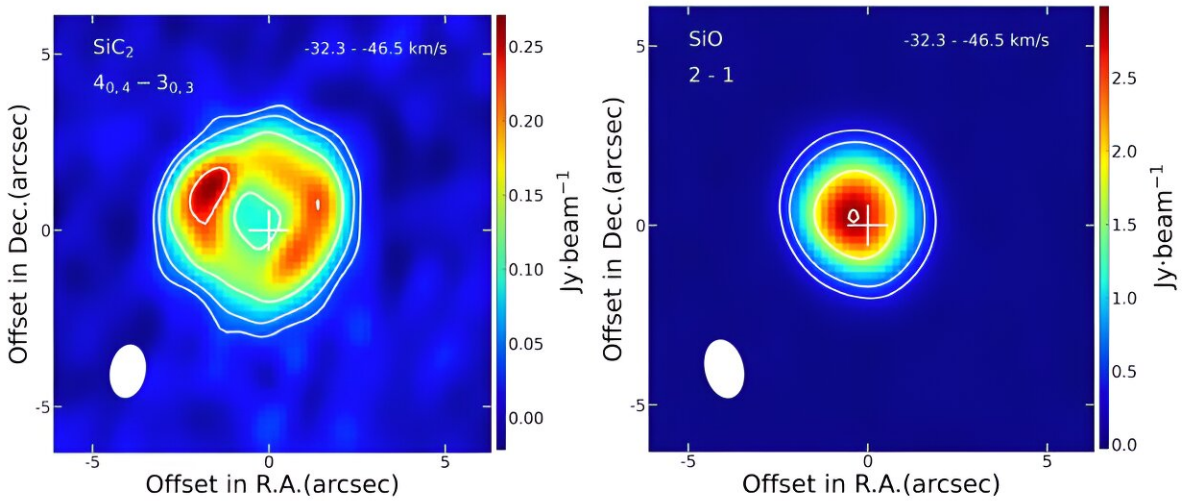
Annular distribution of SiC2 in circumstellar envelopes of carbon-rich asymptotic giant branch stars

October 9 2023, by Li Yuan



Brightness distribution of SiC_2 (left panel) and SiO (right panel) transitions at the source velocity (-32.3 – -46.5 km s^{-1}) in AI Vol. Color bar shows the brightness distribution of different regions. The white cross represents the center of the star in the map. The beam size of the observation in SiC_2 is 1.51 × 0.99 ″, with PA 9.82°. The beam size of the observation in SiO is 1.64 × 1.06 ″, with PA -12.99°. The white contours display the flux levels of SiC_2 at 3, 5, 10, and 20 times of the rms noise, with 1σ = 11.3 mJy·$beam^{-1}$. For SiO (2 - 1), the flux levels are at 5, 10, 30, and 50 times of the rms noise, where 1σ = 58.9 mJy·$beam^{-1}$. Credit: *arXiv*: DOI: 10.48550/arxiv.2307.13216

The circumstellar envelopes (CSE) of asymptotic giant branch (AGB) stars contain a large number of molecules, which account for about one-third of all molecules discovered in interstellar space.

Gas and dust are essential components of CSEs, and SiC_2 is one of the significant constituents of dust grains in carbon-rich AGB stars. Whether SiC_2 is a "parent" molecule formed in the photosphere or during the high-temperature dust formation process (exhibiting a "solid" spatial distribution), or a "daughter" molecule formed through photodissociation of "parent" molecules in the outer envelopes (exhibiting an annular distribution), is an ongoing debate.

Researchers led by Ph.D. candidate Feng Yanan and Prof. Li Xiaohu from the Xinjiang Astronomical Observatory (XAO) of the Chinese Academy of Sciences have conducted observational work on the SiC_2 molecule in circumstellar envelopes of three carbon-rich AGB stars (AI Vol, II Lup, and RAFGL 4211) using the Atacama Large Millimeter/Submillimeter Array (ALMA).

Their study was published in *Frontiers in Astronomy and Space Sciences* on Aug. 14.

They found that the spatial distribution of the four rotational transition spectral lines of SiC_2 molecules around these three sources exhibited an annular distribution, indicating the feature of a typical "daughter" species.

Then they compared the ALMA results of SiC_2 and SiO molecules in AI Vol. The SiO molecule exhibited a "solid" distribution feature, indicating that it is a "parent" molecule, which is consistent with previous studies.

"In future studies, we need to rethink the formation mechanism of SiC_2

in the CSEs of evolved stars," said Prof. Li.

More information: Yanan Feng et al, Photochemical origin of SiC2 in the circumstellar envelope of carbon-rich AGB stars revealed by ALMA, *Frontiers in Astronomy and Space Sciences* (2023). DOI: 10.3389/fspas.2023.1215642

Provided by Chinese Academy of Sciences