TOI-270

TOI-270, also known as **L 231-32**, is a red dwarf star 73.3 light-years (22.5 parsecs) away in the constellation Pictor. It has about 39% the mass and 38% the radius of the Sun, and a temperature of about 3,506 K (3,233 °C; 5,851 °F). TOI-270 hosts a system of three known exoplanets.

Planetary system

The three planets of TOI-270 were discovered in 2019 by the transit method with TESS.[4] Their masses have since been measured by both Doppler spectroscopy[5] and transit-timing variations.[6] The innermost planet, TOI-270 b, is a rocky super-Earth, while the two outer planets are mini-Neptunes.[5] TOI-270 b & c orbit near a 5:3 resonance, while TOI-270 c & d orbit near a 2:1 resonance.[4]

Observations of the outermost planet, TOI-270 d, by the Hubble Space Telescope suggest a hydrogen-rich atmosphere with signs of water vapor.[7] TOI-270 c & d are good targets for atmospheric detection with the James Webb Space Telescope.[8]

The James Webb Space Telescope detected methane (CH_4), carbon dioxide (CO_2) and water vapor in the atmosphere of TOI-270 d.[9] The atmosphere of this planet was also found to be metal-rich, with a mean molecular weight of $5.47\ ^{+1.25}_{-1.14}$ and an atmospheric metal mass fraction (percentage of the mass of metals in the atmosphere) of $58\%\ ^{+8\%}_{-12\%}$.[9] Possible signatures of sulfur dioxide (SO_2) and carbon disulfide (CS_2) were also found.[9]

TOI-270

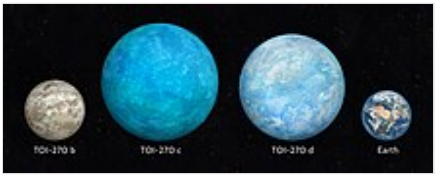
Observation data	
Epoch J2000	**Equinox J2000**
Constellation	Pictor[1]
Right ascension	$04^h\ 33^m\ 39.72001^s$[2]
Declination	−51° 57′ 22.4354″[2]
Apparent magnitude (V)	12.617[3]
Characteristics	
Evolutionary stage	Main sequence
Spectral type	M3.0V[4]
Apparent magnitude (V)	12.617 ± 0.03[3]
Apparent magnitude (R)	12.147 ± 0.05[3]
Apparent magnitude (G)	11.621 ± 0.003[2]
Apparent magnitude (J)	9.099 ± 0.032[3]
Apparent magnitude (H)	8.531 ± 0.073[3]
Apparent magnitude (K)	8.251 ± 0.029[3]
Astrometry	
Radial velocity (R_v)	25.90 ± 0.37[2] km/s
Proper motion (μ)	RA: +83.082 mas/yr[2] Dec.: −269.803 mas/yr[2]
Parallax (π)	44.4899 ± 0.0147 mas[2]
Distance	73.31 ± 0.02 ly (22.477 ± 0.007 pc)
Details[5]	
Mass	0.386 ± 0.008 $M_\odot$
Radius	0.378 ± 0.011 $R_\odot$
Luminosity (bolometric)	0.0194 ± 0.0019 $L_\odot$
Surface gravity (log *g*)	4.872 ± 0.026 cgs
Temperature	3506 ± 70 K
Metallicity [Fe/H]	−0.20 ± 0.12 dex
Other designations	
L 231-32, PM J04336-5157, TOI-270, TIC 259377017, 2MASS J04333970-5157222[3]	
Database references	

SIMBAD	data (https://simbad.cds.unistra.fr/simbad/sim-id?Ident=TOI-270)

The TOI-270 planetary system[5][6]

Companion (in order from star)	Mass	Semimajor axis (AU)	Orbital period (days)	Eccentricity	Inclination	Radius
b	1.48 ± 0.18 $M_\oplus$	0.031 97(22)	3.360 1538(48)	0.0167(84)	89.39 ± 0.37°	1.206 ± 0.039 $R_\oplus$
c	6.20 ± 0.31 $M_\oplus$	0.045 26(31)	5.660 5731(31)	0.0044(6)	89.36 ± 0.24°	2.355 ± 0.064 $R_\oplus$
d	4.20 ± 0.16 $M_\oplus$	0.072 10(50)	11.379 573(13)	0.0066(20)	89.73 ± 0.16°	2.133 ± 0.058 $R_\oplus$

Comparison of the TOI-270 planetary system to Jupiter's moon system[10]



Artist's impression of the three known planets in the TOI-270 system and their size comparison with Earth

