QUANTUM MECHANICS III

PHYS 518

Problem Set # 4

Distributed: November 5, 2008

Due: November 14, 2008

Bell's Theorem Without Inequalities: Ballentine presents a description of Bell's Theorem without inequalities in Chapter 20 (Sec. 20.6, p. 602 ff, esp. Fig. 20.5 p. 604).

The accompanying paper from Zeilinger's group (Pan et al., Nature **403**, 3 Feb. 2000, 515-518 (2000)) provides a different description.

Write an essay that describes the relation between the two descriptions of this theorem. In particular, derive Equs. (4) and (5) in the Nature Letter from Equ. (1) using (2) and (3). Explain where the descriptions by Ballentine and Zeilinger et al. are similar and where they are different. Explain what Ballentine's Fig. 20.5 is trying to say and how it relates to the Pan et al. description of the logic that is given between Eq.(4) and Eq.(5). Explain exactly what Einstein predicts (would have predicted) of this experiment and what Bohr would have predicted.

Describe how the entangled state (1)

$$|\Psi\rangle = \frac{1}{\sqrt{2}} \left(|H\rangle_1 |H\rangle_2 |H\rangle_3 + |V\rangle_1 |V\rangle_2 |V\rangle_3 \right)$$

is produced experimentally.

2. Ballentine, Problem 20.5, p. 611.