

ACTIVITIES OF PARTICIPANTS OF THE PROJECTS 146001 AND 176002 "INFLUENCE OF COLLISIONAL PROCESSES ON THE ASTROPHYSICAL PLASMA SPECTRA" – 2010-2011

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Abstract. The brief review is given, of activities of participants of the projects 146001 (in the 2010 year) and 176002 (in the 2011 year) "Influence of collisional processes on the astrophysical plasma spectra", within the period from 1st January 2010 up to 31st December 2011. Besides the bibliography of scientific results, other activities of the project participants, such as activities in popularization of science and in literature, editing, organization of scientific conferences, etc. are presented.

The period described here was specific, since in 2010 one project cyclus was completed (project 146001) and started a new one in which the project 176002 was submitted with the same name: "Influence of collision processes on astrophysical plasma spectra", but with a much broader content. In addition, the group of Anatolij Mihajlov was included and their experimental investigations of the influence of solar activity on the characteristics of the earth-ionosphere waveguide. Sonja Vidojević with a new topic of research of solar wind was also included as well as foreign associates.

The new Project is the continuation of long standing research of the influence of atomic collisional processes on the spectra of astrophysical and laboratory plasmas, and contains also two Project tasks where the investigations in two new research fields will start. The topics proposed to the Ministry of Education and Science are:

1. Determination of parameters of Stark broadening and investigations of its influence on spectral lines of white dwarfs and of chemically peculiar A and B type stars. This research field is particularly actualized with the development of satellite born astronomy, which provides the good quality spectra with unreachably before resolution, so that spectral lines of trace elements are becoming more and more astrophysically significant. Particularly is interesting recently discovered

new type of white dwarfs with carbon atmospheres,¹ which spectra contain numerous C II lines broadened by impacts with charged particles. Data on their Stark broadening available in literature are scarce and insufficient, and in order to understand the origin and evolution of this new type of stars the inclusion of accurate spectral line broadening is crucial for this type of white dwarf atmosphere modelisation.

The influence of Stark broadening on other types of white dwarf spectra, as well as on that of A and B type stars, will be investigated as well. For determination of Stark broadening parameters, semiclassical perturbation and modified semiempirical method will be used, and the results will be compared with observed stellar spectra and synthetic ones, modeled with SYNTH2 and PHOENIX code. These results enter within the frame of FP7 project VAMDC 239108 (<http://www.vamdc.org/>), in STARK-B database (<http://stark-b.obspm.fr/>), and Serbian Virtual Observatory (<http://servo.aob.rs/~darko/>).

Except for Astrophysics, obtained results will be of importance and for research of laboratory plasma, plasma technologies, lightning, lasers, laser produced plasmas and inertial fusion.

2. The influence of solar activity on the characteristics of waveguide Earth-ionosphere (Space weather), as well as the influence of electrical discharges in the Earth's atmosphere will be studied experimentally, by permanent measuring of the amplitude and phase of VLF radio-waves which propagate through the waveguide Earth-ionosphere. Measuring of the amplitude and phase of narrowband transmitters within the range 10-30 kHz, by using AbsPAL (*Absolute Phase and Amplitude Logger*) and AWESOME (*Atmospheric Weather Electromagnetic System for Observation Modeling and Education*) systems. On the base of obtained data will be analyzed daily changes in the ionosphere which are caused by reinforced radiation from the Sun during flares and the electron density profiles during the flares as well as in the period when regular conditions in the D layer of ionosphere are established. Also, it will be studied the perturbation of the electron density in the D layer of ionosphere during night conditions which are caused by falling down high energy electrons from the radiative bands (*Lightning-induced electron precipitation, LEP event*). We plan the continuation of the work within European action COST ES0803 «Developing space weather products and services in Europe», as well as of the bilateral collaboration with the University of Nova Gorica (Slovenia).

3. We will study the influence of inelastic atom-Rydberg atom and radiative ion-atom collision processes on the kinetics of weakly ionized plasma of Sun, white dwarfs and Earth's ionosphere. As the result, the needed rate coefficients of chemi-ionization/recombination and excitation/deexcitation processes in atom-Rydberg atom collisions, as well as the coefficients of the absorption caused by ion-atom collisions in UV and VUV spectral regions will be determined. On the base of these data the influence of atom-atom and ion-atom collision processes to

¹ Dufour, P., Liebert, J., Fontaine, G., Behara, N. : 2007, White dwarf stars with carbon atmospheres, *Nature*, **450**, 522.

the kinetic transport properties of weakly ionized solar, stellar and ionospheric plasmas will be studied.

4. Within the Project frame is the Project task "Solar wind", led by Sonja Vidojević. By analysis of observations with different devices on the satellites "Wind" and "STEREO", in collaboration with Paris Observatory (Milan Maksimović) will be investigated the interaction of beams with highly energetic electrons, formed in various violent events on the the Sun, with interplanetary plasma (Solar wind), through which they propagate on lines of force of the solar magnetic field. One will work and on the investigation of relationship between Langmuir oscillations/waves, and the type III solar radio bursts. As the result, one expect to determine reliably a large number of parameters of Langmuir oscillations/waves and to prove the cause and effect relationship with the type III solar radio bursts.

