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Phase-space model of a collisionless stellar cylinder embedded in a rotating halo

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Abstract. The phase-space model of a stellar cylindrical bar embedded in a rotating triaxial halo is constructed. The equations of motion of an individual star in the bar are derived and solved. The model has three integrals of motion and the condition of the cylinder boundary conservation is derived. The model is found to represent a four-dimensional ellipsoid in six-dimensional phase space. The phase-space distribution function of stars is derived, which depends on isolating integrals of motion. The centroid velocity field describes longitudinal shear averaged flows in the cylinder. Two non-zero components of the velocity dispersion tensor depend quadratically on coordinates and vanish at the surface of the cylindrical bar.

Key words: first integrals of motion – phase models of galaxies

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Symbolic dynamics, mixing and entropy in the three-body problem

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Abstract. We use symbolic dynamics in the classic equal-mass free-fall three-body problem. Different methods for constructing symbolic sequences (in the process of numerical integration of trajectories) allow one to demonstrate (and illustrate on the Agekian-Anosova map) sensitivity to initial conditions, estimate entropies (Shannon, Markov and others), plot binary collision curves, reveal systems with intensive triple interactions (interplay), etc.

Key words: celestial mechanics – stars: kinematics and dynamics

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Estimating the vertical disk scale height using young galactic objects

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Abstract. We compiled published data on young Galactic objects such as masers with VLBI-measured trigonometric parallaxes, OB associations, H II regions and Cepheids. We have recently established that the vertical disk scale height is strongly influenced by objects of the Local arm. In this study we use samples that do not contain objects in this arm and derive the following vertical disk scale heights in terms of the self-gravitating isothermal disk model for the density distribution: $h = 46 \pm 5$ pc for 69 masers with trigonometric parallaxes, $h = 36 \pm 3$ pc for 59 OB associations, $h = 35.6 \pm 2.7$ pc for 147 H II regions, $h = 52.1 \pm 1.9$ pc for 195 young Cepheids, and $h = 72.0 \pm 2.3$ pc for 192 old Cepheids.

Key words: ISM: structure – Galaxy (Milky Way): kinematics and dynamics

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Kernel density estimation in the study of star clusters

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Abstract. The kernel estimator method is used to evaluate the surface and spatial star number density in star clusters. Both density maps and radial density profiles are plotted. These estimates are used to derive the cluster size, the number of cluster stars and the cluster mass, and to study the cluster structure. The kernel estimator is also used to plot the luminosity function, mass function, the velocity distribution, and Hess diagrams for star clusters. The advantages of the kernel estimator method and technical details of its use are illustrated by modern results for the open cluster NGC 4337.

Key words: methods: statistical – globular clusters: general – open clusters and associations: general

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Photometric study of the Seyfert galaxy NGC 4151

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Abstract. The results of CCD photometry in the Johnson-Morgan BVR system for the Seyfert galaxy NGC 4151 are reported. The observations were carried out from November 15, 2013 to May 13, 2016 with the 1 m telescope of Tien-Shan Astronomical Observatory of the Fesenkov Astrophysical Institute. An analysis of the light curve of NGC 4151 shows that over the time interval considered the brightness of the object varied synchronously in the three filters with the following amplitudes: $\Delta B = 0.68$ mag, $\Delta V = 1.09$ mag and $\Delta R = 1.81$ mag.

Key words: galaxies: Seyfert – galaxies: individual (NGC 4151) – galaxies: photometry

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Ejection of stars with relativistic velocities

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Abstract. We present the results of numerical simulations performed in terms of modified Hills' scenario involving two supermassive black holes (SMBHs). In contrast to the classic Hills scenario (Hills 1988), here one component of the ordinary stellar binary system is replaced with a SMBH that provides a kinetic resource for ejecting a star (the secondary component of the binary) with relativistic velocity (RVS). We examine the conditions that favor relativistic ejections of stars, depending on the pericentric approach, the mass ratio of two SMBHs, and the orbital configuration of the binary system. Applying the simple criteria helped us to sort out the results of numerical simulations by the outcome: conservation of the orbital configuration of the binary system, dynamic recapture of the star by the central SMBH, emission of hypervelocity stars (HVSs), and RVS ejection. In the framework of N-body simulations we estimate the probability for a star to survive in the cross-field of two SMBHs during the ejection with relativistic velocity, and discuss the probability of the detection of RVSs in our Galaxy in the cases where such stars are generated in distant interacting galaxies undergoing a merger of their central parts occupied by SMBHs.

Key words: relativistic velocity stars – stars: supermassive black holes – probability assessment – three body and N-body simulations

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Swing amplification and global modes reciprocity in models with cusps

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Abstract. We use 3D N-body simulations to analyze the onset of the bar in cuspy models, and argue that the role of swing amplification is twofold. Amplified shot noise due to disk discreteness hampers the bar formation, while induced resonance perturbations allow the bar amplitude to overcome shots. The bar pattern speed and the growth rate obtained in N-body simulations agree well with the global mode analysis.

Key words: galaxies: formation – galaxies: evolution

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Gravity-antigravity interplay in the local galaxy flows

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Abstract. The major physical features of the local expansion flows of galaxies are found to be due to antigravity domination in their dynamics.

