INVITED

Evolution of the Vortex Melting Line with Irradiation Induced Defects

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Our experimental research focuses on manipulating the role of defects in altering the phase diagram of vortex matter, thereby creating new vortex transitions within the solid state. Vortex matter offers a unique opportunity for creating and studying these novel phase transitions due to the precise experimental control of thermal, pinning and elastic energies. The vortex melting transition in untwinned $YBa_2Cu_3O_{7-}$ single crystals is investigated in the presence of disorder induced by controlled proton and heavy ion irradiation. We focus on the low disorder regime, where a glassy state and an ordered lattice state can be realized in the same phase diagram. We follow the evolution of the first order vortex lattice melting transition line into a continuous transition line as disorder is increased by irradiation. The transformation is marked by a shift in the lower and upper critical points of the first order vortex lattice melting line. With columnar defects induced by heavy ion irradiation, we find a second order Bose glass transition line separating the vortex liquid from a Bose glass below the lower critical point. Furthermore, we find an upper threshold for columnar defect concentration beyond which the lower critical point disappears altogether with the first order melting line. In addition, we report on the behavior of the vortex liquid state in the presence of dilute columnar defects where a new transition line in the vortex liquid state is suggested.

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