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Stochastic 2-D galaxy disk evolution models. Resolved stellar populations in the galaxy M33

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Abstract. We improved the stochastic 2-D galaxy disk models (Mineikis & Vansevicius 2014a) by introducing enriched gas outflows from galaxies and synthetic color-magnitude diagrams of stellar populations. To test the models, we use the HST/ACS stellar photometry data in four fields located along the major axis of the galaxy M33 (Williams et al. 2009) and demonstrate the potential of the models to derive 2-D star formation histories in the resolved disk galaxies.

Key words: galaxies: evolution – galaxies: individual (M33)

Structural and morphological properties of ultraluminous infrared galaxies at $1 < z < 3$

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Abstract. Using the Hubble Space Telescope (HST)/Wide Field Camera 3 (WFC3) near-infrared high-resolution imaging from the 3D-HST survey, we analyze the morphology and structure of 502 ultraluminous infrared galaxies (ULIRGs; $L_{\text{IR}} > 10^{12} L_{\odot}$) at $1 < z < 3$. Their rest-frame optical morphologies show that high-redshift ULIRGs are a mixture of mergers or interacting systems, irregular galaxies, disks, and ellipticals. Most of ULIRGs in our sample can be roughly divided into merging systems and late-type galaxies (Sb–Ir), with relatively high M_{20} (> -1.7) and small Sérsic index ($n < 2.5$), while others are elliptical-like (E/S0/Sa) morphologies with lower M_{20} (< -1.7) and larger n (> 2.5). The morphological diversities of ULIRGs suggest that there are different formation processes for these galaxies. Merger processes between galaxies and disk instabilities play an important role in the formation and evolution of ULIRGs at high redshift. In the meantime, we also find that the evolution of the size (r_e) with redshift of ULIRGs at redshift $z \sim 1 - 3$ follows $r_e \propto (1+z)^{-(0.96 \pm 0.23)}$.

Key words: galaxies: evolution – galaxies: fundamental parameters – galaxies: structure – galaxies: high-redshift

Optics for nano-satellite X-ray monitor

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Abstract. The Schmidt lobster eye design for a grazing incidence X-ray optics provides wide field of view of the order of many degrees, for this reason it can be a convenient approach for the construction of space X-ray monitors. It is possible to assemble Schmidt lobster eye telescopes with dimensions and focal lengths acceptable for nano class satellites. In this paper, draft of nano-class space mission providing monitoring of specific sky area is presented. Preliminary optical design study for such mission is performed. Two of possible opticle designs are presented. For those designs, field of view, effective input area and other basic optical parameters are calculated. Examples of observed images are presented.

Observational data and orbits of the asteroids discovered at the Baldone Observatory in 2008–2013

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Abstract. The paper presents statistics of the asteroids observed and discovered at the Baldone Observatory, Latvia, in 2008–2013 within the project for astrometric observations of the near-Earth objects (NEOs), the main belt asteroids and comets. CCD observations of the asteroids were obtained with the 0.80/1.20 m, f/3 Schmidt telescope and a ST-10XME 15 × 10 mm CCD camera. In the Minor Planet Circulars and the Minor Planet Electronic Circulars (2008–2013) we published 3511 astrometric positions of 826 asteroids. Among them, 43 asteroids were newly discovered at Baldone. For 36 of these asteroids the precise orbits are calculated. Because of short observational arc and small number of observations, a few asteroids have low-precision orbits and their tracks have been lost. For seven objects with poorly known orbits we present their ephemerides for 2015–2016. The orbits and the evolution of orbital elements of two asteroids, (428694) 2008 OS9 from the Apollo group and the Centaur (330836) Orius (2009 HW77), are recalculated including new observations obtained after 2011.

Key words: minor planets, asteroids – astrometry – ephemerides

On the pseudo phase-space density of dark matter haloes and the universality of density profiles

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Abstract. We examine the radial dependence of the pseudo phase-space density, $\rho(r)/\sigma^3(r)$, for structures on galactic and galaxy cluster scales. We find that it is approximately a power-law only in the range of halo radius resolved by current simulations (down to 0.1% of the virial radius) while it has a non-power law behavior below the quoted scale, with inner profiles changing with mass. The non-power-law behavior is more evident for halos constituted of both dark matter and baryons, while halos constituted just of dark matter are characterized by an approximately power-law behavior. The results argue against universality of the pseudo phase-space density and, as a consequence, argue against universality of density profiles constituted of dark matter and baryons as also discussed in Del Popolo (2009).

Key words: cosmology: theory – cosmology: large-scale structure of universe – cosmology: dark energy – galaxies: formation

Baryon physics and the missing satellites problem

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Abstract. In the present paper, we combine the model of Del Popolo (2009) with the models dealing with tidal stripping, tidal heating, and photo-heating to study how baryon physics can solve the missing satellite problem (MSP) and the too-big-to-fail (TBTf) problem. Applying to the Via Lactea II (VL2) subhaloes a series of corrections similar to those of Brooks et al. (2013), namely, a Zolotov et al. (2012)-like correction obtained with our model, and further correcting for the UV heating and tidal stripping, we find that the number of massive and luminous satellites is in agreement with that number observed in the Milky Way. In conclusion, baryon physics is of fundamental importance in solving the Λ CDM small scale problems.

