国立天文台天文シミュレーションプロジェクト 成果報告書

研究課題名

利用者氏名(所属機関)

利用カテゴリ XC-A ・ **XC-B** ・ XC-B+ ・ XC-MD ・ XC-Trial ・ GRAPE ・ 計算サーバ ・ その他

以下に成果の概要を記入してください。ページ数に上限はありませんが、最終的に提出される PDF のファイルサイズの上限は 2 MB です。
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Our original plan was to follow inhomogeneous metal mixing after the first supernovae with 3D simulations. This is a crucial process to understand the chemical composition of second-generation stars. These old, metal-poor stars still carry the chemical fingerprint of the first supernovae and their spectroscopic observation can be used to study the nature of the first stars in the Universe.
Until now, nobody has modelled inhomogeneous metal mixing on sufficient time and spatial scales from the SN explosion to the formation of the second-generation protostar. To tackle this multi-scale problem, we envisioned to run 3D hydrodynamical simulations with the moving-mesh code Arepo.

To optimise and efficiently plan these 3D simulation, we had first performed an analytical estimate of the expected inhomogeneity: what density resolution do we need? For how long after the supernova do we have to simulate? How many different elements do we have to follow? And what amount of inhomogeneous mixing is necessary to induce dynamical effects? We have published these first analytical results in Hartwig & Yoshida, 2019, ApJ, 870L, 3 and demonstrate that already one order of magnitude difference between the carbon and iron abundance are sufficient to have observable consequences. These results were obtained analytically without the use CfCA resources.

A student from Chile was supposed to join us in Tokyo to work on this project but we had to postpone his travel plans due to Covid-19. Remotely, he is now following a simple Sedov-Tayler supernova solution to test the code and to develop a pipeline for inserting arbitrary, 3D supernova as initial condition for the cosmological simulation. These simulations are currently performed on a supercomputer in Chile, but we will run them on the CfCA computer, once the project made sufficient progress.