

# Quantum Mechanics: Exercises 3

Due to: November 13, 2012.

## Problem 1

The Hamiltonian for a two-state system is given by

$$H = a(|1\rangle\langle 1| - |2\rangle\langle 2| + |1\rangle\langle 2| + |2\rangle\langle 1|), \quad (1)$$

where  $a$  is some number with dimension of energy. Find the energy eigenvalues and the corresponding energy eigenkets (as linear combination of  $|1\rangle$  and  $|2\rangle$ ).

## Problem 2

Show that the commutator of the momentum operator with a function of the position operator is given by

$$[f(x), \hat{p}] = i\hbar \frac{\partial f}{\partial x} \quad (2)$$

## Problem 3

Consider double  $\delta$ -well with potential

$$V(x) = -\alpha[\delta(x - a) + \delta(x + a)] \quad (3)$$

Calculate the spectrum of bound states of this potential. Show how the spectrum depends on the distance  $a$ .