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A low-field disordered-free-moment phase in site-diluted spin-gap antiferromagnets RONG YU, Department of Physics and Astronomy, University of Southern California, Los Angeles, CA 90089-0484, TOMMASO ROSCILDE, Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-strasse 1, 85748 Garching, Germany, STEPHAN HAAS, Department of Physics and Astronomy, University of Southern California, Los Angeles, CA 90089-0484 — Site dilution of spin-gapped antiferromagnets leads to localized free moments, which can order antiferromagnetically in two and higher dimensions. A very important question of high experimental relevance is: what is the response of the diluted system to an applied magnetic field? This is a very complicated problem since the exponentially decaying interactions between the free moments introduce a large variety of energy scales, which respond differently to the field. Here we show how a weak magnetic field drives this order-by-disorder state into a novel *disordered-free-moment* phase, characterized by the formation of local singlets between neighboring moments and by localized moments aligned antiparallel to the field. This disordered phase is characterized by the absence of a gap, as it is the case in a Bose glass. The associated field-driven quantum phase transition is consistent with the universality of a superfluid-to-Bose-glass transition. The robustness of the disordered-free-moment phase and its prominent features, in particular a series of *pseudo*-plateaus in the magnetization curve, makes it accessible and relevant to experiments.

Rong Yu
Department of Physics and Astronomy, University of Southern California, Los Angeles, CA 90089-0484

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