ROMANIAN ACADEMY
ASTRONOMICAL INSTITUTE
CLUJ-NAPOCA BRANCH - ASTRONOMICAL OBSERVATORY
ROMANIAN NATIONAL COMMITTTEE OF ASTRONOMY

"BABEŞ-BOLYAI" UNIVERSITY CLUJ-NAPOCA
FACULTY OF MATHEMATICS AND COMPUTER SCIENCE
FACULTY OF PHYSICS

RECENT DEVELOPMENTS IN ASTRONOMY, ASTROPHYSICS, SPACE AND PLANETARY SCIENCES

International Conference, 27-29 May 2019, Cluj-Napoca

Programme

In the framework of Cluj Academic Days 2019

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FACULTY OF MATHEMATICS AND COMPUTER SCIENCE
FACULTY OF PHYSICS

In the framework of Cluj Academic Days 2019

Monday, May 27th 2019

Astronomical Observatory Cluj-Napoca
Str. Cireşilor nr. 19

9:30

Registration

10:00

Plenary session 1
Chairman: Vlad TURCU

Ferenc SZENKOVITS
Faculty of Mathematics and Computer Science, Babeş-Bolyai University, Cluj-Napoca, Romania
The Jesuit astronomers Nicolaus Ianosi and Maximilian Hell in Cluj

Tiberiu HARKO[1,2,3]
[1]Department of Physics, "Babeș-Bolyai" University, Cluj-Napoca, Romania
[2]School of Physics, Sun Yat-Sen University, Guangzhou, People's Republic of China
[3]Department of Mathematics, University College London, London, United Kingdom
The geometric trinity of gravity: one in three, or three in one?

Zoltán KERESZTES
Theoretical Department of Physics at the University of Szeged, Hungary
The motion and spin evolution of extended bodies in rotating black hole spacetimes

Coffee & tea break

12:00

Plenary session 2
Chairman: Tiberiu HARKO

Bence RACSKÓ, László Á. GERGELY
University of Szeged, Hungary

Null shells in kinetic gravity braiding scalar-tensor theories

Bogdan DĂNILĂ, Gabriela BLAGA, Vlad TURCU
Romanian Academy, Cluj-Napoca Branch, Astronomical Observatory, Cluj-Napoca, Romania

On the degradation of magnetic field measurements due to "the new thermomagnetic effect". Theory and simulations

Diana BEŞLIU-IONESCU [1,2], Dan Alin NEDELCU [1
[1]Astronomical Institute of the Romanian Academy, Bucharest, Romania
[2]Institute of Geodynamics „Sabba S. Ştefănescu" of the Romanian Academy

Analysis of Correlations between the Orbital Decay of Vanguard Satellites and Solar Activity

14:30

Lunch

16:30

Plenary session 3
Chairman: Cristina BLAGA, Alexandru MARCU

Carolina OPINCA
Faculty of Mathematics and Computer Science, Moldova State University, Chișinău, Republic of Moldova
Astronomical computation and data with Wolfram technologies

Radu Dan CAPITAN
Astronomical Institute of the Romanian Academy, Bucharest, Romania
Spatial Interaction Modeling of Star Clusters in M83 Galaxy

Coffee & tea break

18:00

Plenary session 3 continuation

M. YOUSEFI[1], C. WACHIURI[1], V. PALITHARATHNA[1], M. HAMDY[1], B. TLILI[1], M. BĂRBOSU[2], W. A. SAMAD[1]
[1]Rochester Institute of Technology – Dubai, UAE
[2]Rochester Institute of Technology – New York, USA
Thermal protection system for the reentry capsule module of a cubesat

Ioana BOACĂ [1], Simon ANGHEL [1,3], Mădălina TRELIA [4], Dan Alin NEDELCU [1,2], Mirel BÎRLAN [2,1]
[1]Astronomical Institute of the Romanian Academy, Bucharest, Romania
[2] Institut de Mécanique Céleste et des Calculs des Éphémérides, CNRS UMR8028, Observatoire de Paris, PSL Research University, Paris, France
[3]Faculty of Physics, University of Bucharest, Ilfov, Romania
[4] Romanian Space Agency, Bucharest, Romania
The current status of MOROI network. Astrometric reduction of multistation events and meteoroids orbits

19:00

Poster session 1

19:30

Dine Around

Tuesday, May 28th 2019

Astronomical Observatory Cluj-Napoca
Str. Cireşilor nr. 19

10:00

Plenary session 4
Chairman:Dan Alin NEDELCU

Ákos BAZSÓ, Elke PILAT-LOHINGER
University of Vienna, Department of Astrophysics, Vienna, Austria

