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Peculiarities and Variations in the Optical Spectrum of the RV Tauri-type Star R Sct

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Abstract. We analyzed some new high resolution optical spectra of the semiregular RV Tauri-type star R Sct. Fundamental parameters were found to be $T_{\rm eff} = 4500$ K, $\log g = 0.0$ and $\xi_{\rm t} = 4.0$ km s^{-1}. The results of chemical analysis show that R Sct is a metal-poor star with [Fe/H]≈ -0.5. The carbon content with respect to iron is significantly larger than in the Sun, [C/Fe] = 0.84, but there is an evident deficiency of heavy elements. We found no tight correlation of the chemical abundances on the condensation temperatures of elements. This means that in R Sct the depletion by condensation into dust does not work, with possible exception of Ca and Sc. The luminosity derived from the Hipparcos parallax corresponds to a tip of the red-giant branch or slightly above it. Thus it is possible that R Sct evolved off the early-AGB when it has not yet experienced the third dredge-up in thermal pulses, or it is still located on AGB. The peculiarities of spectral features (emissions, line-splitting) and the complicated time-variable radial velocities were also studied.

Key words: stars: atmospheres – stars: individual: R Sct

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On the Spectrum of Extremely Metal-poor Star HD 52961

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Abstract. High resolution spectra of the extremely metal-poor star HD 52961 are investigated. The atmospheric parameters found are: $T_{\rm eff} = 6000 \pm 100$ K, $\log g = 0.5 \pm 0.5$, $\xi_{\rm t} = 6.8$ km s^{-1}, [Fe/H] = –4.50± 0.20. The carbon abundance is close to the solar one, [C/H] = -0.17 ± 0.12. At the same time abundances of heavy refractory elements are very low. The chemical composition and atmospheric parameters have not changed compared to the first observations of the star about 20 years ago, contrary to expectation of dissolving the peculiarities by mass-loss during a relatively short time. We also find evidence of ongoing mass-loss in this post-AGB star with a rate of $\dot{M} \approx 5 \cdot 10^{-6}\, M_{\odot}\, {\rm yr}^{-1}$.

Key words: stars: atmospheres – stars: individual: HD 52961

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Pulsation of IU Per from the Ground-based and 'Integral' Photometry

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Abstract. IU Per is an eclipsing semi-detached binary with a pulsating component. Using our own ground-based, as well as INTEGRAL satellite photometric observations in the B and V passbands, we derived geometrical and physical parameters of this system. We detected the short-term variations of IU Per in the residuals of brightness after the subtraction of synthetic light curves. Analysis of these residuals enabled us to characterize and localize the source of short-term variations as the pulsations of the primary component typical to δ Scuti-type stars.

Key words: stars: binaries: eclipsing – stars: oscillations – stars: variables: δ Scuti – stars: individual (IU Per)

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Further Investigation of the Effect of Galaxy Interactions on Star Formation

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Abstract. From the apparent magnitude-limited the Main galaxy sample of the Sloan Digital Sky Survey Data Release 7, we construct a paired galaxy sample and a control sample without close companions with the projected separations $r_p < 100\ h^{-1}$ kpc and relative velocity $\Delta V < 350$ km/s, and then perform their comparative studies. It is found that galaxy pairs have significantly lower star formation rate (SFR) and specific star formation rate (SSFR) than galaxies without close companions. We also find that this effect probably originates due to a correlation between the environment and the SFR.

Key words: galaxies: fundamental parameters – galaxies: interactions – galaxies: statistics

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Environmental Dependence of Different Colors for the Apparent Magnitude-limited Main Galaxy Sample of the SDSS DR7

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Abstract. The apparent magnitude-limited Main galaxy sample of the Sloan Digital Sky Survey Data Release 7 is used to investigate the environmental dependence of u–r, u–g, g–r, r–i and i–z colors. All the five colors strongly correlate with the local environment: red galaxies tend to be located in dense regions, while blue galaxies tend to be located in low density regions. We also note that with increasing of redshift, the environmental dependence of galaxy colors becomes weaker, especially in the high redshift region (z between 0.17 and 0.20). This can be explained accepting that subsamples with high redshifts contain only luminous and red galaxies.

