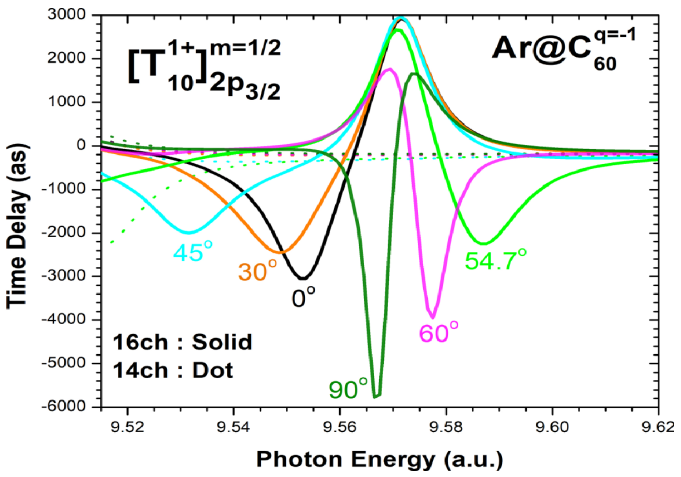
Charged Fullerene as an amplifier to spin-orbit interaction activated interchannel coupling (SOIAIC) effect in the photoionization dynamics

Afsal Thuppilakkadan et al., Phys. Rev. A., 052804 (2023)

Two currently active research directions in the field of atomic photoionization motivate the present work; (i) attosecond science studying the electron dynamics in its natural time-scale, specifically, in this work, studying the time delay associated with the photoemission, and (ii) confined atomic systems such as atom trapped inside a fullerene cage.

The effect of coupling between spin-orbit split-channel channels on the ionization dynamics is relatively less significant for small-Z atoms. In this work published in Phys. Rev. A predicts a novel way to amplify the effect of this coupling by caging the atom inside a charged fullerene.
The charged cage induces strong resonance in the relativistically split channels, which magnify the coupling between the channels. It leads to perceptible features in the photoionization parameters particularly the photoemission time delay. This is demonstrated using a prototype system, $Ar@C_{60}^{-1}$.



The external environment of the atom, presence of charged fullerene induces a large resonance structure in the $2p_{1/2}$ subshell ionization channels. This causes an amplification on the effect of coupling between $2p_{1/2}$ and $2p_{3/2}$ ionization channels, and leads to significant angular anisotropy in the time-delay associated with the 2p3/2 subshell ionization channels as shown in the figure.

The work underscores the importance of incorporating the electron correlation and relativistic interactions while explaining the spectra even for small Z confined atomic systems. It also shows the importance of considering the nature of the surrounding cage. The predicted feature will be absent if the cage is neutral. The stability of the system considered $(Ar@C_{60}^{-1})$, the anisotropy observed and the large variations in the time delay profile make this work very interesting since it opens up the possibility of experimental scrutiny of SOIAIC effect in small confined Z systems. The environment (cage in this case) is responsible for the

anisotropy. Therefore, this study provides insights to many other areas where surrounding environment play important role on the dynamics of an atom to an external field.