



PSR B1257+12

PSR B1257+12, previously designated **PSR 1257+12**, alternatively designated **PSR J1300+1240**,^[6] is a millisecond pulsar located 2,300 light-years (710 parsecs) from the Sun in the constellation of Virgo, rotating at about 161 times per second (faster than a blender's blade).^[1] It is also named **Lich**, after a powerful, fictional undead creature of the same name.^{[7][5]}

The pulsar has a planetary system with three known pulsar planets, named "Draugr" (PSR B1257+12 b or PSR B1257+12 A), "Poltergeist" (PSR B1257+12 c, or PSR B1257+12 B), and "Phobetor" (PSR B1257+12 d, or PSR B1257+12 C), respectively. They were both the first extrasolar planets and the first pulsar planets to be discovered; B and C in 1992 and A in 1994. A is the lowest-mass planet yet discovered by any observational technique, with somewhat less than twice the mass of Earth's moon.

Nomenclature

The convention that arose for designating pulsars was that of using the letters PSR (Pulsating Source of Radio) followed by the pulsar's right ascension and degrees of declination. The modern convention prefixes the older numbers with a B meaning the coordinates are for the 1950.0 epoch. All new pulsars have a J indicating 2000.0 coordinates and also have declination including minutes. Pulsars that were discovered before 1993 tend to retain their B names rather than use their J names, but all pulsars have a J name that provides more precise coordinates of its location in the sky.^[8]

On their discovery, the planets were designated PSR 1257+12 A, B, and C, ordered by increasing distance. They were discovered before the convention that extrasolar planets receive designations consisting of the star's name followed by lower-case Roman letters starting from "b", in order of discovery, was established.^[9] However, they are listed under the latter convention on astronomical databases such as SIMBAD and the Extrasolar Planets Encyclopaedia, with A becoming b, B becoming c, and C becoming d.

PSR B1257+12 Lich

Observation data

Epoch J2000.0	Equinox J2000.0
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<u>Constellation</u>	Virgo
<u>Right ascension</u>	13 ^h 00 ^m 01 ^s
<u>Declination</u>	+12° 40′ 57″

Characteristics

Evolutionary stage Pulsar

Astrometry

<u>Proper motion</u> (μ)	<u>RA</u> : 46.44 ± 0.08^[1] mas/yr <u>Dec.</u> : −84.87 ± 0.32^[1] mas/yr
<u>Parallax</u> (π)	1.41 ± 0.08 mas^[1]
<u>Distance</u>	2,300 ± 100 ly (710 ± 40 pc)

Details

<u>Rotation</u>	0.006219 s^[2]
<u>Age</u>	1–3^{[3][4][a]} Gyr

Other designations

Lich,^[5] PSR 1257+12,
PSR J1300+1240, PSR 1300+1240

Database references

<u>SIMBAD</u>	data (https://simbad.cds.unis-tra.fr/simbad/sim-id?Ident=PSR+B1257%2B12)
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In July 2014, the International Astronomical Union launched NameExoWorlds, a process for giving proper names to certain exoplanets and their host stars.^[10] The process involved public nomination and voting for the new names.^[11] In December 2015, the IAU announced the winning names, submitted by the Planetarium Südtirol Alto Adige in Karneid, Italy, were Lich for the pulsar and Draugr, Poltergeist, and Phobetor for planets A, B, and C, respectively.^{[7][12]}

- A lich is an undead creature known for controlling other undead creatures with magic.
- Draugr refers to undead creatures in Norse mythology.
- Poltergeist is a name for supernatural beings that create physical disturbances, from the German for "noisy ghost".
- Phobetor is, in Ovid's Metamorphoses, one of the thousand sons of Somnus (Sleep) who appears in dreams in the form of beasts.^[13]

In 2016, the IAU organized a Working Group on Star Names (WGSN)^[14] to catalog and standardize proper names for stars (including stellar remnants). In its first bulletin of July 2016,^[15] the WGSN explicitly recognized the names of exoplanets and their host stars approved by the Executive Committee Working Group Public Naming of Planets and Planetary Satellites, including the names of stars adopted during the 2015 NameExoWorlds campaign. This stellar remnant is now so entered in the IAU Catalog of Star Names.^[6]

Pulsar

Discovery

PSR B1257+12 was discovered by the Polish astronomer Aleksander Wolszczan on 9 February 1990 using the Arecibo radio telescope. It is a millisecond pulsar, a kind of neutron star, with a rotation period of 6.22 milliseconds (9,650 rpm), and was found to have anomalies in the pulsation period, which led to investigations as to the cause of the irregular pulses. In 1992, Wolszczan and Dale Frail published a famous paper on the first confirmed discovery of planets outside the Solar System. Using refined methods one more planet was found orbiting this pulsar in 1994.

