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Absolute cross section for electron emission from uracil upon ion collision using velocity map imaging technique

N Sens¹, M Ryszka¹, A Méry¹, J-C Pouilly¹, J-Y Chesnel¹ and V Vizcaino^{1*}

¹Centre de Recherche sur les Ions, les Matériaux et la Photonique (CIMAP), Normandie Univ, ENSICAEN, UNICAEN, CEA, CNRS, 14000 Caen, France

Synopsis Ion-induced electron emission from RNA base uracil has been measured using a newly developed experimental set-up based on velocity map imaging (VMI) technique. Electrons emitted in a solid angle of 4π steradians are extracted and analyzed in energy and angle by the multi-electrodes VMI spectrometer. By monitoring the target density, the projectile ion beam intensity and the beams overlap with the use of a quartz crystal micro balance and an ion beam profiler, we were able to estimate absolute singly- and doubly- differential cross sections for electron emission.

In recent years, ion collision with biologically relevant molecules has received increasing interest due to applications in radiation biology. Absolute total or differential cross sections for electron emission have been measured for small biomolecules such as nucleobases [1-5] or amino acids [6]. Experiments were mainly performed with bare ions such as protons [1,3,4,7], C^{6+} or O^{8+} [2] with a kinetic energy of a few MeV. Absolute cross sections were measured using electrostatic analyzers (parallel plate or hemispherical) mounted on a turntable. Measured electron yields were usually put on an absolute scale by normalization to other collisional processes (for which cross sections are known) such as Rutherford forward scattering [1,4] or projectile elastic scattering at right angle [3].

We have recently developed a new experimental set-up to measure absolute singly or doubly differential cross section for electron emission from atoms or molecules using a velocity map imaging (VMI) spectrometer. This technique allows detecting all electrons emitted in a solid angle of 4π steradians at once, while with hemispherical or parallel plate electrostatic analyzer typical accessible angular ranges are between 20° and 160° due to mechanical constraints. Moreover, with the VMI spectrometer, very low energy electrons (below 1eV) can be detected. To the best of our knowledge, this technique has never been employed to measure ion-induced electron emission and had to be adapted to allow the projectile ion beam to enter the interaction region despite a collection electric field of about 100V/cm.

In our set-up, the target beam crosses orthogonally the projectile ion beam with typical kinetic energies from a few keV to a few MeV. Emitted electrons with energies up to 200 eV are extracted

by the multi-electrodes VMI spectrometer and focused onto a position sensitive detector (micro-channel plates coupled to a phosphor screen). After reconstruction of the 2D image recorded by the camera, one can extract the electron yield as a function of energy or emission angle or both. The target density is measured with the use of a quartz crystal micro balance. A density of about 2.10^9 molecules/cm³ was found for the uracil beam produced by the effusion cell.

In this contribution, we will present the experimental set-up and our methodology to determine absolute cross section. Moreover recent measurements of absolute singly- and doubly- differential cross sections for electron emission from uracil will be discussed and compared to previous data.

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* E-mail: violaine.vizcaino@ganil.fr

