

# Chapter 1

## Introduction

This chapter gives an overview of some of the topics that will be covered so the reader can get a coherent picture of the types of problems and associated mathematical structures that will be developed.<sup>1</sup>

### 1.1 The Classical Water Molecule and the Ozone Molecule

An example that will be used to illustrate various concepts throughout these lectures is the *classical (non-quantum) rotating “water molecule”*. This system consists of three particles interacting by interparticle conservative forces (one can think of springs connecting the particles, for example) so that the total energy of the system, which will be taken as our Hamiltonian, is the sum of the kinetic and potential energies. This system is shown in Figure 1.1.1. The interesting special case of three equal masses gives the “ozone” molecule.

We use the term “water molecule” mainly for terminological convenience. The full problem is of course the classical *three body problem* in space. However, thinking of it as a rotating system evokes certain constructions that we wish to illustrate.

Imagine this mechanical system rotating in space and, simultaneously, undergoing vibratory, or *internal* motions. We can ask a number of questions:

- How does one set up the *equations of motion* for this system?

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<sup>1</sup>We are grateful to Oliver O’Reilly, Rick Wicklin, and Brett Zombro for providing a helpful draft of the notes for an early version of this lecture.

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