

Circumstellar Spirals/Shells/Arcs: the Messages from Binary Stars

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Abstract

A growing consensus has been developing in the past few decades that binarity is key in providing an understanding of the morphological diversities of the circumstellar envelopes (CSEs) surrounding stars in the Asymptotic Giant Branch (AGB) to Planetary Nebula (PN) phase. However, despite extensive efforts to detect companions of AGB stars and the central stars of PNe, the number of detected binaries in particular with their orbital properties derived are still small. As a consequence, the possible roles of binaries in the shaping of PN and in the CSEs of AGB stars have yet to be clarified. On the other hand, recurrent (ring/spiral/arc) patterns are often found in the CSEs of AGB stars and the outer halos of pre-PNe and PNe. Such patterns provide a fossil record and can be used to trace the temporal history of the mass loss dynamics during the AGB phase. In this regard, recent molecular line observations using radio interferometric facilities such as ALMA and JVLA have revealed the spatio-kinematics of such patterns. Numerical simulations of binary interactions producing spiral-shells have been extensively developed and are now becoming increasingly sophisticated, revealing new probes for extracting the stellar and orbital properties from these patterns. I will review the recent theoretical and observational investigations on the circumstellar spiral-shell patterns and discuss their implications in linking binary properties to the asymmetric ejection events in the post-AGB phase.