A swarm of dusty objects in orbit around planetary nebula WeSb1

An international team of astronomers, including researchers from the Slovak Academy of Sciences, has discovered a star that probably destroyed its own planetary system. The results were recently published in the renowned journal Nature Astronomy.

Today we already know more than 5,000 planets that orbit other stars (we call them exoplanets), just like the planets in our own Solar system orbit the Sun. Most exoplanets orbit normal stars, which are called dwarfs. During the development of the star, the dwarf becomes a giant, later an even bigger so-called AGB star, and finally a very tiny white dwarf.
It seems that almost every star has planets or a planetary system where, in addition to planets, there can also be smaller objects such as asteroids or comets. Such objects have been detected around dwarf stars, giants, and white dwarfs. Unfortunately, we still know very little about what happens to planets and planetary systems in AGB stars and during a period when a giant cool AGB star turns into a tiny hot white dwarf.

Between an AGB star and a white dwarf is an intermediate stage we call a planetary nebula. The planetary nebula is a kind of envelope around the central star, but it has nothing to do with planets, it is just "an unfortunate misnomer".
During the AGB stage, the giant star loses most of its mass, which later forms the aforementioned planetary nebula that we see because it is illuminated by a central hot star.

Our team examined about 2,000 central stars of such planetary nebulae.
One of them, called WeSb1, was behaving strangely and suspiciously.
Its brightness often dropped randomly, even by a factor of 10. Sometimes it took days, sometimes weeks, as if something dark was covering the star. This is shown in Fig. 1. Subsequently, we observed the object with several telescopes on the Canary Islands using various methods, the TESS satellite and one night also at Skalnate Pleso. A picture of the object from the NOT and INT telescopes is in Fig. 2. Here you can clearly see the planetary nebula around our star, which is roughly in its center. Through a more detailed analysis and combining all the information, we proposed the following hypothesis and explanation of this behavior of the star.
The star is not obscured by any other stars or planets, but by large dust clouds. These are not in its atmosphere, but orbit around the star. However, the situation is much more complicated. We cannot actually see the central star because it is too hot and radiates in the ultraviolet region of the spectrum.
It seems that the central star is not alone, but has a companion. The star we see is this companion star and it is a star similar to the Sun, only slightly hotter and larger. This is the star which is eclipsed by the dust clouds. But where did such large and dense dust clouds come from?

The most probable explanation is that such dust clouds are the result of the breakup or collisions of larger bodies such as planets or asteroids. After the dwarf star turned into a giant AGB star, the star probably swallowed planets to a distance of about one astronomical unit, which is about the distance of Earth from the Sun. By losing most of its mass, the AGB star also destabilized the planets that orbited further. This changed planetary orbits, there was chaos, collisions of objects occured, some of them strayed towards the companion star, where the collisions and breakup continued creating such huge dust clouds. Planets and dust near the central star probably didn't survive, but those around the companion did, and this is why we can watch this story. It would mean that planets and planetary

systems are present and undergo a rather violent evolution during the planetary nebula stage.
The whole paper can be found here
https://www.nature.com/articles/s41550-024-02446-x

