AIAA JOURNAL
Vol. 34, No. 10, October 1996

Russian and Japanese Aerospace Literature

During 1996 the *AIAA Journal* will carry selected abstracts on leading research topics from Russian aerospace literature and, as space permits, from similar Japanese literature. The topics will be chosen and the abstracts reviewed for pertinency by *AIAA Journal* editors. This month features Orbital Mechanics from Russia and Orbital Mechanics from Japan.

Support for assembling and publishing the selected abstracts has been provided by the Innovative Science and Technology Directorate of the Strategic Defense Initiative Organization (SDIO), with the sponsorship and technical management of the abstract service by the Office of Naval Research (ONR) under ONR Grant N00014-93-I-1074.

Abstracts in this listing have been taken from the monthly abstract journal *International Aerospace Abstracts* (IAA), published by the American Institute of Aeronautics and Astronautics (AIAA). Additional materials can be obtained through searching the Aerospace Database—available online via DIALOG or NASA RECON.

Paper copies and microfiche of the original documents cited are available from Aeroplus Dispatch, 1722 Gilbreth Road, Burlingame, CA 94010; (800) 662-2376. Use the "A" number to identify material you want. Please be advised that most of the original documents are in the original language. Direct questions concerning this abstract section of the *AIAA Journal* to Norma Brennan at AIAA Headquarters.

Russian Aerospace Literature
This month: *Orbital Mechanics*

N96-16962 Optimum transfers between circular coplanar orbits for spacecraft with rocket engine of large limited thrust. K. G. GRIGORYEV (Moscow State Univ., Russia) and A. V. FEDYNA (Moscow State Univ., Russia), *FBIS Report: Science and Technology. Central Eurasia: Mir and Other Russian Spacecraft Orbits Examined*, pp. 23–43. Translated into English from *Kosmicheskiye Issledovaniya* (Moscow, Russia), Vol. 33, No. 4, pp. 403–416. Documents available from Aeroplus Dispatch.

By taking the principle of the maximum as a basis and solving the boundary value problems by a shooting method, the authors present a numerical study of thrust-vector controlled optimum transfers between the coplanar circular orbits of a spacecraft with rocket engines of large limited thrust. Solutions are found for problems of the fastest transfers with and without prescribed limitations on mass expenditure, and for problems of transfers with minimum expenditures of mass with and without prescribed limitations on transfer time. (Author (revised))

A96-27378 Parametric resonance and nonlinear oscillations of a heavy rigid body in the vicinity of its planar rotations (Parametricheskij rezonans i nelinejnye kolebaniya tyazhelogo tverdogo tela v okrestnosti ego ploskikh vrashchenij). A. P. MARKEEV, *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Tverdogo Tela* (ISSN 0572-3299), No. 5, 1995, pp. 34–44. In Russian. 17 Refs. Documents available from Aeroplus Dispatch.

An analysis is made of the three-dimensional nonlinear oscillations of a heavy rigid body that are close to planar pendulum-like rotations. It is assumed that the moments of inertia of the body satisfy the conditions of the orbital instability of planar motion due to the parametric resonance phenomenon. By using the methods of Hamiltonian mechanics, the problem is reduced to that of an analysis of a model autonomous Hamiltonian system with a single degree of freedom, which reflects the resonance nature of the motions of interest. Results of a detailed analysis of the motions in the model problem are presented.

A96-21708 Spacecraft motion control on the geostationary orbit using electrical thruster. Y. RYLOV, G. AVATINYAN (NIIEM, Istra, Russia), Y. TRIFONOV (VNIIEM, Moscow, Russia), A. KOROTEEV (KRC, Moscow, Russia), and A. MOROZOV (IAE, Moscow, Russia), *16th AIAA International Communications Satellite Systems Conference*, Washington, DC, 1996, TP, Pt. 3 (A96-21571 04-32), Washington, DC, American Inst. of Aeronautics and Astronautics, 1996, pp. 1286–1292. 8 Refs. Documents available from Aeroplus Dispatch.

The paper considers the problems of electrical thruster (ET) integration with a geostationary spacecraft (SC) based on the experience of the electropulsion system application on the 'Meteor', 'Resurs', and 'GOMS' series spacecraft. The technological procedures of the SPT integration with SC and the results of the SPT interaction with SC systems in space are also presented. The characteristics of the unique electroheating thruster being utilized for the 'GOMS' SC attitude control system and EW orbit correction are analyzed. The specific features of the SC control and its motion hold on geostationary orbit in all six DOF are considered, and a scheme for SC integration with a second-generation plasma thruster with the capability to control the thruster vector direction and value is proposed. The physical and mathematical model of the operation process in such a thruster is discussed. Results are presented for the electropropulsion system parameters optimization during its integration with SC having different masses, operation time, and types of construction layout of the thrusters on space platforms. (Author)

A96-13739 A case of unperturbed motion in satellite tether dynamics (Ob odnom sluchae nevozmushchennogo dvizheniya v dinamike orbital'noj trosovoj sistemy). I. I. KOSENKO (Moskovskaya Gosudarstvennaya Akademiya Priborostroeniya i Informatiki, Moscow, Russia), *Kosmicheskie Issledovaniya* (ISSN 0023-4206), Vol. 33, No. 5, 1995, pp. 479–484. In Russian. 4 Refs. Documents available from Aeroplus Dispatch.

