

Ultralong-range Rydberg molecules

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In Part 1 we review the history of atom – electron scattering, which is the basis for the formation of ultralong-range Rydberg molecules which were first proposed in 2000 and observed in 2009. Various regimes for the formation of molecular potential curves due to this quantum scattering will be discussed, including so-called “Trilobite” and “Butterfly” molecules. The formation of trimers, polymers and the smooth transition to density shifts and broadenings of Rydberg lines will close the cycle back to the first historic experiments by Amaldi and Segre in 1934 that lead to the development of quantum scattering theory by Enrico Fermi.

In Part 2 we will discuss the recent discovery of a bound state between an ultracold ion and a Rydberg atom based on a flipping dipole interaction. This molecule was studied using a pulsed ion microscope which allowed the direct measurement of the shape of the molecule, its binding length and the vibration around the equilibrium position. And as an outlook we will close this Part with yet another mechanism that can lead to bound states: namely the interaction between a Rydberg electron and a dipolar molecule.