Towards electron-impact dissociation dynamics of biologically relevant molecules in a reaction microscope

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Synopsis We present a new design of an advanced reaction microscope (REMI) for electron collisions with biologically relevant molecules. It will combine advancements which have been implemented for (e, 2e)-experiments, such as multi-hit detectors with a high detection efficiency, as well as new features for target creation and increased fragment acceptance.

After decades of investigation of the ionization dynamics of simple atoms and molecules in electron collision experiments, in recent years significant progress was being made in the study of more complex and finally biologically relevant targets (e.g. [1, 2, 3]). Our aim is to provide highly differential ionization cross sections and insight into fragmentation dynamics, especially of DNA constituents. Data of this nature – with special emphasis on low collision energies – has a high importance in the modeling of radiation damages of biological tissue [4] and in cancer treatment.

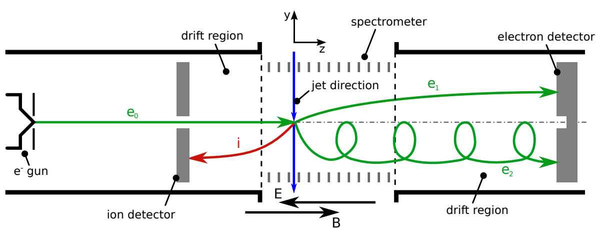

Figure 1. Schematic view of a REMI.

Experimentally this is accessible by using an advanced REMI which was modified for electron impact experiments [5]. Its general working principle can be seen in Figure 1. Briefly, a collimated molecular target beam is crossed with a monoenergetic, pulsed electron beam. All charged particles which emerge from a reaction are detected and their momentum vectors are reconstructed. Hence, it is possible to extract electronic information in form of e.g. triple-differential cross sections as well as fragmentation information like kinetic energy release and molecular orientations. However, with respect to the conventional REMI technique several constrains have to be overcome. Since molecular dissociation can result in large fragment momenta, a short detector distance and/or a pulsed high-voltage extraction is required. Furthermore, the REMI measurement relies on the target species to be present in gaseous form. While some volatile DNA constituents or surrogates can be provided in seeded supersonic jet or by evaporation in an oven, less volatile molecules can be brought into vacuum by laser-induced acoustic desorption (LIAD) from a foil.

Finally, since a good energy resolution is paramount, projectile beam creation requires special attention. Here, several measures, such as electron creation through photo-electric effect, have been taken to create sharp projectile pulses.

A detailed overview of the project and the employed methods and their performance will be presented.

References

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