How do (massive) binary stars form?

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Most massive stars are in binaries. Binarity can drastically alter their evolution, which can result in the formation of X-ray binaries or binary black hole systems, the dominant sources of gravitational waves. While single star formation is increasingly well understood, the detailed physics of binary/multiple star formation has received less attention. In particular, a good understanding of the combined influence of birth environmental conditions such as magnetic fields, gas rotation and turbulence, on (massive) stellar multiplicity is still lacking.

In this talk, I will present recent numerical efforts to clarify these points, using radiation-magneto-hydrodynamical simulations of massive pre-stellar core collapse with the adaptive mesh refinement code RAMSES and including the relevant physics to identify several fragmentation processes. I will show how the pre-stellar core rotation, turbulence (MR et al. 2021, A&A), and magnetization impact the stellar system's multiplicity and properties (e.g. mass ratio, orbital separation) and identify the underlying mechanisms. In particular, I will discuss the role of magnetic fields (MR et al. 2023, A&A). Finally, I will specify how some of the aforementioned results are independent of the stellar mass and can be extended to lower-mass stars.