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Observation of spatially ordered structures in a two-dimensional Rydberg gas PETER SCHAUSS, MARC CHENEAU, MANUEL ENDRES, TAKESHI FUKUHARA, SEBASTIAN HILD, AHMED OMRAN, JOHANNES ZEIHER, Max-Planck-Institut für Quantenoptik, 85748 Garching, THOMAS POHL, Max-Planck-Institut für Physik komplexer Systeme, 01187 Dresden, Germany, CHRISTIAN GROSS, Max-Planck-Institut für Quantenoptik, 85748 Garching, STEFAN KUHR, University of Strathclyde, SUPA, Glasgow G4 0NG, UK, IMMANUEL BLOCH, Ludwig-Maximilians-Universität, 80799 München & Max-Planck-Institut für Quantenoptik, 85748 Garching — The ability to control interactions in ultra-cold atomic gases has paved the way for the realization of new phases of matter with short-range interactions. Rydberg atoms, which are strongly interacting via van der Waals forces, are promising candidates to gain the same amount of control over long-range interacting systems. Here we report on the experimental observation of strong correlations between laser-excited Rydberg atoms using a high-resolution optical detection scheme. The measurements reveal the emergence of spatially ordered excitation patterns with random orientation, but well-defined geometry in the high-density components of the prepared many-body state. The developed techniques might allow for the deterministic adiabatic preparation of ordered states and the investigation of their coherence properties. In combination with single-site addressing the Rydberg atom imaging techniques will enable experiments towards quantum information processing.

[1] P. Schauß et al., Nature 491, 87 (2012)

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