In this unit, you will derive (with help) and explore the energy eigenstates for a particle confined to a sphere (the rigid rotor problem). Then you will learn how to calculate probabilities for the physicial quantities of the system.

Motivating Questions

- What is an expansion in Legendre polynomials and how do you calculate it?
- What are the quantum numbers for the rigid rotor (especially the energy)?
- What shapes do the probability densities for the energy eigenstates of the rigid rotor have?
- What is the algebraic form for the energy eigenstates of the rigid rotor?

Key Activities/Problems

- Activity: Spherical Harmonics on a Balloon
- Activity: Finding Coefficients of a Spherical Harmonics Series
- Activity: Matrix Representation of Angular Momentum
- Problem: Sphere Questions
- Problem: Sphere Table

Unit Learning Outcomes

At the end of this unit, you should be able to:

- Calculate the Legendre polynomial expansion for a function and describe where it is valid.
- Write the energy eigenstates for the rigid rotor in wave function form using a table of spherical harmonics.
- Describe how the values of the quantum numbers for the rigid rotor are related to each other and remember the limits on their ranges.
- For a state of the rigid rotor, given in bra/ket, matrix, or wave function notation, calculate the probabilities associated with energy, total angular momentum (squared), z-component of angular momentum, or position.
- For a state of the rigid rotor, given in bra/ket, matrix, or wave function notation, determine how it evolves with time.
- Relate the wave function and bra/ket notations for stationary states of the rigid rotor to their graphs.

Equation Sheet for This Unit

- Spherical Harmonics Equation Sheet