Surfing effect in Cosmology

Abstract

The physical meaning of the SE lies in the following: When propagating in a single monochromatic GW, the EMW experiences phase modulations (PMs). When calculating the PMs generated by the random GW background one should integrate the dispersion of the PMs generated by partial GWs over angles between the wave vectors of these partial GWs and line of sight. If these angles are small EMW and GW are nearly in phase and their interaction looks like the propagation of EMW through a nearly constant gravitational field. In this case PMs are proportional to the distance passed by EMW through GW (a cumulative change in the phase of EMW) and can give a considerable contribution to the dispersion of random PMs in the random field of cosmological GWs. Due to the transverse nature of both EMWs and GWs, the SE leads to the significant cumulative PMs only if the phase velocity of GWs is smaller than the phase velocity of EMWs (for example, in the case of GWs and EMWs interaction in plasma). The PM analysis which takes into account the SE could be very important in application to cosmological birefringence (CB) due to parity violating Chern-Simons (CS) modifications of standard electromagnetism (EM). Such modification results in 'slow' and 'fast' modes of circularly-polarized light. The fast mode traveling with a phase speed larger than the speed of light in vacuum, can experience cumulative PMs due to the SE. This is a potentially observable effect which could modify the angular (multipole) dependence of CMB polarization and could be used for separation of instrumental systematics from CB. This could be considered as essential observational application of Cosmology to the fundamental Physics of Fields.