A multi-parameter survey of secular perturbations in circumstellar planetary systems of binary star

Alexandru POP
Romanian Academy, Cluj-Napoca Branch, Astronomical Observatory, Cluj-Napoca, Romania

The signature of precession on the Light Travel Time Effect in variable stars with unseen companions

Adrian ȘONKA[1,2⋆], Mirel BÎRLAN[3,1], Andreea GORNEA[1], Ioana BOIAN[1
[1]Astronomical Institute of Romanian Academy, Cutitul de Argint, 040557 Bucharest, Romania
[2]Faculty of Physics, University of Bucharest, 405 Atomistilor, 077125 Magurele, Ilfov, Romania
[3]IMCCE, Observatoire de Paris 77 av Denfert Rochereau, 75014 Paris Cedex, France

Photometry of selected NEA sample in Bucharest

Coffee & tea break

12:00

Plenary session 5
Chairman: Mihail BĂRBOSU

M. BÎRLAN[1,2], A. ŞONKA[1,3], D. A. NEDELCU[2,1], M. BĂLAN[4], S. ANGHEL[1,3], C. PANDELE[4], M. TRUȘCULESCU[4], C. DRĂGĂȘANU[4], V. PLESCA[5,6], C. H. GANDESCU[5,6], C. BANICA[5,6], T. GEORGESCU[7
[1]IMCCE, Observatoire de Paris, France
[2]Romanian Academy, Astronomical Institute, Bucharest, Romania
[3]Bucharest University, Romania
[4]ISS, Romania
[5]Wing Computer, Romania
[6]FEE, Politehnica University, Romania
[7]Elcos Proiect, Romania
Optical asset on mobile platform

Alexandru POP [1, Maria CRĂCIUN [2, Vlad TURCU [1
[1 Romanian Academy – Cluj-Napoca Branch, Astronomical Institute, Astronomical Observatory Cluj-Napoca, Cluj-Napoca, Romania
[2 Romanian Academy – Cluj-Napoca Branch, "T. Popoviciu" Institute of Numerical Analysis, Cluj-Napoca, Romania
Detection of a low level period variability in the pulsating star SZ Lyncis

Simon ANGHEL[1,3], Dan Alin NEDELCU[1,2], Mirel BÎRLAN[2,1] , Ioana BOACĂ[1
[1]Astronomical Institute of the Romanian Academy, Bucharest, Romania
[2]Institut de Mécanique Céleste et des Calculs des Éphémérides, CNRS UMR8028, Observatoire de Paris, PSL Research University, Paris, France
[3]Faculty of Physics, University of Bucharest, Ilfov, Romania
Photometry of all-sky cameras: preliminary results for MOROI network

14:30

Lunch

16:30

Plenary session 6
Chairman: Alexandru POP, Mirel BÎRLAN

Cecília GERGELY, Zoltán KERESZTES, László Á. GERGELY
University of Szeged, Hungary

Gravitational dynamics in a 2+1+1 decomposed spacetime along nonorthogonal double foliations: Hamiltonian evolution and gauge fixing

Cristina BLAGA [1, Paul BLAGA [1, Tiberiu HARKO[2,3,4
[1Faculty of Mathematics and Computer Science, Babeş-Bolyai University, Cluj-Napoca, Romania
[2Department of Physics, "Babeș-Bolyai" University, Cluj-Napoca, Romania
[3School of Physics, Sun Yat-Sen University, Guangzhou, People's Republic of China
[4Department of Mathematics, University College London, London, United Kingdom

Jacobi stability analysis of the circular restricted three body problem with drag forces

Coffee & tea break

18:00

Plenary session 3 continuation

Maria CRĂCIUN[1, Tiberiu HARKO[2,3,4
[1Tiberiu Popoviciu Institute of Numerical Analysis, Romanian Academy,Cluj-Napoca,
[2Department of Physics, "Babeș-Bolyai" University,Cluj-Napoca, Romania
[3School of Physics, Sun Yat-Sen University, Guangzhou, People's Republic of China
[4Department of Mathematics, University College London, London, United Kingdom

Galactic rotation curves in Bose-Einstein Condensate dark matter models

Vlad TURCU [1, Octavian CRISTEA [2, Dan MOLDOVAN [1, Paul DOLEA[2
[1 Romanian Academy, Cluj-Napoca Branch, Astronomical Observatory, Cluj-Napoca, Romania
[2 BITNET CCSS Cluj-Napoca, Str. Madach Imre, Nr. 6, Cluj-Napoca, Romania.

