TEORI GANGGUAN STASIONER

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Tanpa gangguan : 1. Osilator R< L, A= tetap (Harmonis)
2. Osilator pegas
3. Getaran molekul, Translasi, Rotasi dan Vibrasi

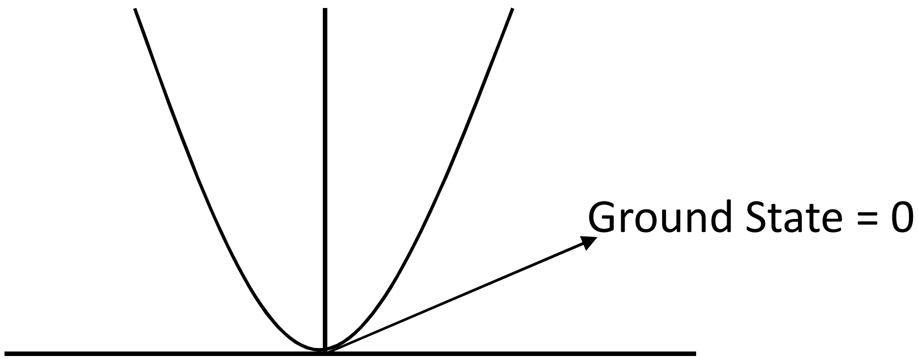
Ada gangguan : 1. Medan listrik
2. Redaman, Medan Gravitasi
3. Medan Listrik(Efek Stock), $\vec{B}$ (Efek Zeeman)

Bagaimana Hamiltonian H suatu system pengganggu

- Energy system(Eigen Value) setelah diganggu?
- Keadaan system (Eigen State) setelah diganggu?

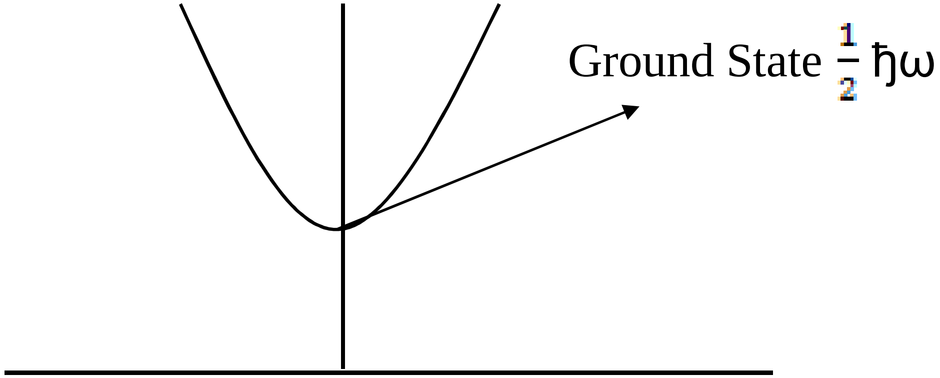
Osilator tanpa gangguan

Klasik



$$E = \frac{1}{2}kx^2$$

Quantum



$$E_n^0 = \left(n + \frac{1}{2}\right)\hbar\omega$$

Osilator dengan gangguan W, $\frac{W}{H_0} \ll 1$

$H = H_0 + W$

Dimana: H_0 = Hamiltonian tanpa gangguan
H = Hamiltonian ada gangguan
W = Penggangu ≠ f(t) → Stasioner

$$H\,|\varphi_n\rangle = E_n\,|\varphi_n\rangle \text{ dengan } H_0\,|\varphi_n^0\rangle = E_n^0\,|\varphi_n^0\rangle$$

Agar dapat diekspansikan

$W = \lambda\hat{W}$; $\hat{W}$ – operator matriks (masih berupa gangguan)

Akhirnya H = f(λ)

$H(\lambda) = H_0 + \lambda\hat{W}$

Syarat : $|\varphi_r^i\rangle \approx$ Vektor eigen dari H_0

Akibat adanya gangguan: Dapat menaikkan dan menurunkan energi

Dapat mempertahankan dan menghilangkan degenerasi

Dapat terjadi degenerasi

Degenerasi → Dalam satu tingkat energy terdapat fungsi gelombang yang berbeda

Nondegenerasi→Macam – macam gelombang yang mempunyai harga energy

$$\varphi_1 = e^{ikx} \qquad ;\varphi_2 = 2e^{ikx} \qquad ;\varphi_3 = \frac{1}{3}e^{ikx}$$

