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# COMMISSION 14 ATOMIC AND MOLECULAR DATA

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|---|---|
| **Div. XII / Commission 14 WG** | **Atomic Data** |
| **Div. XII / Commission 14 WG** | **Collision Processes** |
| **Div. XII / Commission 14 WG** | **Molecular Data** |
| **Div. XII / Commission 14 WG** | **Solids and Their Surfaces** |

## TRIENNIAL REPORT 2009–2012

### 1. Introduction

The main purpose of Commission 14 is to foster interactions between the astronomical community and those conducting research to provide data vital to reducing and analysing astronomical observations and conducting theoretical investigations. One way that the Commission accomplishes this goal is through triennial compilations on recent relevant research in astronomy, atomic, molecular and solid state physics, and related fields of chemical analysis. The most recent compilations appear in the accompanying set of Commission 14 WG Triennial Reports, which were produced by members of the Working Groups and the Organizing Committee of Commission 14.

During the most recent triennial period, members of Commission 14 have also been active in organizing and participating in meetings of various types. In part, it is through these meetings that the astronomical community can communicate their needs to data producers, while data producers provide the results of their studies. Input from the astronomical community is critical to maintaining the vitality of the data producing community, fostering collaboration on proposals and projects that can lead to funding opportunities for data producers. The WG reports provide a record of these meetings and other activities relevant to the Commission.

### 2. Looking forward to the next triennial period

The importance of continued efforts to improve and expand on the current state of atomic and molecular data comes from recent developments in ground-based and orbital astronomical observatories.

Investigations in atomic spectroscopy remain a critical undertaking for the iron-group elements at all wavelengths. These elements provide a large number of spectral lines, which are of interest in their own right as well as contributing to line blending. Data for characterizing spectral lines at ultraviolet wavelengths of post-iron-group elements still remains undetermined for basic abundance analyses. The near-infrared region has come of age in the past few years with the commissioning of high spectral resolution instruments, such as the ESO VLT CRIRES, and requires accurate wavelengths and transition probabilities for most elements. At longer wavelengths, atomic spectra are virtually unchartered territory except for the strongest features. High precision radial velocity determinations and wavelength calibration and standards at infrared wavelengths both require continued laboratory analysis.

With the flow of data at far-infrared and sub-millimeter wavelengths becoming available from the Herschel Space Observatory, ALMA (Atacama Large Millimeter / Submillimeter Array), and SOFIA (Stratospheric Observatory for Infrared Astronomy), molecular data are needed for line identification and chemical abundance studies. Such data include transitions of simple hydrides and complex molecules, infrared spectra of hot bands from molecules that probe brown dwarfs and exoplanet atmospheres, and ultraviolet / optical data of radiative processes associated with photochemistry. These areas continue to draw much activity and the Commission is expected to highlight results in this area for the astronomical community during the next triennial period.

In the last few years the study of particulate matter has experienced an astonishing increase in the number of studies of the formation of molecules on surfaces of dust grain analogs. The long bibliographic list in this area, provided in the WG report, is a subset of a much longer list of publications on this subject. The interest in chemical/physical processes occurring on the surfaces of dust grains has been spurred by the desire to understand observations coming from infrared and sub-millimeter space telescopes.

Collisional cross-sections and processes are necessary for accurate astrophysical plasma modelling and interpretation, as for example modelling atmospheres of exoplanets and developing strategies in the search of biomarkers. Such collisional processes include electron impact excitation and ionization, charge transfer collisions, and neutral hydrogen atom impact excitation and ionization. However, for the elements beyond Ca (with few exceptions, e.g. Fe II), it still appears preferable to use an effective collision strength of unity for forbidden transitions and the van Regemorter formalism for allowed transitions. Thus, experimental and theoretical studies of collision processes remains important for astrophysical research. The WG report on collisional processes provides ample literature appropriate for analysing stellar spectral features. However, developing methods of incorporating these data into spectrum analysis remains fertile ground for future studies.

Concerning line profiles, such data remain of critical importance for analysis, interpretation and synthesis of astrophysical spectra of high resolution, when taking into account plans for Extremely Large Telescopes and space telescopes.

Finally, a continuing effort of importance to the astronomical community is the availability of data and bibliographic information through data bases, along with the critical assessment of these data. The databases most often do not focus on data of solely astrophysical importance, but rather on data of general importance to a wide variety of fields. On-going efforts to standardize formats for spectral line data bases are likely to produce fruitful results within the next few years. The WG Triennial Reports summarize databases of current interest to astrophysics.

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