Problem set 7

1. Use the results for the "warm-up" U on pages 1 and 2 of the handout *Quantum Mechanics II.* Show that if the three ϕ angles are the same, but not necessarily zero, then the matix elements $\langle j | U | i \rangle$ of U are the same in the T basis as they are in the S basis.

2. Again using the 'warm-up" example, suppose that $\phi_0 = 0$, $\phi_+ = \phi$, and $\phi_- = -\phi$. Get the probabilities $P_{00} = |\langle 0\,T' | U | 0\,T\rangle|^2$ and $P_{0+} = |\langle 0\,T' | U | +\,T\rangle|^2$ as a function of ϕ and make a graph of each.

3. Suppose that in some basis, the Hamiltonian for a spin-1/2 (two-state system) has the matrix of amplitudes

$$H_{ij} = \begin{pmatrix} E_0 & -A \\ -A & E_0 \end{pmatrix},$$

e.g. $H_{12} = -A$. What are the two energies in the definite-energy basis? What is the time dependence of each of these two definite-energy states? (Note you do *not* need to find the definite-energy states themselves to answer these questions.)

4. Suppose that in some basis, the Hamiltonian for a spin-1 (three-state system) has the matrix of amplitudes

$$H_{ij} = \begin{pmatrix} 0 & A & 0 \\ A & 0 & A \\ 0 & A & 0 \end{pmatrix},$$

e.g. $H_{12} = A$ and $H_{13} = 0$. What are the three energies in the definite-energy basis? What is the time dependence of each of these three definite-energy states? What physical situation might this describe? (Note you do *not* need to find the definite-energy states themselves to answer these questions.)

5. For a "free particle" moving on the line, the potential is zero: $V(x) = 0$. Show that for an appropriate relation between p and E, a definite momentum state $e^{ipx/\hbar}$ is a solution to the time-independent, free-particle Schroedinger equation. What is the relation between E and p?