



# 29<sup>th</sup> Summer School and International Symposium on the Physics of Ionized Gases

Aug. 28 - Sep. 1, 2018, Belgrade, Serbia

## CONTRIBUTED PAPERS &

ABSTRACTS OF INVITED LECTURES,  
TOPICAL INVITED LECTURES, PROGRESS REPORTS  
AND WORKSHOP LECTURES

Editors:

Goran Poparić, Bratislav Obradović,  
Duško Borka and Milan Rajković



Vinča Institute of  
Nuclear Sciences



Serbian Academy  
of Sciences and Arts

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**S P I G 2018**

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## **PREFACE**

This publication contains the contributed papers and abstracts of Invited Lectures, Topical Invited Lectures, Progress Reports and Workshop Lectures that will be presented at the International Symposium on the Physics of Ionized Gases 2018. This is the 29th of a series of events which reflect the progress in this challenging field of science. The event is organized by the Vinča Institute of Nuclear Sciences in Belgrade and Serbian Academy of Sciences and Arts, with the support of the Ministry of Education, Science and Technological Development of the Republic of Serbia.

The aim of this book is to present new results in the fundamental and frontier theories and technology in the area of general plasma physics (including astrophysical and fusion plasmas), atomic collision processes and particle and laser beam interactions with solids. Also, the presented results and lectures of the 3rd Workshop on X-ray and VUV interaction with Biomolecules in Gas Phase - XiBiGP are also included.

Herein, the Editors would like to thank the authors and reviewers for their support of this event and to wish all participants a pleasant and productive stay in Belgrade. We are grateful to the Serbian Academy of Sciences and Arts for their long term commitment to support this event as well as the Serbian Ministry of Education, Science and Technological Development for their continuing help. We also acknowledge the support of the open access journal "Atom"

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## BEAMDB AND MOLD – COLLISIONAL AND RADIATIVE DATABASES AT THE SERBIAN VIRTUAL OBSERVATORY

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**Abstract.** In this contribution we present a progress report of two atomic and molecular databases, BEAMDB and MoID, which are web services at the Serbian virtual observatory (SerVO) and nodes within the Virtual Atomic and Molecular Data Center (VAMDC). The Belgrade Electron/Atom(Molecule) Data Base (BEAMDB) provides collisional data for electron interactions with atoms and molecules. The MoID database contains photo-dissociation cross-sections for individual rovibrational states of diatomic molecular ions and rate coefficients for the chemi-ionisation/recombination processes. We also present a progress report on the major upgrade of these databases and plans for the future.

### 1. INTRODUCTION

Databases in atomic and molecular physics have become essential for develop of models and simulations of complex physical and chemical processes and for the interpretation of data provided by observations measurements e.g. in laboratory plasmas [1] and plasma chemistries and reactions in planetary atmospheres [2]. In order to solve the problem of analysis and mining of such large amounts of data, the creation of a Virtual Observatory and Virtual Data Center has been crucial [3 and refs. therein]. In this contribution we present a progress report of two atomic and molecular databases, BEAMDB and MoID,

which are web services at the Serbian virtual observatory (SerVO) [4] and nodes within the Virtual Atomic and Molecular Data Center (VAMDC) [5].

This branch of science often entitled ‘Data management’ or ‘Data mining’ is undergoing rapid expansion and development, however nowadays it is not enough for these databases to satisfy the standards of Virtual centers etc., but they have to deal with new challenges such as inputs of large amounts of data i.e. Big Data. Thus, we can expect major investment and activity in this field in the next decade.

## 2. REPORTS FROM BG NODES

The Belgrade nodes of VAMDC are hosted by SerVO (see Fig.1) and currently consists of two databases BEAMDB ([servo.aob.rs/emol](http://servo.aob.rs/emol)) and MoLD ([servo.aob.rs/mold](http://servo.aob.rs/mold)). These databases have been created using the standards developed and operated by the VAMDC project [5], (see Fig 2). VAMDC and SerVO have been through different stages of development. SerVO (<http://www.servo.aob.rs/>) is a project formally created in 2008 but its origins date from 2000 when the first attempts to organize data and to create a kind of webservice was made in the BELDATA project, the precursor of SerVO. VAMDC started, on July 1<sup>st</sup> 2009 as a FP7 funded project. It began with about twenty databases and now there are more than 33 currently running [6].



Figure 1. The home page of the SerVO [4]

We are currently in a transition phase updating the software “platform” (Python update, Django, XSAMS evolution, new Query Store on VAMDC, etc.) as the consequence of the rapid development and expansion.

Some current technical characteristics and aspects of these databases will be briefly introduced here (for details see [3]). Access to the BEAMDB and MoLD data is possible via Table Access Protocol (TAP), a Virtual Observatory standard for a web service or via AJAX (Asynchronous JavaScript and XML)-enabled web interface (<http://servo.aob.rs/>). Both queries return data in XSAMS (XML Schema for Atoms, Molecules and Solids) format. The XSAMS schema provides



a framework for a structured presentation of atomic, molecular, and particle-solid-interaction data in an XML file. The underlying application architecture is written in Django, a Python web framework and represents a customization and extension of VAMDC's NodeSoftware [7,8].

**Figure 2.** VAMDC [5] portal query snapshot (<http://www.portal.vamdc.eu>).

**MolD:** The MolD database has undergone three stages of development [9,10]. The initial stage of development was completed at the end of 2014, when the service for all the photodissociation data for hydrogen  $H_2^+$  and helium  $He_2^+$  molecular ions was constructed together with the web interface and some utility programs. At the end of 2016 MolD completed the stage 2 of development when it added averaged thermal photodissociation cross-sections  $H_2^+$  and helium  $He_2^+$  molecular ions and new cross-section for processes which involve species such as diatomic molecular ions  $HX^+$ , where  $X=Mg, Li, Na$ . During 2017, MolD entered stage 3 of its development in which MolD includes cross-section data for processes which involve species such as  $MgH^+, HeH^+, LiH^+, NaH^+, H_2^+, He_2^+...$ . The third stage also improved the design of the web interface and developed utility programs that allow online data visualization of a wide range of data. This phase of development was completed at the beginning of 2018. The database is currently in the phase of a major upgrade.

**BEAMDB:** The origins of this database date from the early ideas of developing an Information System in Atomic Collision Physics [11] and at first it provided only cross sections for electron interactions with neutral atoms and molecules [12]. However the database has now been extended to cover electron spectra (energy-loss and threshold) and ionic species [3].

### 3. CONCLUSIONS AND FUTURE WORK

Both databases, BEAMDB and MolD databases are in transition and working progress that involves:

- XSAMS evolution to deal with Big Data (resources to be accessed by diverse client platforms across the network; generating and transferring data over a network without requiring human-to-human or human-to-computer; provide security and data quality; etc.)
- Python, Django updates
- Installing the Query Store on VAMDC node that should have a plan store for holding the execution plan information, and a runtime stats store for carrying on the execution statistics information.

In this contribution we have presented a progress report and recent developments of the Belgrade atomic and molecular databases hosted by the SerVO. These databases have been developed using protocols developed by the VAMDC. We expect advances in many fields once VAMDC and the BEMDB/MoID are functionalised and adopted by the whole community.

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