Attitude dynamics of the first Russian nanosatellite TNS-0

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Abstract: Attitude dynamics of the first Russian nanosatellite TNS-0 is considered. The satellite is equipped with an attitude control system comprising a strong permanent magnet mounted along the satellite axis of symmetry and a number of hysteresis rods as a damper. It was expected that the satellite axis of symmetry traces the induction vector of the geomagnetic field. When the satellite has been orbited its angular momentum was unexpectedly high. To interpret motion of the satellite using mathematical study and flight data processing is the purpose of this paper. Three elementary sun sensors are installed on the satellite corp and their measurements analysis shows that the satellite angular velocity was decreasing with a time early in the mission. The analytical study of the motion is carried out. To examine the asymptotical stability of the motion the approximating model of the hysteresis was involved. Finally, the satellite probably reached the following motion: it rotates; the magnet direction precession-averaged follows the induction vector of the geomagnetic field; the angle between the magnet and the induction vector is not rather small and without tendency to be smaller. Actually, the satellite reached a permanent rotation mode almost without energy dissipation. Such a mode was mentioned in the 1960s and now it is explained and recognized in flight.

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