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alle ore 16:30 nell'aula 131 del Dipartimento di Fisica "E. Fermi"

COLLOQUIO GALILEIANO

PROF. PIERRE PILLET

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Title: "Long-range dipole-dipole interactions between cold atoms: from cold Rydberg atoms to ultra-cold plasmas"

The atomic highly excited or Rydberg states have been extensively studied in the eighties for their exaggerated properties. They are so sensitive to weak perturbations that they offer the opportunity to explore phenomena inaccessible in other physical systems. Rydberg atoms are especially known to have huge polarizabilities leading to long-range interaction properties.

After an introduction about the main properties of the Rydberg atoms, we will focus on those of an assembly of cold Rydberg atoms. In a first approximation such an assembly can be considered as a frozen gas, where the dipole-dipole interaction is the dominant feature, leading to properties quite similar to those of an anamorphous solid, as for instance the migration of the excitons. At the opposite for large Rydberg atomic densities and for longer times, cold Rydberg atomic samples have shown a very impressive behavior, their spontaneous evolution to a neutral ultracold plasma.

The physics of the cold Rydberg atoms is therefore at the intersection of atomic physics, solid state physics, and plasma physics. If the initial conditions of the Rydberg ensemble fix its evolution and its behavior, the interactions between Rydberg atoms are the crucial elementary processes. To control the dipole-dipole interactions is the key to control of the evolution of such ensembles. The possibility of controlling the strong long-range interactions between cold atoms has also been pointed out particularly exciting for quantum information applications. One interesting process is the possibility of dipole blockade in the Rydberg excitation of atoms, due to the dipole-dipole interaction shifting the Rydberg energy from its isolated atomic value. The Rydberg dipole blockade offers an efficient quantum engineering for the entanglement of pairs of atoms at a macroscopic distance and for the realization of quantum gates. The control of the dipole-dipole forces exerted between two Rydberg atoms opens also interesting prospects for the control of the ionization into a cold Rydberg gas, which can be an important step for the realization of correlated plasmas, such as the electrostatic energy exceeds the thermal one.