Fundamentals of the orbit and response for TianQin

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TianQin is a proposed space-based laser interferometric gravitational wave detector aimed at detecting gravitational waves at low frequencies (0.1 mHz – 1 Hz). It is formed by three identical drag-free spacecrafts in an equilateral triangular constellation orbiting around the Earth. The distance between each pair of spacecrafts is approximately 1.7×10^5 km. The spacecrafts are interconnected by infrared laser beams forming up to three Michelson-type interferometers. The detailed mission design and the study of science objectives for the TianQin project depend crucially on the orbit and the response of the detector. In this work, we provide the analytic expressions for the coordinates of the orbit for each spacecraft in the heliocentric-ecliptic coordinate system to the leading orders. This enables a sufficiently accurate study of science objectives and data analysis, and serves as a first step to further orbit design and optimization. We calculate the response of a single Michelson detector to plane gravitational waves in arbitrary waveform which is valid in the full range of the sensitive frequencies. It is then used to generate the more realistic sensitivity curve of TianQin. We apply this model on a reference white-dwarf binary as a proof of principle.

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