Why Galaxies Care About AGB Stars:
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ALMA spectrum of the extreme OH/IR star OH 26.5+0.6

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Abstract. We present ALMA band 7 data of the extreme OH/IR star, OH 26.5+0.6. In addition to lines of CO and its isotopologues, the circumstellar envelope also exhibits a number of emission lines due to metal-containing molecules, e.g., NaCl and KCl. A lack of $C^{18}O$ is expected, but a non-detection of $C^{17}O$ is puzzling given the strengths of $H_2^{17}O$ in Herschel spectra of the star. However, a line associated with $Si^{17}O$ is detected. We also report a tentative detection of a gas-phase emission line of MgS. The ALMA spectrum of this object reveals intriguing features which may be used to investigate chemical processes and dust formation during a high mass-loss phase.

Keywords. stars: AGB and post-AGB, circumstellar matter, stars: individual (OH 26.5+0.6), stars: late-type, stars: abundances

1. Introduction

A number of intermediate-mass ($\sim$ 4–8 $M_\odot$) that evolve on the AGB are known to be undergoing hot-bottom burning (HBB) from observations of enhancement of ^{7}Li and other s-process elements (e.g., Garcia *et al.* 2013). The CNO cycle operates during this

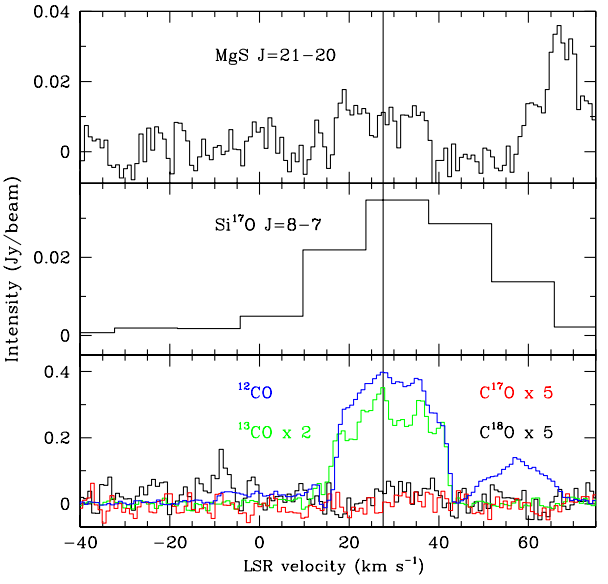

Figure 1. ALMA spectrum of CO J=3-2 and its isotopologues (bottom), $Si^{17}O$ and a tentative detection of MgS. The vertical line denotes the LSR velocity of OH 26.5+0.6.

evolutionary phase and drives the $^{12}C/^{13}C$ towards the equilibrium value of ∼4. The process shuts down when the envelope mass is reduced to $1\,M_{\odot}$ (Karakas & Lattanzio 2014). The Herschel spectrum OH 26.5+0.6 shows a lack of $H_2^{18}O$ while $H_2^{16}O$ and $H_2^{17}O$ are readily detected (Justtanont *et al.* 2013). HBB preferentially destroys ^{18}O (Karakas & Lattanzio 2014) thereby confirming that the progenitor of OH 26.5+0.6 is an intermediate-mass star. We subsequently observed the object with ALMA in band 7 in 2016 with spectral windows centered on the transition J=3-2 of CO, ^{13}CO, $C^{17}O$ and $C^{18}O$ (Justtanont *et al.* 2018, ADS/JAO.ALMA#2015.1.00054.S).

2. The ALMA spectrum

A total of about 60 emission lines have been detected in our ALMA observations. Fig. 1 shows the spectrum of CO isotopologues. The $C^{17}O$ J=3-2 is not detected above the noise which is unexpected considering that strong $H_2^{17}O$ lines have been detected in the Herschel spectrum of the star. However, we detected a line which can be attributed to $Si^{17}O$ J=8-7 at 334.3015 GHz. The resolution of this line is $14\,km\,s^{-1}$ as it falls in a spectral window assigned to a continuum measurement. The ALMA spectrum indicates a possible chemical pathway of molecular formation of oxygen in a high density environment: ^{17}O is locked up in $H_2^{17}O$ and $Si^{17}O$ rather than $C^{17}O$.

A line at 335.9845 GHz may be assigned to a new circumstellar molecule. It corresponds to the MgS J=21-20 transition. Previously, a broad dust emission feature at 30 μm has been attributed to MgS dust, but this has been observed only towards C-rich circumstellar environments. A number of lines in the spectrum are due to the lines of SO and metal-containing molecules like NaCl, KCl and their isotopologues. Unlike the low-mass AGB stars, no SO_2 lines are detected within the spectral range covered by our observations.

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