Key words: cosmological parameters – cosmology: observations – cosmology: theory – dark energy

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Spectroscopic studies of early-type stars with the Kourovka 1.2 m telescope

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Abstract. We briefly describe the characteristics of the 1.2 m telescope of Kourovka Observatory of the Ural Federal University, equipped with a fiber-optic echelle spectrometer, and report the results of spectroscopic studies of several early-type stars (CC Cas, HD 37737, HD 200775, ADS 2984A) obtained during the first five years of the operation of this instrument.

Key words: telescopes – instrumentation: spectrographs – binaries: spectroscopic – stars: early type – stars: individual (CC Cas, HD 37737, HD 200775, ADS 2984A)

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A quasi-stationary twisted disk formed as a result of a tidal disruption event

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Abstract. In this note we briefly review the main results of our recent study of the formation of misaligned accretion disks after the tidal disruption of stars by rotating supermassive black holes. Since the accretion rates in such disks initially exceed the Eddington limit they are initially advection dominated. Assuming the α model for the disk viscosity implies that the disk can become thermally unstable when the accretion rate is comparable to, or smaller than, the Eddington value, while still being radiation pressure dominated. It then undergoes cyclic transitions between high and low states. During these transitions the aspect ratio varies from ~ 1 to $\sim 10^{-3}$, which is reflected in changes in the degree of disk misalignment at the stream impact location. For maximal black hole rotation and sufficiently large values of the viscosity parameter, $\alpha \gtrsim 0.01-0.1$, the ratio of the disk inclination to that of the initial stellar orbit is estimated to be 0.1–0.2 in the advection dominated state, while reaching order unity in the low state. Misalignment decreases with decrease of α, but increases as the black hole rotation parameter decreases. Thus, it is always significant when the latter is small.

Key words: accretion disks – hydrodynamics – galaxies: supermassive black holes

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Orbits of wide binaries – new possibilities

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Abstract. We use the Apparent Motion Parameters (AMP) method for the determination of orbits of visual double stars (Kiselev & Kiyaeva 1980). The quality of AMP orbits is completely dependent on the precision of parameters of relative positions and motions at the same instant. They are calculated on the basis of a short arc of observations. To determine these parameters, we use recent high precision observations obtained with the best modern techniques. New orbits of three stars are presented.

Key words: binaries: visual – stars: individual (HIP 50, HIP 15058, HIP 66195)

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Details of the classification of symbiotic stars: the case of the symbiotic nova AG Peg

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Abstract. We analyze archival and modern spectroscopic and photometric observations of the oldest known symbiotic nova AG Peg. Its new outburst (which began in 2015 June) differs greatly from the first one (which occurred in the mid-1850s). Fast photometric evolution of the new outburst is similar to that of Z And-type outbursts. However, the SED of AG Peg during the 2015 outburst, as well as during the quiescence, can be fitted by a standard three-component model (cool component + hot component + nebula), which is not common for an Z And-type outburst.

Key words: stars: binaries: symbiotic – stars: individual (AG Peg)

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Molecular clouds and star formation rate in disk galaxies

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Abstract. We use N-body/hydrodynamic simulations of a Milky Way-like galaxy to study the physical properties of giant molecular clouds and star formation rate on different spatial scales. We confirm the previous estimates that the dark gas fraction in molecular clouds reaches about 30% by mass. We find that conversion factors for individual molecular clouds deviated by a factor of several times from the mean value for the Milky Way clouds, $X_{\rm CO} = 2 \times 10^{20}$ cm^{-2} (K km s^{-1})$^{-1}$, and hence a constant $X_{\rm CO}$ conversion factor cannot represent the physical properties of an individual molecular cloud or a small sample of clouds sufficiently well, but the conversion factor averaged over the whole ensemble of clouds is believed to be close to the Milky Way value. The $\Sigma_{\rm SFR}^{\rm UV} - \Sigma_{\rm gas}$ relation can be reproduced using UV calibration for smoothing scale compared to the size of individual star-forming complexes, 0.3–1 kpc.

Key words: ISM: clouds – ISM: molecules – ISM: structure – stars: formation – galaxies: spiral – galaxies: structure

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Outer rings in early-type disk galaxies: star formation rate

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Abstract. The total ring star formation rates and their surface densities are determined for 34 early-type disk galaxies with outer stellar rings which were detected in the UV with the GALEX space telescope. The total level of the integrated star formation rate in the outer rings appears to be low – less than 0.1 $M_\odot\,yr^{-1}$, with typical surface densities from 10^{-4} to 10^{-3} $M_\odot\,yr^{-1}\,kpc^{-2}$.

Key words: galaxies: evolution – galaxies: structure – ultraviolet: galaxies

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The tidal potential of a homogeneous torus with an elliptical section of the sleeve

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Abstract. In this paper the problem of the tidal potential of a homogeneous gravitating torus with an elliptical cross-section sleeve is solved. In particular, the potentials in analytical form in the vicinity of the center of the torus and its external region are found. This torus can serve as a gravitational model of the Kuiper belt.

Key words: gravitating torus, tidal potential