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Poster paper

SPECTROPHOTOMETRIC STUDY OF NEARBY SEYFERT NUCLEI

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We present new results about the spectrophotometric study of the nuclear regions in nearby ($z<0.03$) Seyfert galaxies. The observations were carried out using the Multi Pupil Fiber Spectrograph (MPFS), the integral field unit mounted at the 6-m telescope of the Special Astrophysical Obsevatory (Russia). The main purpose of this work is to test the Unified Model in nearby AGNs through the investigation of the the gaseous/stellar environment close the active nucleus. In particular, we show emission line ratio maps, included excitation maps ([O III]/H_α), which allowed us to trace the regions with different degrees of ionization, to identify ionization cones and/or circum-nuclear star forming regions, and to study in detail their physical properties.

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ON THE INFLURENCE OF STARK BROADENING OF Cr I LINES IN THE Cr-RICH Ap STAR β CrB ATMOSPHERES

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Chromium is one of the most anomalous elements in Ap stars. It was shown to be concentrated in the deeper atmospheric layers in Ap stars β CrB and in γ Equ, where electron density is high enough to favor the Stark broadening mechanism, the most significant pressure broadening mechanism for A and B stars. Most Cr I, and Cr II, lines in the optical spectral region have rather small Stark damping constants so no measurable Stark wings appeared. However, Cr I, lines from $4p - 4d$ transitions are known to have fairly large Stark damping constants according to calculations made by Kurucz.

We present here new calculations of Cr I Stark line widths and shifts based on the semi-classical perturbation approach of Sylvie Sahal-Bréchot. Electron-, proton-, and ionized helium-impact line widths and shifts for nine Cr I spectral lines from the $4p^7P^0 - 4d^7D$ multiplet, were calculated for a perturber density of 10^{14} cm^{-3} and for temperatures T = 2,500 − 50,000 K.

The results were used to investigate the influence of Stark broadening effect on Cr I line shapes in the atmosphere of the Cr-rich Ap star β CrB. In spite of the rather large Stark damping constants, the effect is not observable in stars with solar Cr abundance. In hot stars where electron and proton densities are high, the Cr I, lines considered here are generally very weak, while in cooler stars (solar type) other broadening effects are more significant where these lines are strong enough. The only chance to look at Stark effect is in stratified atmosphere of a Cr-rich Ap star, such as the well known magnetic star β CrB.

Our analysis of the Cr-rich Ap star β CrB line shapes was based on its spectrum obtained in February 1998 with the MuSiCoS spectropolarimeter mounted on the 2 m telescope at Pic du Midi observatory (R=35000).It was found (Dimitrijević et al, 2005) that the contribution of proton and He ii collisions to the line width and shift is significant and comparable, and is sometimes even larger than electron-impact contribution depending of the electron temperature. Moreover, not only the Stark line width, but also the Stark shift may contribute to the blue as well as to the red asymmetry of the same line depending on the electron-, proton-, and He ii density in stellar atmosphere. The results were used to investigate the influence of Stark broadening effect on Cr i line shapes in the atmosphere of the Cr-rich Ap star β CrB.

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A STUDY OF CLOSE BINARY SYSTEM EE CET

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Variability of the combined light of close binary EE Cet in the visual/spectroscopic triple system ADS 2163 was discovered by the Hipparcos satellite. New photoelectric BV light curves of EE Cet were obtained at the Rozhen National Astronomical Observatory, Bulgaria. We have combined this photometric with earlier spectroscopic observations to derive the physical parameters of the system. Due to the proximity of the visual companion, the light curves were contaminated by the third light. Spectroscopic observations, which were able to separate EE Cet from its companion, found that spectral type of the system is F8 V (T = 6095K) and mass ratio is $q = \mathcal{M}_2/\mathcal{M}_1 = 0.315$. Our analysis show that EE Cet is a high-overcontact system ($f_{\rm over} \sim 32\%$), with orbital inclination $i \approx 79^\circ$, component masses $\mathcal{M}_1 = 1.37$, $\mathcal{M}_2 = 0.43\ \mathcal{M}_\odot$ and mean radii $\mathcal{R}_1 = 1.35$, $\mathcal{R}_2 = 0.82\ \mathcal{R}_\odot$. Future photometric observations, able to separate EE Cet from its companion, would put even more tight constraints on properties and parameters of this close binary system.

