Abstract Submitted
for the MAR14 Meeting of
The American Physical Society

Topological Superconductivity and Majorana Fermions in RKKY Systems JELENA KLINOVAJA, Department of Physics, Harvard University, Cambridge, Massachusetts 02138, USA, PETER STANO, Department of Physics, University of Basel, Klingelbergstrasse 82, CH-4056 Basel, Switzerland, ALI YAZDANI, Joseph Henry Laboratories and Department of Physics, Princeton University, Princeton, New Jersey 08544, USA, DANIEL LOSS, Department of Physics, University of Basel, Klingelbergstrasse 82, CH-4056 Basel, Switzerland — We consider quasi one-dimensional RKKY systems in proximity to an s-wave superconductor [1]. We show that a $2k_F$ -peak in the spin susceptibility of the superconductor in the one-dimensional limit supports helical order of localized magnetic moments via RKKY interaction, where k_F is the Fermi wavevector. The magnetic helix is equivalent to a uniform magnetic field and very strong spin-orbit interaction (SOI) with an effective SOI length $1/2k_F$ [2,3] . We find the conditions to establish such a magnetic state in atomic chains and semiconducting nanowires with magnetic atoms or nuclear spins. Generically, these systems are in a topological phase with Majorana fermions. The inherent self-tuning of the helix to $2k_F$ eliminates the need to tune the chemical potential [3-6]. [1] J. Klinovaja, P. Stano, A. Yazdani, and D. Loss, Phys. Rev. Lett. 111, 186805 (2013). [2] B. Braunecker, G. I. Japaridze, J. Klinovaja, and D. Loss, Phys. Rev. B 82, 045127 (2010). [3] J. Klinovaja, P. Stano, and D. Loss, Phys. Rev. Lett. 109, 236801 (2012). [4] J. Klinovaja and D. Loss, Phys. Rev. B 86, 085408 (2012). [5] J. Klinovaja and D. Loss, Phys. Rev. X 3, 011008 (2013). [6] J. Klinovaja and D. Loss, Phys. Rev. B 88, 075404 (2013).

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Date submitted: 09 Nov 2013 Electronic form version 1.4