The origin of galactic magnetic fields

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Abstract

Magnetic fields are one of the most fascinating puzzles in the picture of galaxy formation. Recognised to be significant throughout most astrophysical scenarios, they correspondingly often stand as a major source of uncertainty. Particularly for galaxy evolution, one of the major unknowns is what are the mechanisms at play to generate observed equipartition magnetic fields. Already proposed by M. Rees (1987), two main alternate pictures stand as possible drivers of their evolution: either magnetic field are of primordial origin, evolving primarily through galactic processes; or alternatively, they find their origin at the smallest scales, produced in stellar dynamos or AGN, and being subsequently fed into the interstellar medium of galaxies and possibly further out into the intergalactic medium. Numerous preceding studies established that both scenarios can independently attain the magnetic fields observed in galaxies either through galactic dynamos (Rieder & Teyssier 2016, Pakmor et al. 2014, Martin-Alvarez et al. 2018) or magnetised feedback (Beck et al. 2013, Vazza et al. 2017, Butsky et al. 2017). While both pictures appear self-sufficient, none of these studies can shed no light on how the two interact nor whether any of the investigated processes dominates over the others. To be able to answer this question and many others, we developed a brand-new algorithm in RAMSES that follows how magnetic fields from different origins co-evolve. In this talk, we will present this algorithm and how it can be used to resolve many mysteries about magnetic fields. Additionally, we will introduce our first results in the study of the origin of magnetic fields in galaxies, where we first study comic zoom-in MHD RAMSES simulations of primordial and stellar-originated magnetic fields separately. We then analyse a high-resolution simulation combining both sources of magnetic fields with our code capable of unfolding their joint evolution. We give a first answer to the long-standing question of whether magnetic fields in galaxies are of primordial or stellar origin.

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