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Coherent spin and spin-spatial excitations in an ultracold Fermi gas CHRISTOPH BECKER, JANNES HEINZE, JASPER KRAUSER, NICK FLAESCHNER, KLAUS SENGSTOCK, Institute of Laser Physics, University of Hamburg, ANDRE ECKARDT, Max-Planck-Institute for the Physics of Complex Systems, Dresden, ULRICH EBLING, MACIEJ LEWENSTEIN, ICFO-Institut de Ciències Fotòniques, Castelldefels — Ultracold fermions with large spin provide ideal model systems for the investigation of high-spin magnetic properties beyond conventional electronic magnetism. Here, we report on detailed studies of collective spin and spin-spatial excitations in a binary high-spin Fermi mixture. For the first time we observe collective coherent spin-changing dynamics in a fermionic bulk system and find strong indications that Pauli blocking drastically extends the coherence time for low enough temperatures. Introducing a coupling to spatial excitations in such a high-spin system leads to the emergence of multi-component spin waves characterized by tensorial order in the spin- and spatial degrees of freedom. In particular we measure counterflow spin currents in the individual spin components, which we engineer and fully control by tuning the initial state. For all our results we find excellent agreement with mean-field calculations. Our findings open new perspectives for further studies of high-spin magnetic properties such as S>1/2 Mott insulators or color superfluidity.

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