Characteristics

The pulsar is estimated to have a mass of $1.4 M_{\odot}$, which is typical for most neutron stars and pulsars. The radius is estimated to be around 10 kilometres or 6.2 miles ($\sim 1.5 \times 10^{-5} R_{\odot}$), also common for pulsars and neutron stars. The pulsar is extremely hot, with a surface temperature of up to around 28,856 K (28,583 °C; 51,481 °F). The pulsar formed one to three billion years ago from a white dwarf merger, a pair of white dwarfs colliding and collapsing to form a rapidly spinning pulsar.^[16]

The discovery stimulated a search for planets orbiting other pulsars, but it turned out such planets are rare; only five other pulsar planets, orbiting PSR B1620–26, PSR B0943+10, PSR B0329+54, and PSR J1719–1438, have been confirmed.

Planetary system

The PSR B1257+12 planetary system^[4]

Companion (in order from star)	Mass	Semimajor axis (AU)	Orbital period (days)	Eccentricity	Inclination	Radius
<u>A (b / Draugr)</u>	$0.020 \pm 0.002 \, M_{\oplus}$	0.19	25.262 ± 0.003	0.0	$\sim 50^{\circ}$	—
<u>B (c / Poltergeist)</u>	$4.3 \pm 0.2 \, M_{\oplus}$	0.36	66.5419 ± 0.0001	0.0186 ± 0.0002	53°	—
<u>C (d / Phobetor)</u>	$3.9 \pm 0.2 \, M_{\oplus}$	0.46	98.2114 ± 0.0002	0.0252 ± 0.0002	47°	—

Planets

In 1992, Wolszczan and Frail discovered that the pulsar had two planets. These were the first discovery of extrasolar planets to be confirmed;^{[17][18]} as pulsar planets, they surprised many astronomers who expected to find planets only around main-sequence stars. Additional uncertainty surrounded the system, because of a claim of an earlier pulsar planet around PSR 1829-10 that had to be retracted due to errors in calculations. In 1994, an additional planet was discovered. Additionally, this system may have an asteroid belt or a Kuiper belt.

The planets are believed to be the result of a second round of planetary system formation as a result of two white dwarfs merging with each other into a pulsar and a resulting disk of material in orbit around the star.^[16] Other scenarios include unusual supernova remnants or a quark-nova.^[19] However, the white dwarf–white dwarf merge model seems to be the most likely cause of the formation of the planets.



Artist's impression of the planets orbiting PSR B1257+12. The one in the foreground is planet "C".

Retracted claim of fourth orbital body

In 1996, a possible Saturn-like (100 Earth mass) gas giant was announced orbiting the pulsar at a distance of about 40 AU (6.0 billion km; 3.7 billion mi).^[20] The original hypothesis was retracted; a reinterpretation of the data led to a new hypothesis of a dwarf planet one-fifth the size of Pluto orbiting PSR B1257+12. It would have an average orbital distance of 2.4 AU (360 million km; 220 million mi) with an orbital period of approximately 4.6 years.^{[21][22][23][24]} The dwarf planet hypothesis was also

retracted because further observations showed that the pulsation anomalies previously thought to reveal a fourth orbital body are "not periodic and can be fully explained in terms of slow changes in the pulsar's dispersion measure".^[23]

See also

- 51 Pegasi
- Gamma Cephei Ab
- List of exoplanets discovered before 2000 - Draugr, Poltergeist and Phobetor
- PSR B1620-26

Notes

- a. Value taken from the range of 1 and 3 billion years of age, from the two sources.

