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ALMA unveils highly collimated jets in evolved stars

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Contributed talk

Abstract:
The mass-loss processes that occur during final stages of the evolution of low and intermediate-mass stars are of great relevance because they determine the ultimate fate of these stars, as well as the amount of mass and chemical composition of the material that will end up replenishing the interstellar medium. Thus, the study of these processes is important to understand not only the stellar evolution but also the chemical evolution of galaxies. Particularly, in the last decades there has been mounting observational evidence that after the Asymptotic Giant Branch (AGB) phase, low and intermediate-mass stars may develop powerful highly collimated outflows that have a strong impact on the circumstellar envelope (CSE) that formed in previous mass-loss episodes. One important effect of the activity of such collimated outflows is the modification of the shape of the roughly spherical CSE. According to an increasingly popular model that explains the formation of asymmetric planetary nebulae, a fast collimated outflows carve cavities within the spherical CSE, which are eventually seen as bright lobes and bubble-like morphologies in the subsequent planetary nebula phase when the star becomes hot enough to ionise the CSE. This process occurs in a very short time-scale (a few hundred years) during which the star becomes enshrouded by gas and dust that render it invisible at optical wavelengths. As a result, it is difficult to find objects undergoing this ephemeral phase. Nonetheless, there is a particular group, containing 15 known sources in our Galaxy, of oxygen-rich post-AGB objects that exhibit high-velocity water masers tracing high-velocity (>100 km/s) collimated structures and/or bow-shocks. These objects are referred to as “water fountains” (WF) and they are thought to be undergoing the earliest manifestation of collimated mass-loss after the AGB phase. Thus, the study of WF is of great importance to understand the evolution of low and intermediate-mass stars since they hold key information to understand the launching and collimation of collimated outflows, as well as their interaction with the CSE. In this talk I will present novel results of recent observations with ALMA toward two WF for which we have traced for the first time the collimated jets proposed to be creating the seen bipolar structures. The observations reveal that the jets extend beyond the regions traced by the water masers and they exhibit deceleration as they interact with the CSE.

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