<<航天器姿态动力学中的混沌>>

图书基本信息

书名：<<航天器姿态动力学中的混沌>>

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前言

The development of spacecraft has drawn considerable attentions in the field of dynamics since the 1950s. The spacecraft can be regarded as a particle or as a body, depending on whether one focuses on the spacecraft's orbital motion or on its rotational motion about the center of mass. Spacecraft attitude dynamics deals with the rotational motion of spacecraft. In the discussion of attitude dynamics, the rotation of spacecraft is usually assumed not to alter the orbit, while the orbit sometimes influences the rotational motion. Almost all spacecraft have some attitude requirements, either explicit pointing requirements for antennas or cameras, requirements for solar panel orientation, or simply a requirement for a given spin-axis direction. All the requirements are implemented by the design of attitude controls. The strategies chosen in the control process may limit the useful lifetime of the spacecraft, since an all-thruster control system depletes its propellant supply. Attitude dynamics forms a theoretical basis of the design and control of spacecraft. The present monograph is concemed with spacecraft attitude motion, although essential elements of orbital dynamics will be introduced and the effects of orbital motion will be included in a few cases. With the development of nonlinear dynamics, chaos in spacecraft attitude dynamics has stirred renewed interests since the 1990s. In fact, for astronautical investigations, the predictability of spacecraft rotations is critical, and thus chaotic motions must be avoided. On the other hand, there are scientific experiments that require the whole celestial sphere to be scanned, and in those cases the chaotic rotation may be desirable. Therefore chaos theory offers a new method and viewpoint for designing spacecraft. In addition, spacecraft attitude dynamics also provides new mathematical models for engineering application of chaos analysis. Although there are some excellent monographs and textbooks on spacecraft attitude dynamics, there are few treatises on chaotic attitude motion. The present monograph focuses on chaos in spacecraft attitude dynamics. The monograph begins with the necessary fundamentals. Chapter 1 provides a primer on spacecraft dynamics, and Chapter 2 presents a survey of chaos theory. Different chaotic attitude motions are treated in Chapters 3 and 4. Chapter 3 considers only the planar motion of spacecraft, while Chapter 4 covers the spatial motion. The monograph ends with Chapter 5, dealing with controlling chaotic attitude motion. The main goal of the monograph is to provide readers with the knowledge of theory and application of chaos and its control in spacecraft attitude dynamics, including the basic concepts, main approaches and the latest research progress. The material is appropriate for university teachers, scientists, engineers, and graduate students in the fields of mechanics, applied mathematics, and aerospace science.

内容概要

航天器混沌姿态运动的识别和控制问题在航天科学中具有重要实际意义。
《航天器姿态动力学中的混沌》致力于总结该领域的近期发展，提供研究航天器姿态运动的新方法和观点，也为该领域进一步的深入分析研究提供有明确工程背景的新的数学模型。
读者可从《航天器姿态动力学中的混沌》获得混沌和混沌控制理论及其在航天器姿态运动中应用的知识，包括基本概念，主要方法以及最新进展。

书籍目录

章节摘录

版权页： 插图： Intermittency is another frequently observed route to chaos.Intermittency is a phenomenon characterized by random alternations between a regular motion and relatively short irregular bursts.The term intermittency has been used in the theory of turbulence to denote burst of turbulent motion on the background of laminar flow.During early stages of intermittency,for a certain system parameter value,the motion of the system is predominantly periodic with occasional bursts of chaos.As the parameter value is changed,the chaotic bursts become more frequent,andthe time spent in a state of chaos increases and the time spent in periodic motion decreases until,finally,chaos is observed all the time.As a result,the periodic motion becomes chaotic motion. This route was found by Pomeou and Manneville in 1980 [8].Geometrically,the intermittency route is associated with a periodic attractor in the state space bifurcating into a new,larger chaotic attractor,including previous periodic trajectories as its subset.The trajectory of a system can reside some time in the chaotic part of the attractor,but it is ultimately attracted back to the periodic part.As the system parameter is varied,the relative proportion of the chaotic part increases,ultimately covering the whole attractor. Quasiperiodic torus breakdown is the third typical way that a system may evolve as its parameter is changed. Quasiperiodic torus breakdown route signifies the destruction of the torus and the emergence of a chaotic attractor.The system,if it is not externally driven by a periodic action,may be at equilibrium.As the system parameter is varied,the equilibrium may lose its stability,leading to the emergence of a stable periodic motion.Such a change resulting in a new motion frequency iscalled the Hopf bifurcation.In the state space,a point attractor becomes a periodic attractor.With a further change in the parameter,the periodic attractor undergoes a secondary Hopf bifurcation,resulting in a 2-period quasiperiodic attractor.The trajectories in the state space reside on the surface of a torus.If the two frequencies are incommensurable,the trajectory eventually covers the surface of the torus.For some systems,further changes in the parameter result in the introduction of a third frequency.

编辑推荐

Attitude dynamics is the theoretical basis of attitude control of spacecrafts in aerospace engineering. With the development of nonlinear dynamics, chaos in spacecraft attitude dynamics has drawn great attention since the iggo's. The problem of the predictability and controllability of the chaotic attitude motion of a spacecraft has a practical significance in astronautic science. Ihis book aims to summarize basic concepts, main approaches,and recent progress in this area. It focuses on the research work of the author and other Chinese scientists in this field, providing new methods and viewpoints in the investigation of spacecraft attitude motion, as well as new mathematical models, with definite engineering backgrounds, for further analysis.   Professor Yanzhu Liu was the Director of the Institute of Engineering Mechanics, Shanghai Jiao Tong University, China. Dr. Liqun Chen is a Professor at the Department of Mechanics, Shanghai University, China.

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