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Engineering non-local interactions and geometrical frustration in synthetic quantum matter

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Although non-local interactions characterize a variety of experimental setups their full control remains challenging. In this talk I will discuss two novel schemes where non-local interactions can be engineered and naturally put into competition with geometrical frustration. The first scheme is based on Cesium atoms trapped in a one-dimensional optical lattice at the anti-magic wavelength. Thanks to the scattering properties peculiar of this setup, an effective long-range repulsion is induced and able to give rise to different spontaneously symmetry breaking phases. Moreover, such phases result connected through a second order phase transition thus representing an example of one dimensional deconfined quantum critical points not captured by the Landau's theory of phase transitions [1]. The second example relies on Rb atoms in different internal states subject to resonant Raman coupling. This configuration turns out to be properly captured by an effective sub-wavelength extended Bose-Hubbard Hamiltonian characterized by strong long-range interactions giving rise to different density wave structures and by detuning induced tunneling processes making possible the appearance of chiral superfluidity [2].

[1] N. Baldelli, C. Cabrera, S. Julia-Farrè, M. Aidelsburger, L. Barbiero in preparation
[2] D. Burba, G. Juzeliūnas, I. B. Spielman, L. Barbiero in preparation

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