Contribution ID: **470** Type: **Parallel talk**

Detecting Gravitational Waves by Twisted Light - Dipole Interaction of Photons and Gravitational Waves

Saturday, 13 July 2019 10:00 (20 minutes)

Motivated by the next generation of gravitational wave (GW) detectors, we study the wave mechanics of a twisted light beam in the GW perturbed spacetime. We found a new gravitational dipole interaction of photons and gravitational waves. Physically, this interaction is due to coupling between the angular momentum of twisted light and the GW polarizations. We demonstrate that for the higher-order Laguerre-Gauss (LG) modes, this coupling effect makes photons undergoing dipole transitions between different orbital-angular-momentum(OAM) eigenstates, and leads to some measurable optical features in the 2-D intensity pattern. It offers an alternative way to realize precision measurements of the gravitational waves, and enables us to extract more information about the physical properties of gravitational waves than the current interferometry. With a well-designed optical setup, this dipole interaction is expected to be justified in laboratories.

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Session Classification: Astroparticle Physics and Gravitational Waves

Track Classification: Astroparticle Physics and Gravitational Waves