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**Theory of dirty Rashba superconductivity in ultrathin Pb films<sup>1</sup>**

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The University of Texas at Austin — Pb is a typical s-wave superconductor and also has strong atomic spin-orbit coupling. In Pb thin films inversion symmetry breaking combined with the large atomic spin-orbit coupling will split the otherwise spin-degenerate bands of Pb, an effect which can be roughly accounted for by Rashba spin-orbit coupling. Motivated by a recent experiment, we used a 2D model involving Rashba spin-orbit coupling and s-wave pairing to study the influence of the former on the superfluid density, parallel critical field, and the resistive transition to the superconducting phase. We found that in both the clean and the dirty limits, Rashba spin-orbit coupling has little influence on the superfluid density and the Kosterlitz-Thouless transition temperature. However, in the dirty limit the Rashba spin-orbit coupling can significantly enhance the parallel critical field, making the Clogston-Chandrasekhar limit inapplicable. The strong suppression of the spin pair-breaking effect of a parallel magnetic field by the Rashba spin-orbit coupling and impurity scattering can make the orbital pair-breaking effect dominant again even in ultrathin films. Finally, we propose and examine a number of mechanisms that can lead to a smeared resistive transition under parallel magnetic fields.

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