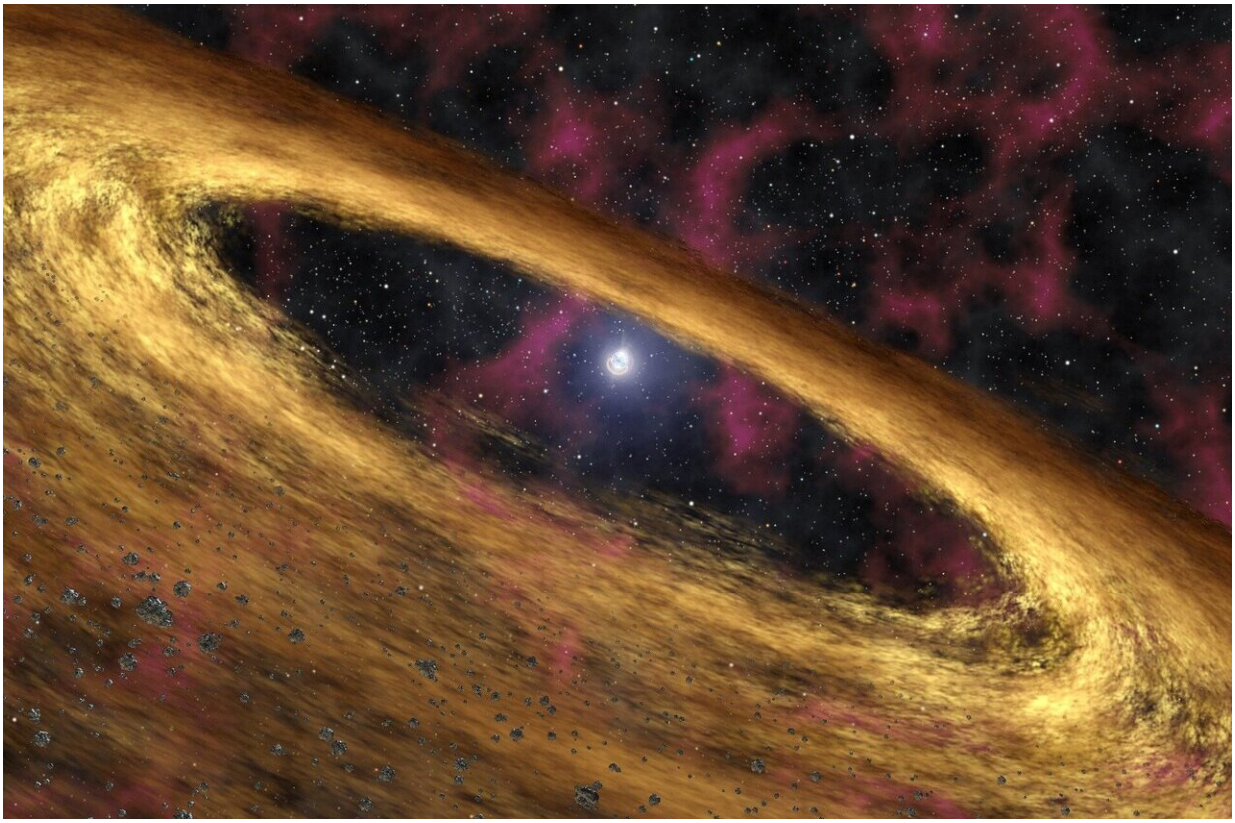
Strongest magnetic field in universe directly detected by X-ray space observatory

September 10 2020, by Liu Jia



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The Insight-HXMT team has performed extensive observations of the accreting X-ray pulsar GRO J1008-57 and has discovered a magnetic field of ~1 billion Tesla on the surface of the neutron star. This is the

strongest magnetic field conclusively detected in the universe. This work, published in the *Astrophysical Journal*, was primarily conducted by scientists from the Institute of High Energy Physics (IHEP) of the Chinese Academy of Sciences and Eberhard Karls University of Tübingen, Germany.

Scientists studied the X-ray pulsar GRO J1008-57 detected by Insight-HXMT during its outburst in August 2017. They discovered for the first time a cyclotron resonant scattering feature (CRSF) at 90 keV at a significance level of > 20σ. (Note that the scientific community confirms a new scientific discovery when its significance level is larger than 5σ.) According to theoretical calculations, the magnetic field that corresponds to this CRSF is up to 1 billion Tesla, which is tens of millions of times stronger than what can be generated in Earth laboratories.

Insight-HXMT is the first Chinese X-ray astronomical satellite. It comprises scientific payloads, including a high-energy telescope, a medium-energy telescope, a low-energy telescope, and a space environment monitor. Compared with other X-ray satellites, Insight-HXMT has outstanding advantages in the detection of cyclotron lines (especially at high energies) due to its broadband (1-250keV) spectral coverage, large effective area at high energies, high time resolution, low dead time and negligible pile-up effects for bright sources.

Neutron stars have the strongest magnetic fields in the universe. Neutron star X-ray binaries are systems consisting of a neutron star and a normal stellar companion. The neutron star accretes matter and forms a surrounding accretion disk. If the magnetic field is strong, the accreted matter is channeled by magnetic lines onto the surface of the neutron star, resulting in X-ray radiations.

As a result, these sources are also called "pulsars." Previous studies have

shown that a peculiar absorption feature (known as a "cyclotron resonant scattering feature") can sometimes be found in the spectrum of X-ray pulsars. Scientists believe this is caused by transitions between the discrete Landau levels of electronic motion perpendicular to the magnetic field. Such a scattering feature acts as a direct probe to the magnetic field near the neutron star's surface.

Insight-HXMT was proposed by IHEP in 1993 and was successfully launched in June 2017. IHEP is responsible for scientific payloads, ground segments and scientific research involving this satellite.

More information: M. Y. Ge et al. Insight-HXMT Firm Detection of the Highest-energy Fundamental Cyclotron Resonance Scattering Feature in the Spectrum of GRO J1008-57, *The Astrophysical Journal* (2020). DOI: 10.3847/2041-8213/abac05

Provided by Chinese Academy of Sciences