5. The second Project's task is "Investigation of exoplanet's reflectance spectra" in order to search biomarkers in them. This is the beginning of such investigations here, and in collaboration with Siegfried Franck from Potsdam our younger researcher will be trained to synthesize, with the JPL (Jena, Potsdam, Lund) code, the reflectance spectrum of a planet and to investigate observability of the influence of biosphere on it. The spectrum of host-star, which should be subtracted, will be modeled with the PHOENIX code or obtained by observations. Unfortunately, this activity stopped, since Professor Siegfried Franck passed away.

Besides the scientific investigations, what is the principal objective of the Project, it will be (as in the previous Project's cycle) a basis for wide international collaboration in this research field, as it is the work on FP7 project VAMDC 239108 (Virtual Center for Atomic and Molecular Data <http://www.vamdc.org/>), which has participants from 9 countries (and the Project's leader, and the author of this text, is a member of the Project Board and leader of the Serbian node - AOB node), and on COST action ES0803 «Developing space weather products and services in Europe» (<http://www.costes0803.noa.gr/>). Because of needed equipment for the Project (observations from satellites „Wind» and "STEREO", observations of stellar spectra) will be continued and enlarged the collaboration with Paris Observatory and Russia. On the other hand, in order to obtain results of high quality, in the work on Project will participate our coauthors and colleagues from France, Russia, Greece, Spain, Germany, Tunisia, Bulgaria, Belgium (Jovo Vranješ) and Slovenia (Vida Žigman). The Project will be and a basis for scientific training and education of the young, so that we expect that at least three PhD Theses will be defended until the end of this Project, and that some tasks on the Project become themes for Diploma theses of Master studies.

Within the 2010-2011 period, participants of the Project published 7 papers in leading international journals, namely (the number of papewrs is in the brackets): Astronomy and Astrophysics (1), Astrophysical Journal (1), Astrophysical Journal Supplement Series (2), Monthly Notices of the Royal Astronomical Society (2), Journal of Physics A: Mathematical and Theoretical Physics (1).

In international journals European Physical Journal: Applied Physics (1), Journal of Quantitative Spectroscopy and Radiative Transfer (1) Physica Scripta (1) Baltic Astronomy (14) and Acta Astronomica (1), 18 papers are published. Moreover, three papers, not connected with project, are published in the journal from SSC list, and in international journals not in SCI list, and books of international publishers 20 papers are published.

The other results are: Invited lectures on international conferences published in journals and books of international publishers (8), national monographies (2), scientific papers in national journals and books (13), scientific papers in proceedings of international conferences (3), contributions on national conferences (12), abstracts of invited lectures on international conferences (12), abstracts of contributions to international conferences (27), abstracts of invited lectures on national conferences (1), book reviews in national journals (1) and 13 entries for Serbian Encyclopedia. In the considered period Dragana Tankosić defended her PhD Thesis.

In total, associates of the Project published 141 bibliographic item, from which 95 are connected with Project and 46 not.

Associates of the Project have organized also four conferences and one summer school, giving and in this way a contribution to the development of scientific collaboration. These meetings are:

1. „DEVELOPMENT OF ASTRONOMY AMONG SERBS VI“, Belgrade, 22 – 26 April 2010, M. S. Dimitrijević Chair of Scientific Committee, M. Dačić member; M. Dačić Chair of Local Organizing Committee, M. S. Dimitrijević member.
2. THE THIRD INTERNATIONAL SCHOOL IN ASTRONOMY: ASTROINFORMATICS – VIRTUAL OBSERVATORY, Belgrade, 29 Jun – 1 July 2010, M. S. Dimitrijević and A. Kovačević Co-Chairs of Scientific Committee, D. Jevremović Co-Vice chair, Z. Simić member, A. Kovačević Chair of Local Organizing Committee, J. Kovačević, M. Dačić, Z. Simić members.
3. I WORKSHOP: SPECTROSCOPY AS A TOOL TO INVESTIGATE ACTIVE GALACTIC NUCLEI AND GRAVITATIONAL LENSES, Бабе (Космај), 7-11. јули 2010, M. S. Dimitrijević, D. Jevremović, A. Kovačević members of Scientific Committee, J. Kovačević Chair of Local Organizing Committee, A. Kovačević member.
4. 8th SERBIAN CONFERENCE ON SPECTRAL LINE SHAPES IN ASTROPHYSICS, Divčibare, 6-10 Jun 2011, D. Jevremović Co-Chair of Scientific Committee, M. S. Dimitrijević, A. A. Mihajlov members, D. Jevremović Co-Chair of Local Organizing Committee, A. Kovačević Secretary, M. S. Dimitrijević, J. Kovačević, M. Dačić, Z. Simić members
5. I WORKSHOP ON ASTROPHYSICAL SPECTROSCOPY, Orašac, 26-30. August 2011. M. S. Dimitrijević co-Chair of the Scientific and Local Organizing Committees, D. Jevremović, Z. Simić, A. Kovačević members,

