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基于非全张量卫星重力梯度数据的张量不变量法

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Method of tensor invariant based on non-full tensor satellite gravity gradients

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摘要 在非全张量卫星重力梯度观测数据的处理过程中,由于卫星姿态角误差、梯度观测数据误差和非全张量观测等原因,重力梯度值从卫星重力梯度仪系转换到地固系后,精度损失严重.本文研究了张量不变量法以解决上述问题.首先在重力梯度张量不变量线性化的基础上,建立了基于卫星轨道面的不变量观测模型,完整地推导了两类重力梯度张量不变量的球近似和顾及地球扁率影响的球面边值问题的求解公式.针对GOCE卫星任务非全张量观测数据类型,分析了张量不变量的计算误差;结果表明,重力梯度观测误差在不变量的计算中并没有被放大.最后运用广义轮胎调和分析方法进行了模拟试验,数值试验证明,在卫星姿态误差较大时,处理张量不变量比处理张量分量更具优势,并且张量不变量法能有效地解决非全张量观测的问题.

关键词: 卫星重力梯度 张量不变量 地球重力场 调和分析 GOCE

Abstract: Due to the errors of satellite attitude, gradient observation as well as non-full tensor observation, the precision of gravity gradient values decreased greatly after transformation from satellite gradiometer coordinate system to earth-fixed coordinate system in the processing of non-full tensor observational data of satellite gravity gradient. The method of tensor invariant is mainly studied to overcome the issue mentioned above. Firstly, with the linearization of gravity gradient tensor, invariant observational model is established on the satellite orbital plane. Formulae solutions of sphere boundary problem of two invariants both in sphere approximation and considering earth eccentricity are given completely. Then, computing errors of tensor invariant are analyzed aiming at non-full tensor observational data of GOCE mission. The result shows that observational errors are not magnified in the processing. Finally, general torus harmonic analysis is introduced in the simulation, which shows that the processing result of tensor invariant is better than that of tensor components with big satellite attitude errors, and the method of tensor invariant could deal with the non-full tensor observational data effectively.

Keywords: Satellite gravity gradient Tensor invariant Earth's gravity field Harmonic analysis GOCE

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