Stellar Yields of Rotating Pair Instability Supernovae and Comparison with Observations

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After the onset of hydrodynamical collapse due to electron-positron pair creation, a very-massive star forming a massive CO core of 65-120 Msun is considered to explode as a pair-instability supernova (PISN) [1]. Peculiar chemical yields as well as the high explosion energy characterize the PISN explosion [2, 3].

Our final goal is to prove the existence of PISN and thus the high mass nature of the initial mass function in the early universe by conducting abundance profiling, in which properties of a hypothetical first star is constrained by metal-poor star abundances. For this purpose, we have investigated the PISN nucleosynthesis taking both rotating and non-rotating progenitors for the first time. In addition, we have conducted systematic comparison between theoretical yields and a large sample of metal-poor star abundances. We have found that the predicted low [Na/Mg] 1.5 and high [Ca/Mg] 0.51.3 abundance ratios are the most important to discriminate PISN signatures from normal metal-poor star abundances, and have confirmed that no currently observed metal-poor star matches with the PISN abundance [4].

The confirmation of the non-detection, together with a fact that currently no observed luminous supernova has been explained as a PISN event, may indicate that something important is missing from current understanding of stellar physics. Finally, we discuss that qualitatively different stellar evolution, which is against PISN explosion, results from a CO core in which a lowered reaction rate for 12C(α,γ)16O is applied [5].

References

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