1. SOME OF THE MAIN RESULTS OF THE OBSERVATORY'S RESEARCH ACTIVITY

We review here contributions to the science of fellows of Belgrade Observatory published in international journals, the results of observational programmes as well as Ph D. theses, since such contributions should be of particular interest to astronomical community.

Milan M. Ćirković in collaboration with N. Bostrom (Ćirković and Bostrom, 2000) have undertaken a cross-disciplinary cosmological and philosophical study of the distant future of the universe. The influence of recent detections of a finite vacuum energy ("cosmological constant") on our formulation of anthropic conjectures, particularly the so-called Final Anthropic Principle is investigated. It is shown that non-zero vacuum energy implies the onset of a quasi-exponential expansion of our causally connected domain ("the universe") at some point in the future, a stage similar to the inflationary expansion at the very beginning of time. The transition to this future inflationary phase of cosmological expansion will preclude indefinite survival of intelligent species in our domain, because of the rapid shrinking of particle horizons and subsequent depletion of energy necessary for information processes within the horizon of any observer. Therefore, to satisfy the Final Anthropic Hypothesis (reformulated to apply to the entire ensemble of universes), it is necessary to show that (i) chaotic inflation of Linde (or some similar model) provides a satisfactory description of reality, (ii) migration between causally connected domains within the multiverse is physically permitted, and (iii) the time interval left to the onset of the future inflationary phase is sufficient for development of the technology necessary for such inter-domain travel. These stringent requirements diminish the probability of the Final Anthropic Hypothesis being true.

In continuation of the work on the origin and properties of Ly-alpha absorption systems carried out in previous years, Milan M. Ćirković and K. M. Lanzetta (Ćirković and Lanzetta, 2000) have investigated the autocorrelation function of these absorption lines. Recent measurements of the autocorrelation function of the Lyα clouds are analyzed from the point of view of a simple model with strong clustering on the small scales. It is shown that this toy model reproduces fairly well the important linear relation between amplitude of the absorber autocorrelation function and neutral hydrogen column density. In addition, it predicts a correct evolutionary trend of the correlation amplitudes. Some possible ramifications of these results are discussed, and it is found that this is another instance of successful application for the galactic halo model for the origin of large fraction of the Ly-alpha forest lines.

Along the similar track, Milan Ćirković and Srdjan Samurović (Ćirković and Samurović, 2000) have put forward a simple consistency argument for the galactic halo origin hypothesis, based on the recent determination of column-density vs. impact parameter relation for the low-redshift gaseous galactic haloes. It is shown that observations of neutral hydrogen absorption around luminous galaxies are consistent with the index of the power-law column density distribution derived from statistical analysis of large samples of high-redshift Ly-alpha forest lines. The similarity between the two numbers is a pure coincidence, unless one is ready to accept that the dominant signal in samples from which the column density index was determined originates in gaseous haloes of normal galaxies.

Finally, the same topic was tackled from another angle in Milan M. Ćirković, Srdjan Samurović and Aleksandra Djorić (Ćirković et al, 2000), where the discussion of the relationship between cooling radius in two-phase adiabatic halo models and observationally established maximal radius of absorption in luminous galaxies at low redshift is presented. It is of paramount importance that any viable model of the halo is able to reproduce empirical value of the absorption cross-section of normal galaxies and its scaling with luminosity. Several ways for bringing the theoretical and observational values into agreement are outlined in that paper. It is of great methodological importance to fully assess the difficulties any model is likely to encounter when testing predicted extent of absorption and column density distribution against recently obtained low-redshift Ly-alpha absorption data.

