Abstract SF2A 2026 – DEDIEU Florian – PhD student in LUX, Paris Observatory

Nuclear ring formation in barred galaxies with hydrodynamical simulations.

Nuclear rings are common and remarkable structures of gas and stars, found in the circum-nuclear regions of ~50% of massive barred galaxies. Usually sites of strong star formation, they are believed to play an active role in secular evolution, especially in the context of starburst activity or Active Galactic Nucleus (AGN) feeding. It is now well established that the presence of nuclear rings in barred galaxies is connected to the existence of different orbit families due to the perturbed gravitational potential. However, the current proposed models still differ in the details of the precise formation process of nuclear rings, which overall remains unclear: do they actually emerge from gas accumulation due to the continuous action of gravity torques by the bar? Where do they precisely form and what is their temporal evolution? What is the contribution from viscosity? Several numerical works have explored these questions but the simulations are generally based on idealized simulations with non-self-gravitating gas and imposed barred potentials, and are thus far from realistic astrophysical conditions. Moreover, no study of nuclear ring formation in galaxies that dynamically form stellar bars with grid-based hydrodynamical simulations yet exists.

In this talk, I will provide some valuable new insight to these questions. First, I will present results about the simulation at high spatial resolution of a bar-forming galaxy that develops a nuclear ring, using the Adaptive Mesh Refinement (AMR) RAMSES code. I will address: 1) from both the theoretical and numerical sides, the main requirements for an isolated gaseous disk galaxy to form a stellar bar in a cold dark matter halo as well as a nuclear ring, alongside the main obstacles due to numerical limitations peculiar to the field of galaxy simulations, e.g. artificial fragmentation or the necessity to use sub-grid models; 2) the usual methods, via Fourier analysis and Orbital integration, to derive the properties of a bar and its impact on the stellar population; and 3) how my results connect to the current landscape of nuclear ring-formation models, and what are the implications for future works, notably in the context of the “bars-within-bars” scenario for AGN fueling.