Observation and Validation Experiments in Medium Earth Orbits

19:00

Poster session 2

19:30

Dine Around

Wednesday, May 29th 2019

Astronomical Observatory Cluj-Napoca
Str. Cireşilor nr. 19

10:00
Masa Rotundă
(Round Table)

Corelarea învățământului astronomic cu evoluția cercetării astronomice în România (Correlation between education in astronomy with astronomical scientific research in Romania)

Moderatori (Moderators): Mirel BÎRLAN, Ferenc SZENKOVITS

Coffee & tea break

12:30

Conference concluding remarks

Dan Alin NEDELCU, Vlad TURCU

ABSTRACTS

ORAL PRESENTATIONS

Plenary session 1

Title: The Jesuit astronomers Nicolaus Ianosi and Maximilian Hell in Cluj

Author: Ferenc SZENKOVITS
Faculty of Mathematics and Computer Science, Babeş-Bolyai University, Cluj-Napoca, Romania

Abstract: With the development of the University of Cluj in the 18th century, science became increasingly important. In this trend, astronomy had an important role. As a result, the establishment of the Astronomical Observatory became necessary. In the astronomical education and in the planning of the Cluj-Napoca Astronomy Observatory, the central role was played by two Jesuits: Nicolaus Ianosi (1701-1741) and Maximilian Hell (1720-1792). Ianosi and Hell spent only a few years in Cluj, but their work was decisive for the development of astronomy in Cluj. Our purpose is to present the works of these two great Jesuits in Cluj.

Title: The geometric trinity of gravity: one in three, or three in one?

Author: Tiberiu HARKO[1,2,3]
[1]Department of Physics, "Babeș-Bolyai" University, Cluj-Napoca, Romania
[2]School of Physics, Sun Yat-Sen University, Guangzhou, People's Republic of China
[3]Department of Mathematics, University College London, London, United Kingdom

Abstract: The geometrical nature of gravity is a direct consequence of the universality contained in the equivalence principle. In the usual formulation of General Relativity, the geometrisation of gravity is performed in terms of the spacetime curvature, an approach which is now the standard description of gravity. However, this is not the only possibility for a geometric interpretation of the gravitational interaction. We discuss some alternative, though equivalent, formulations of General Relativity, in which gravity is fully described either by torsion or by non-metricity. Hence at the theoretical level three apparently unrelated representations of the same underlying theory do exist. We also present in some detail the geometric description of the gravitational field in terms of the non-metricity.

Title: The motion and spin evolution of extended bodies in rotating black hole spacetimes

Author: Zoltán KERESZTES
Theoretical Department of Physics at the University of Szeged, Hungary

Abstract: The evolution of extended spinning bodies is governed by the Mathisson-Papapetrou-Dixon (MPD) equations. The MPD system becomes closed with a spin supplementary condition. In this presentation the spin dynamics is investigated with both the Frenkel-Mathisson-Pirani and the Tulczyjew-Dixon spin supplementary conditions. The spinning body moves in a rotating black hole (BH) spacetime given by either the Kerr or a regular BH geometry. The model can describe black hole binary systems with small mass ratio which can be the source for gravitational waves in the frequency sensitivity range of the planned LISA - Laser Interferometer Space Antenna.
We present the analytical description of spin vector dynamics in both the comoving and zero 3-momentum frames. Two families of fundamental observers are used for obtaining the frame vectors. Outside the ergosphere the frame vectors are obtained from the frames of the static and the zero angular momentum observers by instantaneous boost transformations. The two sets of frame vectors are related to each other by a spatial rotation. The corresponding rotation angle is negligible far from the black hole. Inside the ergosphere only the boosted zero angular momentum frame can be used for describing the spin evolution, because static observers do not exist there. We present numerical examples for spinning bodies moving on spherical, unbound and zoom-whirl orbits and investigate the spin precessional angular velocity.