An analysis is made of the dynamics of a mechanical system consisting of two material points connected by a nonstretchable filament (tether). All the components of the system have a nonzero mass; the linear density of the tether is constant. The entire system moves in a gravitational field. Equations describing the dynamics of the system and the boundary conditions are presented.

A96-12451 Modeling the spacecraft trajectory for nonstationary solar sail characteristics (Modelirovanie traektorii apparata pri nestatsionarnykh kharakteristikakh solnechnogo parusa). E. N. POLYAKHOVA, G. A. SHARIFKULOVA, and V. V. SHUVALOV, *Lectures Devoted to the Development of the Scientific Heritage and Ideas of K. E. Tsiolkovsky, 28th Meeting of the Section 'Space Flight Mechanics,'* Kaluga, Russia, 1993, Transactions (A96-12447 01-12), Moscow, IIEiT RAN, 1994, pp. 35–40. In Russian. 10 Refs. Documents available from Aeroplus Dispatch.

An analysis is made of the effect of changes in solar sail reflectivity (e.g. as a result of erosion due to micrometeorites) on the dynamics of the spacecraft. A formula for determining changes in solar sail reflectivity is obtained. The importance of considering sail erosion in solving practical navigation problems is demonstrated.

A95-45815 Contour motion of a flexible filament loop during the radiation of electromagnetic waves (Konturnoe dvizhenie petli iz gibkoj niti pri izluchenii ehlektromagnitnykh voln). V. A. RULEV, *Lectures Devoted to the Development of the Scientific Heritage and Ideas of K. E. Tsiolkovsky, 27th Meeting of the Section 'Space Flight Mechanics,'* Kaluga, Russia, 1992, Transactions (A95-45809 12-12), Moscow, IIET RAN, 1993, pp. 27–32. In Russian. 2 Refs. Documents available from AIAA Dispatch.

The dynamics of the unsteady relative motion of a flexible conducting filament loop during acceleration to a steady contour velocity is investigated in relation to deployable spacecraft antennas for space radio communications. In particular, the configuration of a filament loop during the contour motion in the presence of electromagnetic wave radiation is examined analytically. Equations describing the dynamics of the loop in contour motion are obtained.

A95-43597 The problem of the shape of celestial bodies with synchronized orbital and rotational motions (K probleme form nebesnykh tel, nakhodyashchikhsya v orbital'no-vrashchatel'nykh sinkhronizmakh). A. A. KHENTOV (Nizhegorodskij Univ., Nizhni Novgorod, Russia), *Astronomicheskij Journal* (ISSN 0004-6299), Vol. 72, No. 2, 1995, pp. 277–284. In Russian. 15 Refs. Documents available from Aeroplus Dispatch.

The possibility of using the principle of minimum interaction for estimating the shape of natural celestial bodies with synchronized orbital and rotational motions is examined. An approximate expression for the perturbing force function is obtained for the case of orbital-rotational synchronism. The observed motion of Mercury is analyzed as an example.

A95-31622 Quasi-satellite orbits in the elliptic restricted three body problem (O kvazisputnikovykh orbitakh v ogranichennoj ehllipticheskoj

zadache trekh tel). M. L. LIDOV and M. A. VASHKOV'YAK (RAN, Inst. Prikladnoj Matematiki, Moscow, Russia), *Pis'ma v Astronomicheskij Zhurnal* (ISSN 0320-0108), Vol. 20, No. 10, 1994, pp. 781–795. In Russian. 7 Refs. Documents available from Aeroplus Dispatch.

We consider, within the framework of the elliptic restricted three body problem, the quasi-satellite orbits with retrogressive movement, encompassing the lower-mass body and located outside the sphere of action of the latter. We provide two methodological approaches to studying such orbits for arbitrary values of system parameters, which include mass ratio and orbit eccentricity for two attracting bodies. The first approach is to find numerically the flat symmetric periodic solutions of the elliptic restricted three body problem; the second approach involves numerical and analytical calculations of long-term evolution for quasi-satellite orbits and is based on an averaging scheme. We trace the transformation of simplest periodical orbits into typical quasi-satellite orbits. We compare the results of calculations carried out independently with the two methods. (Author)

A94-29259 Dynamics of an orbital station with an extended truss (Dinamika orbital'noj stantsii s protyazhennoj fermoj). V. I. GULYAEV, I. S. EFREMOV, A. G. CHERNYAVSKIJ, V. L. KOSHKIN, V. K. BONDAR, and Y. A. SHINKAR, (Kievskij Inzhenerno-Stroitel'nyj Inst., Kiev, Ukraine; NPO Energia, Moscow, Russia), *Kosmicheskie Issledovaniya* (ISSN 0023-4206), Vol. 32, No. 2, 1994, pp. 61–70. In Russian. 14 Refs. Documents available from Aeroplus Dispatch.

