Effect of large-scale structures on cosmological evolution and its signatures through multi-messenger astronomy

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Recent observations have revealed the presence of cosmic structures at very large scales in the Universe even beyond 500 h^{-1} Mpc. This calls for re-examination of the standard paradigm of ΛCDM cosmology based on assumptions of a homogeneous matter distribution at various cosmological scales. The observed large-scale matter inhomogeneities are expected to impact the background Hubble evolution through their backreaction on the cosmological metric. We compute the effects of backreaction employing the Buchert framework for averaging on spatial hypersurfaces. This results in an altered Hubble evolution with pronounced effects on various astronomical signals. We discuss three such signatures, viz. (i) red-shift drift, (ii) 21-cm brightness temperature, and (iii) amplitude of gravitational waves from compact binaries.