

Problem set-12

This set of homework problems is for you to prove a very mathematical relations involving density matrix. Follow the notations of Schiff, section 42.

(1) Show that

$$P_{\alpha}^2 = P_{\alpha} \quad \text{and} \quad \text{trace} (P_{\alpha})=1$$

for both the pure states and the mixed states.

(2) Derive the precession equation for a spin s particle in a magnetic field.

The interaction Hamiltonian is give by

$$H = -\vec{\mu} \bullet \vec{B} = -\hbar s \vec{\sigma} \bullet \vec{B}$$

and show that

$$\frac{d}{dt} \langle \vec{\sigma} \rangle = \gamma \langle \vec{\sigma} \rangle \times \vec{B}$$

(3) Show that if $|\alpha\rangle$ and $|\beta\rangle$ are orthogonal, then

$$\vec{\pi}_{\alpha} = - \vec{\pi}_{\beta}$$

This set of homework problems is a collection of small exercises related to Dirac equations. See equation numbers from your handouts.

(1) Prove eq. (30) for the current density in relativistic form.

(2) Follow the definitions of (38) and $\mathbf{L} = \mathbf{r} \times \mathbf{p}$, and eq. (42), show that $\mathbf{J}$ commutes with H (as given in eq. 36).

(3) prove eq. (47).