

Physics 4410
Quantum Mechanics 2

Lecture 12

Translation symmetry

September 21, 2020

1. Describe (loosely) what symmetries are in quantum mechanics.
How is particle indistinguishability a symmetry?

2. Suppose $[A, B] = 0$. Then A and B are simultaneously diagonalizable.

3. Describe what happens when H commutes with momentum p .

4. Consider a particle moving on a lattice with

$$H = \sum_{n=-\infty}^{\infty} [\alpha|n\rangle\langle n| - \beta|n\rangle\langle n+1| - \beta|n+1\rangle\langle n|].$$

Explain how this is a (one-dimensional) model for an electron moving in a crystalline lattice.

5. Now define the discrete translation operator:

$$T = \sum_{n=-\infty}^{\infty} |n+1\rangle\langle n|.$$

Show that $[H, T] = 0$.

6. Find the eigenvalues/eigenvectors of T .

7. Find the eigenvalues/eigenvectors of H .