**Stockholms universitet**

# Holonomy in Quantum Information Geometry

## Ole Andersson

### Abstract

In this thesis we provide a uniform treatment of the two most popular non-adiabatic geometric phases for dynamical systems of mixed quantum states, namely those of Uhlmann and of Sjöqvist *et al.* We develop a holonomy theory for the latter which we also relate to the already existing theory for the former. This makes it clear what the similarities and differences between the two geometric phases are. We discuss and motivate constraints on the two phases. Furthermore, we discuss some topological properties of the holonomy of 'real' quantum systems, and we introduce higher-order geometric phases for not necessarily cyclic dynamical systems of mixed states. In a final chapter we apply the theory developed for the geometric phase of Sjöqvist *et al.* to geometric uncertainty relations, including some new "quantum speed limits".