Persamaan Hamiltonian: $H_0|\varphi_p^i\rangle = E_p^0|\varphi_n^i\rangle$; $i = 1.2.3, \ldots g i$

$$i = 4 \longrightarrow g_p = 4 \longrightarrow \varphi_p^p \text{ ada 4 macam } \varphi_1, \ \varphi_2, \ \varphi_3$$

Hasil kali skalar antara 2 vektor => notasi dirac menjadi

$\langle \varphi_p^i | \varphi_p^i \rangle = 1$ → kuantum → vektor ada fungsi gelombang harga dan arah

$\overline{A}.\overline{A} = 1 \Rightarrow$ *syarat ternormalisasi*

$\langle \varphi_p^i | \varphi_{p'}^{i'} \rangle = \delta_{pp'}\delta_{ii'} = 1 \Rightarrow | \varphi_p^i \rangle$ *normal*

Eskpansi nilai eigen terganggu

$H(\lambda)|\varphi(\lambda)\rangle = E(\lambda)|\varphi(\lambda)\rangle$

Dengan $E(\lambda) = \varepsilon_0 + \lambda\varepsilon_1 + \lambda^2\varepsilon_2 + \lambda^3\varepsilon_3 + \cdots = \sum_{q=0}^{\sim} \lambda^q \varepsilon_q$

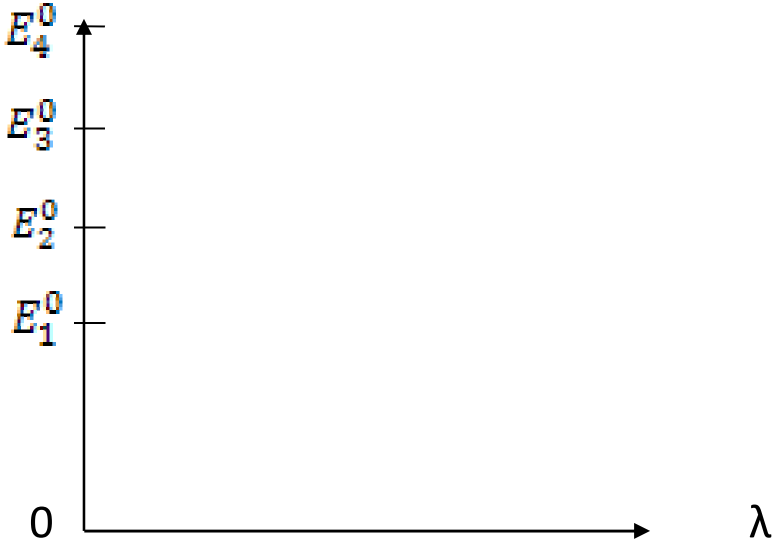
$\varepsilon_0 \equiv$ menyatakan energi sebelum terganggu

$\equiv$ terdiri dari beberapa tingkat energi (bukan satu tingkat

$H_0 | \varphi_p^i \rangle = E_p^0 | \varphi_p^i \rangle; p = 0,1,2, \ldots.$

Osilator tak terganggu $E_0 = E_p^0 = \left(p + \frac{1}{2}\right)\hbar\omega$

$E_p^0 \equiv$ *nilai eigen* ; $| \varphi_p^i \rangle \equiv$ *eigen state* ; $i = 1,2,3, \ldots$ *degenerasi*

