Molecular alignment by trains of short laser pulses

Alignment and orientation of molecules attracts a lot of attention because of multiple applications in chemical reaction dynamics and ultrafast optics. A number of alignment techniques have been suggested using static and time-dependent electric fields. Approaches basing on short laser pulse excitation are of special interest since a considerable alignment may be achieved by the end of the pulse, i.e. At field-free conditions.

We study the alignment of linear molecules with strong ultrafast laser pulses, considering it as a process of generating squeezed angular states. Single-pulse alignment is analyzed and simulated both classically and quantum-mechanically. The quantum dynamics of the molecules repeats itself periodically due to the revival effect, and we show that the most angular squeezed state appears in the revival regime. Moreover, we show that the degree of alignment can be considerably enhanced by applying a sequence of several laser pulses. The optimal two-pulse alignment scheme we suggested has already been successfully tested in femtosecond experiments.