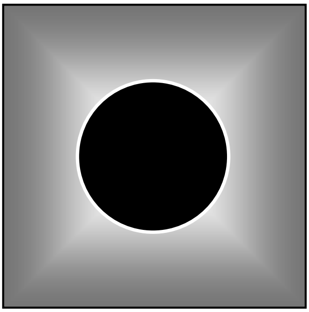
Международная
астрономическая
конференция

ДИНАМИКА ТЕЛ СОЛНЕЧНОЙ СИСТЕМЫ

Томск, 27 июля - 1 августа 2008 г.

Сборник материалов



МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ РФ
ФЕДЕРАЛЬНОЕ АГЕНТСТВО ПО ОБРАЗОВАНИЮ

ТОМСКИЙ ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ

ДИНАМИКА ТЕЛ СОЛНЕЧНОЙ СИСТЕМЫ

Международная астрономическая конференция
Томск, 27 июля – 1 августа 2008 г.

Сборник материалов

Томск
2008

УДК 521
Д 46

Д 46 **Динамика** тел Солнечной системы: Сб. матер. Международ. астрон. конф., Томск, 27 июля – 1 августа 2008 г. — Томск: Томский государственный университет, 2008. — 80 с.

ISBN 5-94621-252-4

Сборник содержит программу и тезисы докладов, представленных на международную конференцию "Динамика тел Солнечной системы" (ТГУ, Томск 27 июля – 1 августа 2008 г.). Тезисы охватывают широкий круг вопросов, связанных с динамикой малых тел Солнечной системы, включая теории движения спутников планет и астероидов, методы построения областей возможных движений небесных тел, использование наблюдений затменных явлений в системах спутников планет и астероидов для исследования динамики этих объектов, анализ динамики астероидов, сближающихся с Землей, численное моделирование динамики метеороидных потоков, развитие и использование в астрономии информационных систем и технологий.

УДК 521

ISBN 5-94621-252-4

MINISTRY OF EDUCATION AND SCIENCE RF
FEDERAL AGENCY ON EDUCATION

TOMSK STATE UNIVERSITY

DYNAMICS OF SOLAR SYSTEM BODIES

International astronomical meeting
Tomsk, July 27 – August 1, 2008

Proceedings

Tomsk
2008

UDC 521

Dynamics of Solar System Bodies: Proc. Internat. Astron. Conf., Tomsk, July 27 – August 1, 2008. — Tomsk: Tomsk State University, 2008. — 80 p.

ISBN 5-94621-252-4

This collection contains the program of the conference and abstracts of papers presented at the international astronomical conference "Dynamics of Solar System Bodies (TSU, Tomsk, July 27 – August 1, 2008). These abstracts cover different aspects of modern dynamics of Solar system small bodies including theories of motion of planet satellites and asteroids, methods of construction of possible motion domain of celestial bodies, usage of observations of mutual events and occultations in natural satellite and asteroid systems, analysis of near-Earth asteroid dynamics, numerical simulation of meteoroid streams dynamics, development and using of information systems and technologies in astronomy.

UDC 521

INTERNATIONAL ASTRONOMICAL MEETING "DYNAMICS OF SOLAR SYSTEM BODIES" Tomsk, July 27 – August 1, 2008

International Scientific Organizing Committee

Arlot J.-E. (IMCCE, Paris Observatory, France), Bordovitsyna T.V. (Tomsk State University, Russia), Emelyanov N.V. (Sternberg Astronomical Institute, Moscow, Russia), Kuimov K.V. (Sternberg Astronomical Institute, Moscow, Russia), Vashkov'yak M.A. (Keldysh Institute of Applied Mathematics of RAS, Moscow, Russia), Stavinschi M. (Astronomical Institute of the Romanian Academy, Bucharest, Romania), Christou A.A. (Armagh Observatory, Northern Ireland), Peng Q.Y. (Department of Computer Science, Jinan University, Chine), Vieira-Martins R. (Observatorio Nacional, Rio de Janeiro, Brazil), Thuillot W. (IMCCE, Paris observatory, France), Chernetenko Yu.A. (Institute of Applied Astronomy of RAS, St. Petersburg, Russia), Williams I.P. (Queen Mary University of London, UK), Ryabova G.O. (Tomsk State University, Russia), Vitkovsky V.V. (Special Astronomical Observatory of RAS, New Arhyz, Russia), Kalinina N.A. (Special Astronomical Observatory of RAS, New Arhyz, Russia), Demkin V.P. (Tomsk State University, Russia), Kulagin M.V. (Interdepartmental Supercomputer Centre, Moscow, Russia), Tomilin A.N. (Institute of system programming of RAS, Moscow, Russia).

Local Organizing Committee:

Bordovitsyna T.V., Demkin V.P., Ryabova G.O., Avdyushev V.A., Ban'shchikova M.A. (secretary), Shikhanova E.N.

Organizers and Sponsors

Faculty of Physics, Tomsk State University;
Applied Mathematics and Mechanics Institute, Tomsk State University;
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Russian Foundation for Basic Research;
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Institut de Mecanique Celeste et de Calcul des Ephemerides;
Sternberg Astronomical Institute of MSU;
Special Astronomical Observatory of RAS.

PLENARY SESSIONS AND ACTIONS

27 July

9^{00}–18^{00} Registration (Hall of the Central Building of TSU)

28 July

8^{00}– 9^{30} Registration (Hall of the Central Building of TSU)

10^{00}–11^{30} Opening session (Conference Hall of Research Library of TSU)
Mayer G.V., Rector of Tomsk State University;
Demkin V.P., Vice Rector of Tomsk State University;
Kuznetsov V.M., Dean of faculty of Physics of TSU;
Bordovitsyna T.V., Head of Department of Astronomy and Space Geodesy.

11^{30}–13^{00} Excursion to the Rare Book Fund of the Research Library of TSU

13^{30}–15^{00} Lunch

29 July

9^{30}–11^{20} MORNING PLENARY SESSION

9^{30} K.V. Kuimov (SAI MSU, Moscow)
Celestial reference frames and reference catalogs for the reduction of the positional observations of Solar system bodies (30 min)

10^{00} K.V. Kholshevnikov, S.A. Orlov (AI StPSU, Saint-Petersburg)
Dust torus in the vicinity of an orbit of a small satellite (30 min)

10^{30} G.O. Ryabova (AMMI TSU, Tomsk)
Meteoroid streams: mathematical modelling and observations (30 min)

11^{00} O.A. Plechova (RFBR, Moscow)
RFBR supporting of Russian scientist participation in scientific arrangements (RFBR competition "z", "mob_z", "mob_z –_rus" 2008) (20 min)

11^{30}–12^{00} Tea-break

12^{00}–13^{30} Excursion to the Botanic Garden of TSU

13^{30}–15^{00} Lunch

30 July

9^{30}–11^{30} MORNING PLENARY SESSION

9^{30} A.P. Platonov (RIPN, Moscow)
Informational infrastructure of Russian network of science and education (30 min)

10^{00} M.E. Prokhorov (SAI MSU, Moscow)
Investigation of Small Bodies of Solar System in New Space Missions "Lyra" and "Svecha" (30 min)

10^{30} A.V. Starchenko (TSU, Tomsk)
High performance computational resources and parallel computations at Tomsk State University (30 min)

11^{00} V.V. Vitkovskij, A.A. Ivanov, E.I. Kaisina, N.A. Kalinina, V.V. Komarov, S.L. Komarjnskij, A.S. Marukhno, V.S. Shergin, V.N. Chernenkov (SAO RAS, Nizhnij Arkhyz)
The system of remote access to SAO RAS telescopes (30 min)

11^{30}–12^{00} Tea-break

12^{00}–13^{30} Tour of Tomsk

13^{30}–15^{00} Lunch

31 July

15^{00}–17^{00} AFTERNOON WORKSHOP DISCUSSION "NETWORK OF ROBOTIC OBSERVATORIES DISTRIBING ALONG LONGITUDE"

1 August

8^{00}–23^{00} AWAY SESSION FOR OBSERVATION OF THE TOTAL SOLAR ECLIPSE

8^{00}–13^{00} Departure from TSU (Tomsk) to SSGA (Novosibirsk)
13^{00}–15^{00} Lunch
15^{00}–16^{40} Preparation for observation of the total solar eclipse
16^{40}–18^{40} Observation of the total solar eclipse
18^{40}–19^{00} Supper
19^{00}–23^{00} Departure from SSGA to Tomsk

28 July

Workshop "Mutual events, occultations and dynamics of natural satellites and asteroids"

15^{00}–19^{20} AFTERNOON SESSION

15^{00} J.E. Arlot (IMCCE, Paris observatory, CNRS, Paris)
2007–2009: mutual events on Uranus, Jupiter and Saturn (30 min)

15^{30} Ch. Ruatti, J.E. Arlot (IMCCE, Paris Observatory, CNRS, Paris)
The catalogue of observations of the mutual phenomena of the natural satellites (20 min)

15^{50} N.V. Emelyanov (SAI, Moscow)
Deriving astrometric data from the photometry of mutual occultations and eclipses of planetary satellites (30 min)

16^{20} A.A. Christou, F. Lewis, M.G. Hidas, T.M. Brown, P. Roche (AO, Armagh; SPA, CU, Cardiff; LCOGT, CA, USA; DP, UC, Santa Barbara)
Mutual events of the Uranian satellites observed with the 2-metre faulkes telescopes (20 min)

16^{40} T. Bitsaki, A.A. Christou, A. Liakos, A. Psalidas, V. Tsamis (AO, Armagh; UA, Athens; HOU, Patras; APS, Athens; IA, Cambridge)
Mutual events of the Uranian satellites (20 min)

17^{00}–17^{30} Tea-break

17^{30} I.S. Izmailov, E.A. Grosheva (MAO RAS, Saint-Petersburg)
CCD observations of the satellites of Saturn and Uran with 26-inch refractor at the Pulkovo (15 min)

17^{45} I.S. Izmailov (MAO RAS, Saint-Petersburg)
Processing of CCD-images by Izmccd software package (15 min)

18^{00} E.Yu. Aleshkina, A.V. Devyatkin, D.L. Gorshanov (MAO RAS, Russian Academy of sciences, Saint-Petersburg)
CCD photometric and astrometric observations of Phoebe S9 in 1999-2008 (15 min)

18^{15} T.P. Kiseleva, I.S. Izmailov, O.V. Kiyaeva, L.G. Romanenko, E.A. Grosheva, O.A. Kalinichenko, M.A. Mozhaev, E.V. Khrutskaya, A.A. Berezhnoj, A.A. Dement'eva, N.V. Narizhnaya, V.V. Bobylev, S.V. Lebedeva, M.Yu. Khovritchev (MAO RAS, Saint-Petersburg)
The results of CCD astrometric observations of the Saturnian and Uranian satellites with 26-inch refractor and Normal astrograph of the Pulkovo observatory during the period from 2004 to 2007 (15 min)

18^{30} A.Y. Sokolova (SAI MSU, Moscow)
CCD positions determined for the outer Jovian satellites with the 2 m reflector of Terskol peak observatory (15 min)

29 July

Workshop "Mutual events, occultations and dynamics of natural satellites and asteroids"

15^{00}–18^{50} AFTERNOON SESSION

15^{00} M.A. Vashkov'yak (KIAM, Moscow)
Orbital evolution of the outer satellites of giant planets. Methods of analysis and results (30 min)

15^{30} V.I. Prokhorenko (SRI RAS, Moscow)
Gravitational sphere of the perturbations caused by the planet's oblateness prevalent influence in comparison with the perturbations by the third body (20 min)

15^{50} V.A. Avdyushev (AMMI TSU, Tomsk)
A method of perturbed observations for building the regions of possible parameters in orbital dynamics inverse problems (20 min)

16^{10} M.A. Ban'shchikova (AMMI TSU, Tomsk)
Investigation of regions of possible motions for Jovian outer satellites (20 min)

16^{30} T.S. Boronenko (TSPU, Tomsk)
Construction of a solution of restricted-three body problem in modified Hill's variables (20 min)

16^{50} N.Yu. Emelyanenko (SUSU, Chelyabinsk)
Temporary satellite captures and temporary gravitational captures by Jupiter (20 min)

17^{10}–17^{30} Tea-break

17^{30} G.A. Kosmodamianskiy (IAA RAS, Saint-Petersburg)
Numerical theory of motion of Jupiter's Galilean satellites (20 min)

17^{50} O.M. Dubas, V.A. Avdyushev, V.A. Tamarov, A.M. Chernitsov (AMMI TSU, Tomsk)
Methods for building confidence regions in nonlinear problems of parameter estimation (20 min)

