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Can we form gravitational wave sources from binaries? The role of stellar winds and envelope structure in the formation of the most massive black holes

The formation of black holes, especially those seen in Gaia binaries and gravitational wave events, is still not fully understood due to gaps in our knowledge of how massive stars evolve. Stellar winds play a key role in mass loss and significantly affect these evolutionary paths. However, existing models are hampered by outdated methods and considerable differences in their underlying assumptions. In this talk, I will share a detailed mapping of stellar winds and envelope structure for massive stars, examining how different physical choices impact their evolution and therefore the formation of gravitational wave sources. From all the uncertainties, robust evolutionary patterns emerge, which are common to most models. These patterns provide important insights into the progenitors of the black holes we observe, including their isolated evolution and the chances of binary mass transfer, thus serving as an essential resource for interpreting both current and future observational data.

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