Features of fast ion-molecule collisions and effect of perturbation strength

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Various features molecular collisions under swift ion collisions are of recent interest for its application towards radiobiology, radio sensitization, astrochemistry of intersteller medium as well as fundamental quantum mechanical issues. Particular interest is the collective plasmon resonance (GDPR and GQPR) which is common thread among the PAH molecules, nano-particles, halouracils, nanosensitizers, fullerenes etc. The PAHs are planar molecules with delocalized π-electron cloud that can oscillate collectively upon external perturbation. Such giant dipole plasmon resonance (GDPR), resulting from strong multi-electron correlation, primarily decays via electron emission. The observation of the GDPR in e-emission channel, at least for smaller PAH molecules, can be challenging due to the presence of large Coulomb ionization background of low energy electrons. A novel idea is demonstrated i.e. use of highly charged ions at a relatively low velocity to create large perturbation strength in order to excite the plasmons effectively. Using such techniques we have observed GDPR in a PAH molecules [fluorine, $C_{13}H_{10}$ and Coronene, $C_{24}H_{12}$] only when it was bombarded by highly charged ions, e,g Si^{13+} and O^{8+} respectively. Similarly the first observation of giant quadrupole plasmon resonsnce (GQPR) has been demonstrated for C_{60}. Apart from electron spectroscopy the recoil-ion mass spectroscopy can also be used. For example the DI-to-SI ratios for PAHs upon HCI impact have been found to be substantially larger than that for smaller gas molecules. In some cases the DI (doubly ionized recoil-ions) can be stronger than SI (singly ionized recoil-ions). The detailed projectile charge (q) and velocity (v) dependence of the ratio has been studied for three different PAH molecules. The influence of GPR resulting from the strong e^--e^- correlations has been shown by scrutinizing the q,-, v-, and q/v-dependences of the ratio. These measurements are carried out using HCIs of energy a few MeV/u as well as 100s keV/u obtained from Pelletron and ECR-based ion accelerators.

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