

## Electron-driven reactivity of molecular cations in cold plasmas

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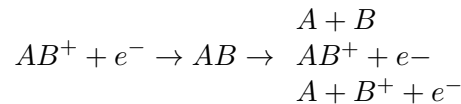
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Electron impact recombination, (ro-)vibrational, electronic and dissociative excitation of molecular cations:



are in the heart of the molecular reactivity in the cold ionized media [1], being major charged particles destruction reactions and producing often atomic species in metastable states, inaccessible through optical excitations. They involve super-excited molecular states undergoing predissociation and autoionization, having thus strong resonant character.

The methods based on the Multichannel Quantum Defect Theory (MQDT) [1,2] are the most suitable for modeling these processes, since they account the strong mixing between ionization and dissociative channels, open – direct mechanism – and closed – indirect mechanism, via capture into prominent Rydberg resonances correlating to the ground and excited ionic states - and the rotational effects. These features will be illustrated for several cations of high astrophysical, planetary atmosphere and fusion edge plasma relevance, such as  $H_2^+$  [3],  $BeH^+$  [4-6],  $SH^+$  [7],  $N_2^+$  [8],  $NeH^+$ ,  $NS^+$  [9],  $N_2H^+$  [10],  $C_2H^+$ , etc.

Comparisons with other existing theoretical and experimental results, as well as the isotopic effects, will be displayed.

## References

1. I. F. Schneider, O. Dulieu, J. Robert, eds., EPJ Web of Conferences 84 (2015).
2. J. Zs. Mezei et al, ACS Earth and Space Chem 3 2276 (2019).
3. M. D. Epée Epée et al, MNRAS 512 424 (2022).
4. S. Niyonzima et al, At. Data Nucl. Data Tables 115-116 287 (2017).
5. S. Niyonzima et al, Plasma Sources Sci. Technol. 27 025015 (2018).
6. N. Pop et al, ADNDT 139 101414 (2021).
7. J. Boffelli et al, submitted to MNRAS (2023).
8. A. Abdoulanziz et al, J. Appl. Phys. 129 052202 (2021).
9. F. Iacob et al, Journal of Physics B: At. Molec. Optical Phys. 55, 235202 (2022).
10. J. Zs. Mezei et al, submitted to EPJST (2023).

## Acknowledgements

Research supported by the Normandy region, LabEx PTOLEMEE, IEPE, CNRS-CEA CNES/PCMI and FR-FCM, ANR-MONA, NKFIH-OTKA and IAEA.

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