Key words: galaxies: fundamental parameters – galaxies: statistics

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A New High-precision Correction Method of Temperature Distribution in Model Stellar Atmospheres

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Abstract. The main features of the temperature correction methods, suggested and used in modeling of plane-parallel stellar atmospheres, are discussed. The main features of the new method are described. Derivation of the formulae for a version of the Unsöld-Lucy method, used by us in the SMART (Stellar Model Atmospheres and Radiative Transport) software for modeling stellar atmospheres, is presented. The method is based on a correction of the model temperature distribution based on minimizing differences of flux from its accepted constant value and on the requirement of the lack of its gradient, meaning that local source and sink terms of radiation must be equal. The final relative flux constancy obtainable by the method with the SMART code turned out to have the precision of the order of 0.5 %. Some of the rapidly converging iteration steps can be useful before starting the high-precision model correction. The corrections of both the flux value and of its gradient, like in Unsöld-Lucy method, are unavoidably needed to obtain high-precision flux constancy. A new temperature correction method to obtain high-precision flux constancy for plane-parallel LTE model stellar atmospheres is proposed and studied. The non-linear optimization is carried out by the least squares, in which the Levenberg-Marquardt correction method and thereafter additional correction by the Broyden iteration loop were applied. Small finite differences of temperature ($\delta T/T = 10^{-3}$) are used in the computations. A single Jacobian step appears to be mostly sufficient to get flux constancy of the order 10^{-2} %. The dual numbers and their generalization – the dual complex numbers (the duplex numbers) – enable automatically to get the derivatives in the nilpotent part of the dual numbers. A version of the SMART software is in the stage of refactorization to dual and duplex numbers, what enables to get rid of the finite differences, as an additional source of lowering precision of the computed results.

Key words: stars: atmospheres – stars: early-type – stars: fundamental parameters

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New Methods in Modeling of Hot Stellar Atmospheres

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Abstract. In the present study we had three main aims. First to study the possibility of reducing the initial model atmosphere data to short analytical polynomials. The second was to use as the depth variable the logarithm of the local gas pressure instead the Rosseland mean. The third aim was to check the applicability of the derived formulae and proposed computation methods to obtain high precision self-consistent results in modeling hot plane-parallel stellar atmospheres. Introducing the dimensionless (reduced) local quantities $\theta = T/T_{\rm eff}$ and $\beta = P/P(T_{\rm eff})$ it has been shown that for hot convection-free stellar atmospheres the curves $\log\theta$ versus $\log\beta$ reduce an initial grid of models to simple polynomials and bring forth some general features of the model stellar atmospheres. Even for stellar atmospheres having the convective zones in the deeper atmospheric layers, the outer part of the atmosphere (up to $T = T_{\rm eff}$ and for $T_{\rm eff} > 5000$ K) can be described in the same manner by curves $\log\theta$ versus $\log\beta$ as for the hotter stars. Iterative modeling of any hot stellar atmosphere can be started from these formulae (obtained for solar abundances), using rational polynomial ratios for $P(T_{\rm eff})$, obtaining from these data the needed T versus P dependence. To check suitability of the formulae, the iterative correction of the model stellar atmospheres has been carried out by the traditional Unsöld-Lucy method and by the novel least squares optimization based on Levenberg-Marquardt method, followed by Broyden correction loop. It has been shown that the flux constancy obtained by it is almost 2 dex higher than obtained by the Unsöld-Lucy method. The precision estimators as criteria of the modeling algorithms self-consistency and of the computational precision level have been proposed and used.

Key words: stars: atmospheres – stars: early-type – stars: fundamental parameters