UNIVERSITY OF CALIFORNIA, SANTA BARBARA
Department of Physics

Physics 115A
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Winter 1997

FINAL EXAM (con't.)

5. For a particular quantum system there are only two eigenstates of the Hamiltonian:

$$H|u_1\rangle = (E_0 + \epsilon)|u_1\rangle \quad \text{and}$$
$$H|u_2\rangle = (E_0 - \epsilon)|u_2\rangle, \quad \text{with}$$
$$\epsilon \neq 0.$$

The Hermitian operator Q has eigenstates $|v_1\rangle$ and $|v_2\rangle$:

$$Q|v_1\rangle = |v_1\rangle \quad \text{and}$$
$$Q|v_2\rangle = -|v_2\rangle.$$

Q does not commute with H and neither H nor Q depend explicitly on time.

(a) Is $\langle H\rangle$ a constant in time?

Yes $[H, H] = 0$

(b) Is $\langle Q\rangle$ a constant in time? No $[H, Q] \neq 0$

$$\frac{d}{dt}\langle Q\rangle = \frac{i}{\hbar}\langle [H, Q]\rangle$$

(c) Is it possible to simultaneously have a precise knowledge of the values of E and Q?

No, since $[H, Q] \neq 0$