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Direct measurement of the van der Waals interaction between two Rydberg atoms

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This talk will report on the direct measurement of the van der Waals interaction between two isolated, single Rydberg atoms separated by a controlled distance of a few micrometers. By working in a regime where the single-atom Rabi frequency of the laser used for excitation to the Rydberg state is comparable to the interaction energy, we observe a partial Rydberg blockade, whereby the time-dependent populations of the various two-atom states exhibit coherent oscillations with several frequencies. A quantitative comparison of the data with a simple model based on the optical Bloch equations allows us to extract the van der Waals energy, and to observe its characteristic C6 /R6 dependence. The magnitude of the measured C6 coefficient agrees well with ab-initio calculations, and we observe its dramatic increase with the principal quantum number n of the Rydberg state. Our results demonstrate a good degree of experimental control, which opens interesting perspectives in quantum information processing and quantum simulation using long-range interactions between atoms.