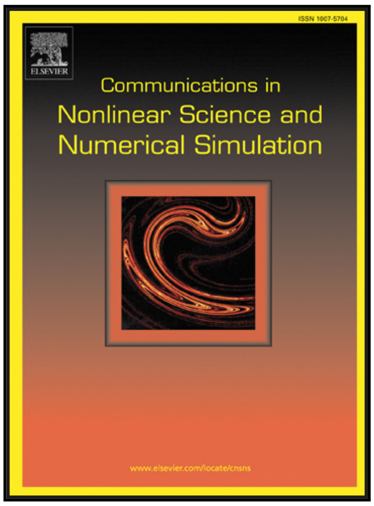
Accepted Manuscript



Attitude dynamics of gyrostat–satellites under control by magnetic actuators at small perturbations

ANTON V. DOROSHIN

PII: S1007-5704(17)30032-1
DOI: 10.1016/j.cnsns.2017.01.029
Reference: CNSNS 4103

To appear in: *Communications in Nonlinear Science and Numerical Simulation*

Received date: 20 October 2016
Revised date: 14 December 2016
Accepted date: 27 January 2017

Please cite this article as: ANTON V. DOROSHIN , Attitude dynamics of gyrostat–satellites under control by magnetic actuators at small perturbations, *Communications in Nonlinear Science and Numerical Simulation* (2017), doi: 10.1016/j.cnsns.2017.01.029

Attitude dynamics of gyrostat–satellites under control by magnetic actuators at small perturbations

ANTON V. DOROSHIN
Space Engineering Department
Samara National Research University

Moskovskoe shosse 34, Samara, Russian Federation 443086
doran@inbox.ru; doroshin@ssau.ru

Abstract: - The angular motion of gyrostat-satellites with one axial rotor is considered under control by magnetic actuators and at the action of small polyharmonic perturbations in the own dipole magnetic moment's components which are created proportionally to components of the angular velocity of the satellite. The attitude dynamics is investigated in conditions of the coincidence of the vector of magnetic induction of the external magnetic field and the initial angular momentum vector of the satellite. General and heteroclinic analytical solutions are obtained for dynamical parameters at the relative smallness of the magnetic torques. The chaotic regimes are examined on the base of the Melnikov method and Poincaré sections.

Key-Words: - Satellite; Gyrostat; Dual-Spin Spacecraft; Rigid Body Dynamics; Explicit Exact Solutions; Elliptical Integrals; Jacobi Elliptic Functions; Omega-Maneuver; Heteroclinic chaos; Melnikov function; Poincaré sections

Introduction

The problem of the dynamics analysis of the spacecraft with complex mechanical structure with rotating parts/bodies/equipment (dual-spin spacecraft, multi-spin spacecraft, gyrostat-satellites) and various actuators of control systems always was one of the important part of mechanics and flight dynamics. This problem can be decomposed on many important tasks, starting from the fundamental tasks of classical mechanics of rigid bodies systems [1-5], continuing with new developments in this area [6-8], and focusing on the application of the fundamental results to the analysis of the non-linear regular and chaotic dynamics [9-28] of spacecraft (SC).

The motion of the spacecraft with magnetic control systems was observed and studied in many works in different tasks' formulations [11-28]. In general, the magnetic control technique is based on the interaction of the external magnetic field (the Earth magnetic field, e.g.) and own spacecraft magnetic dipole moment **m**, which is formed by magnetic actuators (magnetic coils and/or rods); and corresponding control lows follow from the controller programs, which generate the concrete time-dependencies of magnetic torque components relatively the connected SC's coordinates frame. These time-dependencies for the components of the SC magnetic dipole moments can have elementary simple or, in contrary, complex shapes. For example, to solve the task of SC attitude stabilization along the local direction of the induction vector of the external magnetic field, we can use the simplest form of the SC own magnetic dipole moment with constant components relatively the connected coordinates frame. Or, in the purposes of decreasing the value of the angular momentum of the SC, the well-known "B-dot" maneuver can be fulfilled [27, 28], when the components of the own SC magnetic dipole moment are formed by the control system with the help of the SC magnetometers: the magnetometers measure derivatives of values of projections of the induction of the external magnetic filed in the SC connected frame, and the control system form the dipole moment components proportionally (but with the opposite sign) to these measured values. So, many cases of the shape of