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From Wide to Close: how migration shapes massive binary systems

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Massive stars, characterized by their extreme luminosities and crucial roles in stellar and galactic evolution, are often found in complex multiple systems. Understanding their primordial multiplicity provides key insights into their formation, interactions, and ultimate fates. One proposed mechanism to explain the relatively high rate (>30%) of massive short-period (< few months) binaries is the migration scenario, where close binaries form through companion hardening, either via disk-driven inward migration or orbital shrinkage caused by a tertiary, outer companion. To test this scenario it is essential to constrain the true end product of massive binary formation, which in turn requires observations of very young (<1 Myr) massive star-forming regions. This talk will first present interferometric observations (GRAVITY/VLTI) of six young massive stars in M17, detecting companions within 2–120 AU. The presence of numerous relatively massive companions at separations comparable to accretion disk sizes (10–1000 AU) provides strong evidence supporting the migration scenario. In the second part, we will discuss recent findings on a handful of main-sequence massive hierarchical triples, highlighting how the presence of a third companion, detected via interferometry (VLTI/PIONIER), can drive close binarity through Kozai-Lidov oscillations. These oscillations, governed by the relative inclination and eccentricity of the subsystems, induce periodic changes in orbital parameters, ultimately leading to orbital shrinking and circularization, forming short-period binaries. Additionally, we will explore realistic mass and separation distributions for such systems and discuss their long-term stability criterion. By comparing typical timescales, we show that both channels are not mutually exclusive and may work together to explain the observed relatively high fraction of few-Myr-old short-period massive binaries. This talk will explore two key aspects of the migration scenario, showcasing how optical long-baseline interferometry constrains multiplicity and orbital properties in young massive stars. In conclusion, we will briefly discuss ongoing observational efforts to expand our statistical sample and foresee potential collaborations to extend this study to other star-forming regions or young clusters.

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