



## Analyses of Laser Propagation Noise for TianQin Gravitational Wave Observatory Based on the Global Magnetosphere MHD Simulation

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TianQin is a proposed space-borne gravitational wave (GW) observatory composed of three identical satellites orbiting around the geocenter with a distance of 105 km. It aims at detecting GWs in 0.1 mHz – 1 Hz. The detection of GW relies on the high precision measurement of optical path length at  $10^{-12}$  m level. The dispersion of space plasma can lead to the optical path difference (OPD,  $\Delta l$ ) along the propagation of laser beams between a pair of satellites. Here, we study the OPD noises for TianQin. The Space Weather Modeling Framework is used to simulate the interaction between the Earth magnetosphere and solar wind. From the simulations, we extract the magnetic field and plasma parameters on the orbits of TianQin at four relative positions of the satellite constellation in the Earth magnetosphere. We calculate the OPD noise for single link, Michelson, and Time-Delay Interferometry (TDI) data combinations ( $\alpha$  and X). For single link and Michelson interferometer, the maxima of  $\Delta l$  are on the order of 1 pm. For the TDI combinations, these can be suppressed to about 0.05 pm. The OPD noise of Michelson combination is colored in the concerned frequency range; while the ones for the TDI combinations are roughly white. Furthermore, we calculate the ratio of the equivalent strain of the OPD noise to that of TQ, and find that the OPD noises for the TDI combinations can be neglected in the most sensitive frequency range of  $f < 0.1$  Hz.