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Simulating scalar-induced gravitational waves

Scalar-induced gravitational waves (SIGWs) are ubiquitous in many early-Universe processes accompanied by non-Gaussianity; hence, precise calculations of SIGWs involve a full understanding of non-Gaussianity. Therefore, we propose to use the lattice simulations to directly calculate the energy density spectra of SIGWs with non-Gaussianity up to all orders. Our proposal has been first verified to match the existing semi-analytical results with non-Gaussianity, and then applied to more general cases, including high-order primordial non-Gaussianities, the logarithmic dependence in curvature perturbations, the curvaton model, and the ultra slow-roll model. We find that even a modest non-Gaussianity can significantly alter ultraviolet behaviors in SIGW spectra, necessitating
special cautions in future detections as well as mutual constraints on/from primordial black holes.

Primary author(s) : ZENG, Xiang-Xi (ITP, CAS)

Co-author(s) : NING, Zhuan (HIAS and ITP-CAS); WANG, Shao-Jiang (Institute of Theoretical Physics, Chinese Academy of Sciences); CAI, Rong-Gen

Presenter(s) : ZENG, Xiang-Xi (ITP, CAS)