The origin and evolution of strong magnetic fields in white dwarfs

Matthias R. Schreiber & Diogo Belloni

Universidad Tecnica Federico Santa Maria

White dwarfs have been speculated to potentially have strong magnetic fields (exceeding 1 MG) since 1947, but the first detection of a magnetic field in a white dwarf was only obtained more than twenty years later. Ever since, the question why some white dwarfs become strongly magnetic while others do not, has been one of the fundamental unsolved issues of stellar evolution.

Throughout the decades, several theories have been suggested for the magnetic field generation in white dwarfs but the fossil field, the double degenerate merger, and the common envelope dynamo scenarios all fail when confronted with the observed incidence of magnetic fields in single white dwarfs and white dwarfs in binaries.

We suggest that instead a rotation and crystallization driven dynamo similar to those operating in planets and low mass stars is responsible for a large fraction of the observed strongly magnetic white dwarfs (Schreiber et al. 2021, Nature Astronomy, 5, 648). We show that this new scenario can explain the absence of bright intermediate polars in globular clusters, the accumulation of magnetic white dwarfs among metal polluted white dwarfs, the occurrence rate of strong magnetic fields in double white dwarf binaries, and why a large fraction of Cataclysmic Variables but only a small part of their detached progenitor systems contain a strongly magnetic white dwarf.

We conclude that a crystallization and rotation driven dynamo most likely plays a mayor role in the magnetic field generation in white dwarfs.