18^{10} V.A. Shefer (AMMI TSU, Tomsk)
Methods for determining intermediate perturbed orbits from minimal number of observations (20 min)

18^{30} A.P. Baturin, I.N. Chuvashov (AMMI TSU, Tomsk)
Asteroid orbit determination by angular and radar observations using rectangular coordinates as measurements (20 min)

30 July

Workshop "Mutual events, occultations and dynamics of natural satellites and asteroids"

15^{00}–19^{10} AFTERNOON SESSION

15^{00} W. Thuillot, J. Berthier, J. Igl'esias, G. Simon, V. Lainey, F. Vachier (IMCCE, Paris observatory, CNRS, Paris; GEPI, Paris Observatory, Paris)
Use of the data mining for asteroid orbits improvement (30 min)

15^{30} V.V. Beletsky, A.V. Rodnikov (KIAM, MSTU, Moscow)
On the problem of binary-asteroid dynamics (20 min)

15^{50} L.E. Bykova, T.Yu. Galushina, O.N. Razdymahina (AMMI TSU, Tomsk)
Near-Earth asteroid approaching to Jupiter (20 min)

16^{10} L.E. Bykova (AMMI TSU, Tomsk)
Orbital resonances in motion of the NEAs (20 min)

16^{30} N.B. Zheleznov (IAA RAS, Saint-Petersburg)
The study of probability of asteroid encounter with a major planet by Monte Carlo method (20 min)

16^{50} E.A. Smirnov (StPSU, Saint-Petersburg)
Accurate prediction for NEO's orbits (20 min)

17^{10}–17^{30} Tea-break

17^{30} V.V. Ivashkin, C.A. Stikhno (KIAM RAS; LA, FSA, Khimki, Moscow)
Analysis of asteroid Apophis motion and its orbit correction for prevention of its possible collision with Earth in 2036 (20 min)

17^{50} V.V. Prokof'eva, L.G. Karachkina, Yu.V. Batrakov (RI "CAO", Nauchny, Crimea; IAA RAS, Saint-Petersburg)
Asteroid 39 Letitia surely to be the double one (20 min)

18^{10} A.E. Rosaev (YAS, Yaroslavl)
To the problem of origin near earth asteroids (20 min)

18^{30} P. Descamps (IMCCE, Paris observatory, CNRS, Paris)
Mutual events within binary asteroids (20 min)

18^{50} V.G. Sokolov (MAO RAS, Saint-Petersburg)
On convergence criteria for expansions of the disturbing function in the asteroid three-body problem (20 min)

31 July

Workshop "Mutual events, occultations and dynamics of natural satellites and asteroids"

9^{30}–13^{20} MORNING SESSION

9^{30} E.V. Khrutskaya (MAO RAS, Saint-Petersburg)
Astrometry of small bodies of Solar system with Pulkovo Normal Astrograph (20 min)

9^{50} A.A. Bazyey (ONU, Odessa)
The research near earth space in the Odessa National University (20 min)

10^{10} A.A. Bazyey, I.V. Kara (ONU, Odessa)
The research of an orbit of the asteroid 2004 VD17 (144898) (20 min)

10^{30} B.P. Kondratyev (USU, Izhevsk)
Vector approach to the lunar physical libration (20 min)

10^{50} A.A. Tokovenko, A.A. Bazyey (ONU, Odessa)
Classification of asteroids approaching with major planets (20 min)

11^{10}–11^{40} Tea-break

11^{40} M.E. Britavskiy, L.S. Shakun, N.I. Koshkin (AO, ONU, Odessa)
Influence of satellites orbit's parameters on the braking in the Earth's upper atmosphere parameters on the braking in the Earth's upper atmosphere (20 min)

12^{00} V.V. Troyansky (ONU, Odessa)
The Earth model and Moons model in the formalism of the numerical theory DE405 (20 min)

12^{20} V.V. Orlov, G.D. Mulkamanov (AI StPSU, Saint-Petersburg; KSU, Kasan)
Programming complex to study the dynamics of cometary cloud (20 min)

12^{40} L.E. Bykova, E.N. Shikhanova (AMMI TSU, Tomsk)
Numerical simulation of the NEAs resonances domains in the vicinity of the 2/1, 3/1, 7/3 mean motions commensurabilities with Jupiter (20 min)

13^{00} N.I. Perov, Yu.D. Medvedev
(YSPU, Yaroslavl; IAA RAS, Saint-Petersburg)
Central configurations and planetary coorbital satellites (20 min)

28 July

Workshop "Meteoroid streams: dynamics and structure"

15^{00}–18^{50} AFTERNOON SESSION

15^{00} I.P. Williams (Astronomy Unit, Queen Mary, London)
Meteor showers associated with Jupiter family comets (30 min)

15^{30} G.O. Ryabova (AMMI TSU, Tomsk)
Origin of the 3200 Phaethon - Geminid meteoroid stream complex (30 min)

16^{00} E.N. Tikhomirova (YSPU, Yaroslavl)
A method of determination of meteor radiants' shift (20 min)

16^{20} N.G. Barri (IM, MSU, Moscow)
An estimation of separation distance of meteoroid fragments (20 min)

16^{40}–17^{10} Tea-break

17^{10} V.S. Konstantinov, G.O. Ryabova (AMMI TSU, Tomsk)
Preliminary mathematical model of the Quadrantid meteoroid stream formation (20 min)

17^{30} A.V. Bagrov (IA RAS, Moscow)
Zodiacal dust cloud origin and aims of observations its inner part during total solar eclipse (20 min)

17^{50} J. Vaubaillon, W.T. Reach (CALTECH, Pasadena)
The parent bodies of meteoroid streams (20 min)

29 July

Workshop "Informational systems in basic research"

15^{00}–17^{30} AFTERNOON SESSION

15^{00} V.V. Vitkovskij, V.V. Komarov, V.S. Shergin, V.N. Chernenkov (SAO RAS, Nizhnij Arkhyz)
Hardware/software methods of getting "On-line" images to supply observations at the 6m optical telescope BTA (30 min)

15^{30} O.P. Zhelenkova, V.V. Vitkovskij, T.A. Pljaskina (SAO RAS, Nizhnij Arkhyz)
Integration of heterogeneous collections of observation data into the SAO RAS archival system (30 min)

16^{00} Yu.L. Izhvanov (ITTI Informika, Moscow)
RUNNET: state and prospects of development (30 min)

16^{30} M.V. Kulagin (JSC RAS, Moscow)
On problems and development prospects of telecommunication system of RAS (30 min)

17^{00} L.B. Chubarov, N.N. Dobretsov, A.M. Fedotov, V.S. Nikultsev, Yu.I. Shokin (SB RAS ICT, Novosibirsk)
The corporate network of the Siberian branch of the Russian academy of science and its impact on fundamental and applied research (30 min)

30 July

Workshop "Informational systems in basic research"

15^{00}–17^{15} AFTERNOON SESSION

15^{00} N.I. Glebova, M.V. Lukashova, I.N. Netsvetaev, G.A. Netsvetaeva, E.Ju. Parijskaja, M.L. Sveshnikov, V.I. Skripnichenko (IAA, RAS, Saint-Petersburg)
Astronomical yearbooks in editions and program systems (30 min)

15^{30} N.A. Shupikova, G.O. Ryabova (AMMI TSU, Tomsk)
Inaccuracies of trigonometric functions on some computer platforms (15 min)

15^{45} V.A. Alekseev, M.G. Daniyalov, G.G. Matvienko, V.V. Fomichev, V.P. Uryadov (IZMIRAN, Troitsk; DBGS RAS, Makhachkala; IAO, SB RAS, Tomsk; RI, Nizhnii Novgorod)
The project of the study of the response of the atmosphere, the ionosphere and tectonic system of Siberia to the solar eclipse of August 1, 2008 (30 min)

16^{15} I.N. Chuvashov, T.V. Bordovitsyna (AMMI TSU, Tomsk)
Numerical simulation of dynamics of Earth's artificial satellite system using the computer cluster Cyberia (30 min)

V. A. Alekseev[1], M. G. Daniyalov[2], G. G. Matvienko[3], V. V. Fomichev[1], V. P. Uryadov[4]
[1]IZMIRAN, Troitsk, [2]Dagestan Branch of Geophysical Service RAS, Makhachkala, [3]Institute of Atmospheric Optics, SB RAS, Tomsk, [4]Radiophysical Institute, Nizhnii Novgorod, Russia

PROJECT OF THE STUDY OF THE RESPONSE OF ATMOSPHERE, IONOSPHERE AND TECTONIC SYSTEM OF SIBERIA TO THE SOLAR ECLIPSE OF AUGUST 1, 2008

The influence of solar activity on the atmosphere, the ionosphere and the tectonic activity of the Earth at present has not been adequately explored. The solar eclipses present a unique possibility for investigating the dynamic and statistical characteristics of the above processes under conditions of controlled "disconnecting" and "connection" of an ionization source. The first complex investigations of the effect of the solar eclipse on different dynamic processes in the atmosphere, ionosphere and the Earths crust were performed by us during the total solar eclipse on March 29, 2006 on the territory of the Caucasus. These investigations included:

1. Investigations of the propagation of short-wave signals in the ionosphere at the path of slant sensing from Cyprus to N.Novgorod. The estimations have shown that the decreasing of the electron concentration $\Delta N/N$ in the reflection range close to the F-layer's maximum during the solar eclipse as compared to the reference day was 30%.

2. Seismic observations with the use of the equipment, installed in the adit at the Baksanskoye canyon at 400 m depth. The amplitude of seismic oscillations practically decreases by a factor of 2.

3. The measurements of aerosol concentration by a backscattering lidar, and also the measurements of hydrogen concentration using a hydrogen geophysical sensor have shown that the aerosol and hydrogen flows decrease during the solar eclipse. In this project we propose to continue the complex investigations of the effect of the solar eclipse on different dynamical processes in the atmosphere, ionosphere and the Earths crust during the total solar eclipse on August 1, 2008 in the territory of active breaks of the southern Altai with the aim of confirmation of discovered effects.

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Sciences, Saint-Petersburg, Russia

CCD PHOTOMETRIC AND ASTROMETRIC OBSERVATIONS OF PHOEBE (S9) IN 1999–2008

The results of CCD observations of Phoebe, the 9th satellite of Saturn (visual magnitude of about 16.5), with an automatically-operating 0.32-meter mirror astrograph ZA-320M at Pulkovo observatory in Saint-Petersburg are presented. ST6 (375×242 pixels) and FLI (1024×1024 pixels) CCD detectors were used. More then 250 photometric and about 300 astrometric observations were obtained.

Photometric observations are performed both in the integral band of the telescope and in BVR bands of Johnson system. USNO-A2.0 and Ticho-2 reference catalogues were used. Rotational light-curve data for Phoebe taken over the observation period and over short time span (2–8 hours) for several nights are presented. The accuracy of our photometric measurements in arbitrary part of the sky is about 0.1^m and the accuracy of estimation of changes of brightness with the same reference stars is about 0.02^m.

For astrometric reduction the USNO-A2.0, USNO-B1.0 and UCAC-2 reference catalogues were used. The positions of Phoebe are topocentric J2000. A comparison of our astrometric observations to available ephemerides [1,2] was carried out. Standard error of astrometric observations is $0.3''$.

References

1. *Jacobson R. A.* Update of the Ephemeris for Phoebe// JPL Interoffice Memorandum 312.1-96-024 (JPL internal document)
2. *Emelyanov N. V.* Updated ephemeris of Phoebe, ninth satellite of Saturn// Astron.Astroph. 2007. V. 473. P. 343–346. http://www.sai.msu.ru/neb/nss/index.htm

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2007–2009: MUTUAL EVENTS ON URANUS, JUPITER AND SATURN

During the period 2007–2009, it will be the equinox on Uranus, Jupiter and Saturn. This occurrence provides the opportunity to observe very interesting events: the mutual phenomena.

During the equinox, the Sun (and the Earth since it is close to the Sun as seen from the giant planets) will cross the equatorial plane of these planets. Since the main satellites have their orbits in the equatorial plane, mutual eclipses and occultations will occur between the satellites themselves during a six-month period.

The observation of these events will provide many information of scientific interest: the satellites have no atmosphere so these events will be easy to observe with a high accuracy. Astrometric data on the relative positions of the satellites and photometric data on their surfaces will be available. The experience that we had with the former observations has shown that we may have an astrometric accuracy much more higher than with classical imaging observations.

This communication will show the first results of the observations of the mutual phenomena of the satellites of Uranus in 2007 and will explain what we are waiting for in 2009 from the observation of the mutual events of the satellites of Jupiter and Saturn, knowing what was don during the former campaigns of observations.