In a series of papers Milan S. Dimitrijević and Sylvie Sahal-Bréchot, have performed, by using semiclassical - perturbation formalism, large scale calculations of Stark broadening parameters for a number of spectral lines of various emitters from neutrals up to twelve time charged ions. The results of such calculations are of interest for a number of different problems in physics, astrophysics and plasma technology. Their calculations are performed within the semiclassical - perturbation formalism for a number of radiators. As the continuation of this project, Milan S. Dimitrijević and Sylvie Sahal - Bréchot (Dimitrijević and Sahal-Bréchot, 2000) have considered Stark broadening within F VI, Cl VII and Kr VIII spectra. Chlorine and fluorine spectral lines have been observed in Solar (Moore, Minnaert and Houtgast, 1966), as well as in stellar spectra (Merrill, 1956). In Trimble (1991) has been reported that chlorine and fluorine have been found in the ejecta of SN 1987 A supernova. With the development of space-borne spectroscopy, spectral line parameters even for trace elements become of increasing interest for astrophysics. Fluorine is a product of hydrogen burning in stellar interiors and envelopes, chlorine a product of alpha processes - neutron capture on slow time scale (slow means slower than typical beta decay time) where the first step would be photostripping of alpha particles from some Ne^{20} nuclei and their subsequent capture by others, and krypton a product of s (neutron capture on slow time scale orderly evolution of stellar interiors) and r (neutron capture on fast time scale in type I supernovae) processes. Consequently, the data on the spectral line broadening parameters of these elements in various ionization stages are of interest for the considering and modelling of stellar plasma, particularly subphotospheric layers and radiative transfer in stellar interiors. For the investigation and developing of soft X-ray lasers, such data may be useful too (see *e.g.* Griem and Moreno, 1990, and,

Fill and Schöning, 1994). Also, line broadening data for multiply charged ions are of significance for the fusion plasmas and laser-produced plasmas research, and for the investigation of Stark broadening parameter systematic trends along isoelectronic sequences.

Within the semiclassical-perturbation formalism, Milan S. Dimitrijević and Sylvie Sahal - Bréchot (Dimitrijević and Sahal-Bréchot, 2000) have calculated electron-, proton-, and He III-impact line widths and shifts for 2 fluorine VI, 10 chlorine VII and 6 krypton VIII multiplets. for a perturber density of 10^{17} cm^{-3} and temperatures T = 100,000 – 2,000,000 K for F VI and CL VII, and T = 200,000 – 3,000,000 K for Kr VIII. There are no experimental results concerning F VI, Cl VII and Kr VIII. However, for the Cl VII 2178.8 Å predictions by Purić et al (1988) on the basis of systematic trends along isoelectronic sequences exist, and are in rather good agreement with semiclassical - perturbation results of Dimitrijević and Sahal - Bréchot (2000).

Within the above mentioned semiclassical approach, Milan S. Dimitrijević and Sylvie Sahal - Bréchot (Dimitrijević and Sahal-Bréchot, 1999) have considered also electron-, proton-, and ionized helium-impact line widths and shifts for 20 In III and 2 Tl III multiplets, for perturber density of 10^{17} cm^{-3} and temperatures T = 20,000 – 500,000 K, and electron-, proton-, and He III-impact line widths and shifts for 2 Pb IV multiplets, for perturber density of 10^{17} cm^{-3} and temperatures T = 50,000 – 1,000,000 K. The obtained data contribute to finding out a large set of reliable semiclassical Stark broadening data of significance for astrophysical and laboratory plasma research.

