Long-wavelength shift of an ultraviolet pulse spectrum due to inertial nonlinearity of atomic gases

Vrublevskaya N.R.[1,2,@], **Shipilo D.E.**[1,2], **Nikolaeva I.A.**[1,2], **Seleznev L.V.**[2], **Pushkarev D.V.**[1], **Rizaev G.E.**[2], **Kosareva O.G.**[1,2] **and Panov N.A.**[1,2]

[1] Lomonosov Moscow State University, Leninskiye Gory 1, Moscow, 119991, Russia

[2] Lebedev Physical Institute of the Russian Academy of Sciences, Leninsky Avenue 53, Moscow, 119991, Russia

[@] vrublevskaia.nr19@physics.msu.ru

Numerical solution of the time-dependent Schrödinger equation for a UV femtosecond pulse (250 nm) interacting with a one-dimensional potential well shows an inertial cubic response with a 200 as delay, comparable to the 800 as UV field period. This intracycle delay shifts the nonlinear polarization spectrum several nanometers toward longer wavelengths.

These results qualitatively explain experimental observations of UV filamentation in air and argon, conducted at the Lebedev Physical Institute (L. V. Seleznev group), where a 1–2 nm long-wavelength shift of the UV pulse spectrum was recorded for both gases. The physical reason of this shift is the inertia of the electronic nonlinear response [1].

Comparison of quantum mechanical modeling results with current alternative approaches to nonlinearity description has shown that explaining such features of ultraviolet filament spectrum transformation, like its asymmetric long-wavelength shift, requires accounting for quantum effects arising from electron-field interaction.

[1] Shipilo D E, Vrublevskaya N R, Nikolaeva I A, Seleznev L V, Pushkarev D V, Rizaev G E, Levus M V, Ionin A A, Panov N A and Kosareva O G 2025 *Physical Review A* **112** 023516