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A New Empirical Metallicity Calibration for Vilnius Photometry

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Abstract. We present a new calibration of the seven-color Vilnius system in terms of [Fe/H], applicable to F–M stars in the metallicity [Fe/H] range from –2.8 to +0.5. We employ a purely empirical approach, based on about 1000 calibrating stars with high-resolution spectroscopic abundance determinations. It is shown that the color index P-Y is the best choice for a most accurate and sensitive abundance indicator for both dwarf and giant stars. Using it, [Fe/H] values can be determined with an accuracy of ±0.12 dex for stars of solar and mildly sub-solar metallicity and ±0.17 dex for stars with [Fe/H] less than –1. The new calibration is a significant improvement over the previous one used to date.

Key words: techniques: photometric – stars: fundamental parameters – stars: abundances – stars: metallicity calibration

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Optical Spectroscopy of a Post-AGB Star HD 187885

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Abstract. The physical parameters of the atmosphere and its chemical composition for a post-AGB star HD 187885 from high resolution spectra are determined. The effective temperature T(eff) = 8000 K and the surface gravity log g = 1.0 were derived. The star was found to be metal-deficient with [Fe/H] = –0.51. The α-process elements, except of Ca and Ti, and the s-process elements are overabundant. These results partly confirm and supplement the data available in the literature. The spectrum shows many circumstellar lines formed in the multiple expanding shells. Numerous diffuse interstellar bands seen in the spectra may also originate in the same shells.

Key words: stars: atmospheres – stars: individual: HD 187885

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Physical Alternative to the Dark Energy Paradigm

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Abstract. The physical nature of the presently dominating enigmatic dark energy in the expanding universe is demonstrated to be explainable as an excess of the kinetic energy with respect to its potential energy. According to traditional Friedman cosmology, any non-zero value of the total energy integral is ascribed to the space curvature. However, as we show, in the flat universe the total energy also can be different from zero. Initially, a very small excess of kinetic energy originates from the early Universe. The available observational data show that our universe has probably a flat space with an excess of kinetic energy. The evolutionary scenario shows that the Universe presently is in the transitional stage where its radial coordinate expansion approaches the velocity of light. A possibility of the closed Bubble universe with the local Big Bang and everlasting expansion is demonstrated. Dark matter can be essentially contributed by the non-relativistic massive neutrinos, which have cooled to very low temperatures and velocities thus favoring the formation of the observed broad equipotential wells in galaxies.

Key words: cosmology: theory, dark energy, dark matter, neutrinos

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Preparation of the VIRAC Radio Telescope RT-32 for E-VLBI Observations

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Abstract. A fully steerable parabolic antenna RT-32 with the mirror diameter 32 m owned by the Ventspils International Radio Astronomy Centre (VIRAC) is available for fundamental and applied research in radio astronomy. The RT-32 is supplied with the receiving systems for the frequency range from 327 MHz to 12 GHz. The equipment allows recording of signals in two channels with a bandwidth up to 1 GHz in each. The system has a high stability of the time frame, which is prerequisite for the Very Long Baseline Interferometry (VLBI) observations. In 2012 the RT-32 data receiving systems and the network infrastructure were prepared for the work in the e-VLBI mode. The systems were tested together with the Torun Observatory, and later in the EVN e-VLBI observation session at 5 GHz. Experiments have shown that RT-32 is able to observe at a frequency range of 5 GHz and transfer the data in the e-VLBI mode with the speed up to 1 Gbps. The paper describes the current status of RT-32, the application of its receiving and data acquisition units for the e-VLBI observations and the results of the conducted e-VLBI observational experiments.

Key words: instrumentation: radio telescopes, receivers – techniques: radio interferometry, data acquisition

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First Results of the VLBI Experiment on Radar Location of the Asteroid 2012 DA14

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Abstract. An international VLBI experiment on radio location of the asteroid 2012 DA14 was organized on 2013 February 15–16, during its flyby close to Earth. The purpose of observations was to investigate and specify orbital parameters of the asteroid, as well as to evaluate its rotation period and other characteristics. The irradiation of the asteroid was performed by the RT-70 transmitter at Evpatoria (Crimea, Ukraine), while the reflected signals were successfully accepted by the two 32 m radio telescopes at Medicina (Bologna, Italy) and Irbene (Ventspils, Latvia). Processing and interpretation of the data were performed both in the Radiophysical Research Institute and in the Ventspils International Radio Astronomy Center. The first results of this experiment are presented and discussed.

Key words: instrumentation: interferometers, Very Long Baseline Interferometry – methods: observational – techniques: interferometric, radar astronomy – ephemeris – asteroid 2012 DA14

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Compressive Sensing: Analysis of Signals in Radio Astronomy

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Abstract. The compressive sensing (CS) theory says that for some kind of signals there is no need to keep or transfer all the data acquired accordingly to the Nyquist criterion. In this work we investigate if the CS approach is applicable for recording and analysis of radio astronomy (RA) signals. Since CS methods are applicable for the signals with sparse (and compressible) representations, the compressibility of RA signals is verified. As a result, we identify which RA signals can be processed using CS, find the parameters which can improve or degrade CS application to RA results, describe the optimum way how to perform signal filtering in CS applications. Also, a range of virtual LabVIEW instruments are created for the signal analysis with the CS theory.

Key words: methods: radio astronomy signals: compressive sensing, sparsity, filtering

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Modeling of Highly-Excited Atomic Level Populations in Astrophysical Plasmas

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Abstract. Recombination lines arising in transitions between highly-excited atomic levels are becoming increasingly used for the plasma diagnostics, as the sensitivity of astronomical instrumentation increases. This paper describes a model used to compute the level population of the Rydberg levels and gives a collection of hydrogenic approximation expressions that can be used to estimate the relevant atomic data. The Rydberg level populations may also be used to estimate level-specific recombination rate for lower atomic levels accounting for the electron cascade. The expressions are applied to predict the radio recombination line spectrum of the fast-moving knots of the Cassiopeia A supernova remnant.

Key words: atomic data – recombination lines – supernova remnants: individual: Cassiopeia A