17th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Interactive Presentations - 17th IAA SYMPOSIUM ON SPACE DEBRIS (IP)

Author: Dr. Hou-Yuan Lin
Purple Mountain Observatory, Chinese Academy of Sciences, China

Dr. Chang-Yin Zhao
Purple Mountain Astronomical Observatory, China

MODEL OF ATMOSPHERIC DENSITY GRADIENT TORQUE ACTED ON TIANGONG-1

Abstract

Tiangong-1 ended its service in March 2016 and re-entered the atmosphere in April 2018. We organized a joint observation from November 2017 to April 2018 to estimate its rotational state. The angular momentum of Tiangong-1 is relatively stable during observation, but its rotation rate is found to increase, which is an unexpected phenomenon. Because the acceleration of the spin increases significantly with decreasing orbital altitude, which is consistent with the increase in atmospheric density with decreasing orbital altitude, we propose a new torque called atmospheric density gradient torque that considers the torque generated by the change in atmospheric density with orbital altitude at the satellite scale. The order of magnitude of this new torque is estimate in line with the increasing rate of the angular momentum. The atmospheric density gradient at Tiangong-1's position after February 2018 increases faster, which is also consistent with the increasing accelerated rate of the rotational speed. However, the numerical results with aerodynamic torque based on the molecular–surface interaction model show that the new torque model provides a non-negligible effect but cannot fully describe the acceleration. The atmospheric density gradient torque model, as well as aerodynamic model, may need improvement by addressing minor factors omitted in previous models.