# Crystallization questions for large systems with Coulomb and Riesz interactions

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Systems of particles with Coulomb, Riesz and logarithmic interactions arise in various settings : an instance is the classical Coulomb gas which in some cases happens to be a random matrix ensemble, another is vortices in the Ginzburg-Landau model of superconductivity, where one observes in certain regimes the emergence of densely packed point vortices forming perfect triangular lattice patterns, named Abrikosov lattices in physics, a third is the study of Fekete points which arise in approximation theory. We will describe tools to study such systems and derive a next order (beyond mean field limit) renormalized energythat governs microscopic patterns of points and discuss its link with the Abrikosov lattice and crystallization questions. We will also address the statistical mechanics of such systems and how the temperature influences the disorder of the system. This is based on joint works with Etienne Sandier, Nicolas Rougerie, Simona Rota Nodari, Mircea Petrache, and Thomas Leblé.