An Atom Interferometer for Measuring Horizontal Accelerations

Matter-wave interferometry has enabled high precision measurements of inertial forces such as gravity and the Coriolis force. This is facilitated by the long-term stability of the physical properties of atoms and lasers. Recent experiments have demonstrated the operation of portable, robust sensors using atom interferometry. This has potential uses in the context of inertial navigation, where conventional devices suffer from long-term drifts due to bias instability. Furthermore, determining position via dead reckoning requires minimisation of dead time between measurements. This thesis presents the development of an atom interferometer for measuring horizontal accelerations. In this configuration, gravity induces motion across the laser wavefront, which constrains the tolerable level of wavefront distortions. Effective control of the experiment allows the interferometer to be operated at a rate of 4 Hz. A cold ensemble of 10^6 atoms in the same internal state is prepared in 150 ms. The interferometer operates using a sequence of three laser pulses separated by $T = 25\,\mathrm{ms}$ to achieve sensitivity to horizontal accelerations. Combining this with a classical accelerometer provides a method of correcting for vibration-induced noise, as well as determining the interferometer fringe order. After an integration time of 70 s, the sensitivity to horizontal accelerations is better than $1 \times 10^{-6}\,\mathrm{m\,s^{-2}}$. Effects which limit this sensitivity are discussed.