Orbital magnetism with SU(N) fermions

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I will report on recent experiments performed at LENS with ultracold ^{173}Yb Fermi gases. These two-electron atoms are characterized by a large nuclear spin and highly-symmetric interactions, which result in the possibility of performing quantum simulations of multi-component fermionic systems with intrinsic and tunable SU(N) interaction symmetry. By controlling the number of spin components N, we have studied how static and dynamic properties of strongly-correlated 1D liquids of ^{173}Yb fermions change with N, evidencing for the first time intriguing effects caused by the interplay between interactions, low-dimensionality and quantum statistics [1].

In addition to their nuclear spin, two-electron fermions offer experimental access to supplementary degrees of freedom, in particular to long-lived electronically-excited states. In this talk I will focus on our recent observation of fast, coherent spin-exchange oscillations between two ^{173}Yb atoms in different electronic orbitals [2], obtained by coherent control of the atomic state on the ultranarrow $^1S_0 \rightarrow {}^3P_0$ clock transition.

These experiments disclose some of the new possibilities offered by two-electron atoms for quantum simulation, opening exciting directions connected e.g. to exotic quantum magnetism and to the investigation of many-body physics of systems with SU(N) symmetries.

[1] G. Pagano, M. Mancini, G. Cappellini, P. Lombardi, F. Schäfer, H. Hu, X.J. Liu, J. Catani, C. Sias, M. Inguscio, L. Fallani, *Nature Physics*, **10**, 198-201 (2014).
[2] G. Cappellini, M. Mancini, G. Pagano, P. Lombardi, L. Livi, M. Siciliani de Cumis, P. Cancio, M. Pizzocaro, D. Calonico, F. Levi, J. Catani, C. Sias, M. Inguscio, L. Fallani, *Phys. Rev. Lett.*, **113**, 120402 (2014).