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*Interferometry and Metrology with Macromolecules*

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ABSTRACT

The study of matter waves is an active field in quantum physics. Matter-wave interferometers are employed in many laboratories to perform precision measurements of fundamental constants or to gauge the properties of atoms and molecules. This thesis describes the construction and operation of a new Kapitza-Dirac-Talbot-Lau interferometer (KDTLI), which allows us to extend such experiments into a mass range which has been inaccessible so far. A KDTLI is highly sensitive to external forces and can be used to perform precision measurements of diverse molecular properties. In this thesis, measurements of the electric polarizability and the susceptibility are presented. These properties give insight into the molecular structure and the internal dynamics. Interestingly, even the fast conformation changes of hot and highly excited molecules do not impair the interference contrast. In the course of the present thesis, experiments with fluorinated, organic molecules with masses of up to 7000 atomic mass units and nearly 500 atoms have been performed. These particles are the most massive objects for which quantum interference could be observed so far. The demonstrated technology will enable a further increase of the mass range by another two orders of magnitude, permitting the validation of several alternative models of the quantum-classical transition in the future.