GA 21.3

$$P(t) = \frac{\delta^2 \omega}{\gamma}\left[\frac{(2\omega_0 - f)^2 + (2\omega_0 + f)^2 + 2(2\omega_0 + f)(2\omega_0 - f)\cos 2}{(\quad)^2}\right.$$

$$- 4\omega_0 \frac{\left[(2\omega_0 - f)\cos(2\omega_0 + f)t + (2\omega_0 + f)\cos(2\omega_0\right.}{(\quad)^2}$$

$$\left.\left.\frac{-\omega_0}{(\;)^2}\right]\right]$$

$$P(t) = \frac{\delta^2 \omega}{\gamma}\left[\frac{(8\omega_0^2 + 2f^2) + (8\omega_0^2 - 2f^2)\cos 2ft}{(4\omega_0^2 - f^2)^2}\right.$$

$$- 4\omega_0 \frac{\left[(2\omega_0 - f)\cos(2\omega_0 + f)t + (2\omega_0 + f)\cos(2\omega_0 - f)\right.}{(4\omega_0^2 - f^2)^2}$$

$$\left.\left.- \frac{\omega_0}{(4\omega_0^2 - f^2)^2}\right]\right]$$

TEC.

Gr 9.1

$$H' = -eEz$$

STRAIGHTFORWARD PROBLEM THAT SHOWS THE UTILITY OF THE ORTHONORMALITY CONDITION FOR THE SPHERICAL HARMONICS

START w/

$$\langle 200 | H' | 100 \rangle = -eE \int R_{20}(r) R_{10}(r) r^2 dr \; r\cos\theta$$
$$* \int Y^*_{0,0} Y_{0,0} \, d\Omega$$

$$= \underbrace{-eE \int R_{20} R_{10} r^3 dr}_{①} \underbrace{\int Y^*_{0,0} \cos\theta \, Y_{0,0} \, d\Omega}_{②}$$

Now,

$$\cos\theta = \sqrt{\frac{4\pi}{3}} Y_{1,0} \quad \text{AND} \quad Y_{0,0} = \frac{1}{\sqrt{4\pi}}$$

so,

$$② = \frac{1}{\sqrt{4\pi}} \int Y^*_{0,0} \sqrt{\frac{4\pi}{3}} Y_{1,0} \, d\Omega$$
$$= \frac{1}{\sqrt{3}} \int Y^*_{0,0} Y_{1,0} \, d\Omega$$

$$\boxed{② = 0 \quad \text{SINCE} \int Y^*_{l',m'} Y_{l,m} \, d\Omega = \delta_{l'l} \delta_{m'm}}$$

Gr 9.1

FOR THE OTHER STATES, THE STORY IS SIMILAR. WE WILL NEED A STATE w/ $l=1$ AND $m=0$ FOR A NON-ZERO INTEGRAL.

$$\langle 211|H'|100\rangle = 0$$

$$\langle 21-1|H'|100\rangle = 0$$

AND REPEATING $\langle 200|H'|100\rangle = 0$

$$\langle 210|H'|100\rangle = -eE \underbrace{\int R_{21} R_{10}\, r^3 dr}_{1} \underbrace{\int Y^*_{1,0} \sqrt{\tfrac{4\pi}{3}}\, Y_{1,0} Y_{00}\, d\Omega}_{2}$$

$$2 = \frac{1}{\sqrt{3}}$$

$$1 = \frac{1}{\sqrt{3}} \int_0^\infty \left(\frac{1}{2a_0}\right)^{3/2} \frac{r}{a_0} e^{-r/2a_0}\, 2a_0^{-3/2} e^{-r/a_0}\, r^3 dr$$

$$= \frac{1}{\sqrt{3}} \frac{1}{a_0^4} \frac{2}{2^{3/2}} \int_0^\infty e^{-3r/2a_0} r^4 dr$$

$$= \frac{1}{\sqrt{6}} \frac{1}{a_0^4} \int_0^\infty e^{-3z/2} z^4 a_0^4\, a_0\, dz$$

GR 9.1

$$① = \frac{a_0}{\sqrt{6}} 4! \left(\frac{3}{2}\right)^{-5}$$

HENCE

$$\langle 210 | H' | 100 \rangle = \frac{-eE \left(\frac{2}{3}\right)^5 4! \, a_0}{3\sqrt{2}}$$

$$\boxed{\langle 210 | H' | 100 \rangle = -eEa_0 \frac{128\sqrt{2}}{243}}$$

(b) OTHER MATRX ARE ZERO SINCE THE θ, φ INTEGRATION BECOMES AN ODD INTEGRATION OVER $\cos\theta$

$$\boxed{\begin{aligned} &\langle 211 | H' | 211 \rangle = 0 \\ &\langle 210 | H' | 210 \rangle = 0 \\ &\langle 21{-1} | H' | 21{-1} \rangle = 0 \\ &\langle 200 | H' | 200 \rangle = 0 \\ &\langle 100 | H' | 100 \rangle = 0 \end{aligned}}$$