References

1. *Arlot J.E., Stavinschi M.* Past and Future Mutual Events of the Natural Planetary Satellites: Need of a Network of Observation

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A METHOD OF PERTURBED OBSERVATIONS FOR BUILDING THE REGIONS OF POSSIBLE PARAMETERS IN INVERSE PROBLEMS OF ORBITAL DYNAMICS

Recently, with the advent of quick-operating and multiple-processor computers, for investigating the uncertainties in the orbits determined from observations one often resorts to modeling the so-called regions of possible parameters, which are widely used for planning observations and identification of celestial bodies as well as in asteroid hazard problems.

A region of possible parameters in parametric space is a set of points, whose density corresponds to the probabilistic one of the location of the true orbital parameters. The probabilistic regions are usually built on the basis of the estimations of the linear least-squares (LS) problem, therefore its densities are distributed in accordance with multidimensional normal law. Since the connection between observation representations and orbital parameters is generally non-linear, the application of linear estimations for modeling the probabilistic regions is valid only if the regions are rather small when the stated connection can be presented by the linear part of its expansion by the parameters. Otherwise, linear LS-problem estimations describe the probabilistic regions doubtful.

In this paper a method for building large regions of possible parameters when the nonlinearity affects essentially and cannot be neglected is proposed. The method is based on the multiple solutions of nonlinear LS-problem for various samples of observations generated by means of inserting random perturbations in the real observations. In the linear case this approach gives the same results as the conventional ones do in linear problems.

Recently for investigating the uncertainties in orbital parameters similar methods are also often used [1] but their main distinctive feature is that they are regarded only in the context of preliminary orbit determination from two observations.

The work was supported by RFBR grant 08-02-00359.

References

1. *Virtanen J., Muinonen K., Bowell E.* Statistical Ranging of Asteroid Orbits // Icarus. 2001. V. 154. P. 412–431.

A. V. Bagrov
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THE ORIGIN OF ZODIACAL DUST CLOUD AND AIMS OF OBSERVING ITS INNER PART DURING TOTAL SOLAR ECLIPSE

The main source of dust in the interplanetary space near Sun is believed to be comets. Comet nuclei consist of cool mixture of frozen gases and dust particles with some intrusions of heavy refractory moldings. Evaporation of gases drags refractory particles to the orbits close to the parent comet's one. Tiny particles drift to the Sun due to the Poynting-Robertson effect. Their movement closes them to the Sun by a spiral with the decreasing of large semi-axes and the decreasing of eccentricity of their orbits. As a result a cloud of dust particles grews near the Sun, and the dust particles are collected on nearly round orbits. Nevertheless no particle falls to the Sun. When a particle stays hard it does not evaporate, but when it appears at the distance where temperature exeeds the melting temperature, it starts evaporating. At a certain moment the light pressure becomes equal to gravitational forces for thinning particle, and its approach to the Sun stops. At this moment the particle remains in a region where equilibrium temperature is high and dust particle evaporation continues. With time, the balance between light pressure and gravity forces changes. The particle starts to drift away from the Sun, and later it escapes from the Solar system at all. Thus the radius of the sphere that is the inner limit for the cloud must be sharp. This radius is determined by the melting temperature for common matter: it is about $12.75R_{\odot}$ for iron (melting temperature is 1540°C), and for most known refractory matters tantalum carbide and hafnium carbide TaC and HfC (melting temperatures being 3985°C and 3890°C respectively) it is $1.9R_{\odot}$. The maximum of the spectral emission for temperatures of 1540°C and 3985°C is located at 1.6 and 0.67 micron respectively. Hence, the observation of proper heat emission of zodiacal dust cloud is possible in IR only and during total solar eclipse exclusively to avoid direct light pollution from solar corona. The aim of prepared observational experiment is the direct observation of the inner part of zodiacal dust cloud and the estimation of chemical composition of hear-Sun dust.

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INVESTIGATION OF REGIONS OF POSSIBLE MOTIONS FOR JOVIAN OUTER SATELLITES

We present results of the investigation of regions of possible motions for Jovian outer satellites. For constructing initial probabilistic regions we used covariance matrices obtaining in the process of fitting dynamics models of satellites to observations. The probabilistic regions turned out to be very large and elongate for most satellites discovered in 2003. It is mainly connected with a few satellite observations whose times cover very short span, about 100 days. For satellites whose observation times cover long spans, probabilistic regions are rather small.

The results show that probabilistic regions after one revolution for some new satellites (S/2003 J02, S/2003 J03, S/2003 J04, S/2003 J10, S/2003 J12, S/2003 J23) are very large and comparable with sizes of satellite orbits. It follows that the orbital parameters of these satellites are determined very bad and we can lose the satellites even in the near future. Moreover, it is shown also that satellite S/2003 J02 can be an asteroid with the probability 0.06.

The work was supported by RFBR grant 08-02-00359.

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ESTIMATION OF SEPARATION DISTANCE OF METEOROID FRAGMENTS

A meteoric body has a great loading during its passage through the atmosphere with a velocity from 11 to 72 km/s. A meteoroid collapses and its fragments separate in a transverse direction as a result of interaction of shock waves. Besides, smaller fragments decelerate more than the large ones. Thus, there is also a separation in a longitudinal direction. A quite simple analytical expression of transverse velocity of fragment through parameters of the body material (strength and density) and repulsive force coefficient for two identical fragments is obtained. This coefficient is used as an approximation result of the numerical simulation of the flow past two identical spheres [1] and two spheres of different radii [2], [3]. The following model is proposed in the present work for the case of fragments of different masses. Separation of fragments takes place due to strong deceleration of smaller fragment and its deviation in orthogonal direction [2]. In the case of different fragments a transverse velocity depends on a quotient of fragments radii. A numerical solution of combined equations of deceleration and ablation is used for obtaining a description of a longitudinal movement. Calculations in accordance with proposed models and an estimation of separation distance of fragments are carried out in the work. This work was supported by the Russian Foundation for Basic Research, project no. 07-01-00009

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ASTEROID ORBIT DETERMINATION BY ANGULAR AND RADAR OBSERVATIONS USING RECTANGULAR COORDINATES AS MEASUREMENTS

The asteroid orbit adjustment method using the transformation from really observed angular and/or distance measurements to rectangular coordinates has been considered. The advantage of this method over traditional one is the absence of weight coefficients in the least square method's target function. These coefficients are necessary in traditional method to equalize different physical units of angular and length quantities. As is well known, the weight coefficients are calculated by means of additional orbit fittings using separately angular and linear measurements, whereas considered method spares these fittings and allows to obtain final decision just in one stage. Besides, considered method excludes the error put in by weight coefficients. This error is always existing in traditional method because of probability nature of these coefficients.

The accuracy comparison for considered and traditional methods has been carried out by the example of several simulated and real orbit adjustments. It has been displayed the better accuracy of considered method in several cases as compared with accuracy of traditional one.

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THE RESEARCH NEAR-EARTH SPACE IN THE ODESSA NATIONAL UNIVERSITY

The group of astrometry and celestial mechanics is situated in the department of astronomy Odessa National University. We perform a research of the simulation of motions in the near-Earth and near Sun space. To that end in view the post-graduate of the department of astronomy I. Kara created integrators which are based on the Runge–Kutta method of the 10 order and the Everhart methods of the 15–29 orders.

The produced complicated structure of the gravitational field near the Earth is necessary to consider. (The produced from Moon and other celestial bodies increase for the space.) Post-graduate of the department of the astronomy Tokovenko A. has created a dynamic library on the basis of a numerical theory DE405 which allows to receive the vector status of the great planets, Sun, Moon and Pluto. He has realized a numerical research of the motion of the asteroid Apophis 99942 which approaches the Earth dangerously.

The student of the department V. Troyanskiy executed a simulation of the shadow and semishadow of the planet. In the collaboration with the laboratory of near-Earth astronomy of Nikolaev astronomical observatory (head — Shulga A.V.) the software with the purpose of calculations of the satellites' orbits is developed. Engineer S. Korzhavin takes active part there.

All the works are illustrated for the three dimensional computer simulation.

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THE RESEARCH OF AN ORBIT OF THE ASTEROID 2004 VD17 (144898)

It's noteworthy that the problem of asteroid danger is significant for the Earth today. There are many asteroids which are considered potentially dangerous for tellurians. The level of danger overwhelming majority has decreased after more careful researches. Next such object of researches became an asteroid 2004 VD 17.

The asteroid 2004 VD17 with the diameter of about 600 meters was found out by scientist of the Massachusets institute of technology by the bounds of the project on detection of near-Earth space objects. On February, 23rd, 2006 NASA has finished the calculations of its orbit and have appropriated to it a category of danger "2" on the Turin scale. Collision is possible on May, 4th, 2102.

We have carried out the research of an orbit of an asteroid 2004 VD17 with the help of numerical method of Runge-Kutta of the 10 order [1] and numerical methods of Everhart of 15–29 orders [2]. Integration of the equations of movement occurs with the automatic correction of a step. For the method of Runge–Kutta of the 10 order we used a policy of the correction of a step on the basis of a gradient of a gravitational field in a point and for the methods of Everhart the automatic correction of a step was used as it was recommended by Everhart in his article. Our purpose was to find out conditions of the approach of an asteroid with the Earth, and also with Mars and Venus. The given research makes a contribution to an estimation of the danger for the Earth which is represented by this asteroid.

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ON THE PROBLEM OF BINARY-ASTEROIDS DYNAMICS

Presently the motion in the binary-asteroid system is one of the most interesting topics in celestial mechanics. Discovering more than fifty asteroids pairs explain such interest. Different models of the binary dynamics was investigated. We suggest another model based on the simple assumptions. We neglect the external influences upon the relative motion of the pair. We consider the smaller asteroid as a particle with close to zero mass that moves under gravitation of the bigger asteroid being approximated as two massive spheres jointed by a weightless rod. Hence the motion of the dumbbell-shaped asteroid is a regular precession. We deduce the motion equations for the smaller asteroid as two-parametrical generalization of the equations for the Restricted Circular Three-Body Problem. These equations have the stationary solutions corresponding to the smaller asteroid's equilibria relative to the axis of the regular precession and the dumbbell rod. There are two types of such equilibria. The equal distances from the dumbbell endpoints characterize the equilibria of the first type, so we shall name them the triangular libration points (TLPs) by analogy to a classical problem. There exist not more than two TLPs. We deduce coordinates and stability conditions for TLPs [1, 2]. Equilibria of the second type can be named the coplanar libration points (CLPs) as they belong to the plane that contains the bigger asteroid's angular momentum and the dumbbell's rod. The number of CLPs varies from 3 to 7. We study CLPs at parameters change.

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MUTUAL EVENTS OF THE URANIAN SATELLITTES

Uranus has twenty seven (27) known natural satellites. Miranda, Ariel, Umbriel, Titania and Oberon are the major ones. Several mutual eclipses and occultations have occurred and are going to occur during the period 2007–2008 because during this period the planet is reaching one of its annual equinoxes. Two (2) different, GUST86 semianalytical ephemeris and JPL URA027 ephemeris for the satellite state vectors have predicted these events.

Our aim was to determine to what degree GUST86 has "run off" in the intervening twenty (20) years since it was generated. In order to fulfill this aim, we needed to observe some of these events, measure the exact time that each one occurs and its duration and compare these measurements with those predicted by the above two (2) ephemerides.

Our team managed to observe and capture the partial occultation Titania–Ariel, on August 14th 2007 and the partial eclipse Oberon–Miranda, on September 22nd 2007. The method we followed in order to obtain the above measurements was CCD differential photometry. For both of the above observations we used a catoptrical telescope (Cassegrain type — 40 cm mirror) which was equipped by a ATiK 16 IC-C high resolution Charge Coupled Device (CCD) camera.

A preliminary analysis of the data obtained on 14/08/2007 shows a dip near the time predicted by JPL URA027 ephemeris and the analysis of the data obtained on 22/09/2007 is in progress.

In this presentation, we will discuss our results obtained for these two events, the implications for the current state of satellite orbit knowledge, and what our experience has taught us about carrying out such challenging observations with a small telescope.

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CONSTRUCTION OF A SOLUTION OF RESTRICTED THREE-BODY PROBLEM IN MODIFIED HILL'S VARIABLES

In some perturbation theories the expansion of the perterbations in powers of the accentricity needs to be avoided. To carry these theories to a higher order, it is necessary to perform the computer calculation. The algorithm of automated, closed form integration of formulas in elliptic motion was developed by William H. Jefferys [1] for Hill's canonical variables: $\dot{r}$, G, H; r, u, h, where r is the distance to the primary; $\dot{r} = \frac{dr}{dt}$; $G = \sqrt{\mu a(1-e^2)}$ and $H = G\cos i$ are Delaunay variables; $u = f + \omega$; f is the true anomaly; ω is the argument of the perigee; $h = \Omega$; Ω is the longitude of the node.

