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Vortex matter in superconductors: solid or gas? VLADIMIR KOZHEVNIKOV, Tulsa Community College, ANNE-MARIE VALENTE-FELICIANO, Thomas Jefferson National Lab, PETER CURRAN, University of Bath, GUNTHER RICHTER, Max-Planck-Institut for Intelligent Systems, HAOLIANG LIU, ALEXANDER VOLODIN, Solid State Physics and Magnetism Section, KU Leuven, SIMON BENDING, University of Bath, CHRIS VAN HAESENDONCK, Solid State Physics and Magnetism Section, KU Leuven —
We will report on results of our recent study of the equilibrium magnetic properties of the mixed state in type-II superconductors performed with high purity bulk and film niobium samples in parallel and perpendicular magnetic fields using dc magnetometry and scanning Hall-probe microscopy. Equilibrium magnetization data for the perpendicular geometry were obtained for the first time. It was found that none of the existing theories is consistent with these new data. To address this problem a theoretical model is developed and verified experimentally. The new model describes the magnetic properties of the mixed state in an averaged limit, i.e. without detailing the samples' magnetic structure and therefore ignoring interactions between the structural units (vortices). Nevertheless, it is quantitatively consistent with the data obtained in a perpendicular field. At low values of the Ginzburg-Landau parameter, the model converts to that of Peierls and London for the intermediate state in type-I superconductors, valid in the limit of non-interacting normal domains. We will show that description of the vortex matter in type-II superconductors in terms of a 2D gas is more appropriate than the frequently used crystal- and glass-like scenarios.

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