Luka Č. Popović and Milan S. Dimitrijević (Popović and Dimitrijević, 2000) published Stark broadening parameters for 52 transitions of singly-, doubly-, and triply-charged vanadium ions calculated by using the modified semiempirical method developed by Dimitrijević, Konjević and Kršljanin (Dimitrijević and Konjević, 1980; Dimitrijević and Kršljanin, 1986). The Stark widths and shifts have been calculated for an electron density of $10^{23}m^{-3}$ and presented as a function of electron temperature. Vanadium is present in stellar and solar plasmas, and atomic and spectroscopic data for its ions, including Stark broadening parameters, are of interest for the investigation and modeling of such plasmas. The Stark broadening mechanism is the main pressure broadening mechanism in stellar plasma conditions with $T_{eff} \geq 10000$ K, i.e. for plasma present in A and B-type stars photospheres. Moreover, it has been found that vanadium is overabundant in some A-type stars. For example Van't Veer-Mennert, Coupry and Burkhart (1985) have found vanadium overabundance in the Am star HR178, and Sadakane and Ueta (1989) an overabundance in Sirius, also an A-type star. Kocer et al. (1993) have compared V I and V II spectral lines in θ Cyg, ι Psc, 15 Vul, 32 Aqr, and the Sun and they found similar vanadium abundance in all stars considered. Consequently, Stark broadening parameters for vanadium ion lines are of interest not only for the laboratory plasma research and for the testing and developing of the Stark broadening theory for shapes of multicharged ion lines, but also for the consideration of stellar plasma. In the case of singly-, doubly-, and triply-ionized vanadium it is not possible to use the semiclassical method for the calculation of Stark broadening parameters in an adequate manner and with the accuracy usually expected, due to the lack of the reliable atomic data required. Consequently, it is jus-

tified to apply simpler methods like the modified semiemprical method (Dimitrijević and Konjević, 1980; Dimitrijević and Kršljanin, 1986). The obtained results have been compared with simple estimates for V II $a^5D - z^5F^0$ transition based on regularities and systematic trends (Lakićević, 1983). The agreement is good for the width, indicating that such estimates may be of interest for the Stark width estimates when more sophysticated calculations do not exist. For the shift however, the disagreement is considerable.

Milan S. Dimitrijević and Luka Č. Popović in collaboration with Vladimir Milosavljević and Stevan Djeniže published in 2000 (Milosavljević et al., 2000) experimental results for Stark widths and shifts of 14 singly (Kr II) and 11 doubly charged (Kr III) krypton ion spectral lines, measured in the linear, low pressure, pulsed arc at 17,000 K electron temperature and $1.65 \times 10^{23}\mathrm{m}^{-3}$ electron density. This results are the very first ones for Kr III Stark line shift determination, and the second experimental results of reliable Kr II Stark line shifts. Moreover, 14 Kr II Stark line shifts and 2 Kr II Stark linewidths have been calculated within the frame of the modified semiempirical method (Dimitrijević and Konjević, 1980; Dimitrijević and Kršljanin, 1986). Results of calculations by using the modified semiempirical method, of Stark widths and shifts for 5 Kr III multiplets and such results for 3 Kr III multiplets by using the simplified modified semiempirical method (Dimitrijević and Konjević, 1987) are also presented. The obtained results are compared with other experimental and theoretical results.

One should emphasize here that with the help of the Goddard high resolution spectrograph on the Hubble space telescope, krypton has been detected for the first time in the spectra of the interstellar medium (Cardelli, Sarage and Ebbets, 1991; Cardelli and Mayer, 1997), which represents the material from which the young early type stars (as e.g., Ap and Bp type stars where Stark broadening data are of interest) are formed (Leckrone et al., 1993). Consequently, the obtained results will be of help not only for laboratory plasma diagnostics and krypton plasma research and modeling, but also for the analysis of the trace element spectral lines and abundances.

The knowledge on regularities and systematic trends for Stark line shifts within a given spectrum as e.g. similarities among Stark line shifts within a multiplet, supermultiplet or transition array and systematic trends within a spectral series, is useful for the interpolation of new data and the critical evaluation of experimental data. Milan S. Dimitrijević and Dragana Tankosić (Dimitrijević and Tankosić, 2000) analyzed exceptions to the established shift regularities, on the basis of critically selected experimental data as well as of results of semi-classical calculations. It has been demonstrated that the principal reason for the irregularities discussed, is the influence of the intercombination and forbidden perturbing transitions.