Plenary session 2

Title: Null shells in kinetic gravity braiding scalar-tensor theories

Authors: Bence RACSKÓ, László Á. GERGELY
University of Szeged, Hungary

Abstract: Despite the myriad of successes of Einstein's General Relativity (GR), its modifications are heavily researched, as on galactic and larger scales, GR is predictive only if one assumes the existence of dark matter and dark energy, for now unknown, exotic forms of matter. Since they interact only gravitationally with baryonic matter, it is reasonable to try to explain their presence by modifying GR on large scales. One of the simplest, yet most flexible class of modified gravity theories are scalar-tensor theories, where a scalar field is coupled nonminimally to the metric tensor (Jordan frame) or coupled conformally or disformally to matter (Einstein frame). The most general scalar-tensor theory of second order equations of motion in four dimensions is Horndeski's theory with four arbitrary functions of the scalar field and its kinetic term. Recent observations have confirmed the propagation of gravitational waves with the speed of light, which casts stringent constraints on the quintic and quartic sector of Horndeski theory. The remaining part is called kinetic gravity braiding theory. This class of scalar-tensor theories is thus compatible with all measurements, and the nonlinear cubic derivative self-interaction in the action can suppress the scalar field's effect on short scales via the Vainshtein mechanism, hence the theory serves as a good candidate for modelling dark energy. There exists a plenitude of phenomena best modelled by assuming sharp transitions of matter content or spacetime geometry through a boundary hypersurface, such as stellar boundaries, event horizons, shock waves and phase transitions. In GR, the coincidence of the extrinsic curvatures as calculated from the two sides is prescribed to ensure a smooth transition, however discontinuous extrinsic curvatures are also allowed if an infinitely dense layer of matter (a thin shell) is present on the surface. In this case, the Lanczos equation relates the jump of the extrinsic curvature to the distributional source. The above procedure, due to Israel, fails when the hypersurface is null, which is the case for event horizons and impulsive waves. The correct description of general shells was given by Barrabés and Israel, and later specialized to the case of null shells by Poisson, arriving at simpler but somewhat less generic equations. In Horndeski theory, the boundary conditions were calculated by Padilla and Sivanesan for timelike shells, however the null case is unknown. We present our work [B. Racskó, L. Á. Gergely, *Symmetry* 2019, 11(5), 616] on the analogue of the Lanczos equation for null shells in a subclass of kinetic gravity braiding with linear dependence on the kinetic term.

Title: On the degradation of magnetic field measurements due to "the new thermomagnetic effect". Theory and simulations

Authors: Bogdan DĂNILĂ, Gabriela BLAGA, Vlad TURCU
Romanian Academy, Cluj-Napoca Branch, Astronomical Observatory, Cluj-Napoca, Romania

Abstract: Background/context: When a metal is subjected to a temperature gradient, an electric current will appear. This electric current in turn leads to the formation of a magnetic field which introduces errors (disturbances) in magnetic field measurements.
Methods: The issue of magnetometer data degradation is analyzed both theoretically and by simulations in a series of increasingly complex layered metal and insulator configurations.
Results: A theoretical formula appropriate for calculating the disturbance magnetic field in simple configurations is derived. A simulation tool for complex configurations is set up. The analytical and simulation results are consistent with each other and with observational data.

Title: Analysis of Correlations between the Orbital Decay of Vanguard Satellites and Solar Activity

Authors: Diana BEŞLIU-IONESCU [1,2], Dan Alin NEDELCU [1
[1]Astronomical Institute of the Romanian Academy, Bucharest, Romania
[2]Institute of Geodynamics „Sabba S. Ştefănescu" of the Romanian Academy

Abstract: Solar activity has a cycle of ~12 years length. It influences the plasma state of the Earth atmosphere differently as a function of its phase. Long term variations of the orbits for two Vanguard satellites, ones of the longest orbiting objects, are studied during solar cycles 20 to 24. Temporal correlation between orbit decays and solar activity cyclicity are analysed. The correlation coefficient is presented and as well as its statistical significance.

Plenary session 3

Title: Astronomical computation and data with Wolfram technologies

Author: Carolina OPINCA
Faculty of Mathematics and Computer Science, Moldova State University, Chișinău, Republic of Moldova

Abstract: Wolfram Research is a worldwide information technology company focused on advanced computing performance, supporting knowledge generation process to achieve continuous improvement and innovation in education and research. The Wolfram astronomy services provides a wide range of astronomical data types for computing and research on physical objects such as planets, stars, planetary systems and artificial satellites. The knowledgebase used in WolframAlpha is continuously curated and updated with space and astronomy data ranging from natural phenomena to human-created technologies and provides many astrophysical formulas to study properties of celestial bodies.

Title: Spatial Interaction Modeling of Star Clusters in M83 Galaxy

Author: Radu Dan CAPITAN
Astronomical Institute of the Romanian Academy, Bucharest, Romania

Abstract: Spatial modeling in Astronomy can benefit from visualization and data manipulation techniques using Geographic Information Systems (G.I.S.) tools. Preliminary analysis of stellar population characteristics using electro-magnetic radiation that is emitted in different wavelengths shows a spatial aggregation model of stellar clusters that are hierarchically organized near the galaxy's spiral arms. Current research aims to use G.I.S. techniques to identify stellar clusters and help clarify which mathematics and astronomical model can be applied to the role of stellar clustering in galaxy spiral arm formation: either (i) a gravitational aggregation model (density wave theory), or (ii) a model that describe the inhomogeneity theory in which secular resonance of stellar fields creates differences in density across space and produces the stability of the galaxy's spiral arms.

