ONe white dwarf mergers with AREPO

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WORK IN PROGRESS

Stay tuned!

Introduction

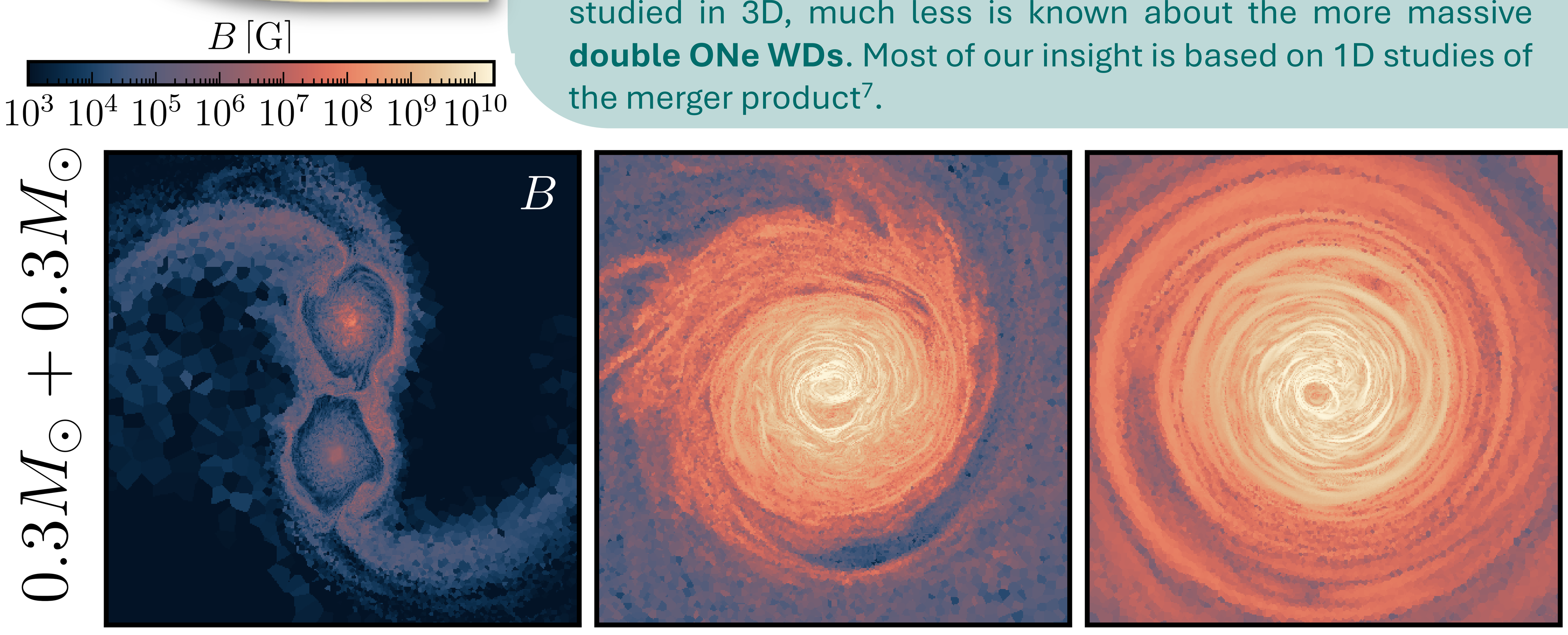
Compact double WDs are believed to be one of the most common endpoints of binary evolution. They are very important for a plethora of exotic astrophysical phenomena:

1. Type Ia supernovae[1,2] and related transients
2. Massive[3] and peculiar[4] WDs
3. Merger-induced collapse, forming a neutron star[5]
4. Gravitational wave signals detectable by LISA[6].

Although mergers of CO and He WDs have been extensively studied in 3D, much less is known about the more massive **double ONe WDs**. Most of our insight is based on 1D studies of the merger product[7].

Our aim is to investigate these ultra-heavy mergers and to understand the possible outcomes using 3D MHD simulations with AREPO[14,15].

In particular, the case of a collapse would be of great interest as the product would likely be a highly magnetized NS, a magnetar, since these mergers have been proven to greatly amplify magnetic fields[8]. A possible implication could be fast radio bursts (FRBs), whose mysterious origin may rest in magnetars[9,10]. This possibility is extremely exciting given the newly available data sets[11,12].



