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Shaping of the stellar wind of evolved red giants and their successors by (sub-)stellar binary companions

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Contributed talk

Abstract:
Planetary nebulae (PNe) reveal a wide range of morphologies. Bipolarity is the main characteristic, but jets and tori are also detected. Several contending theories of the evolution from a (roughly) spherically symmetric Asymptotic Giant Branch (AGB) stellar wind to a very non-spherical PN have emerged. Here, we present the first high-spatial resolution observational campaign of a large sample of oxygen-rich AGB stellar winds obtained in the ALMA Large Program ATOMIUM ('ALMA Tracing the Origins of Molecules formIng dUst in oxygen-rich M-type stars'). The data constitute the first observational proof that (sub-)stellar binary activity is the dominant shaping mechanism of AGB stellar winds, and their successors the PNe. We show that low mass-loss rate oxygen-rich AGB winds are more readily prone to complex structural deformations owing to their slow wind acceleration, whereas a binary-induced spiral structure is more prevalent in other classes of AGB stellar winds. These results resolve several previously unexplained phenomena — including the absence of detached shells around oxygen-rich AGB stars and disks around carbon-rich PNe — and have critical implications for the formation of type Ia supernovae.

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