Title: Thermal protection system for the reentry capsule module of a cubesat

Authors: M. YOUSEFI[(1], C. WACHIURI[1], V. PALITHARATHNA[(1], M. HAMDY[(1], B. TLILI[(1], M. BĂRBOSU[(2], W. A. SAMAD[(1]
[(1]Rochester Institute of Technology – Dubai, UAE
[(2]Rochester Institute of Technology – New York, USA

Abstract: This paper deals with a reentry capsule module inside a 10 cm×10 cm×10 cm×10 cm Cubesat. For this capsule we performed a full aerothermodynamic analysis, combining an analytical approach with a computational one. After a fluid dynamics (CFD) analysis, data was used to design a thermal protection system from scratch, using different alloys and Phenolic Impregnated Carbon Ablator (PICA) as the ablative heat shield. The capsule features a pressurized and non-pressurized section allowing for pressure sensitive equipment and samples of interest to be safely sent to orbit and returned back to Earth.

Title: The current status of MOROI network. Astrometric reduction of multistation events and meteoroids orbits

Authors: Ioana BOACĂ [1, Simon ANGHEL [1,3, Mădălina TRELIA [4, Dan Alin NEDELCU [1,2, Mirel BÎRLAN [2,1
[1 Astronomical Institute of the Romanian Academy, Bucharest, Romania
[2 Institut de Mécanique Céleste et des Calculs des Éphémérides, CNRS UMR8028, Observatoire de Paris, PSL Research University, Paris, France
[3 Faculty of Physics, University of Bucharest, Ilfov, Romania
[4 Romanian Space Agency, Bucharest, Romania

Abstract: The MOROI network recorded 104 double, 13 triple and one quadruple meteor events up to May 2019. Here we present the latest astrometric pipeline, from all-sky image calibration to atmospheric trajectory reconstruction. The meteoroid orbits are numerically integrated in the framework of an accurate model of the Solar System in order to identify their plausible source regions and parent bodies.

Plenary session 4

Title: A multi-parameter survey of secular perturbations in circumstellar planetary systems of binary stars

Authors: Ákos BAZSÓ, Elke PILAT-LOHINGER
University of Vienna, Department of Astrophysics, Vienna, Austria

Abstract: Binary stars are ubiquitous in the solar neighbourhood. Detected exoplanets are not exclusive companions to single stars, but also exist in binary and multiple star systems. However, binary systems are harsh environments for the formation and long-term stability of extrasolar planets, because circumstellar planets are subject to periodic perturbations from the distant secondary star. Orbital dynamics is an important ingredient to assess planetary habitability, so we need to consider the effect of both mean-motion resonances and secular resonances on a habitable planet's orbit. We combine two analytical models [1,2] for the investigation of the secular evolution of exoplanets in the habitable zone (HZ), and quantify the effect of various system parameters (masses, distances, eccentricities) on the occurrence and position of secular resonances. Such perturbations even appear for very distant secondary stars (up to 500 au), which previously were believed to be an unimportant factor to any circumstellar planetary systems.

These new results in combination with previous studies [3,4] allow to quickly identify exoplanetary systems with perturbed habitable zones and to exclude them from in-depth observational programs and habitability analyses.

References:
[1] Andrade-Ines, Eggl (2017), AJ 153, p.148.
[2] Murray, Dermott (1999), Solar System Dynamics, Cambridge Univ. Press.
[3] Pilat-Lohinger, Bazso, Funk (2016), AJ 152, p.139.
[4] Bazso, Pilat-Lohinger, Eggl, et al. (2017), MNRAS 466, p.1555.

Title: The signature of precession on the Light Travel Time Effect in variable stars with unseen companions

Author: Alexandru POP
Romanian Academy, Cluj-Napoca Branch, Astronomical Observatory, Cluj-Napoca, Romania

Abstract: The precession in binary systems with variable components induces a specific signature in the modulation of the orbital period in addition to that caused by the well-known Light Travel Time Effect. The specific pattern which is expected to be found in the amplitude spectrum of the respective *O-C* diagrams is described.

