WD 1856+534

WD 1856+534 is a white dwarf located in the constellation of Draco. At a distance of about 25 parsecs (80 ly) from Earth, it is the outer component of a visual triple star system consisting of an inner pair of red dwarf stars, named G 229-20. The white dwarf displays a featureless absorption spectrum, lacking strong optical absorption or emission features in its atmosphere. It has an effective temperature of 4,700 K (4,430 °C; 8,000 °F), corresponding to an age of approximately 5.8 billion years.[4] WD 1856+534 is approximately half as massive as the Sun, while its radius is much smaller, being 40% larger than Earth.[5]

Planetary system

The white dwarf is known to host one exoplanet, WD 1856+534 b, in orbit around it. The exoplanet was detected through the transit method by the Transiting Exoplanet Survey Satellite (TESS) between July and August 2019. An analysis of the transit data in 2020 revealed that it is a Jupiter-like giant planet with a radius over ten times that of Earth's, and orbits its host star closely at a distance of 0.02 astronomical units (AU), with an orbital period 60 times shorter than that of Mercury around the Sun.

The unexpectedly close distance of the exoplanet to the white dwarf implies that it must have migrated inward after its host star evolved from a red giant to a white dwarf, otherwise it would have been engulfed by its star.[4] This migration may be related to the fact that WD 1856+534 belongs to a hierarchical triple-star system: the white dwarf and its planet are gravitationally bound to a distant companion, G 229–20, which itself is a binary system of two red dwarf stars.[4] Gravitational interactions with the companion stars may have triggered the planet's migration through the Lidov–Kozai mechanism[6][7][8] in a manner similar to some hot Jupiters. An alternative hypothesis is that the planet instead has survived a common envelope phase.[9] In the latter scenario, other planets engulfed before may have contributed to the expulsion of the stellar envelope.[10] JWST observations seem to disfavour the formation via common envelope and instead favour high eccentricity migration.[11]

The planetary transmission spectrum obtained with GTC OSIRIS is gray and featureless, likely because of the high level of hazes.[12] The transmission spectrum was also obtained with Gemini GMOS. It does not show any features beside a possible dip at 0.55 μm. This feature could be caused be auroral emission at the nightside of the planet. The research find a minimum mass of 0.84 M_J by accounting for the transit geometry of a grazing transit. The researchers also revised the white dwarf parameters and found a total age of 8-10 billion years, in agreement with the system beloning to the thin disk.[3]

WD 1856+534

Artist's impression of WD 1856+534 and its planet.

Observation data	Epoch J2000	Equinox J2000
Constellation	Draco	
WD 1856+534		
Right ascension	$18^h\ 57^m\ 39.34^s$[1]	
Declination	+53° 30′ 33.30″[1]	
Apparent magnitude (V)	17.244 ± 0.046[2]	
G 229-20 A		
Right ascension	$18^h\ 57^m\ 38.4^s$[2]	
Declination	53° 31′ 14.43″[2]	
Apparent magnitude (V)	13.15[2]	
G 229-20 B		
Right ascension	$18^h\ 57^m\ 38.33^s$[2]	
Declination	53° 31′ 12.24″[2]	
Apparent magnitude (V)	13.23[2]	
Characteristics		
WD 1856+534		
Evolutionary stage	white dwarf	
Spectral type	DA[3]	
Apparent magnitude (J)	15.677 ± 0.055[1]	
Apparent magnitude (H)	15.429 ± 0.094[1]	
Apparent magnitude (K)	15.548 ± 0.186[1]	
Astrometry		
Proper motion (μ)	RA: −240.759 ± 0.148[1] mas/yr Dec.: −52.514 ± 0.143[1] mas/yr	
Parallax (π)	40.3983 ± 0.0705[1] mas	

A search with transit timing variations found no additional planets. The search exclude planets with a mass more than 2 M_J with orbital periods as long as 500 days and planets with >10 M_J with orbital periods as long as 1000 days.[13]

Distance	80.737 ± 0.144 ly (24.754 ± 0.044[4] pc)
G 299-20 A	
Proper motion (μ)	RA: 256.12 mas/yr[2] Dec.: -52.72 mas/yr[2]
Parallax (π)	40.298 ± 0.024 mas[2]
Distance	80.94 ± 0.05 ly (24.82 ± 0.01 pc)
G 299-20 B	
Proper motion (μ)	RA: 241.4[2] mas/yr[2] Dec.: -44.176 mas/yr[2]
Parallax (π)	40.33 ± 0.024 mas[2]
Distance	80.87 ± 0.05 ly (24.80 ± 0.01 pc)
Details[3]	
WD 1856+534	
Mass	0.576 ± 0.040 $M_\odot$
Radius	0.012 63 ± 0.000 50 $R_\odot$
Surface gravity (log *g*)	7.995 ± 0.065 cgs
Temperature	4860 ± 60 K
Metallicity [Fe/H]	<−8.8[4] dex
Age	6.60 ± 0.48 Gyrs (cooling age) 8 to 10 (total age) Gyr
G 299-20 A[4]	
Mass	0.335 ± 0.024 $M_\odot$
Radius	0.35 ± 0.02 $R_\odot$
Temperature	3,521 K
G 299-20 B[4]	
Mass	0.322 ± 0.023 $M_\odot$
Radius	0.34 ± 0.02 $R_\odot$
Temperature	3,513 K
Position (relative to G 229-20)[4]	
Angular distance	~43″
Projected separation	1030 $^{+130}_{-55}$ AU [4]
Other designations	
LP 141-14, LSPM J1857+5330, 2MASS J18573936+5330332, NLTT 47263, TIC 267574918, TOI-1690, WDS J18576+5331C, WISE J185739.62+533032.9	
Database references	
SIMBAD	data (https://simbad.cds.unistra.fr/simbad/sim-id?Ident=WD+1856%2B534)
Exoplanet Archive	data (https://exoplanetarchive.ipac.caltech.edu/cgi-bin/DisplayOverview/nph-DisplayOvervie

w?objname=WD+1856%2B534+b)

The WD 1856+534 planetary system[4]

Companion (in order from star)	Mass	Semimajor axis (AU)	Orbital period (days)	Eccentricity	Inclination	Radius
b	2.4-13.8[12] or >0.84[3] M_J	0.0204 ± 0.0012	1.407 939 25 ± 0.000 000 04[3]	~0	88.778 ± 0.059°	0.966 $^{+0.040}_{-0.039}$[3][nb 1] R_J

See also

- WD 1145+017, a white dwarf with a transiting disrupted planetary-mass object
- WD J0914+1914, a white dwarf with a disk of debris originating from a possible giant planet
- ZTF J0139+5245, another white dwarf with a disk of debris from a disrupted planetary-mass object
- CWISEP J1935-1546 a free-floating object with aurora emission in the infrared
- List of exoplanets and planetary debris around white dwarfs

Notes

1. Calculated using the Radius ratio in table 4 and the white dwarf radius in table 3, convertion into jupiter radius using 1 $R_\odot$ is 0.1028 R_J, see solar radius

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External links

- NASA Missions Spy First Possible 'Survivor' Planet Hugging White Dwarf Star (https://www.nasa.gov/press-release/nasa-missions-spy-first-possible-survivor-planet-hugging-white-dwarf-star/), Sean Potter, NASA, 16 September 2020
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