Optical Control of Autoionizing Polaritons in Attosecond Spectroscopy

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Laser-dressed autoionizing states have been studied theoretically to predict the stabilization of such states against ionization under certain field parameters. We verified these predictions by using attosecond extreme-ultraviolet transient absorption spectroscopy to investigate the evolution of autoionizing states in argon, when dressed by a tunable femtosecond infrared laser pulse. We observe avoided crossings between the $3s^{-1}4p$ and several light-induced states, whose physics is best described in terms of the formation of polaritons. The properties of these autoionizing polaritons, entangled states of light and Fano resonances are largely unexplored. We show the evidence of stabilization of the polaritons against ionization by using time-delay, detuning, and laser intensity as control parameters. The results show remarkable agreement with ab-initio theoretical calculations. We developed an extended Jaynes-Cummings model to illustrate that this stabilization is due to the destructive interference between the Auger decay and the radiative ionization of the polaritonic components. These results open the doors for optical control of continuum states in polyelectronic systems.

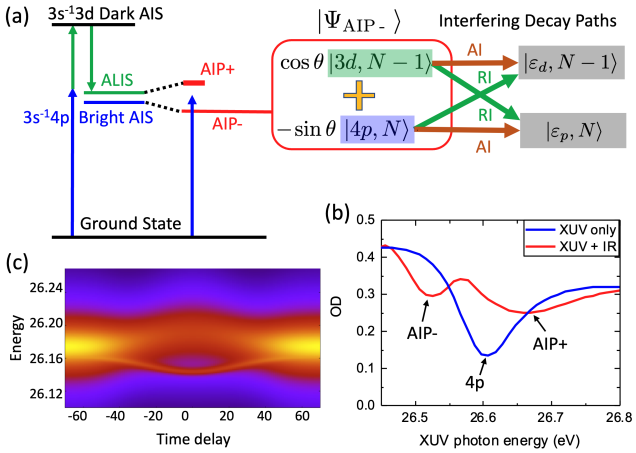

Figure 1: (a) Mechanism of the formation of autoionizing polaritons (AIP) from mixing between the bright autoionizing state (AIS) and the autoionizing light-induced state (ALIS) of the dark level. Auger (AI) and radiative (RI) decay paths for the AIPs interfere coherently. The IR laser parameters can control the amplitudes leading to the destructive interference stabilization against ionization which manifests as the narrow spectral width of the lower polariton branch in the experimental IR modified absorption spectra in (b) and in the simulated delay dependent absorption profile in (c)