Twists and turns of superconductivity from a repulsive interaction

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In my talk, I review recent and not so recent works aiming to understand whether a nominally repulsive Coulomb interaction (i) does not prevent s-wave superconductivity due to electron-phonon interaction and (ii) can by itself give rise to a non-s-wave superconductivity. I discuss a generic scenario of the pairing by combined electron-phonon and electron electron interaction and discuss topological properties of the pairing state. I next discuss the scenario of the pairing by electron-electron interaction, put forward by Kohn and Luttinger back in 1965, and briefly review modern studies of the electronic mechanisms of superconductivity in the lattice systems, which model cuprates, Fe-based superconductors, and even doped graphene. I show that the pairing in all three classes of materials can be viewed as a lattice version of Kohn-Luttinger physics, despite that the pairing symmetries are different. I discuss under what condition the pairing occurs and rationalize the need to do renormalization-group studies. I also discuss most recent work on the pairing near a quantum-critical point, particularly the interplay between superconductivity and non-Fermi liquid physics.