Contribution ID: **67** Type: **Talk/seminar**

Graviton mass in the era of multi-messenger astronomy

Friday 10 September 2021 17:10 (20 minutes)

The idea of massive graviton plays a fundamental role in modern physics as a landmark of most scenarios related to the modification of the theory of gravity. Limits on graviton mass can be obtained with capabilities of multi-messenger astronomy. In particular, non-zero graviton mass would modify estimates of the total cluster mass (Yukawa term influences Newtonian potential). This can be measured through the X-ray surface brightness of the intracluster medium combined with a characteristic distortion in the cosmic microwave background spectrum observed in the cluster direction, known as thermal Sunyaev-Zel'dovich (SZ) effect. Using X-COP galaxy cluster sample, where total masses up to certain radii were measured by using X-ray data from XMM-Newton telescope combined with SZ data from Planck satellite, we obtaned that m_g < (4.99 − 6.79) × 10^(−29) eV (at 95% C.L.) which is one of the stringest available. On the other hand, modified relativistic dispersion relation of massive graviton may lead to changes in travel time of gravitational waves (GWs) emitted from a distant astrophysical objects. Strong gravitational lensing of signals emitted from a carefully selected class of extra-galactic sources like compact object binaries (in particular, binary neutron stars) is predicted to play an important role in this context. Particularly, comparing time delays between images of the lensed GW signal and its electromagnetic counterpart may be a new model-independent strategy, especially promising in the time of successful operating runs of LIGO/Virgo GW detectors (recently joined by KAGRA observatory) resulting in numerous records of GW signals from coalescing compact object binaries. In this talk I will discuss the above ideas in more details.

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Session Classification: Regular Sessions