GA 26.3 TEC

$$P(t) = \frac{1}{\hbar^2} \left| \int_0^t H'_{ba}(t') \, e^{i\omega_{ba} t'} \, dt' \right|^2$$

$$\omega^2 = \omega_0^2 + 2\omega_0 \delta\omega \cos ft + \delta\omega^2 \cos^2 ft$$

IGNORE

$$H' \simeq m\omega_0 \delta\omega \cos ft \; x^2$$

$$\omega_{ba} \simeq \frac{E_b - E_a}{\hbar} = 2\omega_0$$

$$H'_{ba} = H'_{20} = \frac{\hbar}{\sqrt{2}} \delta\omega \cos ft$$

using $\langle n|x^2|0\rangle = \frac{\hbar}{\sqrt{2} m\omega_0}$, $n = 2$

$= 0$, $n \neq 2$

$$① \equiv \int_0^t H'_{20} \, e^{i\omega_{20} t'} \cos ft' \, dt'$$

$$= \frac{\hbar \delta\omega}{\sqrt{2}} \int_0^t \frac{e^{ift'} + e^{-ift'}}{2} \, e^{i\omega_{20} t'} \, dt'$$

Ch. 21.3

$$① = \frac{\hbar\,\delta\omega}{2\sqrt{2}} \int_0^t dt' \left[e^{i(\omega_{20}+f)t'} + e^{i(\omega_{20}-f)t'} \right]$$

$$= \frac{\hbar\,\delta\omega}{2\sqrt{2}} \left[\frac{e^{i(\omega_{20}+f)t'}}{i(\omega_{20}+f)}\Bigg|_0^t + \frac{e^{i(\omega_{20}-f)t'}}{i(\omega_{20}-f)}\Bigg|_0^t \right]$$

$$= \frac{\hbar\,\delta\omega}{2\sqrt{2}} \left[\frac{e^{i(\omega_{20}+f)t} - 1}{i(\omega_{20}+f)} + \frac{e^{i(\omega_{20}-f)t} - 1}{i(\omega_{20}-f)} \right]$$

$$P(t) = |①|^2 / \hbar^2$$

$$= \delta^2\omega/8 \left[\quad \right]^2$$

Now, $$\left[\quad \right] = \frac{1}{i} \left[\frac{(\omega_{20}-f)\left[\cos(\omega_{20}+f)t - 1\right]}{\omega_{20}^2 - f^2} + \frac{(\omega_{20}+f)\left[\cos(\omega_{20}-f)t - 1\right]}{\omega_{20}^2 - f^2} + i\frac{(\omega_{20}-f)\sin(\omega_{20}+f)t}{\omega_{20}^2 - f^2} + i\frac{(\omega_{20}+f)\sin(\omega_{20}-f)t}{\omega_{20}^2 - f^2} \right]$$

GA 21.3

$$P(t) = \frac{\delta^2 \omega}{8}\left[\left(\frac{(2\omega_0 - f)\cos(2\omega_0 + f)t + (2\omega_0 + f)\cos(2\omega_0 - f)t}{(4\omega_0^2 - f^2)^2} - \frac{2\omega_0}{(4\omega_0^2 - f^2)^2}\right)^2\right.$$

$$\left. + \left(\frac{(2\omega_0 - f)\sin(2\omega_0 + f) + (2\omega_0 + f)\sin(2\omega_0 - f)}{(4\omega_0^2 - f^2)^2}\right)^2\right]$$

$$= \frac{\delta^2 \omega}{8}\left[\frac{(A\cos Bt + B\cos At - 2\omega_0)^2}{(4\omega_0^2 - f^2)^2} + \frac{(A\sin Bt + B\sin At)^2}{(4\omega_0^2 - f^2)^2}\right]$$

$$= \frac{\delta^2 \omega}{8}\left[\frac{A^2 + B^2 + 2AB\cos(A-B)t}{(4\omega_0^2 - f^2)^2} - \frac{4\omega_0(A\cos Bt + B\cos At - \omega_0)}{(4\omega_0^2 - f^2)^2}\right]$$