# EE290O
# Homework 2: Quantum Mechanics 1

Problem 1: What is the dynamics of a 1-dimensional free quantum particle? A particle that experiences no potential: $V(x) = 0$ in the Schrödinger equation. Your answer should be a normalized wavefunction. Then argue that a monochromatic (single frequency) wave function is not physical (cannot exist).

Problem 2: I mentioned in the class that with modern technology we are no longer limited to projective measurements. Here is the story how we can do a general quantum measurement. Consider the following measurement setup depicted in Fig. (1). The system of interest is coupled to a second quantum system, probe. System and probe interact for some time before we do a projective measurement on the probe. The outcome of the measurement on the probe yields information about the system. (System and probe are generally from different Hilbert spaces $\mathcal{H}_S$ and $\mathcal{H}_P$).

Here are the steps of this process that I just mentioned:

1: At initial time $t = 0$, $\rho_{Sys-Prob}(0) = \rho_S \otimes \rho_P$.
2: Interaction: The system and probe interact via the Hamiltonian $H_{SP}$ for a time interval $t$.
3: Measure the probe: The probe is measured where the measurement is described by a set of projection operators $\{P_k\}$ acting on the probe only.

The initial probe state $\rho_P$ is known and the unknown is the state of the system $\rho_S$. 1) What is the probability of the classical meter showing the $k$'th outcome corresponding to the projection $P_k$? 2) What is the state of the system after the measurement?

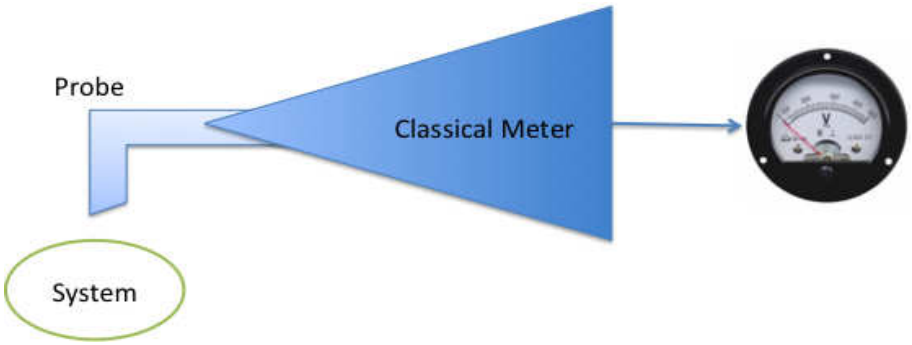


Figure 1: Set-up for indirect measurement