Gojko Djurašević in collaboration with Skopal, A., Jones, A., Drechsel, H., Rovithis-Livaniou, H. and Rovithis, P. (Skopal et al. 2000) performed a photometric study of the eclipsing symbiothic binary AR Pavonis. Light curves of this long periode close binary system ($P \sim 604.^d6$) in quiet and outburst phases are similar to light curves of cataclismic close binary systems. Consequently, in the considered system an intense matter exchange between components occurs, so that for the analysis of these observations, close binary sysstem model with accretion disk has been suggested.

Development and application of adequate model of this symbiotic close binary system represenrs a key contribution to the understanding of physical processes within the system. Optimal model synthetic lightcurves, obtained by solving inverse problem, fit very well observations, so that it is possible to make a real estimate parameters of components, accretion disc and hot-spot due to capture of gas stream from the second component. The accretion disc temperature profile is estimated too, which in the quiet phase deviates considerably from steady state approximation. The distance to the system has been estimated from analysis of observations, as well as the components mass ratio, mass and radius of the giant component loosing mass.

Slobodan Jankov in collaboration with E. Janot-Pacheco and N. V. Leister (Jankov et al, 2000) presents, for the first time, the Fourier-Doppler Imaging (FDI) analysis of periodic line profile variations in a ζ Oph-type star. For this purpose they obtained, in 1996 May 3 to May 5, a total of 242 high resolution, high signal-to-noise ratio spectra of the Be star ζ Oph itself. Using the FDI technique, they examine the variations in both time and wavelength and complement it with time series analysis. This kind of analysis is valid for both non-radial pulsator and rotation modulation model but they discuss the results in terms of the former model, considering it as the more likely explanation for the observed line profile variability. Two distinct groups of modes are detected: medium ($4 \leq l \approx |m| \leq 8$) and high-degree ones (that could be associated with $13 \leq l \approx |m| \leq 17$). It is shown that the high-frequency oscillations were strongly confined to an equatorial belt narrower than 20 deg, and that the line profile variability was caused predominantly by sectoral modes, although tesseral modes $|m| = l - 1$ are not excluded accounting for the effect of fast rotation. They discuss the modal nature of the waves with respect to the characteristic oscillation periods in the corotating frame and the high amplitude of the projected rotational velocity variations ($\approx$ 20 km/s).

Darko Jevremović in collaboration with J. G. Doyle and C. I. Short, considered (Jevremović et al, 2000) the influence of the non-thermal velocity (micro-turbulence) on the formation of chromospheric lines in the atmospheres of late type dwarfs. A review of previous work shows a variety of different approaches to the problem leading to different atmospheric structures and consequently different computed line profiles. In that light, they re-examine the formation of the Hydrogen Balmer lines and Na i D lines using twelve different distributions of the micro-turbulent velocity throughout the atmosphere. Their results show a wide range of possible line shapes. Using the analogy with the solar case and the latest results of the non-thermal component widths as derived from instruments on-board SOHO, they model H alpha and the Na i D lines in an active dMe star Gl 616.2. This study is based in part on observations made at Observatoire de Haute Provence (CNRS), France and SOHO.

Silvana Nikolić in collaboration with Kiss, Cs., Tóth, L. V., Moór, A., Sato, F., and Wouterloot, J. G. A., (Kiss et al. 2000) presented the results of optical, far–infrared and radio observations of the small, non-star forming dark cloud Khavtassi 15, located in the Upper Cepheus–Cassiopeia region. They derive the average extinction and the distance from Digitized Sky Survey data and star counts using objective prism spectroscopy. A fully computerized algorithm was used for non-biased analysis of starcount data. A kinetic temperature of 7 K and a peak number density were

estimated from multiisotopic, multilevel CO measurements. CO measurements also revealed three main condensations inside the cloud. Kh 15 has a total gas mass of 34 solar masses and it is most probably part of a shell seen as a FIR loop called GIRL126+10. We investigated the correlation among optical extinction, radio and FIR emission and masses derived for the dust and gas inside the cloud core. Stability analysis has shown, that Kh 15 is not far from gravitational virial equilibrium, and may be fully stabilized by the external pressure. In addition to Kh 15, the starcounts also indicate the presence of an extended nearby extinction layer at which they consider as the wall of the Local Bubble (LB) towards the Upper Cepheus-Cassiopeia. Distances of the dark clouds LDN 1308, LDN 1333 and Khavtassi 19 are also estimated.