Hill's variables are convenient for developments of the oblateness-type perturbations. But if perturbations by a third body are to be treated it is advantageous to use the eccentric anomaly instead of the true anomaly.

In this work the modified Hill's variables are introduced. They are $\dot{r}$, G, H; r, g, h, where $g = \omega$. With help of Pfaff's theory [2] it may be shown that these variables are canonical.

The use of the modified Hill's variables in the construction of the restricted three-body solution has shown that the resulting theory is sufficiently compact and the generating function does not contain negative powers in r. Consequently, we can perfom all analytical developments in terms of the eccentric anomaly.

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INFLUENCE OF SATELLITES ORBIT'S PARAMETERS ON THE BRAKING IN THE EARTH'S UPPER ATMOSPHERE

The possibility of accomplishing the purposes and applied problems for scientific, geophysical or mercantile artificial satellites is closely related to the possibility of precise defining of their orbits and the prognosis of its modification during the term of the active operation of an artificial satellite. At present the split-hair accuracy of modelling both the Earth's geopotential and gravitational perturbations from the Sun and the Moon can be achieved. However, this is not the case of modelling the forces resisting the motion of an artificial satellite in the EarthвЂ™s atmosphere. Models of thermosphere are still a restricting factor of the precision of determining the orbit and its prognosis.

The accumulated series of high-precision definitions of the orbits of the selected artificial satellites allow, by modelling, to set apart an atmospheric component in the spectrum of orbital perturbations with unprecedented precision. And, with the use of the extensive series of observations and the corresponding orbits of a great set of the catalogued artificial satellites for this purpose, it is possible to obtain the spatial characteristics of global response of the atmosphere to the factors of outer space weather. The purpose of such an approach is to derive extensive factual data on the state of the atmosphere without an immediate connection (in the first phase) with the reasons causing them.

In the given work the influence of orbit parametres on braking of various artificial satellites is considered. For this purpose a group of satellites in different orbits during the 18-months period is chosen; modifications of a medial motion and ballistic parametre B* adduced in NORAD catalogues are considered. Dependences of the modification of these parametres on a medial motion, a centering error, altitude and declination of perigee of an artificial satellite are obtained.

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ORBITAL RESONANCES IN THE MOTION OF NEAs

The review of our investigations ([1, 2] and others) of the NEAs dynamics in the vicinities of low-order resonances with planets is presented. In the investigations, the attention is focused on solving the following problems: revealing low-order mean motion commensurabilities of near-Earth asteroids (NEAs) with planets; investigation of orbital evolution of NEAs in order to predict their possible orbital behavior for several thousand years; determining the stability of the resonance configurations of the asteroid and the planet and their part in protecting asteroids from close encounters.

The technique of the investigation of NEAs orbital evolution and the stability of resonance motions has been developed by author on the base of the construction of possible motions domains of asteroids. The initial domains of possible motions of each object have been constructed on the basis of an estimation of the vector of initial dynamical parameters and the covariance matrix of their errors obtained from analyzing the observations. The evolution of osculating orbital elements, resonance band and critical arguments has been considered for each investigated object and for corresponding ensembles of test particles. All investigations were carried out by numerical methods and by means of numerical experiments.

This research was supported by the Russian Foundation for Basic Researches, Grant N 08-02-00359.

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NEAR-EARTH ASTEROIDS APPROACHING TO JUPITER

The results of investigation of dynamics Near-Earth asteroids (NEAs) approaching to Jupiter are presented in the report. Approach of NEA with so major planet as Jupiter can change asteroid orbit parameters significantly and increase the risk of close approaches and impacts with other planets including the Earth. For solution of this problem orbital evolution of all known NEAs on the time interval of (2007, 3000) years has been considered and a group of asteroids approaching to Jupiter in the range of 1 AU has been extracted. We have found 150 such objects. The dynamics of NEAs moving in the vicinity of orbital resonances has been investigated in more details.

We have investigated 40 NEAs coming into the vicinity of low-orders orbital resonances (we have considered resonances up to the 10th order). For each asteroid the probability motions domain has been constructed. The investigation has been carried out by means of numerical methods. The results of investigations of evolution of nominal orbit and orbits of the test particles from the probability motions domain of NEAs allow us to produce the following resumes. Almost all considered NEAs (37 out of 40) are moving in the vicinity of resonances 2/1, 3/1, 5/2 and 7/3 with Jupiter which correspond to Kirkwood ports. The orbits of these asteroids are closely approaching to the Jupiter orbit. Most of them are moving in the vicinities of resonances with Jupiter and remain unseized into the resonance. Only 9 out of 40 objects together with all test particles from their probability motions domains have regular libration motions near the value of the exact commensurability. But those asteroids have large libration amplitudes.

Thus all considered NEAs from the vicinity of low-order resonances with Jupiter have large libration amplitudes or are not captured into the resonance. Subsequently the "asteroid–planet" geometrical configurations are unstable and do not protect asteroids from close approaches to Jupiter.

This research was supported by RFBR (grant N 08-02-00359).

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NUMERICAL SIMULATION OF THE NEAS RESONANCES DOMAINS IN THE VICINITY OF THE 2/1, 3/1, 7/3 MEANS MOTIONS COMMENSURABILITIES WITH JUPITER

The results of investigations of the NEAs resonances regions for the 2/1, 3/1, 7/3 means motions commensurabilities with Jupiter are presented. The influence of the initial orbital parameters: the eccentricity, the inclination and the mean longitude of asteroid on amplitude and period of librations is considered. The boundary separating regions of resonant and no resonant motions has been defined. The resonances domains have been constructed on the basis of estimations of critical arguments $\beta = k_1 l_a - k_2 l_J + (k_2 - k_1)\varpi$ and the resonance band values $\alpha = k_1 n_a - k_2 n_J$. Here n_a, l_a and n_J, l_J are the mean motion and the mean longitude of asteroid and Jupiter correspondingly, ϖ is the longitude of perihelion of asteroid, k_1, k_2 are integers. Initial set of orbits has been generated by means of the variation of semimajor axis and mean longitude values at the fixed initial values of the others orbital parameters.

Eccentricities of the NEAs orbits are large, as rule. Therefore all estimations have been calculated by means of numerical simulation. Equations of the motion of asteroids have been integrated numerically on the time interval of several thousands years. In the process of numerical integration perturbations from planets and the Moon have been taken into account. Calculations have been executed by Everhart method with help of applied programm system, specially developed by T.Yu. Galushina and L.E. Bykova for investigation and simulation of asteroid motion.

This research was supported by the Russian Foundation for Basic Researches, Grant N 08-02-00359.

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MUTUAL EVENTS OF THE URANIAN SATELLITES OBSERVED WITH THE 2-METRE FAULKES TELESCOPES

The once-in-42-years event of a Uranian equinox presents a narrow window of opportunity for studying this system as the planet's atmosphere, rings and satellites undergo rapid, time-critical changes in response to the Sun (and the Earth) crossing the Uranian equator. Answering a worldwide call for observations of the mutual eclipses and occultations of the major satellites Miranda, Ariel, Umbriel, Titania and Oberon in 2007 and 2008, we used the two Faulkes Telescopes (FT North on the island of Maui, Hawaii and FT South at Siding Spring Observatory, Australia) in order to maximise the observable fraction of these rare events. We were fortunate to capture such a mutual event early on in the season (CBET 959; [3]), an occultation of Oberon by Umbriel that occurred at the beginning of May 2007. During this presentation we will describe our observing strategy, operational setup and data reduction techniques. We will show and discuss several mutual event lightcurves that we obtained, including events involving the small satellite Miranda and some that were predicted to be "near-misses" by one or both of the available ephemerides of the satellites [1, 2].

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THE CORPORATE NETWORK OF THE SIBERIAN BRANCH OF THE RUSSIAN ACADEMY OF SCIENCE AND ITS IMPACT ON FUNDAMENTAL AND APPLIED RESEARCH

The corporate network is an important factor in the efficiency of a modern research organization such as the Siberian Branch of the Russian Academy of Science. The network was started in mid-nineties as a fusion of several regional projects. The structure of the network reflects the intention towards the integration of different institutes within the organization in the information space. Since the start the corporate interests of the organization were prioritized over the interests of individual institutes. This principle is reflected in the present financing and management structure that provides for the maintenance and further development of the network.

At the beginning of 2008 the network had over 150 subscribers. The aggregate daily volume of information transmitted to and from the network to the outside world is over 1 TB. The ratio of outgoing and incoming traffic is about 21 to 29. It is important to note that all the maintenance and development work is carried out according to the principle of priority of corporate interests stated above so that the subscribers do not have to pay for their external traffic.

The network is serving over 50000 users in Novosibirsk and has over 15000 computers connected to the network. Regional scientific centers have another 30000 users. The network provides the basic connectivity as well as several higher level services.

As the network developed through the years it has become the biggest educational and scientific network in Russia in terms of of the number of users, volumes of data as well as the variety and level of services provided.

The work was supported by RBRF grant 06-07-89038 and grants SBRAS 1.7 and 3-o

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NUMERICAL SIMULATION OF DYNAMICS OF EARTH'S ARTIFICIAL SATELLITE SYSTEM USING THE COMPUTER CLUSTER CYBERIA

A problem of numerical simulation of the arbitrary number of Earth's satellites dynamics using the supercomputer SKIF Cyberia is discussed. The efficiency of using the supercomputer for the solving such problems is considered by the example of the numerical simulation of the motion of 1000 geostationary objects. The following perturbations: Earth's non-sphericity and influences of the Sun, the Moon and light pressure have been taken into account in the process of numerical integration of the motion differential equations by Everhart's method.

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MUTUAL EVENTS WITHIN BINARY ASTEROIDS

Since the first earth-based discovery of the binarity of (45) Eugenia in 1998, many other binary asteroids have been detected. Their systematic astrometric follow-up over many years provided accurate orbit solution allowing us to predict mutual events seasons. The photometric observation of such events give valuable insights on the physical structure of these systems in terms of shape, size, and bulk density. International campaigns of observation already took place concerning the asteroids (90) Antiope and (22) Kalliope. Main outcomes are presented. Next opportunities and observability conditions are reviewed.

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METHODS FOR BUILDING CONFIDENCE REGIONS IN NONLINEAR PROBLEMS OF PARAMETER ESTIMATION

In the paper we consider some peculiarities in determination of LS-estimations of initial parameters and confidence regions of asteroid motion from observations. This problem may turn out to be substantially nonlinear for the asteroids observed only at one appearance. At that the choice of orbital parameters used for building confidence regions is of importance.

Some cases of the observability of asteroids are possible when linear methods based on covariance matrices for building confidence regions get inadmissible whatever coordinate system is used. In this case the approach proposed by V. Avdyushev for nonlinear estimation can be acceptable. For observations of unequal precision a simple method is possible to miniaturize a confidence region by introducing appropriate weighting matrices.

It is also shown that when conventional LS-algorithms are used the difference of probabilistic observation error distribution from the normal one results in the extension of the regions of probabilistic scatter of parametric LS-estimations and the confidence regions, the probability of covering the accurate solution by the regions keeping.

The work was supported by RFBR grant 08-02-00359.

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TEMPORARY SATELLITE CAPTURES AND TEMPORARY GRAVITATIONAL CAPTURES BY JUPITER

Temporary gravitational captures (TGC) are defined as temporary satellite captures (TSC) in the Hill's sphere. TGC of observed and modelled comets take place in the vicinity of low-velocity tangency points on cometary orbits. The orbits with TGC are determined for six models of low-velocity encounters on the semimajor axis–eccentricity plane. Two well-known variants of TGC for observed comets are considered. This work was supported by RFBR Grant 06-02-16512.

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DERIVING ASTROMETRIC DATA FROM THE PHOTOMETRY OF MUTUAL OCCULTATIONS AND ECLIPSES OF PLANETARY SATELLITES

The photometry of natural planetary satellites during their mutual occultations and eclipses tends to derive very accurate astrometric data. The drop of satellite brightness during these events depends on a variety of satellite properties, the properties of satellite motion, and the observation techniques and conditions. In this report, we analyze the fairly complicated methods used to derive astrometric data and explore the factors limiting the accuracy of the data obtained. Our analysis is based on the results of the reduction of the entire database of observations made during two international campaigns of observations of mutual occultations and eclipses of Jovian satellites. Recommendations concerning the methods of observation are elaborated with the aim to achieve the astrometric accuracy expected during the organization of the observational campaigns.

