The Effect of Stationary Earth Gravity Field on the Sensitivity of TianQin

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TianQin is a space-based gravitational wave detector consisted of three satellites on a common geocentric orbit with a radius of about 10^5km. There is concern that if the current uncertainty in our knowledge of the Earth gravity field will result in too much inaccuracy in the prediction of the satellite motion, leading to too much error in the abstraction of gravitational wave signals. In this work, we carry out a preliminary study of the problem, focusing on the stationary Earth gravity field. We derive a formula showing how the uncertainty in the satellite motion contributes to the measurement of TianQin. Then we estimate the magnitude of the contribution with two independent orbit solutions (one analytical and one numerical), using two comprehensive global solutions of the stationary Earth gravity field as examples. We find that, not considering the systematic error unknown to these global solutions, their contribution to uncertainty in the prediction of satellite motion is small and is about three orders of magnitude below the expected sensitivity of TianQin.

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