AREPO simulations of a lower mass WDs merger similar to the ones we will perform. In this row slices of magnetic field strength are shown at different times. The merger shows large magnetic field amplification.
From Pakmor et al., 2024, A&A, 691

Aims

We will study a **double ONe WD merger** from immediately before the coalescence up to a few hundred rotations of the product. We are particularly interested in modelling the magnetic field amplification and evolution. This aspect is fundamental, as the product is initially supported by rapid rotation. Understanding the timescale over which the magnetic field removes angular momentum is crucial, as this determines when rotational support is lost and collapse ensues.

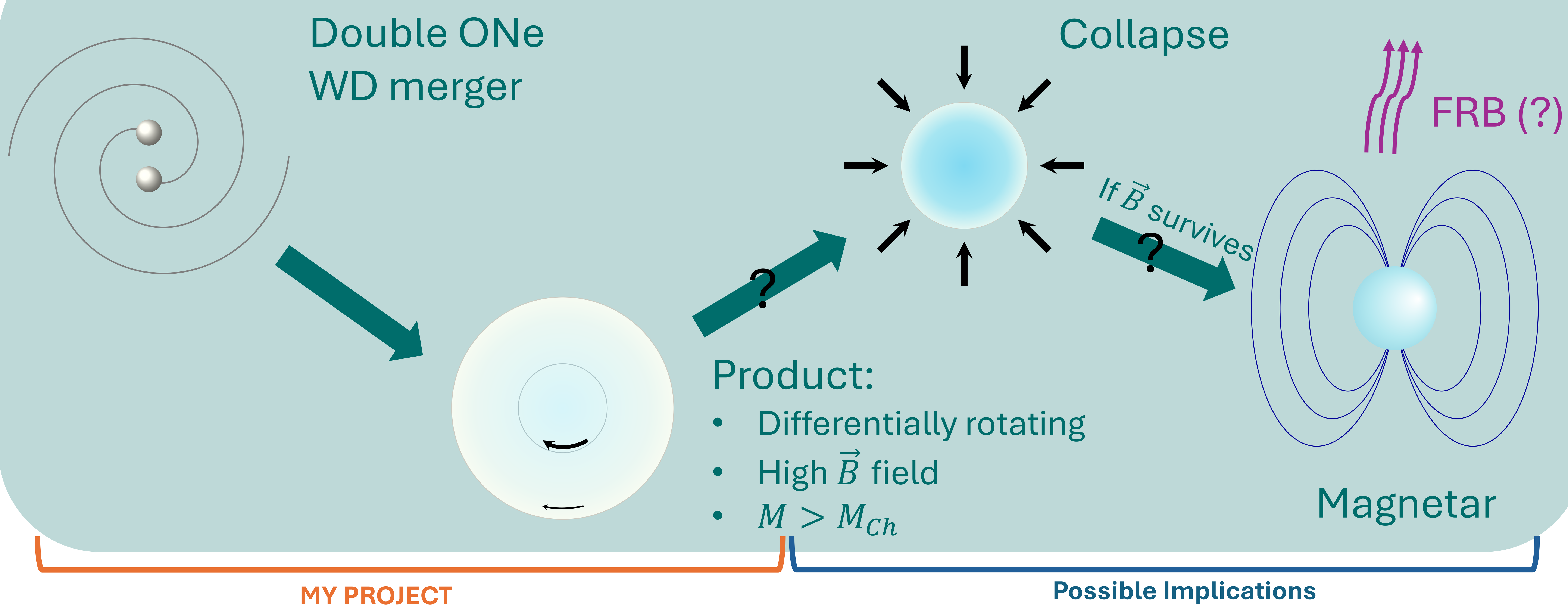
Methods

We use the 1D stellar evolution code MESA[13] to generate a realistic starting model for the ONe WDs. Then, we will use the moving-mesh code **AREPO**[14,15] to simulate the merger and the very first stages of the product following the approach of [8]. AREPO solves the ideal MHD equations in 3D using a second-order finite volume scheme[15]. This allows us not only to provide the first 3D hydrodynamical simulation of such a merger, but also allows us to follow the magnetic field amplification and evolution throughout the event. In addition, the moving-mesh scheme is particularly good to simulate chaotic systems such as a merger.

Limitations

Likely limitations will mainly be linked to the limited amount of time for which we will be able to simulate the event, due to the high computational time required by 3D MHD simulations and the build-up of numerical errors at longer times. In addition, the limited time and the complex physics involved will prevent us to simulate the collapse itself.

Project and (possible) implications



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