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ASTRONOMICAL YEARBOOKS IN EDITIONS AND PROGRAM SYSTEMS

Institute of Applied Astronomy has published "The Astronomical Yearbook" (AY), "The Nautical Astronomical Yearbook" (NAY), "The Nautical Astronomical Almanac" biennial (NAA-2). For the period of their existence they have undergone some reforms. At present the FK6/HIPPARCOS stellar catalogues, new P03 precession and IAU2000 nutational theories were used in these editions. It should be noted that all ephemeris published in the yearbooks are referred to the classical equinox. At the same time in AY the parameters connected with CIRS and matrix elements for the transfer from the ICRS to the CIO are given.

Qualitatively a new stage of the reform became the transition to the domestic EPM2004 ephemerides developed in IAA RAS. Its accuracy is comparable with the DE405/LE405 and DE409/LE409 theories within the limits of accuracy of published ephemerides.

In addition the reform of computing base and technology of preparation ephemeris data for printing is carried out. All calculations are worked out on the basis of the program system ERA.

Along with hard copies of AY, NAY, NAA-2 the electronic versions are elaborated. The important stage is the creation of "The Personal Astronomical Yearbook" (PersAY). The system gives comprehensive facilities for the user to put and solve tasks of calculation of ephemerides for any moment in various time scales, and for any position of the observer on the Earth. The PersAY includes the basic types of ephemerides published in AY and rightfully can be considered as its electronic version. Experimental version of the PersAY was put on the site of IAA `ftp://quasar.ipa.nw.ru/pub/PERSAY/persay.zip`.

Besides the "Navigator" system of the remote access is developed. It is intended to solve some navigation tasks described in NAY and NAA-2. The output of the solutions is in full accordance with the accuracy and the form accepted in these editions.

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ANALYSIS OF MOTION OF ASTEROID APOPHIS AND ITS ORBIT CORRECTION FOR PREVENTION OF ITS POSSIBLE COLLISION WITH THE EARTH IN 2036

Characteristics of the asteroid Apophis motion are studied regarding its possible approachings the Earth. According to the asteroid observations performed and the defining of its orbit on this base, a "tube" of the Apophis trajectories that is defined by the errors of the observations has some dangerous trajectories, which will lead to an impact with the Earth during their approach in 2036. A method for determining these asteroid's orbits in its "tube", which have the collision with the Earth, is proposed. On this base, a family of the asteroid trajectories that collide with the Earth in 2036 [1] is determined . Characteristics of these trajectories and the consequences of this possible impact are investigated. A problem of the necessary correction for asteroid's orbit to deflect it from the Earth in 2036 is analyzed. Some correction strategies are investigated: for the cases of one-two impulsive short-term effects [1] and slow long-term gravity ones. It is shown that the correction is desirable to be performed before the asteroid-Earth previous approach in 2029. In this case, the energy consumption for the correction will be less considerable than after this approach. Evaluations for characteristics of the kinetic-impact effect, of nuclear one as well as of slow gravity influence for this correction are provided. There are also found the asteroid trajectories, which lead after the effect to the deflection from the Earth and to the motion to the Moon and then to collision with the Moon. Characteristics of this impact are evaluated.

The study is supported by the Russian Foundation for Basic Studies (Grant 06-01-00531).

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PROCESSING OF CCD-IMAGES BY IZMCCD SOFTWARE PACKAGE

Processing of CCD-images is presented from the point of view of a final user. The list of the actions for calculating equatorial coordinates and magnitudes of celestial bodies is described. Basic algorithms of program are given briefly.

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CCD OBSERVATIONS OF THE SATELLITES OF SATURN AND URAN WITH 26-INCH REFRACTOR AT THE PULKOVO

The 26-inch refractor ($D = 65$ cm, $F = 10413$ mm) of the Pulkovo observatory has been equiped with CCD-camera FLI Pro Line 09000 ($12' \times 12'$, 3056×3056 px) at the end of the year 2007. The results of the observation of Saturnian and Uranian satellites and the comparison with the theory are presented. Astrometric reduction algorithm is based on Therner's method.

This works have been carried out with the support of RFBR N 07-02-00235.

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DUST TORUS IN THE VICINITY OF AN ORBIT OF A SMALL SATELLITE

Impacts of meteoroids on a small satellite lead to the ejection into space a regolith mass being much greater than the mass of a projectile. Imaging that at an epoch t_0 we observe an isotropic ejection with velocities lower in absolute value than a maximal possible b. Due to inequality of orbital periods fragments fill densely a certain domain D. The same domain is filled after a burst of an artificial satellite on a high orbit. In 1–3 months longitudes of nodes and pericenters will be distributed along a circumference and the domain D become a body of revolution, a topological solid torus. The research objects are the domain of possible motion of particles and its boundary S immediately after a collisional event (unperturbed case), and the same domain supposing that the initial longitudes of nodes and pericenters managed to undergo sufficient change (perturbed case). In both cases we succeed to construct the domain D and its boundary S analytically: we obtain parametric equations of S containing relatively simple functions only. Principal topological and differential-geometric properties of S are examined completely. Partially the properties of S are described in the paper [1].

Comparison of our analytical results shows a good agreement with the numerical modelling (see, for example, [2, 3]).

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ASTROMETRY OF SMALL BODIES OF THE SOLAR SYSTEM WITH THE PULKOVO NORMAL ASTROGRAPH

The systematic CCD observations of the asteroids were carried out with the Normal astrograph of the Pulkovo observatory (D/F = 0.33 m/3.5 m, lim. mag is 17 with 2 min exp. time) from 2005 to 2007. 279 asteroids have been included into the observation program. This list contains 13 asteroids that have been observed since 1949, double asteroid candidates, Eos and Hygiea families asteroids, NEA. A number of asteroids at the points of maximum curvature of the apparent path and apparent close approaches to the stars of the modern catalogs were observed. The internal (external) positional standard errors are within 30(40) to 50(150) mas in dependence of magnitude. The results have been submitted to MPC and available via Pulkovo astrometric data bases (www.puldb.ru). These observations correspond to tasks that would be relevant before GAIA project realization. These tasks are collecting the results of positional observations of the Solar system bodies and new double asteroids detection; construction of the input catalogs of the positions of small bodies for future space missions; improvement of the accuracy of the CCD astrometric observations of asteroids by applying the methods that are traditionally used in astrometric catalogs construction (mainly by taking into account the magnitude and color equations); CCD observations of the occultations of the stars by asteroids and apparent close approaches to the stars of the modern catalogs. Expediency of the new reductions of the old photographic plates with images of asteroids in modern reference frame is considered. At present time there are more than 1700 plates with images of these objects taken from 1949 to 2004 at Pulkovo observatory (http://www.puldb.ru/db/plates/index.php).

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THE RESULTS OF CCD ASTROMETRIC OBSERVATIONS OF SATURNIAN AND URANIAN SATELLITES WITH 26–INCH REFRACTOR AND NORMAL ASTROGRAPH OF THE PULKOVO OBSERVATORY DURING THE PERIOD FROM 2004 TO 2007

The observations of the Saturnian (1 to 8) and Uranian (1 to 4) satellites were made with 26-inch Refractor ($D/F = 0.65$ m/10.5 m, CCD ST6, $3' \times 2'$) and NA (Normal astrograph, $D/F = 0.33$ m/3.5 m, CCD S2C, $18' \times 16'$). The NA CCD images were processed with the reference stars of the UCAC2. The 26-inch Refractor CCD images were calibrated using close pairs of stars of the Tycho-2 and only relative positions "satellite–satellite" were determined. The observational data were compared with modern theories of satellites motions. The (O-C) values were calculated via "Natural satellites service" [1]. The internal standard errors of observations of satellites were estimated as 10 to 50 mas, but external standard errors of satellites positions determined by the comparison with modern ephemerides are about of 50 to 200 mas in dependence of satellites and conditions of observations. All results are available via Pulkovo astrometric databases (www.puldb.ru). This work was supported by RFBR grant 07-02-00235a.

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VECTOR APPROACH TO THE LUNAR PHYSICAL LIBRATION

The new analytical approach is developed to the problem about physical libration of the solid Moon. The Eulerian equations, where are taken into account gravitational perturbations on the Moon from the Earth and Sun are complemented by twelve kinematic ones. Motion is described by fifteen variables that does the method more suitable, informative and flexible in comparison with traditional one. After transformation and linearization the problem is reduced to nine linear differential first-order equations. The system decomposes on two independent groups that allows libration on longitude to study apart from libration on latitude.

Libration on longitude is presented by three equations and is described free and forced oscillations. The first one have a period 2.8785 years (and amplitude 1.855"). Forced physical libration of the Moon on longitude is presented by period in 27.32 d (15.30"), 365.256 d (4.12") and half year (18.17"). The influence of the Sun on this type of the oscillations is comparable to earth one, but contribution to change of the angular velocity of the Moon from Sun even on order more, than from the Earth.

Six equations describe the physical libration on latitude. Here are free, unrestricted and forced oscillations. The free period is 148.167 years, the unrestricted ones — 27.32 d and 27.212 d, and the forced oscillations — 27.296 d, 74.066 years and 27.212 d. In spite of accepted to opinion, the period 74.066 years is not a moon analogue of the wobble mode of the Earth, to such follow to refer the period 148.167 years. Motion of the instant pole is described by four harmonics: two unrestricted ones with the period 1.729 years and 74.066 years, two other harmonics (forced and free) give beating with period 48.47 years. From comparison with observations are found amplitudes of the unrestricted oscillations, however, oscillation 1.729 years until is not discovered. For important relation $\frac{y_2}{y_1} = \frac{\sin I}{\sin(I+i)} \approx 0.2311$ the theory gives $\frac{y_2}{y_1} \approx 0.2307$, consequently, the vector approach gives best fit with results of the observations.

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PRELIMINARY MATHEMATICAL MODEL OF THE QUADRANTID METEOROID STREAM FORMATION

It is still unclear when and how the Quadrantid meteoroid stream was generated. The two last hypothesis are the following: the shower nucleus was generated about 200–300 years ago by asteroid 2003 EH1, the background part of the stream was generated about 3500 years ago [1], and the stream was generated at the end of XV century during breakup of the comet C/1490 Y1 [2].

Numerical modelling of meteoroid streams is an expensive process, because the expenditures of computer time run into thousand hours. So as the first step we modelled ejections of 30 000 test particles for each of three differing masses and for each revolution of 2003 EH1 from 1602 to 1807. Then the evolution of the particles was followed till the present time. A rigorous way to model the intersection of a test meteoroid with the Earth is to keep tracking of the distance between the meteoroid and the Earth, and consider the meteoroid as registered if this distance is less than a threshold (say, 0.01 AU). We used also another way of registration when the test meteoroids having *nodes* within 0.01 AU of the *Earth's orbit* are considered as observed on the Earth.

The amount of registered test meteoroids for the "nodal" method is found to be 50 times greater than for the rigorous one. That allowed to decrease the registration threshold down to 0.001 AU and therefore to increase the accuracy. Preliminary analysis of the model radiants and nodal regression has shown a good agreement with observations.

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NUMERICAL THEORY OF MOTION OF JUPITER'S GALILEAN SATELLITES

The numerical theory of motion of Galilean satellites was constructed. 3586 positional observations were used for this aim. 1617 observations were made in Flagstaff from 1998 to 2006, 658 in La Palma from 1986 to 1997 and 1311 at Nikolaev observatory from 1962 to 1998. Constructing of the theory was done applying the method of numerical integration of satellites motion equations. Integration was done by Everhart's method using ERA program system developed in IAA RAS. Perturbations from Jupiter's ellipticity, Saturn und Sun and mutual perturbations of Galilean satellites were considered. As result of integration coefficients of Chebyshev's series expansion of satellites coordinates and velocities from 1962 to 2010 was obtained.

Observational rms residuals

	Right ascension	Declination
Io	$0.''18$	$0.''16$
Europa	$0.''15$	$0.''15$
Ganymede	$0.''18$	$0.''16$
Callisto	$0.''16$	$0.''16$

Initial satellites coordinates and velocities, masses of satellites, mass of Jupiter, equatorial coordinates of Jupiter's pole and value of Jupiter's J2 were determined more precisely.

Using the constructed theory ephemerides of Galilean satellites of Jupiter was obtained. This ephemerides and ones obtained using theories of J. H. Lieske [1] and V. Lainey [2] was compared.