References

1. Yan, Zhen; et al. (2013). "Very long baseline interferometry astrometry of PSR B1257+12, a pulsar with a planetary system" (<https://doi.org/10.1093%2Fmnras%2Fstt712>). *Monthly Notices of the Royal Astronomical Society*. **433** (1): 162–169. Bibcode:2013MNRAS.433..162Y (<https://ui.adsabs.harvard.edu/abs/2013MNRAS.433..162Y>). doi:10.1093/mnras/stt712 (<https://doi.org/10.1093%2Fmnras%2Fstt712>).
2. Manchester, R. N.; Hobbs, G.B.; Teoh, A.; Hobbs, M. "PSR B1257+12 in the ATNF Pulsar Database" (https://www.atnf.csiro.au/research/pulsar/psrcat/proc_form.php?version=1.66&Name=Name&JName=JName&RaJD=RaJD&DecJD=DecJD&P0=P0&Dist=Dist&startUserDefined=true&c1_val=&c2_val=&c3_val=&c4_val=&sort_attr=jname&sort_order=asc&condition=&pulsar_names=B1257%2B12&ephemeris=short&coords_unit=raj%2Fdecj&radius=&coords_1=&coords_2=&style=Long+with+last+digit+error&no_value=*&size=3&x_axis=&x_scale=linear&y_axis=&y_scale=linear&state=query&table_bottom.x=28&table_bottom.y=32). *atnf.csiro.edu*. Australia Telescope National Facility. Retrieved 9 January 2022.
3. "PSR 1257 12 d" (https://exoplanet.eu/catalog/psr_1257_12_d--236/). *Extrasolar Planets Encyclopaedia*. Retrieved 5 October 2017.
4. Konacki, M.; Wolszczan, A. (2003). "Masses and Orbital Inclinations of Planets in the PSR B1257+12 System". *The Astrophysical Journal*. **591** (2): L147–L150. arXiv:astro-ph/0305536 (<https://arxiv.org/abs/astro-ph/0305536>). Bibcode:2003ApJ...591L.147K (<https://ui.adsabs.harvard.edu/abs/2003ApJ...591L.147K>). doi:10.1086/377093 (<https://doi.org/10.1086%2F377093>). S2CID 18649212 (<https://api.semanticscholar.org/CorpusID:18649212>).
5. International Astronomical Union (10 August 2018). "Star Names" (https://www.iau.org/public/themes/naming_stars). *Naming Stars | IAU*. International Astronomical Union. Retrieved 23 October 2019.
6. "IAU Catalog of Star Names" (<https://www.pas.rochester.edu/~emamajek/WGSN/IAU-CSN.txt>). 4 April 2022. Retrieved 28 July 2016.
7. International Astronomical Union (15 December 2015). "Final Results of NameExoWorlds Public Vote Released" (<https://www.iau.org/news/pressreleases/detail/iau1514/>). *iau1514 — Press Release*. Retrieved 30 January 2024.
8. Lyne, Andrew G.; Graham-Smith, Francis (1998). *Pulsar Astronomy*. Cambridge University Press. ISBN 0-521-59413-8.

9. Hessman, F. V.; et al. (3 December 2010). "On the naming convention used for multiple star systems and extrasolar planets". [arXiv:1012.0707](https://arxiv.org/abs/1012.0707) (<https://arxiv.org/abs/1012.0707>) [[astro-ph](https://arxiv.org/archive/astro-ph).SR (<https://arxiv.org/archive/astro-ph>.SR)].
10. International Astronomical Union (9 July 2014). "NameExoWorlds: An IAU Worldwide Contest to Name Exoplanets and their Host Stars" (<https://www.iau.org/news/pressreleases/detail/iau1404/>). *iau1404 — Press Release*. Paris. Retrieved 30 January 2024.
11. International Astronomical Union. "NameExoWorlds" (<https://web.archive.org/web/20150815025117/http://www.nameexoworlds.iau.org/process>). Archived from the original (<http://nameexoworlds.iau.org/process>) on 15 August 2015. Retrieved 5 October 2017.
12. "NameExoWorlds" (<https://web.archive.org/web/20170405053828/http://nameexoworlds.iau.org/systems/106>). International Astronomical Union. 3 January 2016. Archived from the original (<http://nameexoworlds.iau.org/systems/106>) on 5 April 2017.
13. OVID (1916). Goold, G. P. (ed.). "Metamorphoses" (https://www.loebclassics.com/view/ovid-metamorphoses/1916/pb_LCL043.165.xml). *Loeb Classical Library* (Book XI ed.). Harvard University Press: 164–165. doi:10.4159/DLCL.ovid-metamorphoses.1916 (<https://doi.org/10.4159%2FDLCL.ovid-metamorphoses.1916>). Retrieved 30 January 2024.
14. "IAU Working Group on Star Names (WGSN)" (https://www.iau.org/science/scientific_bodies/working_groups/280/). Retrieved 22 May 2016.
15. "Bulletin of the IAU Working Group on Star Names, No. 1" (http://www.pas.rochester.edu/~emamajek/WGSN/WGSN_bulletin1.pdf) (PDF). Retrieved 28 July 2016.
16. Podsiadlowski, P. (1993). "Planet Formation Scenarios". *Planets Around Pulsars; Proceedings of the Conference*. Vol. 36. California Institute of Technology. pp. 149–165. Bibcode:1993ASPC...36..149P (<https://ui.adsabs.harvard.edu/abs/1993ASPC...36..149P>).
17. "Pulsar Planets" (https://web.archive.org/web/20051230112904/http://www.astro.psu.edu/users/alex/pulsar_planets.htm). Archived from the original (http://www.astro.psu.edu/users/alex/pulsar_planets.htm) on 30 December 2005.
18. Wolszczan, A.; Frail, D. (1992). "A planetary system around the millisecond pulsar PSR1257 + 12". *Nature*. **355** (6356): 145–147. Bibcode:1992Natur.355..145W (<https://ui.adsabs.harvard.edu/abs/1992Natur.355..145W>). doi:10.1038/355145a0 (<https://doi.org/10.1038%2F355145a0>). S2CID 4260368 (<https://api.semanticscholar.org/CorpusID:4260368>).
19. Keränen, P.; Ouyed, R. (2003). "Planets orbiting Quark Nova compact remnants". *Astronomy and Astrophysics*. **407** (3): L51–L54. arXiv:astro-ph/0301574 (<https://arxiv.org/abs/astro-ph/0301574>). Bibcode:2003A&A...407L..51K (<https://ui.adsabs.harvard.edu/abs/2003A&A...407L..51K>). doi:10.1051/0004-6361:20030957 (<https://doi.org/10.1051%2F0004-6361%3A20030957>). S2CID 18748570 (<https://api.semanticscholar.org/CorpusID:18748570>).
20. Wolszczan, Alex (1997). "The Pulsar Planets Update". *Planets Beyond the Solar System and the Next Generation of Space Missions. Proceedings of a workshop held at Space Telescope Science Institute, Baltimore, MD, 16–18 October 1996. ASP Conference Series, Vol. 119*. Astronomical Society of the Pacific. p. 135. Bibcode:1997ASPC..119..135W (<https://ui.adsabs.harvard.edu/abs/1997ASPC..119..135W>).
21. Fischer, Daniel (25 October 2002). "A comet orbiting a pulsar?" (<http://www.astro.uni-bonn.de/~dfischer/mirror/244.html>). *The Cosmic Mirror* (244).
22. "Smallest extra-solar planet found" (<http://news.bbc.co.uk/2/hi/science/nature/4264603.stm>). BBC News. 14 February 2005.
23. Wolszczan, Alex (January 2012). "Discovery of pulsar planets". *New Astronomy Reviews*. **56** (1). Elsevier: 2–8. Bibcode:2012NewAR..56....2W (<https://ui.adsabs.harvard.edu/abs/2012NewAR..56....2W>). doi:10.1016/j.newar.2011.06.002 (<https://doi.org/10.1016%2Fj.newar.2011.06.002>).
24. "Scientists announce smallest extra-solar planet yet discovered" (<https://web.archive.org/web/20081012120754/http://live.psu.edu/story/10180>) (Press release). Pennsylvania State University. 2005. Archived from the original (<http://live.psu.edu/story/10180>) on 12 October 2008.