The paper is concerned with the problem of the motion of a maneuvering space system consisting of an orbital station and an elastically attached extended truss carrying a massive rigid body at its free end. A mathematical model and computational algorithms are developed for investigating the free and induced vibrations of such a system. The 14-m truss of the Mir Space Station designed to carry a powerplant is examined as an example.

A95-16845 Gravitational interaction of two planetesimals moving in close orbits (Gravitatsionnoe vzaimodejstvie dvukh planetezimalej, dvizhushchikhsya po blizkim orbitam). S. I. IPATOV (RAN, Inst. Prikladnoj Matematiki, Moscow, Russia), *Astronomicheskij Vestnik* (ISSN 0320-930X), Vol. 28, No. 6, 1994, pp. 10–33. In Russian. 48 Refs. Documents available from Aeroplus Dispatch.

The results of investigations of orbits of two gravitationally interacting objects—material points moving around the sun—are presented. These investigations were made based mainly on the results of numerical integration of the equations of motion of the planar three-body problem. The following types of evolution are investigated: the motion around triangular points of libration in tadpole and horseshoe synodical orbits (N- and M-types), the case of close encounters of objects (A-type), and the chaotic variations in orbital elements when close encounters cannot take place (C-type). (Author)

A95-15682 Stationary motions of a rigid body in a central gravitational field (O statsionarnykh dvizheniyakh tverdogo tela v tsentral'nom gravitatsionnom pole). E. V. ABRAROVA and A. V. KARAPETYAN, *Prikladnaya Matematika i Mekhanika* (ISSN 0032-8235), Vol. 58, No. 5, 1994, pp. 68–73. In Russian. 4 Refs. Documents available from Aeroplus Dispatch.

Consideration is given to the problem of the plane translational-rotational motion of a rigid body in a central gravitational field. All the stationary motions of the body are determined, their stability is investigated, and bifurcation diagrams are plotted. Some new effects are identified which result from the use of an exact expression for the gravitational force potential.

A95-12235 Optimal orientation control for a system of two coupled bodies carrying flywheels (Optimal'noe upravlenie orientatsiej sharnirnoj svyazki dvukh tel, nesushchikh makhoviki). I. K. VALEEVA, V. I. GULYAEV, and V. L. KOSHKIN, *Rosijskaya Akademiya Nauk, Izvestiya, Mekhanika Tverdogo Tela* (ISSN 0572-3299), No. 3, 1994, pp. 31–38. In Russian. 5 Refs. Documents available from Aeroplus Dispatch.

The paper is concerned with the problem of time-optimized control of the motion of the relative center of mass of a mechanical system of two bodies carrying flywheels connected to each other via a double universal coupling. The orbital motion of the system is neglected, and it is assumed that the center of mass is stationary in the inertial space, and control is effected by internal gyroscopic moments generated due to changes in the angle between the flywheel axes (or due to changes in the relative orientation of the carrying bodies). The optimal control is to achieve a change in the spatial orientation of the axis of one of the flywheels within a minimum time interval. This approach may be sufficiently effective for the orientation control of solar cell panels, antennas, reflectors, and solar sails.

A95-11615 Nearly periodic rotations of a magnetized satellite in the geomagnetic field (Pochti periodicheskie vrashcheniya namagnichennogo sputnika v geomagnitnom pole). M. V. DEMIN (Moskovskij Gosudarstvennyj Tekhnicheskij Univ., Moscow, Russia), *Kosmicheskie Issledovaniya* (ISSN 0023-4206), Vol. 32, No. 3, 1994, pp. 130–133. In Russian. 3 Refs. Documents available from Aeroplus Dispatch.

The motion of a magnetized satellite around its center of mass in the geomagnetic field is analyzed assuming a strong magnetic interaction and negligible small gravitational perturbations. The case of a conservative field is considered, where the orbit of the satellite's center of mass is circular. The periodic motions of the satellite are constructed in the form of absolute converging series. In Euler angles, the periodic solution obtained here corresponds to a nearly periodic solution.

A94-19276 Single-impulse transfer problems and construction of a safety region in a Newtonian field (O zadachakh odnoimpul'snogo perekhoda i postroenii oblasti bezopasnosti v n'yutonovskom pole). Y. I. BERDYSHEV, *Kosmicheskie Issledovaniya* (ISSN 0023-4206), Vol. 31, No. 6, 1993, pp. 3–10. In Russian. 4 Refs. Documents available from Aeroplus Dispatch.