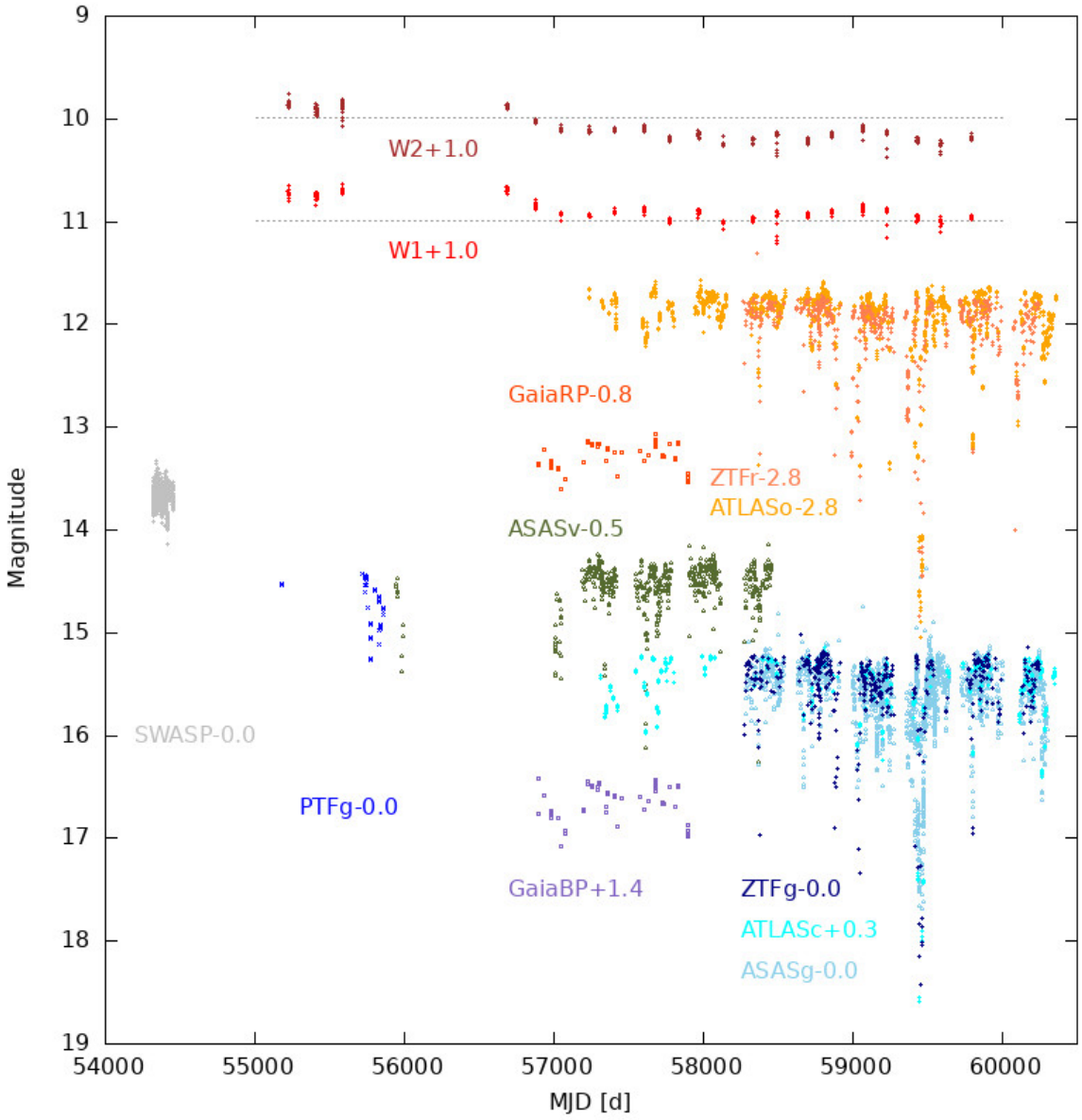

Fig.1. The brightness of the central star WeSb1 in different filters. On the x-axis is time in days. We see random dips in brightness. Observations come from the ZTF, Gaia, ASAS-SN, ATLAS, WISE, PTF, and SWASP projects. Image is from Nature Astronomy Jan. 8, 2025.

Fig.2. Planetary nebula WeSb1. It shines mainly in the emission lines of hydrogen (Halpha-red color) and oxygen ([OIII]5007-blue and green). The central star is in the middle, shifted slightly to the top. Taken from Nature Astronomy Jan 8, 2025.

Jan, 2025

Ján Budaj
(Astronomický ústav SAV, Tatranská Lomnica, Slovenská Republika)
Klaus Bernhard
(Bundesdeutsche Arbeitsgemeinschaft für Veränderliche Sterne e.V. , Berlin, Germany)
David Jones
(Instituto de Astrofísica de Canarias, La Laguna, Spain
Departamento de Astrofísica, Universidad de La Laguna, La Laguna, Spain
Nordic Optical Telescope, Breña Baja, Spain)
James Munday
(Department of Physics, University of Warwick, Coventry, UK)