- Wolszczan, A. (1994). "Confirmation of Earth Mass Planets Orbiting the Millisecond Pulsar PSR B1257+12" (<https://web.archive.org/web/20110720034147/http://www2.astro.psu.edu/~niel/astro550/week07-wolszczan-pulsar-planets.pdf>) (PDF). *Science*. **264** (5158): 538–542. Bibcode:1994Sci...264..538W (<https://ui.adsabs.harvard.edu/abs/1994Sci...264..538W>). doi:10.1126/science.264.5158.538 (<https://doi.org/10.1126%2Fscience.264.5158.538>). PMID 17732735 (<https://pubmed.ncbi.nlm.nih.gov/17732735>). S2CID 19621191 (<https://api.semanticscholar.org/CorpusID:19621191>). Archived from the original (<http://www.astro.psu.edu/~niel/astro550/week07-wolszczan-pulsar-planets.pdf>) (PDF) on 20 July 2011.
- Wolszczan, A.; et al. (2000). "Timing Observations of Four Millisecond Pulsars with the Arecibo and Effelsberg Radio Telescopes" (<https://doi.org/10.1086%2F308206>). *The Astrophysical Journal*. **528** (2): 907–912. Bibcode:2000ApJ...528..907W (<https://ui.adsabs.harvard.edu/abs/2000ApJ...528..907W>). doi:10.1086/308206 (<https://doi.org/10.1086%2F308206>).
- Salter, C. (2001). "Radio Astronomy Highlights" (<https://web.archive.org/web/20081219192204/http://www.naic.edu/~newslet/no33/NAICNo33.pdf>) (PDF). *Arecibo Newsletter* (33). Archived from the original (<http://www.naic.edu/~newslet/no33/NAICNo33.pdf>) (PDF) on 19 December 2008. Retrieved 24 July 2006.

External links

- Pulsar Planets (https://web.archive.org/web/20051230112904/http://www.astro.psu.edu/users/alex/pulsar_planets.htm)
- PSR 1257+12 (<https://web.archive.org/web/20080525161540/http://exoplanet.eu/star.php?st=PSR+1257+12>) on *The Extrasolar Planets Encyclopaedia* (<https://web.archive.org/web/20080613163808/http://exoplanet.eu/index.php>)
- Britt, Robert Roy (29 May 2003). "A World With Two Suns" (http://www.space.com/scienceastronomy/aas_earthsize_020329.html). SPACE.com.
- Lytle, Wayne (1992). "Does This Pulsar Have Orbiting Planets?" (<https://www.youtube.com/watch?v=UrhfVH8itPE>). Cornell Theory Center

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