Electron capture induced dissociation of water embedded nucleotide anions

To cite this article: N Haag et al 2009 J. Phys.: Conf. Ser. 194 102023

View the article online for updates and enhancements.

Related content
- Collisions with biomolecules embedded in small water clusters
  N Haag, B Liu, S Brandsted Nielsen et al.
- Photoelectron imaging of interstellar medium anions
  Nrisimhamurty Madugula, Roby Chacko, Pranawa C Deshmukh et al.
- Dissociation dynamics of transient anion formed via electron attachment to sulphur dioxide (SO2)
  Krishnendu Gope, Vaibhav S. Prabhudesai, Nigel J Mason et al.
Electron capture induced dissociation of water embedded nucleotide anions


*Department of Physics, Stockholm University, AlbaNova University Center, S-10691 Stockholm, Sweden
†School of Physics and Information Optoelectronics, Henan University, Kaifeng, 475004, China
‡Department of Physics and Astronomy, University of Aarhus, DK-8000 Aarhus C, Denmark
&Centre de Recherche sur les Ions, les Matériaux et la Photonique (CIMAP), Boulevard Henry Becquerel, F-14070 Caen Cedex 05, France

Synopsis We have studied fragmentation of the hydrated nucleotide anion adenosine 5′-monophosphate after collisions with neutral sodium atoms. Regardless of the initial number (≤ 16) of water molecules attached to the ion, dianion formation always leads to water evaporation as well as loss of a single hydrogen atom, possibly from the adenine part. This damaging effect becomes more important as the number of initially attached water molecules increases, which is just the opposite to the protective behavior observed for collision induced dissociation processes without electron transfer.

Nucleotides are the building blocks of DNA and RNA strands and it is their sequence which defines the genetic information. Therefore, they are considered to be among the most important targets for cellular radiation damage due to direct interaction with high energy quanta or secondary particles, such as free electrons, which may lead to strand breaks even at energies below the ionization thresholds [1]. In order to shed light on the mechanism of fragmentation by electron attachment, Electron Capture Induced Dissociation (ECID) has been studied in collisions between the RNA nucleotide adenosine 5′-monophosphate (AMP) and sodium [2]. To find out if and how an aqueous environment, which can be crucial for biochemical reactions and the dissipation of vibrational excitation, influences the fragmentation behavior on the single molecular level, parent ion beams of electrosprayed AMP⋯(H₂O)ₘ (with up to 16 water molecules) have been used in the experiment.

We find that the yield of dianions with microsecond lifetimes increases strongly with m, which is explained by dielectric screening of the two charges by the water cluster. Dianion formation always leads to evaporation of at least a few water molecules. Additionally, the loss of a single hydrogen atom has been identified as the dominant fragmentation process by a precise calibration of the energy analyzer. For collision induced dissociation (CID) processes (without electron capture), however, it had been found that a sufficiently large water cluster protects the AMP molecule from any damage [3].

Although the fragmentation behavior is quite different for ECID and CID, relative cross sections as functions of the number of remaining water molecules may be qualitatively accounted for by means of a common simple water evaporation model. Using this model, distributions of internal energy of the systems prior to fragmentation have been deduced which are characteristically different for the two processes.

References

1E-mail: haag@fysik.su.se