

How can we simulate dark matter-baryon interactions?

Although various experiments have investigated potential non-gravitational interactions between dark matter and baryons, clear evidence for such interactions is still missing. Stringent constraints on several models have been established through observations of the cosmic microwave background and direct detection experiments. Nevertheless, dark matter-baryon interactions may still play a significant role in the evolution of cosmic structures, such as galaxy clusters and the formation of the first halos. Modeling these interactions in current cosmological simulations, however, presents a substantial challenge. I will introduce a novel numerical scheme that allows incorporating dark matter-baryon interactions into state-of-the-art cosmological simulation codes. I will present results from tests conducted using our simulation code, OpenGadget3, demonstrating the accurate modeling of various particle physics processes. Additionally, I will discuss the application of this approach to the formation of the first halos, highlight remaining challenges, and outline potential future directions.

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