Reflective atom interferometry and its sensing capability

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The field of atom interferometry has seen remarkable growth in recent decades, finding applications across a wide spectrum of areas. These range from fundamental research, such as exploring the transition between classical and quantum realms with high-mass or slower particles, to practical applications in magnetic and gravity sensing, quantum metrology, atomic clocks, dark matter detection, and gravitational wave detectors, including those in space. Additionally, matter-wave lithography benefits from these advancements. Recently, portable atom gravimeters have emerged for geophysical investigations, including prospecting and oil surveys, driven by the broad beam splitting of the atomic wave function. Many of these applications utilise cold atoms or Bose-Einstein condensates, leveraging laser pulses to achieve atomic wave function splitting with beam separations extending over several centimetres [1].

In contrast, transmission interferometers employing thermal atoms rely on dielectric objects [2] or a standing laser field [3] for beam splitting, thereby restricting the separation to mere milliradians [4]. This presentation unveils an innovative reflective atom interferometer design, utilising surface diffraction between two parallel plates to realise a substantial angular separation of the wave function, see Fig. 1 [5]. The discourse delves into a viable interferometer configuration, presents anticipated interference patterns, and delineates optimal designs for acceleration measurements and velocity selection applications [6].

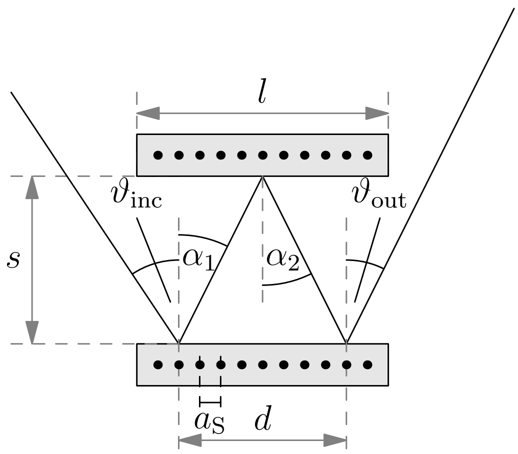

Figure 1: Sketch of the setup: Two parallel nano-structured slabs of length l and period a_S are separated by a distance s. An incoming beam at an incidence angle ϑ_inc undergoes three reflections: initially into diffraction order n_1 with angle α_1, then into order n_2 with angle α_2, and finally exiting the apparatus after a third reflection into order n_3 at angle ϑ_out.

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