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CELESTIAL REFERENCE FRAMES AND REFERENCE CATALOGS FOR THE REDUCTION OF THE POSITIONAL OBSERVATIONS OF SOLAR SYSTEM BODIES

Different systems of celestial coordinates which are used for the presentation of the results of astrometric observations of the solar system bodies, and their reduction to the ICRS system are considered. Stars reference catalogues, used for the astrometric observations, are discussed in terms of their accuracy, random and systemic errors, and possible ways of taking the systemic errors into account.

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DIFFERENCES IN METEOR FLUX RATES IN OUTER SOLAR SYSTEM PLANETARY BODIES AS COMPARED WITH INNER SOLAR SYSTEM BODIES

Introduction: The outer bodies the outer solar system are likely in a situation where they receive a different amount and composition of infalling bolides. They are closer to the Kuiper Belt which is the source for comets and has frozen volatiles.

The author proposes that this would mean that because there is less outgassing of bolides before impact from being closer to the sun as occurs in bolides in the rocky Inner solar system. This might increase the volume of material that impacts. Another factor is that the gravitational sweep of the large planetary bodies in the outer solar system would create a greater gravity well encompassing a greater area that would mean a greater number of meteors. The author proposed before that while the Cassini mission was being planned that meteor flux rates be examined in the upper atmosphere of Saturn and flux rates on the moons of Saturn. Mission constraints prevented this phenomena being looked at.

Meteor trails would leave trails that could be detected in the visual and oter electronmagnetic spectrum around Saturn. As they are detected around Earth. These trails which are essential the dust grains that burn up and leave an ionization trail in the upper atmosphere of planetary bodies are at a micro level the same amalgamation process that occurred in the formation of all of the planetary bodies in our Solar system.

It might also be possible that the background streams of meteors in the Outer Solar system are different due to the distance from the Inner Solar system. The Suns gravity well itself might concentrate or disperse the background dust and other non-volatile as a factor of the distance from the Sun. A type of Bode's Law for smaller Solar system bodies down to dust particles.

Conclusion: The data that came back from the major Jupiter and Saturn missions might contain data of the appearance and potential measurement possibility of meteor flux rates in Outer Solar system bodies that could be compared with data from Earth. This data might begin to indicate different flux rates and composition as a factor of distance from the Sun.

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PROGRAMMING COMPLEX TO STUDY THE DYNAMICS OF COMETARY CLOUD

We cannot observe Oort cometary cloud composing objects. But simulated computations permit us to obtain some integration parameters of stellar environment which allow to outline a district of stability in the phase space. These are the average stellar velocity, the distances between the stars, the firm of character masses of the stars and some else ones. Of course we must remember about giant molecular clouds, a field of the Galaxy, planets near the “mother-star” [1, 2] etc.

Our program complex IAmod generates net- or matrix-model of orbits transformation. We set initial conditions (parameters of stellar environment) and watch the dynamics of Oort cloud by passing stars. At the end of the calculations we have a true exhibition about evolution and stability of cloud.

Algorithms for stellar perturbation computations were considered by Rickman et al. [3]. At the first time we use classical impulse approximation (CIA), as a simple solution. We try to build an abstract system of equations, when the output matrix does not depend on a concrete normalization.

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CENTRAL CONFIGURATIONS AND PLANETARY COORBITAL SATELLITES

We consider the problem of the motion of a zero-mass body in the vicinity of three gravitating bodies forming a central configuration.

The definition of the central configuration is given in the monograph by Wintner: N vectors $\mathbf{R}_J$ that specify the positions of N bodies with masses $m_1, \ldots, m_N$ in the barycentric coordinate system form a central configuration with respect to the positive constants $m_1, \ldots, m_N$ if the attractive force acting on $j-$body at the fixed time is proportional to the mass m_J and vector R_J:

$$\mathbf{F}_J = \sigma\ m_J\ \mathbf{R}_J, \quad J = 1, 2, \ldots, N.$$

Here, the scalar σ does not depend on j; on the basis of this equation and Newton's laws, σ is defined uniquely.

The case when the gravitating bodies with masses $m_2 = m_3 \neq m_1$ form the regular triangle with sides a rotating around the barycenter of this system with the same angular velocity is considered. We calculate the equilibrium points of such system and investigate the stability of these points. The equilibrium point which lies on the angle bisector (altitude and median) from the vertex with gravitating mass m_1 is stable under the condition of mass ratio: $m_1/m_2 = m_1/m_3 > 367.0540108$.

For critical values of mass ratio 367.0540108 the distance between the equilibrium point and the barycenter of this system is 0.996833 a, the barycentric distances of gravitating masses are 0.00469321 a for m_1 and 0.995938 a for m_2 and m_3.

It should be noted that two bodies with masses m_2, m_3 and the zero-mass body located in the equilibrium point are moving practically along the same circular orbit. This dynamical system is stable under the mentioned condition. The possibility of using this stable configuration for describing the action of the "shepherd" satellites on particles from the planetary ring is considered.

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GRAVITATIONAL SPHERE OF THE PERTURBATIONS CAUSED BY THE PLANET'S OBLATENESS PREVALENT INFLUENCE IN COMPARISON WITH THE PERTURBATIONS BY THE THIRD BODY

Peculiarities of the satellite's orbits evolution under joint gravitation perturbations caused by third body and oblatness of the planet are determined by the value of the parameter $\beta = \frac{2}{5}\frac{r_0^2 J_2 \mu}{n_k^2}\frac{1}{a^5}$. The following designations are used: r_0 is the equatorial radius of the planet, J_2 is the coefficient of the second zonal harmonic in the planet's gravitational potential, μ is the product of the gravity constant and the planet's mass, n_k is the mean motion of the perturbing body, a is the semi-major axis of the satellite's orbit. The parameter β characterizes (in the first approximation [1]) the relationship between perturbing accelerations caused by oblatness of the planet and one caused by the third body.

Let us transform the expression for β, introducing variable d, having the dimension of the length, $\beta = \left(\frac{d}{a}\right)^5$, $d = \sqrt[5]{\frac{2}{5}\frac{r_0^2 J_2 \mu}{n_k^2}}$. The value of d_Σ for the system of the n perturbation body in coplanar orbits can be expressed by the following formula $d_\Sigma = \sqrt[5]{\frac{2}{5}\frac{r_0^2 J_2 \mu}{\sum\limits_{k=1\ldots n} n_k^2}}$. We will call the planet-centric sphere of the d radius *the gravitational sphere of the prevalent influence of the perturbations caused by the planet's oblatness.*

Outside of this sphere, where $\beta < 1$ is the little parameter, the asymptotic of the restricted tree body problem is acting and the period of the orbital elements' evolution is proportional to the value $a^{-3/2}$. Inside of this sphere, where $\beta > 1$, the little parameter is $1/\beta < 1$. In that case the asymptotic of the oblatness influence is acting and the period of the orbital elements' evolution is proportional to the value of $a^{7/2}$.

For the Earth–Sun–AES system $d = 7R_E$, for the Earth–Moon–AES system $d = 6R_E$, for the four body system $d_\Sigma = 5.56R_E$.

The work was supported by RFBR, project 05-08-17894.

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INVESTIGATION OF SMALL BODIES OF SOLAR SYSTEM IN NEW SPACE MISSIONS "Lyra" AND "SVECHA"

In Sternberg Astronomical Institute of Moscow State University two scientific space missions "Lyra" and "Svecha" were proposed.

Lyra is high precision 10-band (in 200–1000 nm) all sky photometric survey in the frame of Basic Research Program on Russian Segment of International Space Station. The precision of photometry is 0.003–0.001^m till 12^m and 0.01^m till 16^m. The project is on the conceptual design stage.

Svecha is Russian space astrometric experiment. General goals of the Svecha space experiment are:

1. Astrometrical catalog of all objects (with coordinates, proper motions and parallaxes) with precision of 25 μas for objects till 16^m and with precision of 100 μas till 20^m.
2. Catalog of multiband photometry (10–16 filters) with precision of 0.001^m for all objects till 18^m and with precision of 0.01^m till 22^m.
3. Catalog of radial velocities for all objects brighter than 18–19^m in 4-6 spectral intervals independently.
4. Medial resolution spectral catalog ($R = 1/1000$–$1/3000$) for all objects till 12^m and till 16–18^m selectively.

Experiment is based on autonomous satellite on geosynchronous orbit. Mission is on theoretical stage of development.

Both missions will observe bodies of Solar System with high coordinate and photometrical precision. Possible astronomical applications of the data will be discussed.

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ASTEROID 39 LETITIA SURELY TO BE THE DOUBLE ONE

During the last decade the population of asteroids having satellites was detached in the Solar system. The family of these objects has now more than 150 members. Three of them are the triple systems. About one third of them is moving in MBA (the main belt of asteroids), (http://www.johnstonarchive. het/astr).

Different disturbing forces are acting on these asteroids and influence the relative and heliocentric motion of the components. Among these forces one can mention the Sun and major planets attraction, the mutual attraction of the components, the solar radiation pressure including the Yarkovsky effect, the possible resistance of the medium and the effects of elasticity and plasticity of the components substance.

The knowledge of properties of satellite systems in the asteroid belt is of certain need if one has in mind to cope with problems of the origin of asteroids, determination of their masses, densities, figures and the rotation motion of the components.

The big asteroid 39 Letitia from MBA has maxima and minima of its light curve changing greatly from night to night. It was observed at the TV-complex of the Reseach Institute CrAO at two oppositions of 1999 and 2000 in the BVR-bands. Analysis of the absolute magnitude changes for the asteroid of interest within 2000 has showed distinctly the existance of the known period of rotation, $P = 0\overset{d}{.}214093$, with the amplitude of changes of brightness close to $0\overset{m}{.}3$. In colour indexes B-V and V-R this period is absent. So, the asteroid is apparently the double one. When analysing changes of colour indexes B-V, V-R in 1999 and 2000, periods $P1 = 0\overset{d}{.}237$ and $P2 = 0\overset{d}{.}177$ were found. They seem to correspond to the rotation of the two components having a little different sizes. The P1-component seems to be the satellite and the P2-one can be considered as the central body.

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TO THE PROBLEM OF ORIGIN NEAR EARTH ASTEROIDS

The problem of origin Near Earth Asteroids (NEA) is permanently discussed. However, some aspects are unresolved before present. When origin of some minor planets is definitely main belt, relative another part of NEA's population, this appearance seems unlike. It is possible, that some objects are disintegrated comets, but not all of them. On our opinion, significant numbers of NEAs appear in collision and fragmentation directly near Earth orbit. To study this ability, highly inclined orbits and orbits with small semimajor axis are most interesting. We select 46 such orbits. First of all, we use minimal orbit intersection distance (MOID) as a search criterion. There are 184 Near Earth Asteroids between 16000 first numbered minor planets, had taken into account. For most of objects, origin remains unclear. However, for 16 minor planets we expect participation in relative recent catastrophic events in neighborhood Earth orbit. Some of them have particular interest. Minor planet 3200 Phaeton related with one or more meteor stream. Asteroid 3753 Cruithne moved near Sun-Earth Lagrangian libration point. Minor planets 7474 and 7480 have very similar orbital elements. We find 18 cases of triple orbit intersections. The next step of our investigation was a search for close encounter of selected minor planets at very recent time between 1600 and 2000 year. We use HORIZONS system numeric integration with all perturbations and initially, with step 10 day. There are few interesting cases were found. For them, new series of integrations with step 0.1 day were applied. In spite of very short time interval, there are two cases close encounter between minor planets within distance 0.01 a.u (about 1.5 million km): 1620 Geographos and 14402 at epoch 28.11.1842 and 7474 and 7480 at epoch 08.05.1961.

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THE CATALOGUE OF THE OBSERVATIONS OF THE MUTUAL EVENTS OF THE NATURAL SATELLITES

Mutual events of the main satellites of Jupiter, Saturn and Uranus are observed now extensively during each equinox opportunity. The mutual events of the Galilean satellites of Jupiter are observed since 1973, these of Saturn since 1979 and these of Uranus only in 2007. All these data are very interesting for analysis for several purposes: astrometry of the relative positions of the satellites and photometry of the surfaces of the satellites. In order to be able to use these observations for scientific purpose, the data must be proposed under a useful form.

The raw data may be either a photometric light curve recorded during the mutual eclipses or occultations or a series of images taken during the event. These data need to be carefully reduced before providing relative positions of the satellites and the parameters of the surfaces. The problems are similar for all three systems, Jupiter, Saturn and Uranus but it is necessary that the observers understand what we need for the good achievement of the reduction.

In this communication, we will explain all the operations to be made from the observation until the catalogue of useful data to be published and to be used by astronomers analysis the concerned planetary system.

