FYS-KJM4480 - Quantum mechanics for many-particle systems

Project 2

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- For the Github repository containing programs and results, follow this link: `https://github.com/UiO-INF5620/INF5620-evenmn/tree/master/project_2`

1 Introduction

Words for motivation

2 Theory

Here I should present all the important equations

3 Exercise 1

3.1 h

$$\hat{H} = \hat{H}_0 + \hat{V} \tag{1}$$

We use equation ... and ..., and get

$$\begin{aligned}
\hat{V} &= -\frac{1}{2} g \sum_{pq} c^\dagger_{p+} c^\dagger_{p-} c_{q-} c_{q+} \\
&= -\frac{1}{2} g \sum_{p}^{M} c^\dagger_{p+} c^\dagger_{p-} \sum_{q}^{M} c_{q-} c_{q+} \\
&= -\frac{1}{2} g \Big(\sum_{p=1}^{4} \hat{P}^\dagger_p \Big) \Big(\sum_{q=1}^{4} \hat{P}_q \Big)
\end{aligned} \tag{2}$$

Similarly we get

$$\begin{aligned}
\hat{H}_0 &= \sum_{p\sigma} \varepsilon_p c^\dagger_{p\sigma} c_{p\sigma} \\
&= \sum_{p} (p-1) \sum_{\sigma} c^\dagger_{p\sigma} c_{p\sigma} \\
&= \sum_{p} (p-1) \hat{n}_p .
\end{aligned} \tag{3}$$

Thus we end up with

$$\hat{H} = \sum_{p} (p-1) \hat{n}_p - \frac{1}{2} g \Big(\sum_{p=1}^{4} \hat{P}^\dagger_p \Big) \Big(\sum_{q=1}^{4} \hat{P}_q \Big) \tag{4}$$

4 Garbage

Table 1: This table represents the error when solving the system for a constant solution.

Elements	1D	2D	3D
P1	2.77555756e-15	3.55271367e-15	2.60902410e-14
P2	1.26343380e-13	1.39666056e-13	8.69304628e-14