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The AtMoCIAD database

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Abstract

Numerical models are important to account for the basic plasma processes in the Earth and planetary atmospheres, and more generally, for heliophysics studies.

One of the greatest sources of inaccuracies for these models are the cross sections used to compute ionizations, dissociations, and excitations of the different atoms and molecules, by photon, electron, proton (...) impact. Up to now, several sets of cross sections have been used by different teams, sometimes with significant differences. Therefore, cross models comparisons have been mostly a test of each datasets rather than a test of the physics of the interactions.

To account for these issues, we are developing a database called "AtMoCIAD" for "Atomic and Molecular Cross section for Ionization and Airglow/aurora Database". It consists of:
– a set of techniques to check the integrity of the cross sections.
– a set of techniques to estimate the influence of these uncertainties on the model outputs.
– a central database, with recommended cross sections, and their uncertainties.
– a set of tools to discuss the cross sections, to add new ones, to compare the different versions.

Currently, the main upper atmosphere species have been integrated into the database. The addition of other species needs an effort that should be supported by the community, especially if partial sets of cross sections have been compiled elsewhere. To support that evolution, the database interface is being actively developed to allow improved user interactions.

1. Introduction

Numerical kinetic models, such as *Aeroplanets* [2, 3] are now able to compute the uncertainties in the production of ions, excited species, and light emissions in the upper atmospheres of planets. To do so, they use Monte-Carlo techniques based on the perturbation of the cross sections with claimed uncertainties.

The Aeroplanets model outputs show that it is important to carefully check the uncertainties before trying to adjust the cross sections to the observations. This demonstrates the real need for an important effort around a unified cross section database addressing uncertainties.

2. The database

AtMoCIAD, "Atomic and Molecular Cross section for ionization and Airglow/aurora Database", aims at being the main source of information for cross sections in planetology/heliophysics plasma research. Its evolution will be driven by the community: the observation of discrepancies between model and observations, the needs of the modelers, the measurements of experimentalists, will be highlighted in the scope of the database in itself to ensure a constant update.

2.1 Description

The core of the database consists of the cross sections for photon, electron, and proton impact. The total cross sections will be complemented by the relative ionization, dissociation, excitation and emissions cross sections (doing so allows the greatest precision, since, for example, it is better to compute the absorption of a flux with the measured total absorption cross section instead of summing the cross sections for the partial processes).

For each processes, the sources are checked carefully, along with the claimed uncertainties. Instead of giving a unique cross section for each processes, AtMoCIAD gives the different values published in the literature, but also recommends which one to use. An example of compilation of the recommended data can

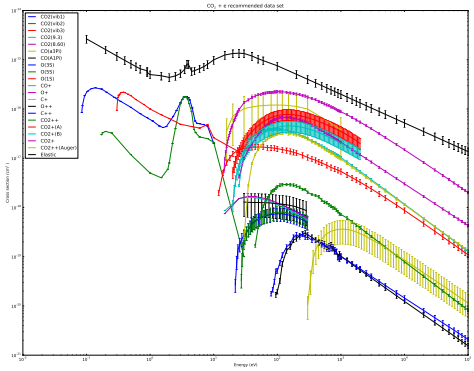

Figure 1: Recommended cross sections for the electron impact on CO_2

be found in Fig.1 in the case of electron impact on CO_2.

2.2 Testing the cross sections

For the consistency of the recommended cross sections of the database, a number of different tests have to be performed. It includes the comparison of the partial cross sections with the total cross section, the possibility to extrapolate cross sections, a comparison of the claimed uncertainties for different sources, and of course, a bias toward the measured cross sections.

On top of that, a technique based on the computation of the mean energy expended in the production of an electron-ion pair by electron impact has proven its capacity to check the accuracy of different sets of cross sections for electron impact [3]. Such efforts ensure the completeness of currents cross section datasets within AtMoCIAD, and will be of great importance for future evolutions.

2.3 The future prospectives

Along with the additions of new species, new processes, the AtMoCIAD database is planned to have a collaborative user interface, which allows the users to choose their own set of cross sections depending on the studies made and to use previously recommended cross sections sets to compare with legacy work. For each cross sections, it will also be possible to discuss the recommendation, for example to try to understand why a specific data set works better for the Earth than for Titan.

3. Summary and Conclusions

AtMoCIAD, a database in development, will address several problems of the planetology/heliophysics community, including calibration and comparison efforts. The evolution of the database will imply the involvement of experimentalists, modelers, observers and instrumentalists.

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