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A nugget from FOCUS:

Atom Counting Statistics in Ensembles of Interacting Rydberg Atoms

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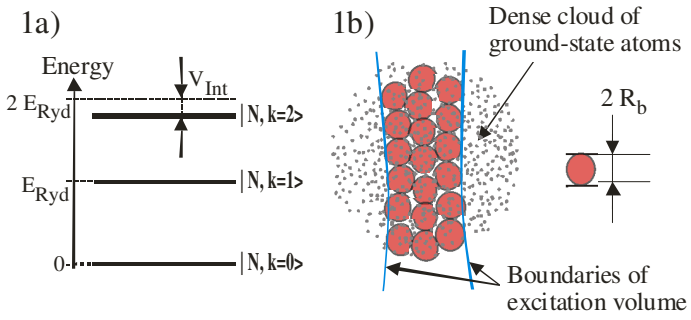
A blockade effect in many-body Rydberg systems is useful for a number of applications ranging from atomic clocks to quantum information processing and cryptography. This work is the first demonstration of the blockade effect in small samples and is an important first step towards using Rydberg atoms for quantum information processing (PRL 95 253002).

Interatomic potentials for Rydberg atoms scale as n^{11}/R^6 and n^4/R^3 for van der Waals and dipole-dipole interactions, respectively (n is the principal quantum number). In an ensemble of Rydberg atoms the large interaction potentials cause an uneven ladder of excitation energies as shown in Figure 1a. If the laser line width is less than the interaction energy, only one or no Rydberg excitations will be created within a small sample of atoms (bubbles in Figure 1b). This is known as the blockade effect. The radius of the bubbles shown in Figure 1b is determined by the strength of the interaction and the line width of the excitation laser.



Due to this blockade effect, the number of Rydberg excitations created in the system follows a sub-poissonian distribution, i.e. the distribution has a spread that is lower than the spread of the distribution one would obtain with a random excitation process. The spread of the distribution is measured by the Mandel Q parameter. There, $Q<0$ corresponds to a sub-poissonian, $Q=0$ to a poissonian, and $Q>0$ to a super-poissonian distribution. Sub-poissonian distributions with Q-values of order -0.5 are observed for Rydberg states with principal quantum numbers n larger than 80. As n decreases to about 50, the measured values of Q gradually approach zero. Thus, the sub-poissonian characteristics and the blockade effect gradually disappear with decreasing n. This trend is expected because of the n-dependence of van der Waals and dipole-dipole interactions between Rydberg atoms.