The Stellar Finale: Modelling the Interactions of Dying Stars in 3D

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Abstract

The massive outflows of evolved stars - highly enriched in dust and heavy elements - not only play a central role in the chemical evolution of galaxies, but also provide the raw material for planetary systems and life. The origin of these outflows is poorly understood, however, the recent tremendous progress in computational facilities, together with spatially resolved, multi-wavelength and increasingly multi-epoch observations, presents a perfect opportunity to test our theories and improve our understanding of mass loss from stars in their final phases of evolution.

Our high-resolution ALMA observations of the extended envelopes of evolved, cool giant stars have revealed complex and intricate structures like spirals, shells, arcs, jets and disks; fossil records of their stellar mass-loss histories which give important clues to the physical processes driving their outflows. Using front-line numerical codes that include realistic treatments of the important microphysics, hydrodynamic and radiative processes, I model these cool giants in full 3D geometry, to understand the flow of matter from the stellar atmosphere through the circumstellar envelope to the interstellar medium. In this talk, I will focus on our studies of the impact of interactions with a nearby companion, and their role in driving and shaping the complex and in some cases, explosive outflows. I will present results of a new mode of binary interaction, called wind Roche-lobe overflow, and discuss its implications for a wide range of phenomena, e.g., the formation of chemically peculiar stars, X-ray binaries and the progenitors of Type Ia supernovae.

Biography

Prof. Shazrene Mohamed is a computational stellar astrophysicist and holds a joint position at the University of Cape Town (UCT) and the South African Astronomical Observatory (SAAO). She completed her undergraduate studies in Astronomy, Astrophysics and Mathematics at Harvard University and then, awarded a Rhodes Scholarship, she obtained her PhD in Astrophysics from Oxford University. After two years as an Argelander Fellow in Bonn, Germany, she moved to Cape Town where she is currently an Associate Professor and a UCT Vice-Chancellor's Future Fellow. She is an NRF P-rated researcher and recipient of the South African Institute of Physics (SAIP) Silver Jubilee Medal. Using supercomputer simulations she studies the outflows and explosions of single and binary star systems to understand how they inject gas, dust, radiation and momentum into their surrounding environments. The models are relevant for a wide variety of systems, from the progenitors of gravitational wave sources and supernovae to the formation and evolution of bow shocks around runaway stars.