A. Kovačević Co-Chair of Local Organizing Committee, M. Dačić, J. Kovačević, Z. Simić members.

In addition, associates of the Project contributed and to the organization of the following conferences:

1. 7th BULGARIAN-SERBIAN ASTRONOMICAL CONFERENCE, ASTROINFORMATICS, Chepelare, 1 – 4. June, 2010, M. S. Dimitrijević, D. Jevremović, Z. Simić members of Scientific Committee.
2. IX CONFERENCE NEW TECHNOLOGIES AND STANDARDS: NATIONAL HERITAGE DIGITIZATION, Belgrade, 16-17. June 2010, M. S. Dimitrijević member of the Organizing Committee.
3. 20th International Conference on Spectral Line Shapes, 6-11 June 2010, St. Johns, Newfoundland, Canada, Milan S. Dimitrijević member of Scientific Committee.
4. 12th International Conference on Computer Systems and Technologies, CompSysTech'11, Wien, 16-17 June 2011, International Programme Committee, M. S. Dimitrijević, member.
5. 10th CONFERENCE NEW TECHNOLOGIES AND STANDARDS: NATIONAL HERITAGE DIGITIZATION, Belgrade, 22-23 September 2011, M. S. Dimitrijević member of the Organizing Committee.

During 2010, on the project 146001 seven associates participated, six from Astronomical Observatory and Andjelka Kovačević from Mathematical Faculty (MF). The Project Leader was Zoran Simić and the list of associates is:

1. **Miodrag Dačić**, (born 1946) with 10 rm (research months)
2. **Milan S. Dimitrijević**, (born 1947) with 12 rm
3. **Darko Jevremović**, (born 1968) with 9 rm
4. **Andjelka Kovačević**, (born 1972, MF) with 8 rm
5. **Nenad Milovanović**, (born 1972) with 12 rm
6. **Zoran Simić**, (born 1967) with 12 rm
7. **Dragana Tankosić**, (born 1968) with 4 rm

During 2011, twenty six researches have been engaged on the new project 176002, sixteen from Serbia and ten from abroad. Among researches from Serbia, seven was from Astronomical Observatory (AO), four from Institute of Physics (IF), three from Mathematical Faculty (MF), one from Mathematical Institute (MI) and one from Institute for chemical power sources (IHIS). The Project leader was M. S. Dimitrijević and the list of participants is:

1. **Sonja Vidojević**, (born 1960, IHIS) with 12 rm (research months)
2. **Miodrag Dačić**, (born 1946, AO) with 0 rm
3. **Milan S. Dimitrijević**, (born 1947, AO) with 9 rm

4. *Sanja Životić*, (born 1984, MF) with 2 rm
5. *Ljubinko Ignjatović*, (born 1959, IF) with 12 rm
6. *Darko Jevremović*, (born 1968, AO) with 3 rm
7. *Andjelka Kovačević*, (born 1972, MF) with 7 rm
8. *Jelena Kovačević*, (born 1981, AO) with 1 rm
9. *Dušan Marčeta*, (born 1980, MF) with 4 rm
10. *Nenad Milovanović*, (born 1972, AO) with 2 rm
11. *Anatolij Mihajlov*, (born 1941, IF) with 0 rm
12. *Aleksandra Nina*, (born 1977, IF) with 5 rm
13. *Zoran Simić*, (born 1967, AO) with 10 rm
14. *Vladimir Srečković*, (born 1972, IF) with 5 rm
15. *Dragana Tankosić*, (born 1968, AO) with 6 rm
16. *Brankica Šurlan*, (born 1974, MI) with 6 rm

Foreign participants of the Project were *Jovo Vranješ* (Belgium), *Milan Maksimović* (France), *Tatjana Ryabchikova* (Russia), *Magdalena Christova* (Bulgaria), *Emanouel Danezis* (Greece), *Antonios Antoniou* (Greece), *Sylvie Sahal-Bréchet* (France), *Nebil Ben Nessib* (Tunisia), *Maria Dolores Calzada* (Spain) and *Siegfrid Franck* (Germany).

In 2010, seven participants of the project 146001 realized 67 months of research, ie. 5.6 years. Average age of researchers was 1963.9 or about 46 years. In 2011 the situation is different because we have ten foreigners and two retired with zero months. If we consider only funded researchers, fourteen associates participated with a total of 84 months of research or 7 years. Average age was 1970.6 or about 40.4 years.

An important result of the project is the PhD thesis defended by Dragana Tankosić in 2010. The information concerning the achieved scientific results and extensive international cooperation, provides the bibliography of published works, listed in the Appendix. The new project, which was accepted by the Ministry of Education and Science in the new cycle, which began in 2011, greatly exceeded the old, completed in 2010, both in scope and in number of research assistants, as well as with opportunities for further education of the young. Also, a fruitful and successful international cooperation with a number of colleagues from other countries has been developed and the obtained results are, and will be included in European projects such as FP7 (Virtual Atomic and Molecular Data Center) and COST action.

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