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## Cosmological Neutrinos, Dark Sector, and Particle Physics Synergies from the High-Redshift Cosmic Web

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As Stage IV large-volume surveys are expected to reach an exquisite sub-percent level of statistical accuracy and precision in cosmological measurements, an accurate modeling of the dark sector is needed in order to obtain reliable likelihoods and unbiased cosmological parameters. This is particularly true at high-redshift and at small scales, where baryonic physics and feedback mechanisms can mimic subtle neutrino mass signatures or warm dark matter effects. We present the Sejong Suite, an extensive collection of high-resolution cosmological hydrodynamical simulations developed for the dark sector (massive neutrinos, dark radiation, warm dark matter). The resolution can be enhanced up to 110 billion particles in a  $[100 \text{ Mpc}/h]^3$  volume - optimal for the coming generation of cosmological surveys, including the Dark Energy Spectroscopic Instrument (DESI). The suite is grouped into 3 categories, addressing different science targets. In particular, we will focus on the Systematics Suite and present a number of effects that can impact parameter constraints, related to the modeling of additional species or intrinsic to the numerical nature of our simulations. We will also highlight the novelty of extended mixed scenarios for the dark sector, indicate ongoing improvements in numerical performance and resolution, and pinpoint interesting synergies with particle physics.

### Summary

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