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Precise constrained cosmological simulations of the Local Group

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Cosmological simulations have been used to understand the formation of structure in the ΛCDM paradigm on small and large scales. Most simulations start with unconstrained Gaussian initial conditions, and therefore generically do not produce good analogues of the Local Group at present day. While constrained simulations exist, these have difficulty in precisely satisfying all our observational constraints on the Local Group, and their result is not an unbiased and fair sample of the posterior distribution of ΛCDM universes subject to the observational constraints of the Local Group. Some applications of such a sample include putting into cosmological context our distribution of satellites, the alignment of the dark-matter haloes and their spin and the relation to the assembly history, and to determine the effect of our environment on the Local Group's spatial configuration and kinematics.

In this work, we extend the BORG algorithm (Bayesian Origin Reconstruction from Galaxies), that has already been used to model the Local Large-Scale Structure, to reconstruct the Local Group. Using this toolset, we perform a statistical inference on the history of the Local Group, following a ΛCDM prior on the cosmological initial conditions, and a likelihood that constrains local observational quantities, like the masses, positions, velocities of the Milky Way and M31 haloes, and the quiet local Hubble flow. In the near future, we also plan to embed our Local Group in a realistic large-scale structure. This is the first time a cosmological simulation has been able to reproduce all these properties simultaneously with high precision.

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