DAMOP16-2016-000099

Abstract for an Invited Paper
for the DAMOP16 Meeting of
the American Physical Society

Quantum Localization in Laser-Driven Molecular Rotation

ILYA AVERBUKH, Weizmann Institute of Science, Israel

Recently we predicted that several celebrated solid state quantum localization phenomena – Anderson localization, Bloch oscillations, and Tamm-Shockley surface states – may manifest themselves in the rotational dynamics of laser-kicked molecules. In this talk, I will present these new rotational effects in a gas of linear molecules subject to a moderately long periodic train of femtosecond laser pulses. A small detuning of the train period from the rotational revival time causes Anderson localization in the angular momentum space above some critical value of J – the Anderson wall. This wall marks an impenetrable border stopping any further rotational excitation. Below the Anderson wall, the rotational excitation oscillates with the number of pulses due to a mechanism similar to Bloch oscillations in crystalline solids. I will present the results of the first experimental observation of the laser-induced rotational Bloch oscillations in molecular nitrogen at ambient conditions (Stanford & Weizmann, 2015). We will also discuss the prospects of observing the rotational analogues of the Tamm surface states in a similar experimental setup. Our results offer laser-driven molecular rotation as a new platform for studies on the localization phenomena in quantum transport. These effects are important for many processes involving highly excited rotational states, including coherent optical manipulations in molecular mixtures, and propagation of powerful laser pulses in atmosphere.