



Mo Tu We Th Fr Sa Su

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*Perturbation theory.*

$$H |E_n\rangle = E_n |E_n\rangle$$

$$H = H_0 + \lambda H_1$$
$$E_n = \sum_{i=0}^{\infty} \lambda^i (E_n)^{(i)}$$

$$|E_n\rangle = \sum_{i=0}^{\infty} \lambda^i |E_n^{(i)}\rangle$$

$$(H_0 + \lambda H_1) \sum_{i=0}^{\infty} \lambda^i |E_n^{(i)}\rangle = \sum_{i=0}^{\infty} \sum_{j=0}^{\infty} \lambda^i \lambda^j |E_n^{(j)}\rangle$$

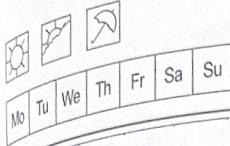
$|E_n^{(0)}\rangle$  is complete basis.

$$|E_n^{(i)}\rangle = \sum_m \langle E_m^{(0)} | E_n^{(i)} \rangle |E_m^{(0)}\rangle$$

impose  $\langle E_n^{(0)} | E_n \rangle = 1 = \sum_{i=0}^{\infty} \lambda^i \langle E_n^{(0)} | E_n^{(i)} \rangle$

$$= 1 + \lambda \langle E_n^{(0)} | E_n^{(1)} \rangle + \dots$$

$$\Rightarrow \langle E_n^{(0)} | E_n^{(i)} \rangle = \delta_{0,i}.$$



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$$(H_0 + \lambda H_1) (|E_n^{(0)}\rangle + \lambda |E_n^{(1)}\rangle) = E_n^{(0)} |E_n^{(0)}\rangle + \lambda (|E_n^{(0)}\rangle |E_n^{(1)}\rangle + |E_n^{(1)}\rangle |E_n^{(0)}\rangle)$$

$$H_0 |E_n^{(0)}\rangle + \lambda (H_1 |E_n^{(0)}\rangle + H_0 |E_n^{(1)}\rangle)$$

$$\Rightarrow H_0 |E_n^{(0)}\rangle = E_n^{(0)} |E_n^{(0)}\rangle$$

$$H_1 |E_n^{(0)}\rangle + H_0 |E_n^{(1)}\rangle = E_n^{(0)} |E_n^{(1)}\rangle + E_n^{(1)} |E_n^{(0)}\rangle$$

$$\Rightarrow H_1 |E_n^{(0)}\rangle$$

$$\langle E_n^{(0)} | H_1 | E_n^{(0)} \rangle + \langle E_n^{(0)} | H_0 | E_n^{(1)} \rangle = \cancel{\langle E_n^{(0)} | E_n^{(0)} \rangle} \langle E_n^{(1)} | E_n^{(1)} \rangle$$

$$\Rightarrow \cancel{\langle E_n^{(0)} | H_1 | E_n^{(0)} \rangle} + \cancel{\langle E_n^{(0)} | E_n^{(0)} \rangle} = \cancel{\langle E_n^{(1)} | E_n^{(0)} \rangle}$$

$$\Rightarrow \boxed{E_n^{(1)} = \langle E_n^{(0)} | H_1 | E_n^{(0)} \rangle}$$