**Project 2**

Computational Physics I FYS3150/FYS4150

Hyejin Yun, Yisha Chen

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**Abstract**

We solved the eigen value problem of a Schrodinger’s equation of one and two particles in a harmonic oscillator. Jacobi rotation algorithm is used as a method in order to diagonlize a given matrix, which is a symmetrical diagonal matrix rewritten by a Schrodinger’s equation of one and two particles in a harmonic oscillator, and extract the diagonal to find the eigen values for one particle harmonic oscillator system. Increasing the range of *ρ*, where , and , decreases the eigen values. The comparison with armadillo functions and unit tests assures the reliability of the solution. Afterwards, we modify the code of the diagonal element to apply it for a two particle harmonic oscillator system which not considers Coulomb interaction between the two particles. When varies, the eigen value increases proportionally to the range of *ρ*.

## Introduction

The aim of this project is to develop a program that uses Jacobi’s method for finding eigenvalues. The Jacobi’s method is implemented to diagonalize a given matrix, which is a symmetrical diagonal matrix rewritten by a Schrodinger’s equation of one and two particles in a harmonic oscillator, while not violating the value of dot product and orthogonality of the original matrix. Armadillo library is used to manage matrix and vectors, but dynamic allocation is mainly used. By comparing the eigenvalues with the solution attained by numerical calculation, we can see how many mesh points are needed at least to receive accurate eigenvalues. The modified eigenvalue solver for two particle harmonic oscillator system shows that we can apply a general eigenvalue solver program to other systems by controlling the diagonal elements. Through varying the frequency of the harmonic oscillator it is shown that the eigenvlaues increase in a certain proportion depending on the range of distance(*ρ*). Implemented unit tests check the functionality of functions used in the program. Detail methods and algorithms are described in the following section.

## 2. Methods

**2.1. Unitary Transformation**

## 3. Results and Discussion

(d)

Figure 1 eigenvalues when varying size of wr, where ro\_M=0.9, n=3

Figure 2 eigenvalues when varying size of wr, where ro\_M=8.0, n=3

## 4. Conclusion and Perspectives

## Appendix with extra material

Github address for full code :

## Bibliography

David Potter,Computational Physics, *Imperial College, London, John Wiley & Sons,* 1973, pg 82-87