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Bipradeep Saha: Understanding the role of early stars in galaxy formation and evolution using cosmological simulations

In the ΛCDM cosmological paradigm, smaller objects merge to form larger ones. Stars in galaxies are classified into Population I (PopI), which are metal-rich, and Population II (PopII), which are metal-poor but have higher metallicities than primordial gas. This led to the hypothesis of Population III (PopIII) stars, which are metal-free and the first stars in the universe. Despite extensive searches, no PopIII stars have been observed. These stars form in dark matter halos with masses around 10ˆ6 M⊠, and their formation is driven by molecular hydrogen cooling, resulting in large characteristic masses.

PopIII stars' stellar radiation ionizes and heats surrounding regions, driving shocks that enrich both the host and nearby halos with metals, promoting PopII star formation. They burn brighter and hotter than metal-rich stars, playing a crucial role in ending the cosmic dark ages and initiating reionization. Understanding PopIII stars is essential for deciphering galaxy origins and early universe processes.

Here, I present a comprehensive model for simulating PopIII stars, incorporating a refined thermochemistry network and detailed spectra calculations, along with a model for PopIII supernova feedback. Using cosmological zoom-in simulations, the study reveals the significant impact of PopIII stars on early galaxy formation, gas content, metal enrichment, and ionization. The findings provide a valuable framework for studying PopIII stars and generating predictions for observations with the James Webb Space Telescope, enhancing our understanding of their role in shaping the early universe.

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