The Physics of the Dusty Spirals of Wolf-Rayet Binaries Revealed by Observations of WR140

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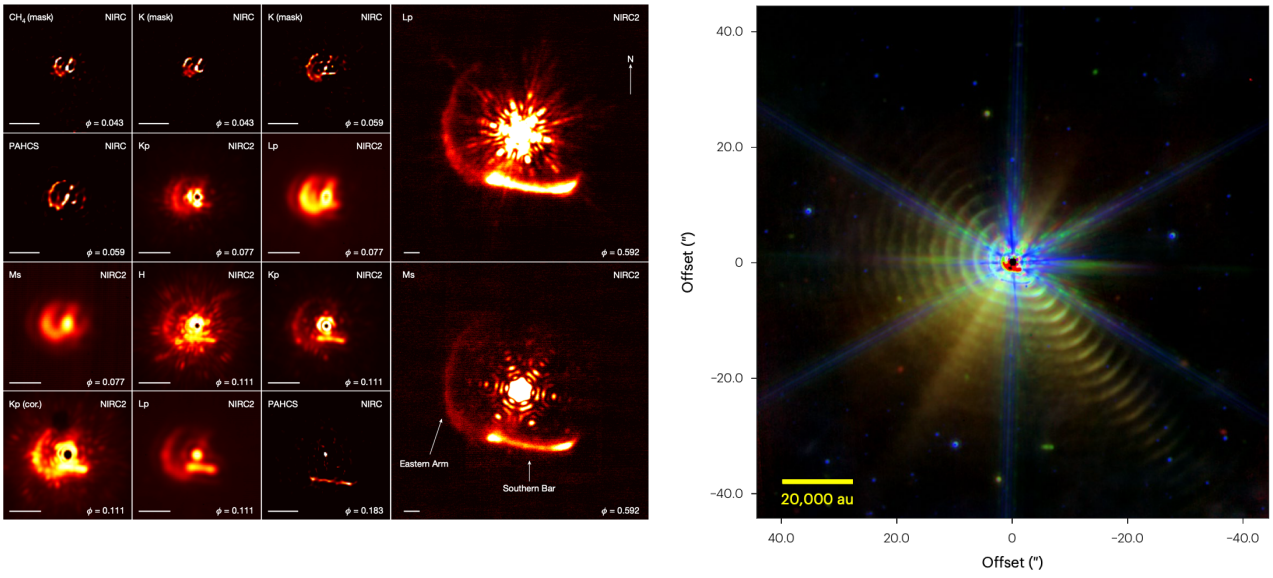
Classical Wolf-Rayet stars are the final phase of evolution of the most massive stars before they become supernovae. Their extremely high luminosities drive fast, dense stellar winds that are sometimes rich in carbon. Despite this harsh circumstellar environment, Wolf-Rayet stars can sometimes precipitate the right conditions to form large amounts of dust. One way in which this could occur is via stellar wind collisions if the Wolf-Rayet star is found in a binary. Imaging campaigns have revealed that under this mechanism, dust shells form in spectacular shapes sculpted by the orbit of the binary. We recently analysed a series of images of the dust produced by the Wolf-Rayet binary WR140 over 17 years. These images enabled us to model the geometry of the dust shell and track its motion. Surprisingly, our analysis revealed the dust to be accelerating, which likely constitutes a first direct witness of stellar radiation pressure accelerating matter in the circumstellar environment. I also discuss recent JWST ERS observations of the system, which detected a stunning series of 20 concentric dust shells spanning two light years, visualising the role of Wolf-Rayet binaries in enriching the dust content deep into the interstellar medium. The structure of these dust shells which have reached terminal velocity shows high repeatability and is well-explained by the geometry of dust produced under a colliding-wind mechanism, tracing the surface of a conical spiral. In addition to recent findings focussed on WR140, I also provide a brief overview of colliding-wind Wolf-Rayet binaries and discuss some outstanding questions that future observations and theory may wish to investigate.



Left: Keck observations showing the expansion of the inner dust shell of WR140 (Han et al. 2022). Right: JWST observations of a series of concentric dust shells of WR140 (Lau et al. 2022).