Rydberg-Rydberg interactions and two electron atoms

The original Rydberg-Rydberg resonant energy transfer experiments were collision experiments conducted with atomic beams. They can be described simply in terms used to describe radio frequency resonance experiments. The appealing feature of these collisions is their long duration, 1 ns, compared to the 1 ps duration of a gas kinetic collision. The long duration enabled a systematic study of radiative collisions, those in which photons are absorbed or emitted during the collisions. The quest for longer duration collisions led to lower temperatures, and eventually to a magneto optical trap (MOT), in which Forster resonant energy transfer was observed. The essential similarity of the beam and MOT experiments is brought out by a molecular picture of the resonant transfer. Using the cold atoms of the MOT we have observed microwave transitions of pairs of atoms, which are radiatively assisted collisions and are easily described as Forster resonances of Floquet states. Rydberg states of two (valence) electron atoms provide new opportunities due to the possibility of isolated core excitation (ICE), the excitation of the core valence electron, with the Rydberg electron remaining a spectator. The result is an autoionizing Rydberg state, the properties of which are reviewed. ICE is described in detail and its possible application to trapping bound Rydberg atoms.