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METEOROID STREAMS: MATHEMATICAL MODELLING AND OBSERVATIONS

Mathematical modelling of meteoroid streams formation and evolution is a very fruitfull method for obtaining not only cosmogonical knowledges, but also information about the stream up-to-date structure as well.

Computer simulation of meteoroid streams formation and evolution has gone through several stages, which were dictated mainly by computer power. At the first stage mainly a single mean orbit of a meteor shower was integrated, or the orbit of its parent comet; or it was not numerically integrated, only the secular perturbation changes were calculated analytically. Or it was a pure analytical method entailed by cumbersome mathematical manipulations. Later on general dynamics of streams was studied by integrating of small amounts of meteoroid orbits. With computer power increasing, large scale integration studies have became possible.

In this review we consider the general principles of mathematical modelling, advances of the method, and applications to meteoroid streams of different schemes of formation. At present we have only two more or less full models for meteoroid streams [1], namely for the Geminid and the Perseid meteoroid streams. We shell consider also a model aimed at the Leonids predictions, but having all the potential to grow into a full model. We also discuss the part played by observations, and the feedback between models and observations. Attention is drawn to some unresolved problems and promising areas of application. Some results showing that mean motion resonances can cause evident changes in the structure of a meteoroid stream will also be outlined.

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ORIGIN OF THE (3200) PHAETHON – GEMINID METEOROID STREAM COMPLEX

The Geminid meteor shower is one of the most intense annual showers. The Geminid shower structure is known quite well. A qualitative model of the stream, which sums up a 20-year sequence of publications, explains most of the stream's features [1]. The activity profile for the Geminid shower has a special shape [1], and the shape is ensured by a cometary model of the stream generation.

The asteroid (3200) Phaethon is the likely parent body for the Geminid meteoroid stream. No cometary activity has ever been observed, so the link between Phaethon and the Geminids is based on the similarity of their orbits, but probability of a chance alignment is less than 0.001. Its Tisserand parameter $T_J = 4.5$ argues for an asteroidal origin, rather than a cometary one (most comets have $T_J < 3$). Licandro et al. [2] assume that Phaethon is an "activated" asteroid scattered from the main-belt to the NEO population. Recently discovered Apollo asteroid 2005 UD is a candidate for being a member of the Phaethon–Geminid stream complex [3] as well as another Apollo asteroid 1999 YC [4].

The origin of the Phaethon–Geminid complex is still unclear. We'll discuss possible scenarios.

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METHODS FOR DETERMINING INTERMEDIATE PERTURBED ORBITS FROM MINIMAL NUMBER OF OBSERVATIONS

On the basis of the theory of intermediate orbits developed earlier by the author [1, 2], a new approach to the solution of the problem of preliminary orbit determination is suggested. This approach enables taking into account the main perturbations in celestial body motion. The orbit, on which the motion is represented as a combination of two motions, is constructed. The first is the uniform rectilinear motion of the fictitious attracting centre, the mass of which varies in accordance with the first Mestschersky law. The second is the motion around the fictitious centre. It is described by the equations of the Gylden–Mestschersky problem. The parameters of the constructed orbit are such that their limiting values at the reference epoch determine the superosculating intermediate orbit with third-order tangency. By the suggested approach the classical problems of orbit determination from three and four pairs of angular measurements are solved. The new algorithms can be considered as generalizations of the well-known Lagrange–Gauss method and a four-position Gauss-type procedure that are all based on the solution of the two-body problem. By the examples of orbital motion of the minor planets (1383) Limburgia and (1566) Icarus the comparison of the results of the use of the classical Lagrange–Gauss method, a four-position Gauss-type procedure, and the new methods has been performed. The comparison shows that the new methods are a highly efficient device for studying the perturbed motion. Their advantage over the usually used methods is especially considerable in case when we have high accurate observations, which span short orbital arcs.

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INACCURACIES OF TRIGONOMETRIC FUNCTIONS ON SOME COMPUTER PLATFORMS

In July 1998, Astronomical Data Analysis Center of National Astronomical Observatory of Japan upgraded the operating system of the Sun SPARC workstations. Soon after upgrading it was noticed that some of obtained numerical results differed from those obtained before. The accuracy of certain sorts of numerical integration was definitely lower than it had been before. In particular, the total angular momentum of gravitational N-body system was no longer conserved in a certain type of numerical integration. As it turned out, the reason was in numerical inaccuracy in some of built-in trigonometric functions [1].

We decided to test available computer systems using the approach of Ito ang Kojima [1] and present the research of accuracy of trigonometric functions sin() and cos() for the following platforms and compilators: Windows XP + Turbo Pascal 7.0, Windows XP + Borland Delphi 7, Windows XP + C++ Builder, Kubuntu Gutsu Gibbon 7.10 (kernel Linux – 2.6.22-14)+ FreePascal 1.0.8.2007/02/02 (Compiler Version 2.0.4) We calculated deviation from zero of $\cos^2 x + \sin^2 x - 1$ (which theoretically must be exectly zero) and also standard map, also known as the Chirikov–Taylor map. The results of the analysis are discussed.

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ACCURATE PREDICTION FOR NEO'S ORBITS

The asteroid 2004MN4 Apophis approaches the Earth in 2029. It is actual to calculate the accurate location of it. Generally the Everhart's method is used, but there are significant calculating errors near critical points in it [1]. Therefore we developed and used the better methods of numerical integration [2] : Yoshida method, Runge-Kutta method, selfstarting Hermit's algoritm, multisteps predictor-corrector methods, Parker-Sochacki algoritm. We found that the Hermit's method was faster, the Yoshida's method coud use longer step (with the same accuracy) in comparison with the Everhart's method [1].

According to our results there is a close approaching between Apophis and Earth. It will be on 13 April 2029 and the distance will be about 37480 km. Then we integrated the orbit of the object till 2100. The impacts of Apophis and Earth are not predicted for nominal trajectory. The minimal distance between them will be more than 0.04 AU.

Producing variations of velocity (1–2 m/s) in 2029 we have shown that there would be the trajectories which would pass through the Earth. These variations are possible because Apophis can come into collision with the objects of geostationary orbit. Using interval arithmetic method we calculated the mathematical probability of collision of Apophis and the Earth in 2036. It is about $2.5 \cdot 10^{-5}$.

Also we have investigated the accuracy of the observation of NEO for ISSO-project [3]. Due to obtained results we will be able to do a more accurate prediction of NEO's orbits (e.g. for Apophis).

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ON CONVERGENCE CRITERIA FOR EXPANSIONS OF THE DISTURBING FUNCTION IN THE ASTEROID THREE-BODY PROBLEM

The absolute convergence criteria for expansions of the disturbing function R in the planetary three-body problem in power series with coefficients in terms of time (or the mean anomaly) as the independent variable of the equations of perturbed motion have been obtained in (Sundman, 1916; Ferraz-Mello, 1994). Meanwhile, as it is known, using the eccentric or true anomaly instead of time may give some advantages because, for instance, it allows to represent the coordinates of the perturbed planet through the elementary functions which are holomorphic in the unit open disk of the complex plane. The same properties has also the general anomaly, offered by M.F. Subbotin (1936), the eccentric and true anomalies being the particular cases. The problem of the convergence of the R expansions with coefficients as functions of the eccentric and true anomalies has been considered in (Samoilova-Yakhontova, 1939; Banachiewicz, 1926), but only the divergence conditions have been given in them. The general method for determining the convergence domains for the R expansions in powers of the eccentricities with coefficients in terms of the mean, eccentric or true anomaly was suggested in (Sokolov, 2007). In the present paper this method is used to obtain the convergence criteria for the R expansions in the planar three-body asteroid problem. The coefficients of these expansions are represented by trigonometric polynomials with respect to one of the following five anomalies (eccentric, true, tangential or one of the two Subbotin's mutual anomalies) of the asteroid as the independent variables. It has been determined that using any of the above-mentioned anomalies instead of time extends the holomorphy domain of the principal part of R, moreover the true anomaly gives the largest one. As for the indirect part, the corresponding expansions converge at any asteroid's eccentricities limited by unity, while using time as the independent variable sets the convergence domain to the Laplace limit 0.6627. Advantages of using each anomaly are discussed.

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CCD POSITIONS DETERMINED FOR THE OUTER JOVIAN SATELLITES WITH THE 2 M REFLECTOR OF TERSKOL PEAK OBSERVATORY

CCD positions determined for the outer Jovian satellites are presented here. The positions calculated for CCD observations of satellites J6, J7, J8, J9, J10, J11 (these are 6 satellites from outer Jovian satellites group). The observations were performed in July 2007 with the 2-m reflector of International Center for Astronomical, Medical and Ecological Research at Terskol peak. 71 positions of satellites were determined and they are accurate to $0.''1$–$0.''2$ upon the average. The accuracy obtained with the 2-m reflector at Terskol peak was compared with the 1-m reflector by Special Astrophysical Observatory of the Russian Academy of Sciences (SAO RAS). The report represents the agreement between these positions and the latest JPL ephemeris for the same satellites. The same comparison was performed for the State Astronomical Institute ephemeris.

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HIGH PERFORMANCE COMPUTATIONAL RESOURCES AND PARALLEL COMPUTATIONS AT TOMSK STATE UNIVERSITY

In 2007 under the financial support of the national project 'Education' TSU has got the supercomputer Linux-cluster SKIF Cyberia. In terms of its parameters this supercomputer is included into the TOP-500 list and now is among the leaders of the supercomputer park of Russia.

The 283-node SKIF Cyberia was constructed on the basis of double core processors Intel Xeon with supporting of 64-bit extensions. Every computational node includes two processors, 4Gb RAM, 80Gb HDD. All nodes are connected by both the system network Infiniband and the service network. The Cyberia cluster has now a peak speed of 12 teraFLOPS and 9 trillion floating operation per second (teraFLOPS) on LINPACK. The modern system and applied software for parallel computations is installed and used on the cluster: Microsoft Windows Compute Cluster Server 2003, Linux SUSE Enterprise Server 10.0, MPI library, Intel and PGI compilers, TotalView debugger, ANSYS software, MM5 and WRF models, SCALAPACK, PETSc, FFTW, MKL, SPRNG.

Besides on the SKIF Cyberia cluster own original software is being actively developed. At present time parallel computing systems for modelling of the weather and the climate in Tomsk area and the Western Siberia, researches of the quality of the atmospheric air in Tomsk and Tomsk area, designing and optimization of technical devices and devices, development of mathematical methods of protection of the information, an estimation of the fire danger of the woods of Tomsk area are created.

Installed at TSU the computing system is used in the realization of educational programs with participation of TSU and other universities of the 'Siberian open university' association, in training students, in carrying the Siberian schools-seminars on parallel calculations out, in the improvement of professional skill of teachers and employees of high schools, scientific institutes, the enterprises and the companies of Russia, by preparation of textbooks on technologies of parallel programming.

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USE OF THE DATA MINING FOR ASTEROID ORBITS IMPROVEMENT

The use of ancient observations is a powerful method to improve the orbital parameters of the Near Earth Objects. For the newly discovered objects, a long time interval between the date associated to the archived data and the date of the discovery is a guaranty to get a strong observational constraint. This is the case even when the archived data is not to a high astrometric precision. Consequently the data mining can allow us to access very precious observational data, but it requires to use specific tools in order to efficiently process massive amounts of data. We have developed tools for the data mining within the Virtual Observatory framework in order to carry out such a task. For this goal, we have developed a specific tool named SkyBoT, a soft which can identify Solar System object in any field on a long period of time and its data-mining pipeline counterpart AstroId which performs an automatic identification of the Solar System Objects present in astronomical archives. We have applied them to the DENIS survey. This infrared survey has been performed from 1995 to 2001 in the I, J, K' spectral bands with a 1m telescope at ESO La Silla, Chile. As a result, we have detected 15 181 Solar System objects, including 273 Near-Earth Objects which could include around 170 NEO precoveries.

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A METHOD OF DETERMINATION OF METEOR RADIANTS' SHIFT

In papers [1, 2] in semianalitical form the influence of photons and the solar wind at motion of meteoroids is taken into account separately. Below, we determine the evolution of the meteor particles' elliptic orbits analytically in view of simultaneous action of photons and protons. Thus the dependence between variations of eccentricities, semimajor axes of meteoroid's orbits and shift of meteor radiants at the interval of time appropriate to one orbital revolution of meteoroid particles is found in a clear form.

