

Phys 501: Quantum Mechanics II

Homework Set 0(Due 1230pm, Wed, Jan 9, 2019)

Objectives:

Understand the basic properties of spherical waves: spherical Bessel functions j , Neumann functions n (or 2nd kind of Bessel function) and Hankel functions h

Math requirements:

** You need to know how to work with spherical Bessel functions (first kind and second kind), Henkel functions etc.*

*** Understand the asymptotic behaviors of these functions at large or small distances.*

Prob. 0

You can find more discussions on solutions to 3D Schrodinger equations (rotationally invariant systems) in Chapter 12. For this problem, you can also read the supplementary materials which summarize what you need to know and work out. For most of later discussions on low energy scattering of finite range interactions, it turns out in many cases, we only need the asymptotic behaviors of spherical waves rather than the whole structures.

We need the short distance behavior so that we can determine how the waves are deformed by interactions and we need large distance behavior to understand how the waves look like from an observer's point of view. As these asymptotic properties are universal, hence low energy scattering physics can be very universal, insensitive to many details of the interaction " $V(r)$ " such as shapes etc. In HW set I, we will turn to these robust universal aspects of scattering phenomena. Here in this warm-up set, you are asked to

- 1) Verify Eq. 1 (short distance behavior), E.q 2,3,4 (large distance asymptotics).
- 2) Discuss why Eq.3-4 are very similar to Eq.5 for S-wave.