近代物理期末考

1. Consider a Quantum Simple Harmonic Oscillator of angular frequency . Under the fourth energy eigenstate , calculate . (20)

Hint: ,,

解答：

這正好使。

1. Consider the wave packet-like state as described in Example 2-1 of P27, for which the wave function in momentum space is:

It wavefunction in position space is equal to

1. The constant can be determined by the condition . Calculate . (10)
2. Calculate the expectation values: . (10)

Hint: Use wave function in momentum space。

解答：

1. ，。
2. 期望值：
3. Consider the stationary state in a step potential as shown below:

A picture containing text, sky, map

Description automatically generated

Consider the stationary state of energy . We know that can be written as:

From the continuity conditions of and , calculate the coefficients and the probability density as a function of in . (20)

Hint: 解答應可化簡表示為與參數例如無關的形式。

解答：Since , we know 。

要求及在邊界原點連續：

第二式可以簡化為：

解出：

In , . The probability density equals .

1. Calculate and . (15)

Hint:. . .

解答：

1. In class, we use the eigenstates of the spin operator in direction as the basis of the 2-dimensional vector space. We can in fact construct the spin operator pointing in any direction. For example, is the spin pointing in the direction with . The eigenvectors of , expressed as column vectors in the basis of , are .

Calculate the coefficients . Please normalize the coefficients so that .

When the electron is in the state what is probability to find its ? The eigenstate of with eigenvalue is . When the electron is in the state what is probability to find its ? (25)

解答：

找的eigenvalues :

如預料，分別對應eigenvalues of ：。

對應eigenvector滿足：，，

The probability to find its is .

The probability to find its is .

The probability to find its is . 與軸及軸都夾，這結果很合理。