Title: Photometry of selected NEA sample in Bucharest

Authors: Adrian ȘONKA[1,2⋆], Mirel BÎRLAN[3,1], Andreea GORNEA[1], Ioana BOIAN[1
[1]Astronomical Institute of Romanian Academy, Cutitul de Argint, 040557 Bucharest, Romania
[2]Faculty of Physics, University of Bucharest, 405 Atomistilor, 077125 Magurele, Ilfov, Romania
[3]IMCCE, Observatoire de Paris 77 av Denfert Rochereau, 75014 Paris Cedex, France

Abstract: We present photometric data for 26 NEAs during a three-year observational survey from The Astronomical Institute of the Romanian Academy. Our data is used to determine the rotational period of NEAs and to confirm previous results. We present data for five NEAs which are possible sources for meteor showers and 16 NEAs with Δv lower than 12 km·s−1. For some objects we could only estimate a possible minimum rotational period. Phase curves for eight asteroids are also reported.

Plenary session 5

Title: Optical asset on mobile platform

Authors: M. BÎRLAN[1,2], A. ŞONKA[1,3], D. A. NEDELCU[2,1], M. BĂLAN[4], S. ANGHEL[1,3], C. PANDELE[4], M. TRUȘCULESCU[4], C. DRĂGĂȘANU[4], V. PLESCA[5,6], C. H. GANDESCU[5,6], C. BANICA[5,6], T. GEORGESCU[7]
[1]IMCCE, Observatoire de Paris, France
[2]Romanian Academy, Astronomical Institute, Bucharest, Romania
[3]Bucharest University, Romania
[4]ISS, Romania
[5]Wing Computer, Romania
[6]FEE, Politehnica University, Romania
[7]Elcos Proiect, Romania

Abstract: The ephemerides of Near-Earth Objects (NEOs) and artificial objects orbiting around Earth need to be improved continuously. Rapid response optical assets are ideal for the accomplishment of surveillance and tracking of these objects. The increasing importance is addressed to space debris because of the increasing of space activities during the last decade. The lecture enlarges the development of concept for a mobile optical asset [Birlan et al., RoAJ 2018] which will be used for both artificial objects and Near-Earth Object observations. A new solution using the same mount for two telescopes pointing simultaneously the same region of the celestial sphere will be presented.

Title: Detection of a low level period variability in the pulsating star SZ Lyncis

Authors: Alexandru POP [1], Maria CRĂCIUN [2], Vlad TURCU [1]
[1] Romanian Academy, Cluj-Napoca Branch, Astronomical Observatory, Cluj-Napoca, Romania
[2] Romanian Academy – Cluj-Napoca Branch, "T. Popoviciu" Institute of Numerical Analysis, Cluj-Napoca, Romania

Abstract: The high amplitude δ Scuti star SZ Lyncis is already known to be component of a spectroscopic binary system. The Light Travel Time Effect (LTTE) displayed by its *O-C* diagram was already studied by different authors. In the present study we analysed all the photoelectric and CCD times of maximum light of SZ Lyncis. After removing the modulation due to the LTTE, we detected the presence of a statistically significant low amplitude period modulation with a periodicity of about 40 years. The possible causes of this phenomenon are discussed.

Title: Photometry of all-sky cameras: preliminary results for MOROI network

Authors: Simon ANGHEL[1,3], Dan Alin NEDELCU[1,2], Mirel BÎRLAN[2,1], Ioana BOACĂ[1]
[1]Astronomical Institute of the Romanian Academy, Bucharest, Romania
[2]Institut de Mécanique Céleste et des Calculs des Éphémérides, CNRS UMR8028, Observatoire de Paris, PSL Research University, Paris, France
[3]Faculty of Physics, University of Bucharest, Ilfov, Romania

Abstract: During a long-term analysis of MOROI all-sky images, along with meteor data, we can estimate the number of photometric nights and the annual trend of atmospheric extinction parameters. The advantages listed above come with a series of challenges, unique for each hardware and software configuration, that need to be solved. We address these challenges for MOROI network, and we outline a new set of routines for handling the photometric data.

Plenary session 6

Title: Gravitational dynamics in a 2+1+1 decomposed spacetime along nonorthogonal double foliations: Hamiltonian evolution and gauge fixing

Authors: Cecília GERGELY, Zoltán KERESZTES, László Á. GERGELY
University of Szeged, Hungary

Abstract: Motivated by situations with temporal evolution and spatial symmetries both singled out, we develop a new 2+1+1 decomposition of spacetime, based on a nonorthogonal double foliation. Time evolution proceeds along the leaves of the spatial foliation. We identify the gravitational variables in the velocity phase-space as the 2-metric (induced on the intersection $\Sigma_{t\chi}$ of the hypersurfaces of the foliations), the 2+1 components of the spatial shift vector, together with the extrinsic curvature, normal fundamental form and normal fundamental scalar of $\Sigma_{t\chi}$, all constructed with the normal to the temporal foliation.

