Invited speaker

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Engineering quantum transport and materials with cold atoms and hot molecules

Abstract

The ability to control and modify inter-particle interactions using external electric, magnetic and electromagnetic fields has proven an outstanding tool to cool and stabilize gases of atoms and to harness novel quantum many-body phases in these systems. In this talk we review recent results for alkali atoms prepared in their absolute ground-state, where strong and long-ranged inter-particle interactions are obtained by weakly dressing the ground-state by laser light with a highly-excited Rydberg state [1]. We demonstrate theoretically that novel exotic quantum materials can be engineered with these types of interactions, where, for example, frictionless superfluid flow of particles can coexist with solid [2,3] or disordered glassy phases [4]. Lessons learned in the cold atom world can sometimes be transferred back to room temperature materials and devices: We demonstrate that both exciton and charge transport in disordered molecular materials can be substantially enhanced by coupling organic molecules to the vacuum field of a cavity or of a properly tuned two-dimensional plasmonic structure [5,6]. This may have interesting consequences for the design of optoelectronic devices at room temperature.

References

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[5] Schachenmayer et al., Phys. Rev. Lett. 114, 196403 (2015)

[6] Orgiu et al., Nature Materials, 14, 1123-1129 (2015)

About the Author

Guido Pupillo is Professor of Physics at the University of Strasbourg (France) and Director of the Laboratory of Quantum Physics at the "Institut des Science et d'Ingenierie Supramoléculaires" and "Institut de Physique et Chimie des Matériaux de Strasbourg". After receiving his PhD from the University of Maryland in 2005 (USA), he was Research Associate at the University of Innsbruck (AT) and Senior Scientist at the Austrian Academy of Sciences. In 2012 he was appointed Full Professor at the University of Strasbourg. His research activity is in the fields of theoretical atomic, molecular and optical physics and in nonequilibrium dynamics of quantum systems. Among other recognitions, he is the recipient of the 2012 ANR Chair d'Excellence and of the ERC-St grant 2012 of the European Research Council. Since 2014, he is member of the Global Young Academy and of the Young Academy of Europe.