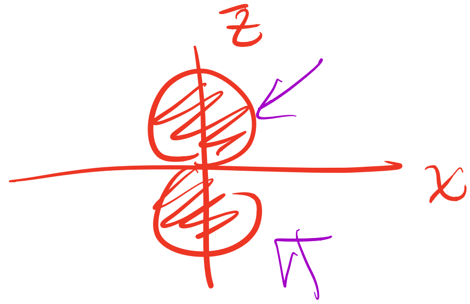
$$\vec{d} = q\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$$

$$\underline{|210\rangle}$$



$$\underline{\langle \vec{d} \rangle = 0 \quad ?}$$

$$|210\rangle \doteq \frac{1}{2\sqrt{\pi}} \left(\frac{1}{2a_0}\right)^{3/2} \frac{r}{a_0} e^{-r/2a_0} \cos\theta$$

$$r\cos\theta = z$$

$$r = \sqrt{x^2 + y^2 + z^2}$$

$$\langle \psi | \vec{d} | \psi \rangle = \langle \psi | -e(x\hat{i} + y\hat{j} + z\hat{k}) | \psi \rangle$$

$$-e\hat{i}\,\underline{\langle \psi | x | \psi \rangle} + -e\hat{j}\,\underline{\langle \psi | y | \psi \rangle}$$

$$-e\hat{k}\,\underline{\langle \psi | z | \psi \rangle} = \langle \vec{d} \rangle$$

$\langle\psi|x|\psi\rangle \leftarrow \quad = 0 \quad ?$

$\langle\psi|y|\psi\rangle \leftarrow \quad = 0$

$\langle\psi|z|\psi\rangle \leftarrow \quad = 0$

$$\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} \psi^* x \psi \, dx\,dy\,dz$$

$$z e^{-(x^2+y^2+z^2)^{1/2}}$$

$$\underline{x}\, z^2 e^{-(x^2+y^2+z^2)} \propto \psi^* \psi$$

$$\langle\psi|x|\psi\rangle \quad \int_{-\infty}^{\infty} \cdots dx = 0$$

$$\langle\psi|z|\psi\rangle \propto z^3 e^{-\cdots}$$