A slowed coherent atomic beam as a new source for atomic interferometry

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Slowed atomic beams are usually made to allow the complete trapping, e.g. in a magneto optical trap, for further experiments requiring small velocities. Another approach is possible taking advantage of the transverse coherence of a standard supersonic atomic beam and a large longitudinal coherence length due to slow velocities, i.e. the atomic "de Broglie" wavelength gets into the nanometre range. Such a slowed atomic beam fills then the gap between the extremely well velocity – defined supersonic beam and the large atomic wavelength of the "cold atoms". It is, however, surprisingly the first time to our knowledge that such beam will be used as an atomic source. A usual Zeeman slower configuration (i.e. a contra propagating resonant laser beam added to an appropriate magnetic field profile that compensates the Doppler effect) allows us to change the speed of the atoms from 560m/s to less than 10m/s [1]. Such an unusual atomic source is presently under study and will be used for atom – surface experiments, typically in the nanometres range.

The first new experiment that will be done is based on an efficient coupling between atomic Zeeman states (for atoms with internal angular momentum) allowed by the quadrupolar component of the surface-induced van der Waals (vdW) interaction [2]. This exo-energetic "vdW - Zeeman" transition provides a tuneable (magnetic field intensity dependent) beam splitter that we theoretically illustrate by the simplest possible interferometer: an atomic counterpart of Fresnel biprism [3]. The velocity – adjustable atomic beam is here coming across two opposite surfaces (single slit of a nano-grating, Fig 1). For a transverse coherent radius large enough, the atom wave packet will be strongly inelastically diffracted by the two opposite surfaces at some distances from the slit to yield non localised interference fringes. The calculation has been done for Ar* metastable atoms with a grating of 100nm period and different velocities of the atoms (560 to 10 m/s). Via the interference pattern (Schlieren image), this device should give access to such novel information as the oscillating part of the complex vdW – interaction transition amplitude. This simplest configuration is not sensitive to inertial effect. As a next step, a loop – closing transmission grating will be added to realize a new type of compact interferometer.

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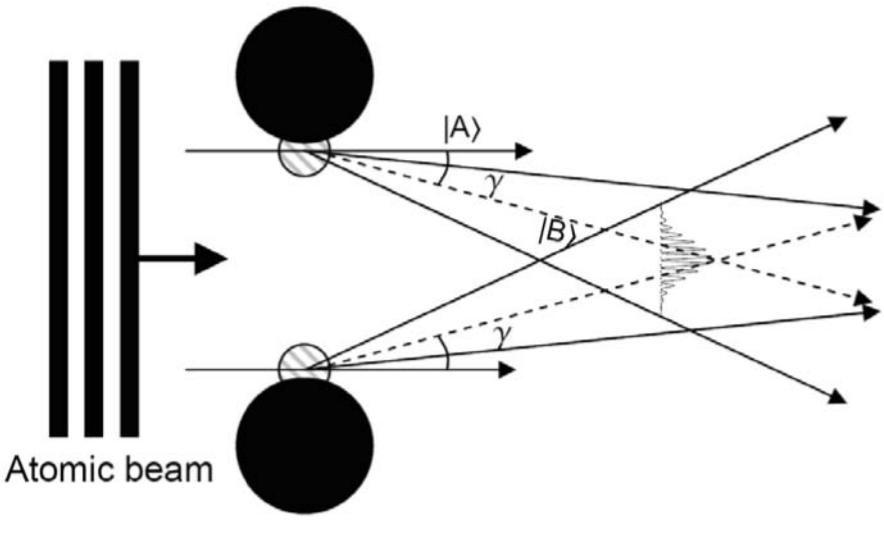

Figure 1: *The atomic Fresnel biprism interferometer principle. γ is the angular deviation induced by the passage from the* |A> *to the* |B> *magnetic sub-level.*

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