Presentation Title: Carbonaceous dust formation via gaseous CO disproportionation reaction in hydrogen-poor outflows
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Abstract:

Carbonaceous dust grains are most commonly thought to form in relatively cool regions with high hydrogen densities. In these conditions hydrocarbon precursors can form and subsequently polymerise, producing larger aliphatic and aromatic structures - dust grains. Yet how do we observe such efficient dust formation in hotter hydrogen-poor areas (Wolf Rayet stars, Nova outflows, red supergiants) with extreme and opposite conditions?

We propose a gas phase reaction that can produce solid deposits of carbon which can act as the nucleation sites for dust formation.

The CO disproportionation reaction also known as the Boudouard reaction (1) is well studied in terrestrial environments in industry and catalysis but has not yet been considered in astronomical environments.

$$CO_{(g)} + CO_{(g)} \rightarrow C_{(s)} + CO2_{(g)} \quad (1)$$

Large activation energy barriers (11.6eV) comparable to the CO bond energy (11.2eV) are associated with the Boudouard reaction. To overcome this CO has to be highly vibrationally and electronically excited. These reaction conditions can be achieved through shocked gas.

To model this reaction as the main driver of dust formation we chose a shockwave scenario occurring after a nova outburst. Nova ejecta contains material from inside a white dwarf, a degenerate body that lacks hydrogen. The shock creates high temperatures (>10,000 K) and exposes molecules to UV and optical radiation, allowing for CO to get highly vibrationally and electronically excited.

Our results indicate that it is not only possible to create solid carbon but it is abundant enough to achieve successful dust formation as the fractional abundance of nucleation sites > 2×10^{-14} (J. Rawlings & D. Williams 1989)