Quantum coherent interactions of Rydberg atoms with controlled sequences of femtosecond laser pulses

Jana Preclíková[1], Martin Kozák[2], Daniel Fregenal[3], Bjørn Tore Hjertaker[1], Børge Hamre[1], Øyvind Frette[1], Ladislav Kocbach[1], Jan Petter Hansen[1]

[1]Department of Physics and Technology, University of Bergen, N-5007, Norway
[2]Faculty of Mathematics and Physics, Charles University in Prague, Ke Karlovu3, 121 16 Prague 2, Czech republic
[3]Centro Atómico Bariloche and Consejo Nacional de Investigaciones Cientícas y Técnicas. R8402AGP S.C. de Bariloche, Argentina

jana.preclikova@ift.uib.no

We report on experimental and theoretical studies of interaction of Rydberg atoms with sequences of gaussian femtosecond laser pulses. Sequences of pairs of laser pulses allow the control of the phase between each excited state in a coherent superposition of Rydberg wave packet. We demonstrate that an excitation of a selected Rydberg state on picosecond timescale can be reached by a pure sequence of four pairs of femtosecond laser pulses with precisely set delays.
Experimentally, we studied populating of the atomic Rydberg states after interaction with a pair of identical femtosecond laser pulses, with a pair of pulses in which one of the pulse was strongly chirped and with two pairs of femtosecond laser pulses. Evolution of superpositions of 20f-30f states of lithium atoms was determined by the selective field ionisation (SFI) method as a function of the time delay between the femtosecond laser pulses [1].
All our observed results are in excellent agreement with theoretical calculations given by the first order perturbation theory.

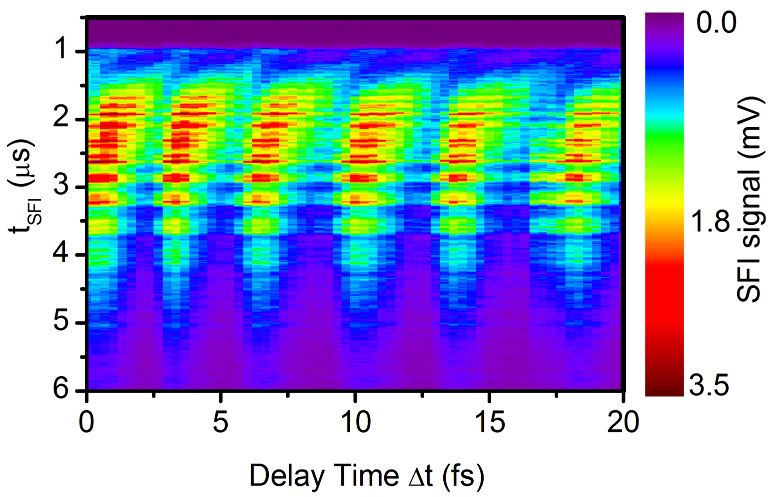

Fig. 1 Map of SFI spectra as a function of femtosecond scale time delay Δt between one Fourier transform limited femtosecond laser pulse and one down-chirped femtosecond laser pulse.

References:

[1] J. Preclíková, M. Kozák, D. Fregenal, Ø. Frette, B. Hamre, B. T. Hjertaker, J. P. Hansen, and L. Kocbach, Phys. Rev. A **86**, 063418 (2012)