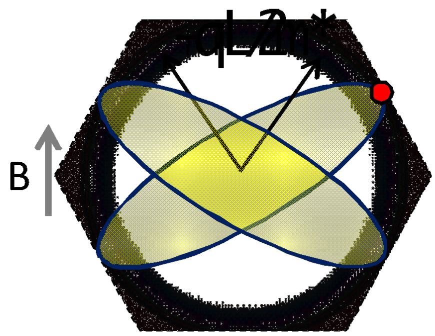
Induced magnetic dipole moments in single quantum loops

Directeur de these : J.L. GALLANI
IPCMS, 67034, Strasbourg
Tel : 3 88 10 71 59; e-mail : gallani@ipcms.u-strasbg.fr

Quantum loops are artificial two- or three-dimensional nanostructures which enfold currents either self-sustained or driven by external stimuli. They are designed to exhibit adjustable quantum characteristics usually not found in nature. A wide range of future application fields such as quantum processing, quantum networks, sensitive emitters, new magnets will all benefit from their properties. We intend here to experimentally and theoretically study individual metallic loops of few tens of nanometers, recently achieved in our laboratory by chemical synthesis (J.L. Gallani and B. Donnio IPCMS/DMO).



When charged particles circulate in a circuit they induce orbital magnetic dipole moments of magnitudes depending on the flowing current density. However in low scale metallic loops the currents are expected to change discontinuously, inducing quantized magnetic moments. These phenomena obviously depend on several parameters including loop's nature, geometry, or local environment. Experimental tools proficient to locally probe single nano-ojects are the scanning probe microscopes. An atomic force microscope AFM and its magnetic sensitive form appear here the most helpful solution. This is mostly because one can then detect weak forces originating from long range magnetic interactions. Hence, the protective organic ligands at the surface of the metallic loops do not impede the measurements. The experiments are expected to be non-invasive, as no other probing electrons are used for measurements. The idea is therefore to use the dynamics of a cantilever beam magnetostatically coupled to a loop to detect moments induced by charge distribution effects at the level of a single electron. We intend here not only to monitor the magnetostatic force and to link it to the intrinsic currents, but also to examine the evolution of stimulated charging and the role of the electron levels. The experimental data will constitute an essential basis for theoretical analyses.