Poster paper

LINE-DRIVEN WINDS NEAR BHs

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We propose a general physical mechanism which could contribute to the formation of fast line-driven outflows at the vicinity of strong gravitational field sources (BH's, NS's). We argue that the gradient of the gravitational potential plays the same role as the velocity gradient plays in Sobolev approximation. Both Doppler effect and gravitational redshifting are taken into account in Sobolev approximation. The radiation force becomes a function of the local velocity gradient and the gradient of the gravitational potential. The derived equation of motion has a critical point that is different from that of Castor, Abbott and Klein 1975 theory. A comparison with CAK theory is presented. It is shown that the developed theory predicts terminal velocities which can be as 50CAK theory. The developed theory can have an important contribution to the formation of radiation-driven jets/winds near compact objects.

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Poster paper

INVESTIGATION OF ROTATIONAL VELOCITY OF E-PERSEI (EPSILON-PERSEI)

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We present the analysis of spectral line profiles of the Si III triplet at 455,3 nm, 456,8 nm and 457,4 nm of a variable star ϵ-Persei, and we investigate the vsin(i) value of the star using Fourier transform technique. Since the star is a strong non-radial pulsator the spectra averaged over several pulsational cycles have been used.

The derived average value using all lines is vsin(i)=134 km/s.

Poster paper

ELECTRIC DIPOLE TRANSITION PROBABILITIES IN Al IV AND Al V IONS

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Electric dipole transition probabilities in triply and four times ionized aluminium have been calculated in intermediate coupling.

The present calculations were carried out with the general purpose atomic-structure program SUPERSTRUCTURE (Eissner et al.1974), as modified by Nussbaumer and Story (1978). The wavefunctions are of the type $\psi = \sum_i \phi_i C_i$, where the basis functions ϕ_i are constructed using one-electron orbitals ψ. The latter are calculated with a scaled Thomas-Fermi statistical model potential (Eissner and Nussbaumer 1969) or obtained from the Coulomb potential (Nussbaumer and Storey 1978).

The relativestic corrections to the non-relativestic Hamiltonian are taken into account through the Breit-Pauli approximation.

We have also introduced a semi-empirical correction (TEC) for the calculation of the energy-levels

The adopted atomic model for Al IV includes 12 configurations corresponding to 103 fine structure levels. For Al V the model includes 25 configurations corresponding to 434 fine structure levels.

Poster paper

EMERGENT LINE PROFILES FROM RAPIDLY ROTATING STARS

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We present theoretical line profiles emerging from rapidly rotating stars calculated using our multidimensional radiative transfer code. The radiative transfer equation is solved in axial symmetry and the velocity field in the whole photosphere is taken into account. Comparison with the commonly used convolution method gives significant differences especially for extended photospheres.

Poster paper

THE REDUCTION OF ECLIPSING BINARY STARS SPECTRA OBSERVED AT ROZHEN OBSERVATORY

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Several binary stars of Algol type were observed at Rozhen Observatory with 2m telescope using coude spectrograph. Observations were made from 2001 to 2004. We present the preliminary results of reduction of these spectra.

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Poster paper

GAS TEMPERATURE FROM LINE BROADENING IN A NEON MICROWAVE PLASMA AT ATMOSPHERIC PRESSURE

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We have used the collisional broadening of neutral neon lines to determine the gas temperature of a microwave discharge at atmospheric pressure. The gas temperature can be obtained from the van der Waals broadening, provided that the Stark broadening is negligible. Thus, the variation of the Stark broadening of the H_β, H_α, H_γ lines has been compared with the Lorentzian width of several prominent neutral neon lines from low-lying levels (close to the ground state). The values of gas temperature obtained have been compared with those provided by OH radicals with an excellent agreement.

Poster paper

SELF-ABSORPTION EFFECTS IN THE EQUIVALENT WIDTH OF THE SPECTRAL LINES IN A NEON MICROWAVE PLASMA AT ATMOSPHERIC PRESSURE

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Atomic metastable Ne($^3P_0$) and resonant Ne($^3P_1$) levels atom concentrations have been determined from the ratio of the total intensities of two partially *self-absorbed* lines, one of them being more strongly absorbed than the other. The ratio of the intensities is related to the *equivalent width*, W, of the spectral lines, whose shape is approximated to a Voigt function resulting from the convolution of a Lorentzian (Stark and Van der Waals effects) and a Gaussian (Doppler effect and optical broadening) profiles. Thus, we have study W in different plasma column lengths and its influence on the value of the metastable and resonant level populations. Under the operative conditions investigated, the concentrations of these levels were $\sim 10^{11}\mathrm{cm}^{-3}$

