MILLIMETER DETECTION OF AlO ($X^2\Sigma^+$): METAL OXIDE CHEMISTRY IN THE ENVELOPE OF VY CANIS MAJORIS

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A new circumstellar molecule, the radical AlO ($X^2\Sigma^+$), has been detected toward the envelope of the oxygen-rich supergiant star VY Canis Majoris (VY CMa) using the Arizona Radio Observatory (ARO). The N = 7 $\rightarrow$ 6 and 6 $\rightarrow$ 5 rotational transitions of AlO at 268 and 230 GHz were observed at 1 mm using the ARO Submillimeter Telescope (SMT) and the N = 4 $\rightarrow$ 3 line was detected at 2 mm using the ARO 12 m. Based on the shape of the line profiles, AlO most likely arises from the dust-forming region in the spherical outflow of VY CMa, as opposed to the blue- or red-shifted winds, with a source size of $\theta_s \sim 0.5''$. Given this source size, the column density of AlO was found to be $N_{tot} \sim 2 \times 10^{15}$ cm^{-2} for $T_{rot} \sim 230$ K, with a fractional abundance, relative to H_2, of $\sim 10^{-8}$. Gas-phase thermodynamic equilibrium chemistry is the likely formation mechanism for AlO in VY CMa, but shocks may disrupt the condensation process into Al_2O_3, allowing AlO to survive to a radius of ~ 20 R_*. The detection of AlO in VY CMa is additional evidence of an active gas-phase refractory chemistry in oxygen-rich envelopes, and suggests such objects may be fruitful sources for other new oxide identifications.