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Multidimensional simulations of Type Ia supernovae

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Despite substantial progress in theoretical modeling and numerical simulations over the past years, our understanding of the physical mechanism of Type Ia supernovae remains incomplete. This has two main reasons. (i) The progenitor systems from which these explosions arise have not been identified, and therefore the initial conditions for the explosion simulations are uncertain. (ii) Modeling the explosion stage itself is a severe multi-scale multi-physics challenge and relies on assumptions and approximations.

Some of these approximations could be mitigated with multidimensional hydrodynamical simulations. They form a cornerstone of a consistent modelling pipeline that follows a progenitor model over explosion and nucleosynthesis to the formation of observables. By avoiding tuneable parameters, this approach facilitates a direct comparison of model predictions with astronomical data and conclusions on the validity of the assumed progenitor scenarios. I will describe the construction and the application of such a pipeline of multidimensional models and discuss achievements and shortcomings of current models of Type Ia supernovae.

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