Key words: cosmology: theory – cosmology: large-scale structure of universe – galaxies: formation

A young star cluster in the Leo A galaxy

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Abstract. We report a serendipitous discovery of a star cluster in the dwarf irregular galaxy Leo A. Young age (~ 28 Myr) and low mass ($\sim 510 M_{\odot}$) estimates are based on the isochrone fit assuming a metallicity derived for H II regions ($Z = 0.0007$). The color-magnitude diagrams of the stars, located in and around the cluster area, and the results of aperture photometry of the cluster itself are presented.

Key words: galaxies: dwarf, irregular – galaxies: individual (Leo A) – galaxies: star clusters

Supershells in the M 33 galaxy

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Abstract. We report preliminary results of the study of 18 supershells located in the Southern arm of the M 33 galaxy. Their age, size, and expansion velocity were determined and compared with the parameters of the H I holes detected in M 33. We conclude that the accurate identification of the supershells from H I observations can be effectively supplemented by simultaneous use of the H α , CO, and dust emission maps, as well as resolved stellar photometry data.

Key words: galaxies: individual (M 33) – galaxies: ISM: supershells

Structural parameters of star clusters: signal to noise effects

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Abstract. We study the impact of photometric signal to noise on the accuracy of derived structural parameters of unresolved star clusters using MCMC model fitting techniques. Star cluster images were simulated as a smooth surface brightness distribution following a King profile convolved with a point spread function. The simulation grid was constructed by varying the levels of sky background and adjusting the cluster’s flux to a specified signal to noise. Poisson noise was introduced to a set of cluster images with the same input parameters at each node of the grid. Model fitting was performed using “*emcee*” algorithm. The presented posterior distributions of the parameters illustrate their uncertainty and degeneracies as a function of signal to noise. By defining the photometric aperture containing 80% of the cluster’s flux, we find that in all realistic sky background level conditions a signal to noise ratio of ~ 50 is necessary to constrain the cluster’s half-light radius to an accuracy better than $\sim 20\%$. The presented technique can be applied to synthetic images simulating various observations of extragalactic star clusters.

Key words: galaxies: star clusters: general, techniques: image processing

Artificial star test for crowded field CCD photometry

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Abstract. A new method of performing an artificial star test (AST) for crowded field stellar CCD photometry is proposed. This AST method is superior in the cases when it is necessary to account for varying photometric quality across the study field, arising due to crowding variations. For this purpose, the color-magnitude diagrams (CMDs) of AST stars with statistically reliable error estimates, as well as completeness maps, can be generated at a required spatial resolution.

Key words: galaxies: stellar content – techniques: photometric – catalogs

Ultraviolet and infrared correlation studies in Orion

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Abstract. We have studied the variation of diffuse ultraviolet (UV) radiation in the northern part of the Orion constellation using a set of eight areas of the GALEX All-Sky Imaging Survey in the far and near UV. Different components of diffuse UV radiation, like dust scattered emission and H₂ fluorescence, were quantified and separated after removing the point sources and the foreground emission in each of the fields. Then the dependence of the individual UV components on the infrared 100 μm dust emission was studied. We do not find any positive correlation between the intensities of these radiations, probably due to either high optical depth of the region or the presence of dust emission behind the Orion cloud which has no relation to the diffuse UV radiation. However, in the far UV we noticed the presence of an excess emission in addition to the dust scattered radiation, which is clearly absent in the near UV. This excess emission, identified as the H₂ fluorescence, is produced by the Trapezium stars in the surrounding molecular clouds. We also compare our results with those of previous studies in the region, based on spectroscopic observations of Far Ultraviolet Spectroscopic Explorer (FUSE).

Key words: ISM: individual objects (Orion Nebula) – ISM: ultraviolet scattering – ISM: infrared emission

Ultraviolet spectroscopic investigation of HU Aqr and AN UMa with the data from HST and IUE

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Abstract. We present ultraviolet spectroscopic study of two polar systems, HU Aqr and AN UMa, observed with the Hubble Space Telescope's Space Telescope Imaging Spectrograph (STIS) and Faint Object Spectrograph (FOS) and with the International Ultraviolet Explorer (IUE) during the period 1979–2003, to diagnose the ultraviolet fluxes of CIV 1550 Å and He II 1640 Å emission lines originating in an accretion stream during different orbital phases. The reddening of two systems is determined from the 2200 Å absorption feature. Different spectra for both systems, showing the variations in line fluxes at different orbital phases, are presented. We concentrated on calculating the line fluxes of CIV and He II emission lines. From HST and IUE data, we derived accretion luminosities and accretion rates for the two systems. The average temperature of the accretion stream for HU Aqr and AN UMa is about 5000 K and 6000 K, respectively. Our results show that there are variations in line fluxes, accretion luminosities and accretion rates with time for the two systems. These modulations are attributed to the variations of both density and temperature as a result of a changing rate of mass transfer from the secondary star to the primary star. These results from the HST and IUE observations support the irradiation model producing sufficient ultraviolet flux for orbital modulations.

Key words: accretion – stars: individual (HU Aqr, AN UMa) – cataclysmic variables – ultraviolet: stars