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Gas-phase interactions of fast ions and soft X-ray photons with DNA

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To improve our understanding of the molecular mechanisms underlying radiation therapy, the interaction of MeV ions and X-ray photons with gas-phase biomolecules has been intensively studied for more than 15 years. Most of the experimental studies were limited to relatively small DNA building blocks. Recently, this limitation was overcome by employing electrospray ionization, to bring large biomolecular systems into the gas phase. In our studies, electrosprayed DNA anions are mass selected and trapped in a radiofrequency ion trap, where they are exposed to MeV ions or to soft X-rays. Even though electron detachment is the dominating channel, DNA damage is clearly observed. We find that this damage prefers to occur at repetitive guanine (G) sequences, as present in human telomeres. The 3D structure of the DNA (linear, duplex, G-quadruplex) is of key relevance for the molecular response. Most relevantly, whereas soft X-ray induced DNA damage is quenched in larger oligonucleotides, MeV ions can always induced base loss and backbone damage, even for large and complex oligonucleotides.