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VOIGT DAMPING PARAMETER OF THE SPECTRAL LINES EMITTED BY A PLASMA FLAME AND A PLASMA COLUMN GENERATED BY MICROWAVE AT ATMOSPHERIC PRESSURE

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Atomic emission spectroscopy (AES) is a non-disruptive method to perform plasma physics diagnosis, by collecting and analyzing the radiation, registered as spectral lines, emitted by the plasma. The spectral line parameters (intensity, width) allow the values of the plasma species temperatures and populations to be determined, and in this way obtaining information about the thermodynamic equilibrium state of the discharge.

Under high pressure conditions, line profiles are adequately fitted by a Voigt function, which is the convolution of a Gaussian and a Lorentzian function. One of the parameter which characterizes this spectral lines is the *damping* or *Voigt-a* parameter, which is equal to $\Delta\lambda_L\sqrt{\ln(2)}/\Delta\lambda_D$, being $\Delta\lambda_L$ the Lorentzian broadening of the spectral line (Stark and van der Waals) and $\Delta\lambda_D$ the Gaussian broadening (Doppler effect). Its value, an indication of the relative importance of each components, supply information regarding the quantity of the local collision interactions which take place in the plasma compared to the other processes, and which must be taken into account when doing a complete description of the radiation source. In this study a simple method to experimentally obtain the *Voigt-a* parameter value of the spectral lines emitted by two kind of SWDs, a column and a flame, is presented. The Lorentzian contribution has been obtained by deconvolution of the spectral profiles and the Doppler width from the temperature of the gas; this temperature was measured using the rotation-vibration spectrums of the OH specie, which is present as impurity in the discharge.

The a-parameter values found are within interval values registered in the literature. It has observed that the modification of the discharge parameters affects the a-parameter value, which indicates that the state of the plasma and its inhomogeneity significantly influences the shape of the spectral lines and therefore also influence their parameter values. In addition, the variation shown is not the same for all the spectral lines, but it depends on the level they come from. For example, for the spectral lines involving high-lying levels the a-parameter is more sensitive to the changes of the electron density than for the lines from the internal levels. It has been observed that the a-parameter value is higher for the lines emitted from the plasma flame than from the plasma column. This is a reflection of the increase of the electronic temperature and density, and therefore of the collision and excitation capacity of the flame in relation to the column.

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ON THE STARK BROADENING PARAMETERS FOR Cu III AND Zn III LINES IN A TYPE STAR ATMOSPHERES

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Stark broadening of ion and atom lines is of interest in the investigation of laboratory and astrophysical plasma. With the development of space-born spectroscopy, observations of spectral lines of trace elements like copper and zinc, become available. From the analysis of 11 Hg-Mn star spectra (Jacobs and Dworetsky, 1981) for example, it follows that copper is clearly overabundant in 10 of investigated stars. Zinc spectral lines are present as well in stellar spectra (see e.g. Adelman 1994, Cowley et al. 2000, Ryabchikova et al. 2000).

The knowledge of Stark broadening parameters is also of interest for the investigation of laboratory and technological plasmas. For example, Spectral lines of Cu III and Cu IV are of particular interest for the diagnostic and modelling of plasma created in electromagnetic macro particle accelerators where in experimental work, the plasma is usually created by Cu or Al foil evaporation. Also, doubly charged zinc ion is a member of the nickel isoelectronic sequence, known to include possible candidates for development of ultraviolet lasers.

Here we present Stark widths for six transitions of Cu III and six transitions of Zn III calaculated by using the modified semiempirical approach (Dimitrijevi and Konjevi 1980). Obtained theoretical results are used to consider the influence of Stark broadening for A type star atmospheres conditions.

Obtained results demonstrate that in A type star atmospheres exist layers where the influence of Stark broadening on Cu III and Zn III line shapes is important in comparison with Doppler broadening. The obtained Stark broadening parameters contribute also to the creation of a set of such data for as large as possible number of spectral lines, of significance for a number of problems in laboratory, technological and astrophysical plasma research.