Formulas are obtained for the boundaries of a set of all points which can be reached by a material point at an arbitrary moment of time from a fixed position when a single finite impulse is applied at this position. In a particular case, such a set represents a safety region. Results of a qualitative analysis of single-impulse transfer problems for a Keplerian motion model are presented.

A94-17552 A fast algorithm for the approximate construction of a reachability region in a Newton field for a specified moment of time (O bystrodejstvuyushchem algoritme priblizhennogo postroeniya v n'yutonovskom pole oblasti dostizhimosti na zadannyj moment vremeni). Y. I. BERDYSHEV and L. M. YAROSH, *Kosmicheskie Issledovaniya* (ISSN 0023-4206), Vol. 31, No. 5, 1993, pp. 21–25. In Russian. 8 Refs. Documents available from Aeroplus Dispatch.

Formulas are obtained for the approximate calculation of the boundary of a set of all points that can be reached by a material point at a specified moment of time from a fixed position when a finite impulse is applied at this position. These formulas are used in developing a fast algorithm for constructing a reachability region and determining whether a given point belongs to this region.

A94-17551 Control characteristics for spacecraft transfer to the vicinity of the L2 point of the sun-Earth system using lunar gravity—The Relikt-2 mission (Kharakteristiki upravleniya pri vyvedenii KA v okrestnost' tochki L2 sistemy solntse-zemlya s ispol'zovaniem gravitatsii luny—Proehkt Relikt-2'). M. L. LIDOV, V. A. LYAKHOVA, and N. M. TESLENKO, *Kosmicheskie Issledovaniya* (ISSN 0023-4206), Vol. 31, No. 5, 1993, pp. 3–20. In Russian. 5 Refs. Documents available from Aeroplus Dispatch.

The paper is concerned with the problem of the analysis of special trajectories for the transfer of a spacecraft to a halo orbit in the vicinity of the L2 point of the sun-Earth system using lunar swingby. The applicability of such trajectories to the Relict-2 mission depends to a large degree on the requirements to the control system that implements the trajectory. Here, a near-optimal control scheme is proposed. Trajectory control parameters are calculated for a mission starting in October–November 1994.

A94-11703 The dynamics of Martian satellites from observations. N. V. EMEL'YANOV, S. N. VASHKOVYAK, and L. P. NASONOVA (State Astronomical Inst., Moscow, Russia), *Astronomy and Astrophysics* (ISSN 0004-6361), Vol. 267, No. 2, 1993, pp. 634–642. 27 Refs. Documents available from Aeroplus Dispatch.

This paper deals with the study of the motion of Martian satellites and with the determination of kinematic and dynamic parameters describing this system of satellites and planet. The values of these parameters are found on the basis of all available data of ground-based and space-based observations of Phobos and Deimos. The original analytical theory of the motion of the satellites was used and the data set was wider than in similar papers of other authors. Thus, a new specified model of the motion of Mars' satellites has been constructed. (Author)

A94-11676 Period variations and phase residuals in freely precessing stars. G. S. BISNOVATYJ-KOGAN (RAN, Inst. Kosmicheskikh Issledovanij, Moscow, Russia; Max-Planck-Inst. fuer Physik und Astrophysik, Garching, Germany) and P. KAHABKA (Max-Planck-Inst. fuer Extraterrestrische Physik, Garching, Germany), *Astronomy and Astrophysics* (ISSN 0004-6361), Vol. 267, No. 2, 1993, pp. L43–L46. 9 Refs. Documents available from Aeroplus Dispatch.

An analytical solution is derived for the observed period and phase variations for a star radiating like a pulsar, which is also freely precessing like an axisymmetrical rigid body. The disagreements which arose between Kohabka (1987) and Bisnovatyi-Kogan et al. (1987) concerning this problem are clarified.

A94-11034 Plane resonance motions of a viscoelastic body in an elliptic orbit (Ploskie rezonansnye dvizheniya vyazkouprugogo tela na ehllipticheskoj orbite). B. S. BARDIN and A. P. MARKEEV, *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Tverdogo Tela* (ISSN 0572-3299), No. 3, 1993, pp. 95–102. In Russian. 7 Refs. Documents available from Aeroplus Dispatch.

The dynamics of a viscoelastic homogeneous circular ring with a fixed material point in a central Newtonian gravitational field is investigated analytically assuming that the ring is sufficiently rigid and that the dissipative forces are small in comparison with the elastic forces. An equation is obtained which describes the motion of the ring as a whole relative to the center of mass in the plane of a Keplerian orbit. The stationary regimes of ring motion in a weakly elliptical orbit in the presence of resonances are determined, and their stability is analyzed.