Spatial distributions of AlO and SiO molecules around an aluminum-oxide-rich AGB star, W Hydrae

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Asymptotic giant branch (AGB) stars supply a large amount of gas and dust into the Galaxy. Dust formation around these stars have an important role in acceleration of stellar winds by radiation pressure on them. Isotopic compositions of presolar grains found in the primitive meteorites and cometary dust particles show that most of them originate from such AGB stars and red giants. Dust formation around AGB stars is a key for understanding precursor materials of the solar system.

Silicon is a ten times more abundant element than aluminum in space. However, mid-infrared observations showed that many of oxygen-rich AGB stars are rich in aluminum oxide dust and poor in silicate dust contrary to expectations [1]. It has remained a significant conundrum as to why aluminum oxide dust is abundant around oxygen-rich AGB stars.

AlO and SiO are gaseous molecules consumed to form aluminum oxide and silicate dust, respectively. We obtained the detailed images of AlO and ^{29}SiO molecules around an aluminum oxide–rich AGB star, W Hydrae, using the Atacama Large Millimeter/submillimeter Array (ALMA) [2].

The AlO molecules were distributed within three stellar radii, which was similar to the dust distribution observed previously [3, 4], whereas ^{29}SiO was distributed in the accelerated wind beyond 5 stellar radii and more than 70% of SiO molecules remain in the gas phase without forming dust. These results indicate that a small addition of silicate dust to preexisting aluminum oxide, which grows and piles up near the star, may trigger the wind acceleration. The wind acceleration decreases the gas density, which would suppress further formation of silicate dust in the accelerated wind. The present study may explain common presence of aluminum-oxide-rich and silicate-poor AGB stars.

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