Modulation induced transparency in IR pump-XUV probe ionization experiments

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Controlling light-matter interaction is one of the key goals of modern physics. In recent years, interaction of a quasi-resonant extreme ultraviolet (XUV) radiation with atoms dressed by a moderately strong infrared (IR) laser field became a topic of active experimental studies [1, 2]. The growing attention to this area of research is caused by the possibility to combine effects of strong-field atomic physics with those of physics of resonant processes. The IR field does not cause ionization from the ground atomic state, but leads to Stark shift (and/or splitting) of the excited energy levels and ionization from the excited states, which vary on a sub-IR-field-cycle time scale [2, 3]. One of the interesting recently observed phenomena is the XUV transparency of helium simultaneously interacting with the IR field (765nm) and its 11th and 13th harmonics, the later being quasi-resonant to the 1s↔2p transition [1]. Namely, suppression of ionization was demonstrated by combination of 11th or 13th harmonics, while 13th harmonic alone resulted in strong ionization of atoms in the presence of the fundamental laser field [1].

In this contribution, we show that the ionization suppression results from inhibition of atomic excitation by the XUV radiation due to modulation-induced transparency [4]. On the basis of Floquet theory we show that dressing of atoms by the IR field [5] is equivalent to periodic modulation of energy of the excited state 2p, Fig. 1. We provide a simple theoretical (analytical and numerical) description of the experimentally observed effect of XUV transparency [1] and suggest the ways for its optimization.


Fig. 1.XUV transparency of IR-dressed He. The presence of IR field leads to time modulation of energy of 2p level.