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Effect of coulomb confinement resonances on time delay in Ne@C_{60}^{5-}

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Synopsis Wigner time delay for inner and outer shells of Ne@C_{60}^{5-} have been studied using relativistic random phase approximation (RRPA) [1]. Coulomb confinement resonances (CCR) due to the charged nature of fullerene cause prominent effects on the photoionization time delay of 1s subshell. These CCRs in 1s also results in significant modifications of the time delay in 2s and 2p ionization channels through interchannel coupling at energies far above their thresholds.

Sophisticated experimental techniques such as attosecond streaking and Reconstruction of Attosecond Bursts by Ionization of Two-photon Transitions (RABITT) [2] have opened up a new domain in photoionization experiments; it is now possible to measure the difference in delay time for the ejection of photoelectrons from different subshells of an atom with attosecond precision. A number of theoretical and experimental works have been reported in the recent past along this direction [3-6].

Dolmatov et al. [7] has predicted the re-emergence of confinement resonances at very high energies far away from the 2p threshold in Ne@C_{60}^{5-}. This revivification of confinement resonances was attributed to the presence of CCRs in the 1s subshell of Ne@C_{60}^{5-}. The present work reports the Wigner time delay in 2s ionization channels due to the presence of these CCRs in 1s subshell. The effect of these CCRs on the time delays of 2s and 2p subshells of Ne@C_{60}^{5-} are also studied in the region far above respective thresholds.

A model potential is used to simulate the effect of charged fullerene [7]. Wigner time delay is determined in the photon energy range of 880 to 920 eV within the frame work of relativistic random phase approximation (RRPA) which takes into account the important many electron correlations.

As an example, the time delay and phase shift for 2s → ep_{3/2} are shown in Fig. 1 (2s → ep_{1/2} is essentially identical). In the region of CCRs (~ 882 - 894 eV) the phase changes significantly. In each CCR region the phase shift initially increases and then decreases. As a result a flip in the sign of time delay profile is observed.

These rapid changes of phase shift in the region of CCRs are seen to enhance the time delay significantly.

References

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