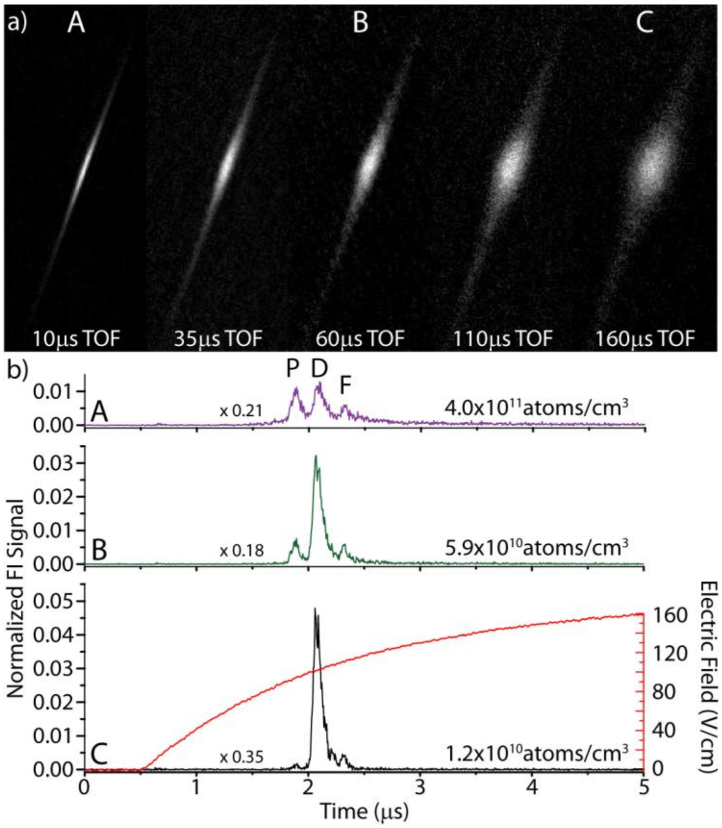
FRONTIERS IN OPTICAL COHERENT AND ULTRAFAST SCIENCE
A NATIONAL SCIENCE FOUNDATION PHYSICS FRONTIER CENTER AT
THE UNIVERSITY OF MICHIGAN AND THE UNIVERSITY OF TEXAS AT AUSTIN

RANDALL LABORATORY, 450 CHURCH STREET, ANN ARBOR, MI 48109-1040
PHONE (734)763-4932 FAX (734)764-5153
http://www.umich.edu/~focuspfc

A nugget from FOCUS:

Title: State-mixing Rydberg Atom Interactions

Investigators: Kelly. C. Younge, Aaron Reinhard, Thomas Pohl, Paul R. Berman, and Georg Raithel



Rydberg atoms, atoms which have their outer electron promoted to a high energy state, exhibit strong interactions that are not present in ground state neutral atoms. These interactions are the basis of many interesting effects, such as excitation blockades, which have applications in several fields including cryptography, atomic clocks, and quantum computation.

Here, we trap Rubidium atoms in an optical dipole trap, as shown in part a) of the figure. After narrow-band laser excitation (bandwidth about 1 MHz) to Rydberg states, state selective field ionization allows us to determine the quantum states of the Rydberg atoms. Atoms remaining in the initially excited state produce the central peak in the field ionization data [D-peak in part b) of the figure, located at about 2.1μs]. In high density samples (4x1011cm-3), we find an unexpectedly large amount of state mixing from the originally excited state into initially unpopulated states [P- and F-peaks]. The mixing becomes much more obvious as the density of the sample increases.

The standard way of describing state mixing in Rydberg atoms is via a single or several sequential collisions on atomic two-body potentials. This theory is not sufficient to explain our observations. Based on experimental and theoretical work, we provide first proof that many-body interactions are essential for an accurate description of state-mixing in dense Rydberg-atom samples.