Chapter 1

Introduction and Overview

In this thesis I discuss a number of different topics: atomic tunneling with dissipation, the metallization of liquid hydrogen, universality of electron-ion structure factors and non-linear response theory:

Chapter 2 discusses how a a phonon environment can *qualitatively* change the tunneling behaviour of an atom.

Chapter 3 gives an overview of theoretical questions related to dense liquid metallic hydrogen, as recently discovered by Bill Nellis and co-workers.

Chapter 4 shows how and why the response of a single atom in an electron gas is well approximated by linear + second order response.

Chapter 5 demonstrates that electron-ion correlations functions $S_{eI}(k)$ fall either into the *low valence* or *high valence* classes for liquid metals.

Chapter 6 establishes some exact results for pseudo-atoms and effective ion-ion potentials.