MULTILEVEL ATOM DYNAMICS AND REFLECTION PROCESSES NEAR SURFACES

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Quantum reflection of atoms on material surface has undergone a renewed interest in the recent years, thanks to the development of laser cooling techniques allowing one to produce ultra cold atoms with an actual quantum-mechanical behaviour of the atom centre-of-mass[1]. A number of specific properties appear in the quantum reflection process, due to both the surface response and the atomic structure. Long-range atom-surface attraction (of the non retarded van der Waals-London type, or of the Casimir-Polder type) are an essential feature and depend on the atom internal energy level and the material properties. For excited atomic systems, new peculiar characteristics appear such as long range repulsion, as well as surface-induced quenching induced by resonant coupling with surface polariton modes. Such processes have been observed on excited alkali atoms[2,3]. The extension to thermal excitations of surface modes resonantly coupled to atom resonances is presently considered[4]. Surface-induced energy level coupling produced by the anisotropic component of the van der Waals interaction leads to a new phenomenon of inelastic reflection of atoms which has been experimentally studied on rare gas atoms[5,6]. Finally we will show that, thanks to the production of a narrow coherent supersonic beam, quantum reflection processes of fast metastable atoms can be observed on a metallic micro-grating, paving the way to new types of matter-wave beam splitter[7].

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