Our work [C. Gergely, Z. Keresztes, L. Á. Gergely, *Phys. Rev. D*, in press (2019)] generalizes a previous decomposition based on orthogonal foliations, a formalism lacking one metric variable, now reintroduced. The new metric variable is related (i) to the angle of a Lorentz-rotation between the nonorthogonal bases adapted to the foliations, and (ii) to the vorticity of these basis vectors.

As a first application of the formalism, we work out the Hamiltonian dynamics of general relativity in terms of the variables identified as canonical, generalizing previous work. As a second application we present the unambiguous gauge fixing suitable to discuss the even sector scalar-type perturbations of spherically symmetric and static spacetimes in generic scalar-tensor gravitational theories, which has been obstructed in the formalism of orthogonal double foliation.

Title: Jacobi stability analysis of the circular restricted three body problem with drag forces

Authors: Cristina BLAGA [1, Paul BLAGA [1, Tiberiu HARKO[2,3,4
[1Faculty of Mathematics and Computer Science, Babeş-Bolyai University, Cluj-Napoca, Romania
[2Department of Physics, "Babeș-Bolyai" University, Cluj-Napoca, Romania
[3School of Physics, Sun Yat-Sen University, Guangzhou, People's Republic of China
[4Department of Mathematics, University College London, London, United Kingdom

Abstract: The restricted three body problem, which considers the motion of an infinitesimal particle due to the gravitational attraction of two massive primaries moving on circular orbits about one another is a very useful model for the investigation of the behavior of real astronomical objects in the Solar System. In such a system there are five Lagrange equilibrium points, and one important characteristics of the motion is the existence of stable equilibria at the two points that form equilateral triangles with the primaries in the plane of the primaries' orbit. We analyze the stability of the equations of motion in the restricted three body problem by using the Jacobi stability analysis, the Kosambi-Cartan-Chern (KCC) theory, a differential geometric theory of the variational equations for the deviation of the whole trajectory to nearby ones.

Title: Galactic rotation curves in Bose-Einstein Condensate dark matter models

Authors: Maria CRĂCIUN[1, Tiberiu HARKO[2,3,4
[1Tiberiu Popoviciu Institute of Numerical Analysis, Romanian Academy,Cluj-Napoca,
[2Department of Physics, "Babeș-Bolyai" University,Cluj-Napoca, Romania
[3School of Physics, Sun Yat-Sen University, Guangzhou, People's Republic of China
[4Department of Mathematics, University College London, London, United Kingdom

Abstract: In this paper we study the properties of the galactic rotation curves in the hypothesis of a Bose-Einstein Condensate dark matter model, with quadratic self-interaction, by using more than one hundred galaxies from the Spitzer Photomery & Accurate Rotation Curves (SPARC) data.

Title: Observation and Validation Experiments in Medium Earth Orbits

Authors: Vlad TURCU [1, Octavian CRISTEA [2, Dan MOLDOVAN [1, Paul DOLEA[2
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Abstract: We describe some observation and validation experiments for GNSS satellites using optical sensors at Astronomical Observatory Cluj, Feleacu Station and BITNET CCSS, Mărișel Station during the last 4 years. We outline the methods for the calculation of differences between angular positions measurements made by a telescope and angular positions derived from IGS radio ranging network data. The "O-C" differences for the available data sets are in the range of few arc seconds, within the expected limits for the performance of the observational equipment used. The outcomes of the past experiments are considered for the future SST observation and validation experiments in MEO, GEO and HEO.

POSTER PRESENTATIONS

Title: The dynamics of some orbits in the triangular and rhomboidal four-body problem

Authors: Brahim BENHAMMOUDA[1], Abdalla MANSUR[1], Muhammad SHOAIB[1], Iharka SZÜCS-CSILLIK[2]
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Abstract: In this paper, we have considered the Poincaré surface of section for the study of dynamics of some orbits in the triangle and rhomboidal four-body problem. It is assumed that in the first case, three equal masses are arranged on the vertices of an isosceles triangle and the fourth mass is on the axis of symmetry inside the triangle, and in the second case two equal masses are align on the horizontal axis and the other two masses are on the vertical axis (it is not necessary to be equal). The methodology consists of modelling the above mentioned problems through introducing the Hamiltonian formalism, studying the equations of motion, then using the Poincaré map to analyzing the periodic, quasiperiodic orbits of the original system in a lower dimensional state space give some examples to better understand the behavior of the system from different perspective.

