Phys 402: Applications of Quantum Mechanics

More on matrix Hamiltonian for D=2 Hilbert space (either for truncated two-level quantum systems as ammonia molecules or Spin-1/2 physics in textbook section 4.4). In this problem, you have an opportunity to work with these matrix operators more closely.

1) For ammonia molecules, we have introduced the phenomenological matrix Hamiltonian for the tunneling physics and interaction with an electric field. What basis state vectors have we worked with? Discuss the meaning of each matrix element in your matrix, what process stands for.

2) Let us instead work with basis vectors which are the eigen states of the tunneling Hamiltonian we introduced during last lecture. How do the tunneling Hamiltonian and electric field interaction Hamiltonian look like, i.e. the matrix elements defined in terms of new basis vectors?

3) General discussions: assume that an arbitrary interaction is represented by a Hermitian matrix operator F (in terms of basis vectors |u>, |d>). Can you describe how to computer the matrix element of F between two orthogonal states |X> and |Y> ? (here |X>, |Y> are known and can be expressed in terms of |u>, |d>).

4) What is the most general structure of D=2 Hermitian matrices?
"Theorem of matrix decomposition"

5) Understand spinor states and spin algebras (see textbook section 4.4).