Phys. 670 (Xerxes Tata, Fall 2020)

This class builds on a year long undergraduate course (such as PHYS 480 and PHYS 481 at UH) that you should have already had. Among other things, I will assume that you have already solved the Schroedinger equation for simple problems and know how to find the eigenvalues and eigenfunctions for the simple harmonic oscillator and the hydrogen atom, and that you have also obtained the spherical harmonics as eigenfunctions of orbital angular momentum. **Indeed, spherical harmonics (which you should also have seen in undergrad E & M) should be your friends.**

Although some of the topics that we discuss will be a repeat of what you may have seen, the treatment will be at a deeper level. PHYS 670 will be treated as the first part of a two-semester course (with PHYS 671). For Phys. 670, we will use Principles of Quantum Mechanics by R. Shankar as the main text, but you are encouraged to supplement this with any of the other excellent texts of your choosing. These include: Sakurai, Merzbacher, Schiff, Landau and Lifschitz, Davydov, Messiah, Baym, Dirac, Gottfried & Yan, and Weinberg, to name a few. Remember that different texts present different perspectives, something very useful at this stage in your education. You will be required to have some knowledge of Hamiltonian mechanics and of electromagnetic theory at the undergraduate level. It will be helpful to know something about the Poisson Bracket formulation of classical mechanics (Sec. 2.7 of our text, or Chap. 9 of Goldstein).

Topics to be covered:

- Brief review of problems with classical physics
- Linear vector spaces, operators, eigenvalue problems; special issues with infinite dimensional spaces.
- Postulates of Quantum mechanics
- One dimensional quantum mechanics
- The simple harmonic oscillator – creation and annihilation operators
- The path integral formulation
- The generalized uncertainty relations
- Quantum mechanics in 3-dimensions
- Multiparticle systems
- Identical particles
- Symmetries in quantum mechanics

- Rotational invariance and orbital angular momentum
- Spherically symmetric potentials; free particle in spherical polar coordinates
- Intrinsic angular momentum

I would like to cover through Chapter 14 this term, but if we do not get there, Phys. 671 will continue where we stop.

HW will be assigned regularly (roughly weekly), and will count for 20-30% of your grade. You are welcome to discuss it among yourselves or with me if you wish, but **please write it up independently**. Also, we will have one mid-term and a final exam (format TBD), each counting for 35-40% of your grade. This weighting assumes that we do not have a big disruption from covid, and that we are able to collect HW on a regular basis. If things change, we may have to weight the HW less. **However, please keep in mind that the HW is essential to your learning, and treat it seriously independently of the weighting for the grade.**

The class will prepare you for PHYS 671 and will provide a treatment of topics in non-relativistic quantum mechanics at an advanced level relative to what you may hav seen in your undergrad QM class.