Let's determine a difference of true anomalies of one and the same meteoroid, which has a specified a radius and density, after a full revolution,"migrated" from one elliptic heliocentric orbit to another one, with a little changed parameters. We admit, that the values of true anomalies of the meteoroid in these two orbits correspond to the average distance from the Sun up to the Earth. Let's take into account light pressure, the effect of Poynting-Robertson and the corpuscular effect of Poynting-Robertson. We shall also assume that the argument of perihelion of meteoroid's osculating orbit does not change, and angular shift of meteors' radiants coincides with the value of true anomalies' difference.

The variations of meteoroids' true anomalies, connected with some known meteor showers are calculated. In given examples for the meteor streams the radiant's shift under the action of Poynting-Robertson effect $\Delta\nu$ exceeds the shift of the argument of perihelion under the action of gravitational perturbations of the planets $\Delta\omega$. For Orionids the values are: $\Delta\nu = 0.057$,$\Delta\omega = 0.013$ and for Quadrantids the values are: $\Delta\nu = 0.192$, $\Delta\omega = 0.052$. Here, $\Delta\nu$ and $\Delta\omega$ are given in the absolute value.

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CLASSIFICATION OF ASTEROIDS APPROACHING MAJOR PLANETS

The number of known asteroids has grown continuously since the first asteroid was discovered in 1801. Approximately 150 000 objects have been discovered up to the present day.

The most interesting asteroids are those moving closer to Earth as they are potentially the most dangerous.

In the 20th century three groups of these asteroids have been identified. They were designated as Amor, Apollo and Aten (the A-A-A group). The probability of getting closer to earth and the condition of each group is different. Similar groups of asteroids can be identified for each of the major planets in the solar system.

We have modelled the asteroids approach with the major planet position shown at intervals from 1600 to 2200 [1, 2]. To produce this solution we used the Everhart method of integration of differential equations of the 17th order [3]. This allowed us to produce a similar classification (AAA) for each planet and to define the most typical conditions.

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THE EARTH MODEL AND MOONS MODEL IN THE FORMALISM OF THE NUMERICAL THEORY DE405

Calculations of the motion path of the celestial bodies are one of the problems of the theoretical astronomy. In case of a simulation motion of the satellites the light pressure and the solar wind must be taken into account. This factors influence the near-Earth and near-Moon orbital motions. It is important for the low satellites since just they regularly hit in the shadow and remain for long.

We set oneself to describe the conditions of the brightness of the Earth and Moon satellites. Toward this end we create the procedure which allows to receive the location and the measurement of the Earth's and the Moon's shadows in the interval from 1600 to 2200 on the basis of the numerical theory DE405. The Earth shadow and the Moon shadow are represented in the form of the elliptic cone at the heart of is meridian section of the spheroid corresponding to celestial body. Furthermore we consider the refraction of the sunlight in the Earth's atmosphere[1].

Circumscribed model was realized on the Delphi 7. We used it for the description of the conditions of the observations of the two near - Moon satellites "Chang'e 1" and "RAE-2". Obtainable efemerises will be supposed for observations in the Nikolaev astronomical observatory.

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ORBITAL EVOLUTION OF THE OUTER SATELLITES OF GIANT PLANETS. METHODS OF ANALYSIS AND RESULTS

The methods and the results of the analysis of the orbital evolution of outer satellites of giant planets are presented. The overwhelming majority of these satellites were discovered in the recent decade. The substantial irregularity of their orbits required the refinement of the already known and the development of new analytical methods for analyzing their long-term evolution. These methods are based on various averaged variants of the Hill problem. The qualitative analyses of these variants earlier performed by N.D.Moiseev, A.A.Orlov, M.L.Lidov, and Y.Kozai, were extended by constructing the general solution of the double averaged Hill problem and by developing a combined numerical-analytical method. In this paper the results obtained by various methods are presented and are compared with those obtained by the most accurate method of numerical integration of the equations of perturbed motion of real satellites of giant planets. The special attention is paid on the satellite orbits with librational behavior of the variation of the argument of the pericenter. This libration is usually associated with the well-known Lidov-Kozai resonance, however, in the case of orbits of three Jovian satellites it is determined by large-amplitude periodic solar perturbations.

We plan (together with N.M.Teslenko) mass computations of the orbital evolution of all hitherto known outer satellites. The aim of these computations is to systematize the data on the ranges of variation of semi-major axes, eccentricities, and inclinations of evolving satellite orbits, and also the data on the periods of nodes precession and periods of precession or libration of the arguments of their pericenters. Graphical visualization of the behavior of the evolution of each orbit would provide us with a sort of an "evolutionary atlas" of the systems of outer satellites. A comparative analysis of various research techniques used allows the domains of applicability to be determined for each method.

This work is supported by RFBR international grants nos. $07-02-92169-NTsNI_a$ and $07-02-91229-YaF$ as well as the grant of scientific school ϵ $NSh-1123.2008.1$.

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OUTBURSTING COMETS 73P AND 17P AS PARENT BODIES OF METEOROID STREAMS

It is well established that most of meteoroid streams are created by the outgasing of comets. Some are also created through the disruption of cometary nuclei, such as 3D/Biela (parent body of the Andromedids). We will present our analysis of comet 73P that fragmented in 1995 and 2006 as well as comet 17P that exploded in 2007. In particular we will show how the ejection velocity can be constrained from infrared observations. Consequences in term of properties of cometary nuclei are derived

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THE SYSTEM OF REMOTE ACCESS TO SAO RAS TELESCOPES

The SAO RAS is the unique large ground center of astronomical researches in the country and it provides for the problems of collective access to the resources of unique scientific tools. The distributed structure at the present stage of development of telecommunication means demands not only data exchange, but also a remote access to experimental complexes, an opportunity of real-time dialogue of researchers, operators, students, teachers.The system of remote access to telescopes of the SAO is based on the fibre-optical technology. It is organized by the program complex of the control of the telescope and the observer Web-interface for passive and active participation in supervision. On the basis of the usage of the video digital equipment a system of round-the-clock sky monitoring, of positioning of the telescope, of monitoring the atmospheric transparency in the telescope vicinities, and a system of TV-guides for updating a telescope position during the supervision has been created. The control system operator and the astronomer receive full information about meteo conditions by means of meteoreceivers. Collecting and outputing the meteodata through the Web-interface on the homepage of the SAO allows to estimate the temperature conditions and speed of the wind. The observer should not only work by means of the special client interface, but also have an opportunity of audio communication with the BTA control system operator. In 2008 in the SAO the remote supervision room for BTA primary focus was made. The level of the development of the telescope and the software automation systems, realized by the present time, allow the cooperating with the telescope remote. The work made in the observatory that was directed to the control and management by complexes of the observant equipment automation, and also to the development of the television complex for granting an operative observant video information from the telescope focuses, allowed to realize a mode of remote supervision in full.

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HARDWARE/SOFTWARE METHODS OF GETTING "ON-LINE" IMAGES TO SUPPLY OBSERVATIONS AT THE 6M OPTICAL BTA TELESCOPE

In SAO RAS a complex of getting "on–line" images for providing observations at large optical telescopes (6m BTA & 1m Zeiss–1000) has been worked out and put into use. This complex is available via Internet and has a remote visual control of large optical telescopes, that allows both operator and astronomer to remote control of state and work of the main telescope systems, pointing, operating and astroclimate conditions in real time.

Input devices of this system are special high sensitivity television cameras. Digitizing of video images is implemented both centralized, with the use of special video server, and by autonomous computers, placed at the telescope foci of BTA and Zeiss–1000. The obtained and processed images are available for scientific analysis from any computer in the local net (and Internet) for all members of observational process, which is an important additional scientific potential that has not been used before.

This work presents the created equipment, new hardware/software methods of receiving and processing images of stellar objects. The worked–out means are given along with the web–interface allowing to have a remote access to the "Live–TV" images of BTA and Zeiss–1000 in real time.

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METEOR STREAMS ASSOCIATED WITH JUPITER FAMILY COMETS

Meteor showers have been observed for a considerable time and the cause, meteoroids from a meteoroid stream ablating in the Earth's atmosphere, has also been understood for centuries. 150 years ago the connection between meteoroid streams and comets was also established. and the exact relationship, dust being eject from the comet during perihelion passage, became clear when Whipple proposed his dirty snowball model for the comet nucleus. Since that date our ability both to understand the physics and to numerically model the situation has steadily increased. Some of the best known, and best modeled, showers such as the Leonids, the Perseids, the Orionids and the η Aquarids are associated with dust from long period comets. In many ways the evolution of these are fairly predictable and uneventful since they very rarely have close encounters with any planet, though some of the meteoroids may be trapped in resonance with Jupiter.

Streams associated with Jupiter Family Comets tend to be less spectacular, but also show much more variety in their behaviour, driven in the main by the gravitational perturbations from Jupiter. Three of these showers have a particularly interest behaviour and history, namely the Draconids, the Taurids and the Quadrantids. In these cases, the association between stream and parent is far from clear. Either the associated comet seems far too small to have released all the observed meteoroids, or indeed is an asteroid, currently releasing no dust. Hence a different history from the simple ejection according to the Whipple model is called for.

These three streams will be discussed individually in some detail.

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INTEGRATION OF HETEROGENEOUS COLLECTIONS OF OBSERVATION DATA INTO THE SAO RAS ARCHIVAL SYSTEM

In 2003 the General Assembly of the International Astronomical Union (IAU) had accepted a resolution about the open web-access to the observation archives of the observatories, financed from the state budget. Nowadays methods of data management and manipulation in astronomy are determined by the standards of the International Alliance Virtual Observatory (IVOA), that impose definite requirements on the level of the organisation of data resources. Unfortunately, there are no endpoint solutions for bringing the raw observation data up to the level required by the IAU and IVOA standards.

SAO RAS has the archive of observations that consists from 16 different digital collections. 20 years ago, when the archive was been started, there were no perfect requirements to the certain parameters of a file with observation data to compared with modern conditions dictated by Internet and software system interoperability. Data preparation for manipulation in a network infrastructure requires significant labor expenses. The archive data re-engineering is conducted step by step, starting from the analysis of the completeness of the necessary parameters in each collection and the correction, where it is possible, of the missing parameters of an observation file.

Now we provide the open web-access to the SAO RAS observations archive. Data requests are realized with the search information system (SIS) based on PostgreSQL server. Each observation file is described in the database tables with more than 60 parameters. They are used for the dynamic formation of web-interface, observation file identification and so on. Relations between parameters of different collections of observation files stored in FITS-format and attributes of the SIS database tables are set up with the thesaurus that contains all available in the archive FITS keywords. This makes it possible to integrate heterogeneous collection in the archive system. There are no hard constraints to file formats in the system and therefore the new local archive addition does not cause difficulties in case sufficiently simple rules in data organisation are executed.

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THE STUDY OF PROBABILITY OF ASTEROID ENCOUNTER WITH A MAJOR PLANET BY MONTE CARLO METHOD

The probability of an asteroid encounter with a major planet can be estimated by Monte Carlo method. The main problem of random choice of initial conditions is the presence of nonzero non-diagonal elements of covariance matrix which are the consequence of correlation between orbit parameters. Since the matrix is symmetrical it can be transformed to diagonal form. In this coordinate frame the value of each coordinate can be generated independently. Then generated initial values for each coordinate are transformed to the initial coordinates frame to be used for numerical calculation of asteroid orbit.

To transform covariance matrix into diagonal form we used well-known technique. At first Hauseholder reduction transforms covariance matrix into tri-diagonal form, and later the QL-algorithm with implicit shift returns the elements of diagonal matrix. The corresponding FORTRAN-subroutines were found at the site of Research Computing Center of Moscow State University [1].

The close approaching of asteroid (99942) Apophis with the Earth in April 13 2029, and 2007 WD_5 with the Mars in January 30 2008 have been researched taking into account the sets of observations giving maximal estimation of encounter probability. Our estimations of probability resemble that of NASA. For considered examples, it is shown, that neglecting the correlations leads to much worse results for predicting probability of collision.

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Contents

Научное издание

ДИНАМИКА ТЕЛ СОЛНЕЧНОЙ СИСТЕМЫ

Сборник материалов
Международной астрономической конференции
27 июля – 1 августа 2008 г.

Оригинал-макет подготовлен
по материалам, представленным
редакционной коллегией сборника

Оригинал-макет редколлегии
Дизайн обложки В.А. Авдюшев

Подписано к печати 01.07.2008 г. Формат 64х80/16.
Бумага офсетная. Гарнитура Times.
Усл. печ. л. 4,65. Тираж 250 экз. Заказ №

Томский государственный университет
634050, г. Томск, пр. Ленина, 36
Участок оперативной ризографии и офсетной печати
Редакционно-издательского отдела ТГУ

ISBN 5-94621-252-4
9 785946 212526