaia astrometric excess noise, and Gaia radial velocity variability constraints. This catalog extracts the maximum information from the existing Hipparcos and Gaia data releases, allowing new astrometric discoveries and additional orbit constraints on known exoplanets.

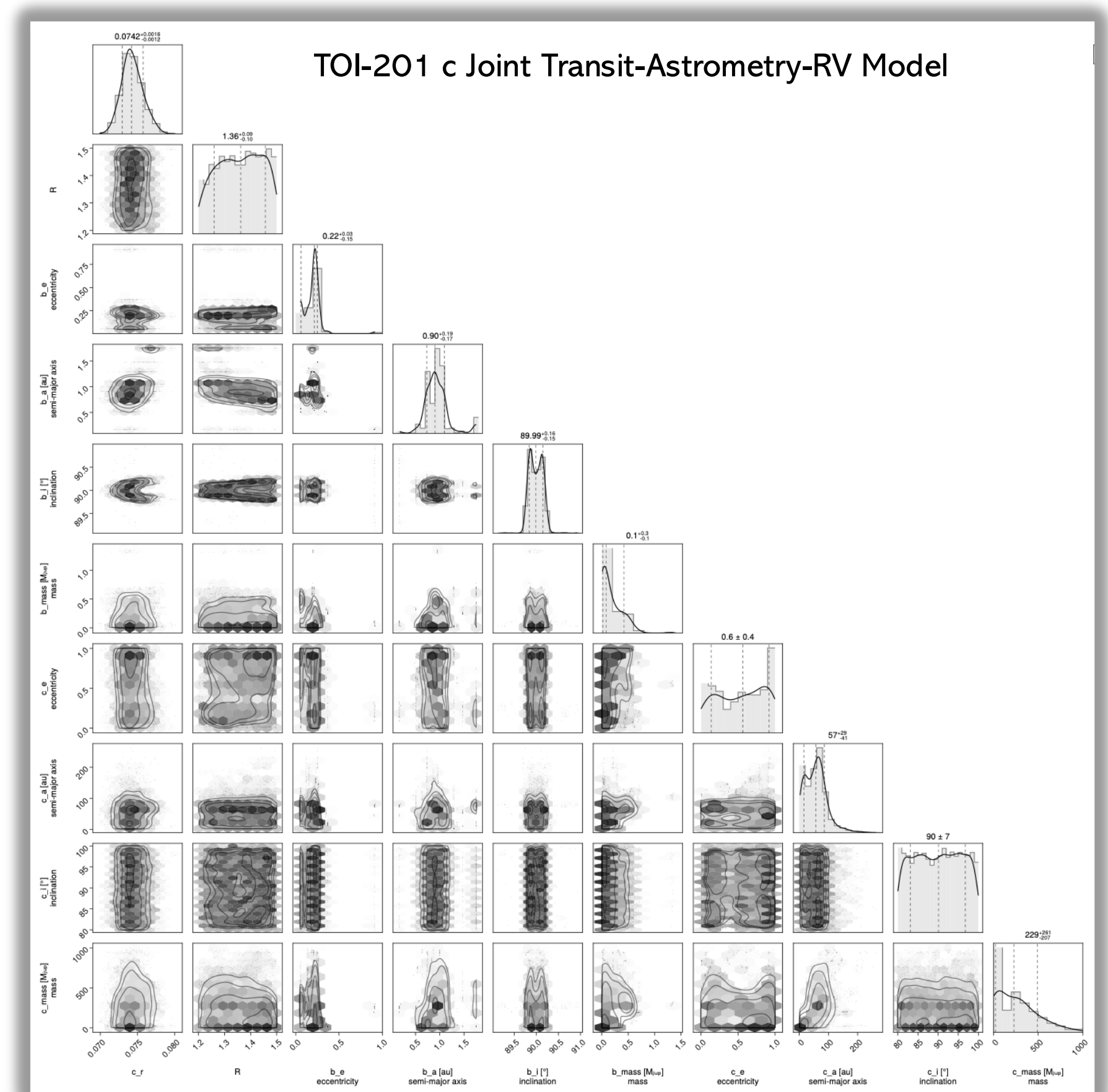


## Independent Confirmation of TOI-201 c

Using the G23H catalog, archival HARPS + CORALIE RV data, and orbit analysis using Octofitter, we find independent evidence of TOI-201 c. Our results, summarized in mass/separation shown to the left, are consistent with the modeling done in the discovery work<sup>2</sup>, which found a companion mass  $14.2 (+1.0/-1.2) M_{\text{jup}}$  and semimajor axis  $4.28 (+0.36/-0.21)$  AU with eccentricity  $0.643 (+0.009/-0.021)$ , indicated by the red circle.

## Preliminary Joint Transit-Astrometry-RV Modeling

We are currently working on joint modeling of the G23H data and archival RVs with the single transit observed by TESS. We fit the transit signal using quadratic limb darkening<sup>5,6</sup> provided by Transits.jl<sup>7</sup> along with the astrometric signal from G23H and DACE RVs. Current results are summarized in the corner plot to the right, however the model is not currently converging. Additional testing of the joint modeling is underway. In the future, the TESS transits observed for planet b can also be included in the joint fit to further constrain its orbit.



## Next Steps

More testing of the joint model is currently underway. The G23H catalog is available now with the methods paper<sup>3</sup> on the arXiv now. Other TOIs with Hipparcos and Gaia data could also be modeled in a similar joint model to further constrain orbital parameters, especially with Gaia DR4 coming soon. With extremely large telescopes on the horizon, along with next-generation instruments such as VLTI-MATISSE or GPI2, there is also the potential of direct detection follow-up observations, which can be used to improve the orbit models even further.

### References

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- [3] Thompson, W., et al. "Octofitter: Fast, Flexible, and Accurate Orbit Modeling to Detect Exoplanets," in *AJ*, vol. 166, no. 4, pp. 164, 2023.
- [4] W. Thompson et al. "Detecting and Characterizing Companions with a Calibrated Gaia DR2, DR3, and Hipparcos Catalog (G23H)," arXiv: astro-ph.EP2602.00235, 2026.
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