Discovery and Properties of the TOI-700 System

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Abstract

This study presents the discovery and validation of a three-planet system orbiting the nearby (31.1 pc), bright M2 dwarf star **TOI-700** [1].

TESS (Transiting Exoplanet Survey Satellite) continuously observed this star in the Southern Ecliptic Hemisphere across 11 sectors. Analysis revealed three planets with radii ranging from approximately 1.0 to 2.6 Earth radii ($R_\oplus$) and orbital periods between 9.98 and 37.43 days, named **TOI-700 b**, **TOI-700 c**, and **TOI-700 d**.

Habitable Zone and Energy Balance

The outermost planet, **TOI-700 d**, has a radius of $1.19 \pm 0.11\, R_\oplus$ and receives about 86% of the solar radiation Earth receives, placing it within the conservative *habitable zone*. The planet's energy balance can be modeled by the relationship between the incoming stellar flux and the planet's emitted energy:

$$S = \sigma T_{\text{eq}}^4 \tag{1}$$

where S is the stellar flux received, σ is the Stefan–Boltzmann constant, and T_{eq} is the planet's equilibrium temperature. For TOI-700 d, $T_{\text{eq}} \approx 269\,\text{K}$.

Planetary Properties

Table 1: Key properties of the TOI-700 planets

Planet	Radius ($R_\oplus$)	Orbital Period (days)	Received Flux ($S_\oplus$)
TOI-700 b	1.01	9.98	4.12
TOI-700 c	2.63	16.05	2.61
TOI-700 d	1.19	37.43	0.86

As seen in the table, TOI-700 b is the innermost planet with high stellar flux, reducing its habitability potential. TOI-700 c is a sub-Neptune-sized planet, providing an excellent target for atmospheric characterization.

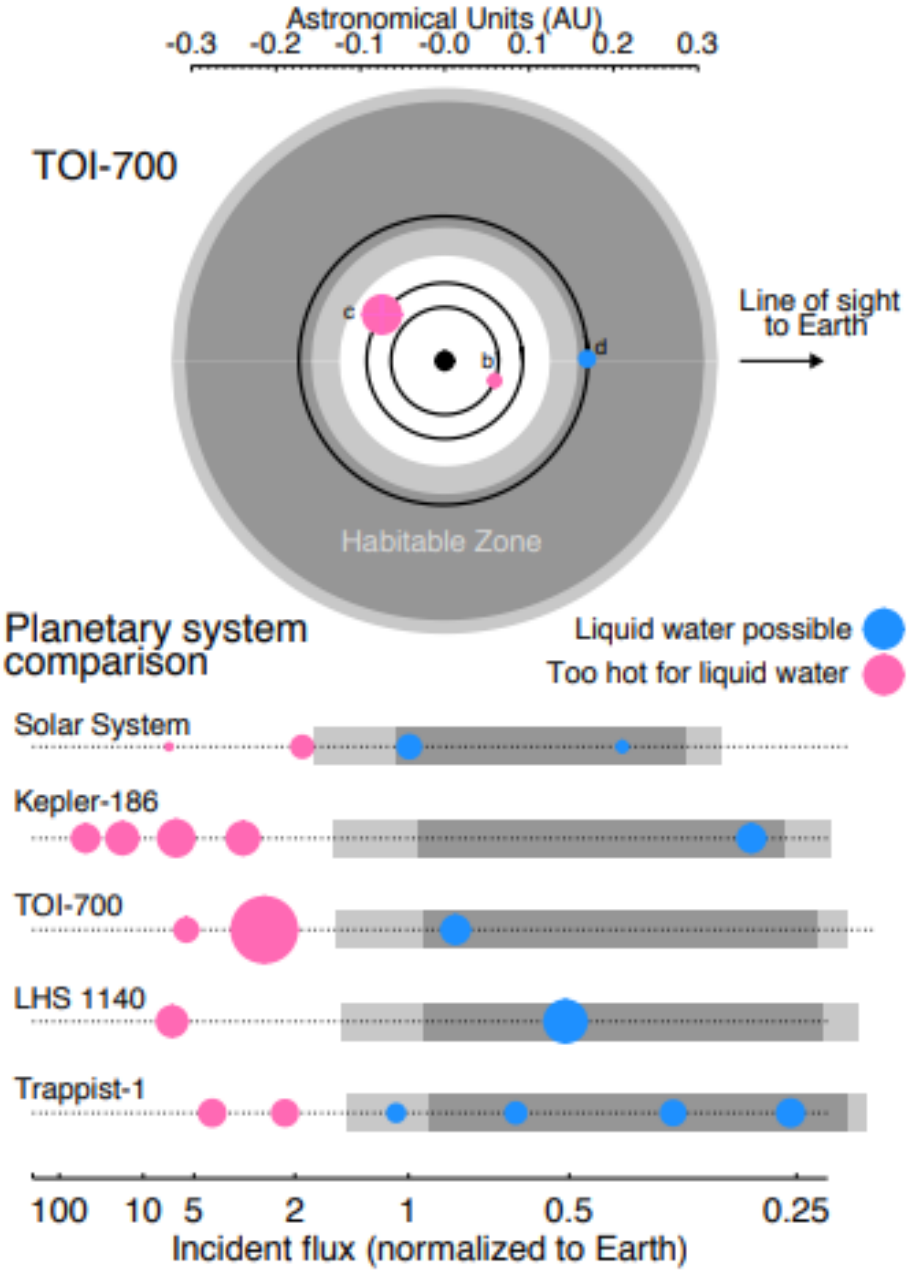

Figure 1: Schematic representation of the TOI-700 system (Source: NASA).

Conclusion

The TOI-700 system hosts three planets around a low-activity star, varying in size and properties. TOI-700 d is particularly valuable due to its Earth-like size and location in the habitable zone. Continued TESS observations will allow for more precise characterization and potential discovery of additional planets.

References

[1] Gilbert, E. A., et al. (2020). *An Earth-sized Planet in the Habitable Zone of a Nearby Cool Star*. The Astronomical Journal, 160(3), 116.