# Optical lattice quantum gases with new options for internal and external degrees of freedom

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**Résumé**

For the inital quantum gas experiments the coherence properties and quantum degeneracy of the ensembles set the newly created states of matter dramatically apart from classical gases. Not soon after, however, the internal degree of freedom of the particles was made available as a free variable and led to even richer quantum manybody systems.
Analog to this, initial experiments with degenerate gases in optical lattices were focusing on the external degrees of freedom - conduction vs. insulators in the lowest band, dynamics and band fillings. In the last few years, however, andvances in the preparation and manipulation of such gases have made it possible to consider optical lattice systems as quantum simulators for systems with more degrees of freedom such as including more than one band, or considering ground states involving correlations of external and internal states, such as a particle's (real or effective) spin. I will discuss current experimental advances to implement spin and multi-band physics and discuss how different approaches from the ones implemented with Alkali atoms are possible with less common types of atoms with different internal structure, such as in our new project employing ensembles of alkaline-earth-type atoms in optical lattices.

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