Synthetic quantum systems with multicomponent fermions

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I will report on recent experiments performed at University of Florence with degenerate gases of ultracold ^{173}Yb fermions. These two-electron atoms are a powerful resource for engineering synthetic many-body quantum systems, as they exhibit distinct internal degrees of freedom nuclear spin and electronic state that can be both manipulated with high levels of quantum control. By coupling different internal states we have demonstrated the possibility of engineering synthetic dimensions, in which effective lattice dynamics are encoded in the internal Hilbert space of single atoms. By using this approach, we have demonstrated new techniques for the production of synthetic gauge fields for neutral atoms and studied the emergence of edge currents in fermionic ladders with large tunable flux [1, 2]. I will also discuss new directions and ongoing work for the study of Fermi gases with tunable interactions and spin-orbit coupling.

[1] M. Mancini et al., Science **349**, 1510 (2015).

[2] L. F. Livi et al., Phys. Rev. Lett. **117**, 220401 (2016).