References

1. "Finding the constellation which contains given sky coordinates" (http://djm.cc/constellation.html). *djm.cc*. 2 August 2008.
2. Vallenari, A.; et al. (Gaia collaboration) (2023). "*Gaia* Data Release 3. Summary of the content and survey properties" (https://doi.org/10.1051%2F0004-6361%2F202243940). *Astronomy and Astrophysics*. **674**: A1. arXiv:2208.00211 (https://arxiv.org/abs/2208.00211). Bibcode:2023A&A...674A...1G (https://ui.adsabs.harvard.edu/abs/2023A&A...674A...1G). doi:10.1051/0004-6361/202243940 (https://doi.org/10.1051%2F0004-6361%2F202243940). S2CID 244398875 (https://api.semanticscholar.org/CorpusID:244398875). Gaia DR3 record for this source (https://vizier.u-strasbg.fr/viz-bin/VizieR-S?Gaia%20DR3%20478119611546995302 4) at VizieR.
3. "L 231-32" (http://simbad.u-strasbg.fr/simbad/sim-basic?Ident=L+231-32). *SIMBAD*. Centre de données astronomiques de Strasbourg. Retrieved 18 October 2023.
4. Günther, Maximilian N.; Pozuelos, Francisco J.; et al. (July 2019). "A super-Earth and two sub-Neptunes transiting the nearby and quiet M dwarf TOI-270". *Nature Astronomy*. **3** (12): 1099–1108. arXiv:1903.06107 (https://arxiv.org/abs/1903.06107). Bibcode:2019NatAs...3.1099G (https://ui.adsabs.harvard.edu/abs/2019NatAs...3.1099G). doi:10.1038/s41550-019-0845-5 (https://doi.org/10.1038%2Fs41550-019-0845-5). S2CID 256707535 (https://api.semanticscholar.org/CorpusID:256707535).
5. Van Eylen, V.; Astudillo-Defru, N.; et al. (October 2021). "Masses and compositions of three small planets orbiting the nearby M dwarf L231-32 (TOI-270) and the M dwarf radius valley" (https://doi.org/10.1093%2Fmnras%2Fstab2143). *Monthly Notices of the Royal Astronomical Society*. **507** (2): 2154–2173. arXiv:2101.01593 (https://arxiv.org/abs/2101.01593). Bibcode:2021MNRAS.507.2154V (https://ui.adsabs.harvard.edu/abs/2021MNRAS.507.2154V). doi:10.1093/mnras/stab2143 (https://doi.org/10.1093%2Fmnras%2Fstab2143).

6. Kaye, Laurel; Vissapragada, Shreyas; et al. (March 2022). "Transit Timing Variations in the three-planet system: TOI-270" (https://doi.org/10.1093%2Fmnras%2Fstab3483). *Monthly Notices of the Royal Astronomical Society*. **510** (4): 5464–5485. arXiv:2308.10763 (https://arxiv.org/abs/2308.10763). Bibcode:2022MNRAS.510.5464K (https://ui.adsabs.harvard.edu/abs/2022MNRAS.510.5464K). doi:10.1093/mnras/stab3483 (https://doi.org/10.1093%2Fmnras%2Fstab3483).
7. Mikal-Evans, Thomas; Madhusudhan, Nikku; et al. (March 2023). "Hubble Space Telescope Transmission Spectroscopy for the Temperate Sub-Neptune TOI-270 d: A Possible Hydrogen-rich Atmosphere Containing Water Vapor" (https://doi.org/10.3847%2F1538-3881%2Faca90b). *The Astronomical Journal*. **165** (3): 84. arXiv:2211.15576 (https://arxiv.org/abs/2211.15576). Bibcode:2023AJ....165...84M (https://ui.adsabs.harvard.edu/abs/2023AJ....165...84M). doi:10.3847/1538-3881/aca90b (https://doi.org/10.3847%2F1538-3881%2Faca90b).
8. Chouqar, J.; Benkhaldoun, Z.; et al. (June 2020). "Properties of sub-Neptune atmospheres: TOI-270 system" (https://doi.org/10.1093%2Fmnras%2Fstaa1198). *Monthly Notices of the Royal Astronomical Society*. **495** (1): 962–970. arXiv:2004.12475 (https://arxiv.org/abs/2004.12475). Bibcode:2020MNRAS.495..962C (https://ui.adsabs.harvard.edu/abs/2020MNRAS.495..962C). doi:10.1093/mnras/staa1198 (https://doi.org/10.1093%2Fmnras%2Fstaa1198).
9. Benneke, Björn; Roy, Pierre-Alexis; Coulombe, Louis-Philippe; Radica, Michael; Piaulet, Caroline; Ahrer, Eva-Maria; Pierrehumbert, Raymond; Krissansen-Totton, Joshua; Schlichting, Hilke E. (2024-03-05), *JWST Reveals CH$_4$, CO$_2$, and H$_2$O in a Metal-rich Miscible Atmosphere on a Two-Earth-Radius Exoplanet*, arXiv:2403.03325 (https://arxiv.org/abs/2403.03325)
10. Reddy, Francis (29 July 2019). "NASA's TESS Mission Scores 'Hat Trick' With 3 New Worlds" (https://www.nasa.gov/universe/nasas-tess-mission-scores-hat-trick-with-3-new-worlds/). NASA. Retrieved 18 October 2023.
