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Self-localization of a single hole in Mott antiferromagnets ZHENG ZHU, Institute for Advanced Study, Tsinghua University, Beijing, 100084, China, HONG-CHEN JIANG, Kavli Institute for Theoretical Physics, University of California, Santa Barbara, CA, 93106-4030, U.S.A., YANG QI, CHUN-SHUN TIAN, ZHENG-YU WENG, Institute for Advanced Study, Tsinghua University, Beijing, 100084, China — Anderson localization - quantum suppression of carrier diffusion due to disorders - is a basic notion of modern condensed matter physics. Here, we report a novel localization phenomenon totally contrary to this common wisdom. Strikingly, it is purely of strong interaction origin and occurs without the assistance of disorders. Specifically, by combined numerical (density matrix renormalization group) method and analytic analysis, we show that a single hole injected in a quantum antiferromagnetic ladder is generally self-localized even though the system respects the translational symmetry. The localization length is found to monotonically decrease with the increase of leg number, indicating stronger self-localization in the two-dimensional limit. We find that a peculiar coupling between the doped charge and the quantum spin background causes quantum interference among different hole paths. The latter brings the hole's itinerant motion to a halt, a phenomenological analogy to Anderson localization. Our findings are opposite to the common belief of the quasiparticle picture for the doped hole and unveil a completely new paradigm for lightly doped Mott insulators.

Zheng Zhu
Institute for Advanced Study, Tsinghua University, Beijing, 100084, China

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