The orbital elements, masses and orbital paralaxes are communicated for the first time by Georgije Popović, Rade Pavlović and Vesna Živkov (2000) for the following eight double stars: WDS 04089+4614 = ADS 3007 = A 998 = HD 25987, WDS 04275+1113 = ADS 3228 = BU 1186 = HD 28217, WDS 04400+2301 = ADS 3370 = HU 442 = HD 29538, WDS 18018+0118 = ADS 10990 = AB = BU 1125 = HD 164577, WDS 18033+3921 = ADS 11023 = STF 2275 = HD 88432, WDS 18054+6216 = ADS 11073 = HU 1290 = HD 166206, WDS 19389+3514 = ADS 12746 = HU 953 = HD 185696, WDS 20176+2622 = ADS 13649 = BU 984 = HD 193095. The orbital elements are derived by using the procedure proposed by Popović and Pavlović (1995) while the absolute magnitudes of the components, masses and parallaxes are obtained by applying Angelov's (1993) relations.

During 2000, Milan M. Ćirković defended at the State University of New York in Stony Brook his Ph D Thesis *Gaseous Galactic Haloes and Lya Absorption Line Systems*. This thesis studies various aspects of the intragalactic origin theory for a large fraction of Lyα absorption line systems observed in spectra of all known QSOs. This long-standing problem has been approached along several different lines, with underlying assumption of the basic unity of physical processes relevant for the structure and evolution of the baryonic content of the universe. A new wave of interest in galactic origin of Lyα forest absorption systems has recently been sparked by observational determination of the extent and structure of extended gaseous haloes of luminous galaxies, and is yet far from being exhausted.

One of the main conclusions is that all observational data gathered so far are in compliance with the picture of two populations of physical objects causing Lyα absorption in QSO spectra: a diffuse, unclustered population of primordial IGM inhomogeneities, dominant at high redshift and the lowest column densities; and population of clouds residing in gaseous haloes of luminous galaxies dominant at low- and intermediate-redshifts and in the higher column density regime. The gradual transition between these two populations represents a major evolutionary event in the history of the gaseous content of the universe. Another lesson learnt in the course of the present work, is that while unraveling the puzzles of the baryonic matter evolution in the universe we need an interdisciplinary approach which will connect seemingly unrelated fields of physics and astronomy into a coherent picture of structure and evolutionary development of the matter as we know it.

During 2000, Nataša Vranešević obtained at Belgrade University the M. Sc. degree with the thesis entitled *Milky Way Kinematics in Solar Neigborhood on the Basis of*

the Heliocentric Velocities Module Analysis.

At the Large Refractor of the Astronomical Observatory, Georgije Popović and Rade Pavlović continued their observations of binary or multiply systems, with the help of a CCD St-6 camera. Their results from 1998-2000 periode, together with results of Danilo Zulević from March 1990 until his death in 1998 are published in Zulević, Popović and Pavlović (2000). At the visual telescope of the Ascania astrograph of 13,5/160 cm, photographic observations have been performed by V. Protitch Benishek with CCD ST-6 and ST-8 cameras. Results of comets C/1999 L3 (LINEAR) and C/1999 S4 (LINEAR) as well as minor planets 2000 DO_1, 1999 RH_{27} and 1999 NS_3 observations have been reported in several IAU Circulars. Moreover, 143 precise astrometric positions of seven comets from CCD observations during the period December 1998 - June 2000 have been published (Protitch-Benishek and Benishek, 2000).

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