24.111 Philosophy of QM Spring, 2002

Assignment #3: Bell's Inequalities and Spin Measurements (due Lec #7)

1. Read chapters 1 and 2 of Hughes, and chapter 2 of Albert.

2. Do all eight problem in Hughes, pp. 37-8.

3. Describe, in the abstract, what would be required of an experiment performed on a spin-1/2 particle in order for that experiment to count as a *simultaneous* measurement of spin in two distinct directions, θ_1 and θ_2. Hint: How many distinct outcomes would this experiment need to have? What would their probabilities have to be (assuming, say, that the experiment is performed on a particle for which Prob(UP,0°) = 1)?

4. Show that, given the quantum mechanical probabilities for the experimental arrangement described in part II of handout #1, it is not possible to design an apparatus which simultaneously measures the spin components of particle 1 in both the 0° direction and the +120° direction (i.e., the probabilities that such a joint measurement yields for UP,0° and UP,+120° must be the same as those yielded, respectively, by an ordinary 0°-measurement and by an ordinary +120°-measurement). You may assume that if you *could* design such an apparatus, then you could *also* design an apparatus which simultaneously measures the spin components of particle 2 in both the 0° direction and the -120° direction. Hint: It's easy—just think about the derivation of Bell's Inequalities in handout #1.

5. It is possible to prepare a spin-1/2 particle in a state such that no matter what spin-measurement is performed on it, Prob(UP) = .5. Show that this state cannot be represented by a vector.