Title: The revolution of Copernicus

Author: Doina IONESCU
Romanian Academy, Astronomical Institute, Bucharest, Romania

Abstract: This paper is a short presentation of Copernicus' cosmology .We put with an emphasis on the fact that Nicolaus Copernicus was the last astronomer of the Middle Ages, who relied more on study of the ancients than on the direct observation of nature, and at the same time the first astronomer of the modern times, the one who put an end to Ptolemy's domination in astronomy and set up a new heliocentric system.

Title: On the Taurus constellation

Author: Doina IONESCU
Romanian Academy, Astronomical Institute, Bucharest, Romania

Abstract: This paper is a brief presentation of the Taurus constellation as analyzed by renowned astronomers, like Camille Flammarion by comparison with the way it was interpreted by the Romanian folk people.

Title: An analytic study of exponential-type potentials

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Abstract: The exponential law appears nowadays in lots of models of the real world, and it has accompanied the human knowledge for a very long time. Among the corrections proposed to the original *1/r* Newtonian potential, there are ones which contain exponential terms. We accomplish an analytical study of such exponential-type potentials, including those proposed by Seeliger and Neumann. We give a complete description of the potentials, for the entire range of the parameters involved.

Title: 132 years of the Astronomical Observatory in Belgrade

Author: Nataša TODOROVICI
Astronomical Observatory of Belgrade, Belgrade, Serbia

Abstract: Astronomical observatory in Belgrade was established in 1887 by a Serbian astronomer and enthusiast Milan Nedeljkovic. In the following decades this observatory grew into a eminent research institute and remains the only astronomical institution in Serbia. Today the Astronomical observatory in Belgrade engages 35 researches working on observation, numerical simulation, data processing and theoretical work in different fields of astronomy. In this presentation we give a short review of the historical and scientific development of this research institute.

Title: Tracking some space debris around the earth

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Abstract: Tracking and monitoring the artificial satellites around the Earth is very important, especially in the last phase when they become space debris. The importance of tracking space debris is to know that debris when and where falls out of the sky. These predictions are not precise, because the motion of the space debris depends from various forces in the field of action that are shaping its trajectory. On the other hand, monitoring and modeling the artificial satellites' motion will improve the estimation of orbital parameters. Through these improvements, the numerical integrators used to predict decay will optimize, and can provide a more accurate indicator. Firstly, we studied the equations of motion of an artificial satellite under the perturbation forces, and secondly, as an application, we integrated 56 space debris' motion part of the *Microsat-R* earth observing satellite served as target for Indian anti-satellite experiment on March 27, 2019.

Title: Functional fuzzy systems for forecasting the sunspot number

Author: Remus BOATĂ
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Abstract: The Sun, our star, has a cyclic activity with an important influence on the space weather. The solar activity can be quantified very well by using the Wolf sunspot number, introduced in 1848 by R. Wolf [M. Stix, The Sun. An Introduction. Second Edition, Springer-Verlag Berlin Heidelberg, New York, 2002]. This measure can be forecasted using tools inside the traditional statistics. As an alternative, the artificial intelligence techniques can become a useful instrument for forecasting sunspot number. In many cases, the artificial intelligence methods present an improved accuracy. For example, the fuzzy sets theory [L. A. Zadeh, Inf Control 8, 338-353, 1965], a component of the artificial intelligence techniques, was applied with success in this research area. This paper describes a new model based on Takagi-Sugeno fuzzy systems [T. Takagi, M. Sugeno, Systems Man Cybernet 15, 116 – 132, 1985] for forecast the sunspot number. A detailed description of model construction methods are presented in this paper. An acceptable level of accuracy obtained by using this new fuzzy model is demonstrated.

Title: Two-site optical observation of earth satellites at Astronomical Observatory of Cluj-Napoca

Authors: Vlad TURCU, Dan MOLDOVAN, Iharka SZÜCS-CSILLIK, Liviu MIRCEA, Tiberiu OPROIU
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Abstract: The paper deals with the determination of geocentric positions of Earth artificial satellites by means of synchronous optical observations (CCD) from two stations. An application is made for *Navstar 38* satellite (COSPAR ID: 1996-041-A). We can conclude that the orbit determination obtained from the two-site observation is more accurate than the orbit determination by Gauss method with the one-site observation.

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