

Lesson IV

a) Homework:  $Z = e^{-\beta H}$  in statistics

→ relate to entropy  $S = -k_B \text{tr}(\rho \ln \rho)$

i) 'OR' in QM state: Density Matrix, stochastic wave function

2/25/99

ii) Nonlocality: Bell's inequality GHZ

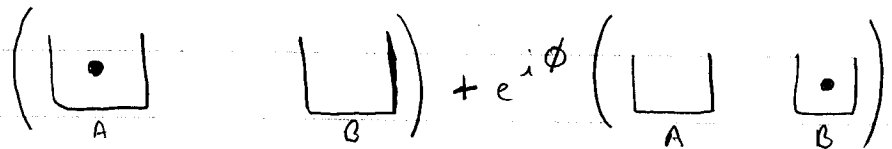
iii) Introduction to Nonlinear QM: computation of TSP with nonlinear QM

I] 'OR'

Superposition

a)  $|\psi\rangle = \frac{1}{\sqrt{2}} [ |1,0\rangle + e^{i\phi} |0,1\rangle ] \equiv$  superposition state,

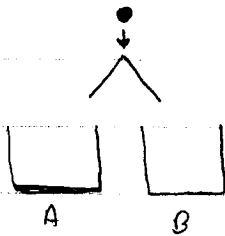
This state contains a continuous parameter of infinite precision  $\phi$ , the 'phase' to define it. Thus the two possibilities 1 particle in A, 0 in B



AND 1 particle B, 0 in A are connected by  $\phi$ .

Mixed state

b) Classically if I have a ball and drop it on a partition



the ball will end up in either A OR B with no phase relation between the two possibilities. In standard bra and ket vector notation ~~there is~~ This situation, in which there is no phase relation between two possibilities is called a mixed state. In standard bra & ket vector notation there is no way to write a mixed state. Rather we go to a new notation called the density matrix.

b.1]

IFF  $|\psi\rangle = \sum_n c_n |n\rangle$

$$\rho = \sum_n \sum_m c_n c_m^* |n\rangle \langle m|$$