South Africa's SALT Telescope aids in discovery of unique white dwarf star system

SALT (www.salt.ac.za)

The Southern African Large Telescope (SALT) nestled beneath the open skies of Sutherland in the Karoo.

Continuing with South Africa's stellar legacy when it comes to astronomy, the Southern African Large Telescope (SALT) recently aided in the discovery of a unique white dwarf system that may help scientists to explain the origins of certain supernovae.

Researchers from the Max Planck Institute for Extraterrestrial Physics, in collaboration with South African astronomers, have discovered a rare white dwarf binary star system, located in the Large Magellanic Cloud, that sheds new light on supernova explosions.

The discovery of this system, named [HP99] 159, was made using the well-known Southern African Large Telescope (SALT) based in Sutherland, in the Karoo desert, and it could help solve the mystery surrounding the circumstances under which white dwarfs explode. These results have just been published in the journal *Nature*.

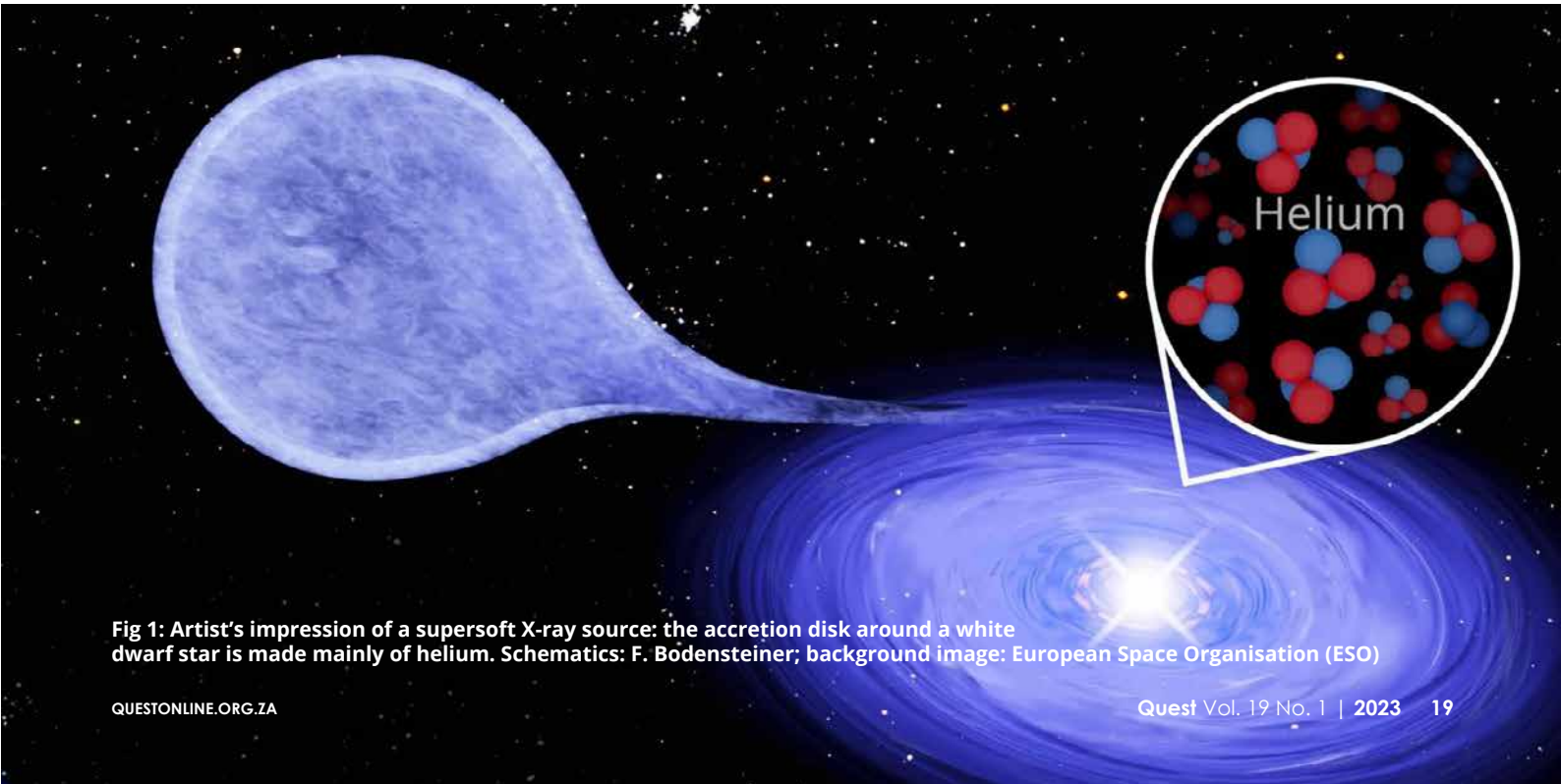

Fig 1: Artist's impression of a supersoft X-ray source: the accretion disk around a white dwarf star is made mainly of helium. Schematics: F. Bodensteiner; background image: European Space Organisation (ESO)

SALT nestled beneath the open skies of Sutherland in the Karoo. Did you know the SALT telescope has 91 mirrors that work together as 'one' 10 metre diameter mirror? Click here to explore the different areas inside the telescope via the SALT website: https://www.salt.ac.za/telescope/

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White dwarfs can only explode as supernovae when their mass exceeds a certain limit. One of the primary aims of this research was to understand the process by which the mass of a white dwarf can grow to this point, known as the Chandrasekhar limit. The team found that [HP99] 159, unlike other known Super Soft Sources (SSS), was overflowing and burning helium, not hydrogen, which had not been observed before in such detail.

Helium surprise

Using SALT's two spectrographs, the team was able to determine that the optical spectra of the system were entirely consistent with helium accretion. The measured luminosity suggests that the mass of the white dwarf is growing more slowly than previously thought possible, which could potentially help understand the number of supernovae caused by exploding white dwarfs.

"This demonstrated the uniqueness of this object, but also the capability of SALT's two spectrographs allowing for the required detailed follow-up optical observations, confirming the nature of the source ", said Dr Itumeleng Monageng, one of the contributing researchers from the South African Astronomical Observatory (SAAO).

The discovery of [HP99] 159 also raises questions about the progenitors of Type Ia supernovae (SN Ia), which are exploding white dwarfs. While SN Ia are considered the main source of iron in the universe and are important for cosmology, their origins remain unclear. Theoretical models predict that about 2-5% of the matter of the helium companion star will be carried away by the SN Ia explosion and ejected into the environment, but this amount of helium has not been found in most observed SN Ia supernovae.

The unique properties of [HP99] 159 suggest that it could end up in a subclass of SN Ia, known as SN Iax, which have weaker explosions and therefore less helium is blown away. The team hopes to find dozens of similar sources in the two Magellanic Clouds with the eROSITA telescope, which could help further constrain the conditions for SN Ia progenitors.

"This is another excellent example of the productive collaborations between our team and the German eROSITA team in discovering and studying new and interesting transient phenomena," said Prof. David Buckley at the SAAO, who leads the SALT transient programme for which the optical observations were obtained, and with Monageng, is one of the *Nature* paper's co-authors.

Article compiled from a media release issued by the South African Astronomical Observatory (SAAO), prepared by SAAO science engagement astronomer Daniel Cunnama. For the full paper, visit: https://www.nature.com/articles/s41586-023-05714-4.