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How a stellar companion influences the dust-gas chemistry within AGB outflows and beyond (R)

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Spherically symmetric AGB outflows are the exception rather than the rule: both small-scale asymmetries (e.g., clumps) and large-scale asymmetries (e.g., spirals and disks) are widely observed. Binary interaction, either with a stellar or a planetary companion, has been proposed as the driving mechanism behind the large-scale asymmetries.

Recently, we found a stellar companion can strongly influence the gas-phase chemistry throughout the entire outflow. Its impact depends on the intensity of the stellar UV radiation and on the extinction it experiences as it radiates outward through the envelope. Photodissociation can now occur in the dense, inner regions of the outflow, altering the nature and products of chemical reactions which affect the entire circumstellar envelope. The outcome of the chemistry depends on the balance between two-body reactions, which build up complexity, and photoreactions, which destroy this.

Motivated by these findings, we now include stellar companion photons in our unique comprehensive dust-gas chemical network. Our previous work shows that dust-gas interactions have a strong influence on the gas-phase composition of higher-density outflows, depleting gas-phase species onto the dust, building up an icy mantles around the dust grains. In our latest work on dust-gas chemistry, we included the photoprocessing of volatile complex ices into inert refractory organic material. Such a refractory organic mantle is necessary to explain the properties of dust in the ISM and thought to be formed in diffuse clouds. When allowing photoprocessing to occur within the AGB outflow, we find that dust in high-density, carbon-rich outflows can have a refractory coverage of up to 22%. This is too low to have a significant impact on the ISM.

The presence of a close stellar companion, especially in an asymmetrical outflow, could significantly influence the dust-gas chemistry within AGB outflows and beyond. Here, we present our initial findings on the effects on the gas-phase chemistry throughout the outflow (i.e. depletion and formation of gas-phase species), on the complex chemistry on the grain surface, and on the refractory organic coverage of the dust as it enters the ISM.

Session

Dust and presolar grains

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