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Poster paper

STUDYING OF SOME SEYFERT GALAXIES BY THE METHODS OF PANORAMIC SPECTROSCOPY

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We have studied some galaxies with active nuclei using method of panoramic spectroscopy. The results of panoramic spectroscopy obtained with Russian 6m telescope are presented: the circumnuclear region were observed with integral-field spectrograph MPFS, the large-scale velocity fields of the ionized gas were constructed from observations with scanning interferometer Fabry-Perot. We have constructed intensity maps and velocity fields as in different lines of ionizing gas as in stars. Also diagnostics diagramms have been made in order to define what is a source of ionization (active nuclei, hot young stars or shock waves).

Poster paper

ANALYTICAL CURVES REDUCTION BY USING FRACTIONAL DERIVATIVE SPECTROMETRY

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A new fitting method that is useful in the fitting procedure has been discovered. Several positive effects of a fractional derivative connected with the behavior of its zero-crossing and maximal amplitude allow one to fit experimental data into well-known profiles such as Gaussian, Lorentz ant Tsaliss, to estimate their spectral parameters. This method is based on the ordinary least squares approach, but fractional derivatives help one to avoid possible problems of least squares method approach. In this paper described method is demonstrated on model files and on experimental too. In this paper we utilize this method using Lorentz-Gaussian model for decomposition of overlapping peaks with a fractal noise.

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COMPUTER-SIMULATED BALMER-ALPHA LINE PROFILE FOR CALCULATING THE ELECTRON NUMBER DENSITIES

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In general, the profile of the spectral lines observed in cold plasmas with a low density and at pressures of over 100 Torr, can be approximated well enough by means of Voigt type functions. This function is the result of the convolution of a gaussian function with a lorentzian function. In this way, by using a model permitting us to fit the Voigt function and intermediate theories, it is possible to obtain fundamental parameters characterizing the plasma (electron density and temperature, gas temperature, etc.)

In the present work, we have fitted the experimental profiles of the Hydrogen Balmer serie lines to a simulated profile obtained from the theoretical Stark profiles given by Gigosos *et al*[M.A. Gigosos, M.A. Gonzlez and V. Cardeoso: Spectrochim. Acta B **58** (2003) 1489.]. by means of the Model Microfield Method. For this treatment it is necessary to find out the most important effects causing the line broadening in our "low density plasmas": Van der Waals, Doppler, instrumental and Stark broadening.

This study was carried out for the first Hydrogen Balmer series line (H_α), this being the most problematic line because it depends heavily on the electron temperature and has a strong broadening by ion dynamics. This method permits the inclusion of ion dynamics effects and also to take into account the difference between T_e and T_g existing in the plasma, by means of the reduced mass, μ. (In our Ar-H plasma with $T_e = 6500$K y $T_g = 1400$K, μ is approximately 4). The best simulated profile corresponded to the convolution between a Van der Waals profile for a gas temperature of 1400 K (≈ 0.035), a Gaussian profile (Doppler+Instrumental) of approximately 0.02 nm and a Stark profile for a μ equal to 4 and an electron density of $\approx 4 - 5 \cdot 10^{14}\text{cm}^{-3}$, with a 95% approximation to the experimental profile.

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TEMPERATURE DEPENDENCE OF NON HYDROGENIC ATOM-LINES STARK WIDTHS

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We investigate in the present work the temperature dependence of Stark widths for neutral atom spectral lines in order to find a more precise method for scaling with temperature than sometimes used dependence $T^{-1/2}$, which is often inadequate particularly for Stark broadening of neutral emitter lines.

We propose here a method which provides better possibilities for scaling with temperature. In order to demonstrate the applicability of this scaling, we have applied it to Stark line widths of He I, Mg I, and Ar I. The present results concerns the data at a perturber density $10^{16} cm^{-3}$ and (temperature = 2.510^3 - 5.010^4 K).

In order to obtain a better method for the scaling of Stark broadening parameters with temperature we have used formulae for estimating Stark widths of neutral atom lines based on the simple method of Freudenstein and Cooper and its generalization (i) for the cases where there are more than one important perturber level and (ii) for the shifts, by Dimitrijević and Konjević.

We present results for temperature scalings of Stark half-halfwidths with the proposed method, which are compared with width calculations according to the semiclassical perturbation formalism (versions of Sahal-Bréchot and Griem, Baranger, Kolb and Oertel)and with results obtained with symplified methods of Freudenstein and Cooper, and of Dimitrijević and Konjević.