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Quantum gas microscopy of Rydberg macrodimers SIMON HOLLERITH, Max-Planck-Institute for Quantum Optics, JOHANNES ZEIHER, University of California, JUN RUI, ANTONIO RUBIO-ABADAL, Max-Planck-Institute for Quantum Optics, VALENTIN WALTHER, THOMAS POHL, Aarhus University, DAN M. STAMPER-KURN, University of California, IMMANUEL BLOCH, Ludwig Maximilians University, CHRISTIAN GROSS, Max-Planck-Institute for Quantum Optics, MAX-PLANCK-INSTITUTE FOR QUANTUM OPTICS TEAM, LUDWIG MAXIMILIANS UNIVERSITY TEAM, AARHUS UNIVERSITY COLLABORATION, UNIVERSITY OF CALIFORNIA COLLABORATION — Rydberg macrodimers - molecules consisting of two bound highly excited Rydberg atoms - provide huge bond lengths even resolvable with optical wavelengths. Here we report on the microscopic observation, characterization and control over the formation of such Rydberg macrodimers in a gas of ultracold atoms in an optical lattice. The size of about 0.7 micrometers matches the diagonal distance of two atoms in the lattice. Starting from a two-dimensional array of one atom per site, the discrete density provided by atoms in their motional ground state combined with a narrow-linewidth ultraviolet laser enables the resolved two-photon photoassociation of more than 50 theoretically predicted vibrational states. Using our spatially resolved detection, we observe the macrodimers by correlated atom loss and demonstrate control of the molecular alignment by the vibrational state and the polarization of the excitation light. Our results allow for a detailed test of Rydberg interactions and establish quantum gas microscopy as a new tool for quantum chemistry.

Simon Hollerith
Max-Planck-Institute for Quantum Optics

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