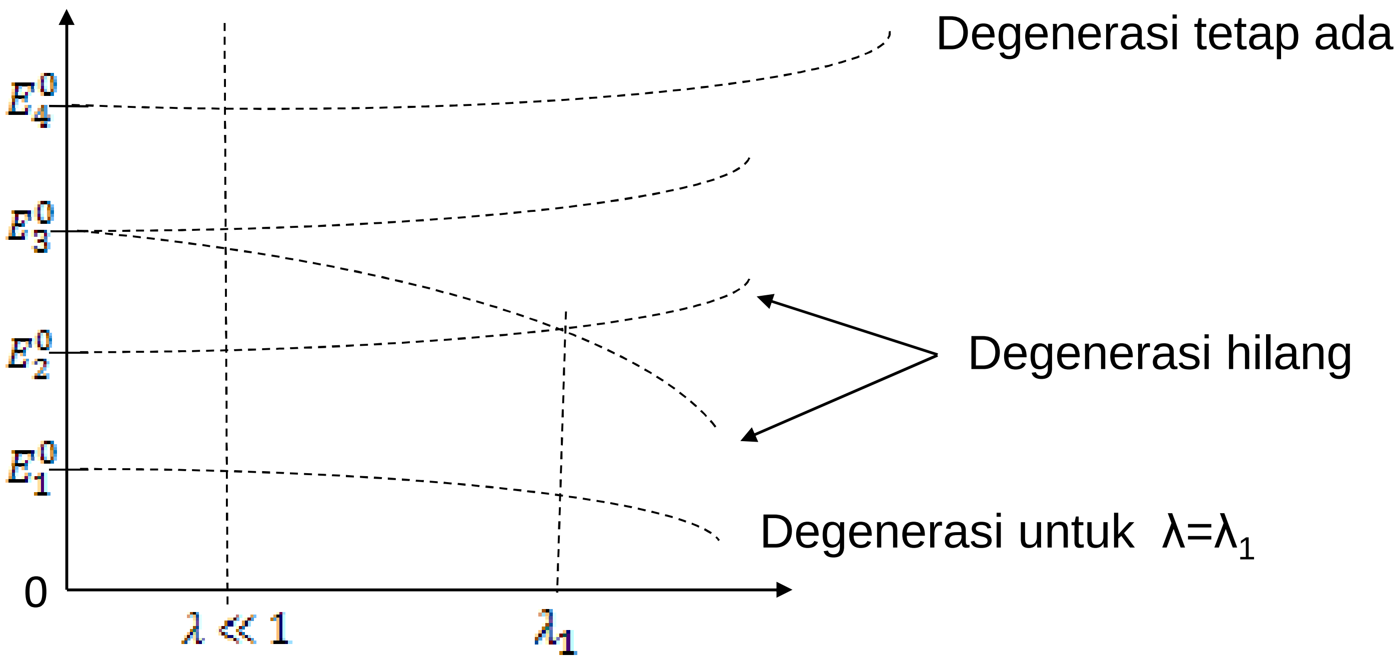


Sebagian diganggu

$$H_0 \left| \varphi_p^i \right\rangle = E_p^0 \left| \varphi_p^i \right\rangle$$

$$\left\langle \varphi_p^i \middle| \varphi_{p'}^{i'} \right\rangle = \delta_{pp'} \delta_{ii'}$$

$$\sum_p \sum_{i\cdot} \left| \varphi_p^i \right\rangle \left\langle \varphi_p^i \right| = 1$$



Seluruhnya diganggu

$H(\lambda) = H_0 + \lambda\hat{W}$

$H(\lambda)|\varphi(\lambda)\rangle = E(\lambda)|\varphi(\lambda)\rangle$

$E(\lambda)$= nilai eigen dan $|\varphi(\lambda)\rangle$= vektor eigen

$E(\lambda) \approx E_p^0$; $|\varphi(\lambda)\rangle = |\varphi_p^i\rangle$

$(H_0 + \lambda\hat{W})(\sum_{q-0}^{\sim} \lambda^q |q\rangle) = \sum_{q'=0}^{\sim} \lambda^q \varepsilon_{q'} (\sum_{q=0}^{\sim} \lambda^q |q\rangle)$

$$E(\lambda) = \varepsilon_0 + \lambda^1\varepsilon_1 + \lambda^2\varepsilon_2 + \cdots \lambda^q\varepsilon_q = \sum_{q'=0} \lambda^q \varepsilon_{q'}$$

$$\varphi(\lambda) = |0\rangle + \lambda\langle 1| + \lambda^2 |2\rangle + \ldots \lambda^q |q\rangle$$

Koefisien ruas kiri = koefisien ruas kanan

Orde ke nol q = 0 maka $H_0|0\rangle = \varepsilon_0|0\rangle \Rightarrow tak\, terganggu$

Orde ke satu q = 1

$$H_0|0\rangle + \hat{W}|1\rangle = \varepsilon_0|1\rangle + \varepsilon_1|1\rangle$$

$$(H_0 - \varepsilon_0)|1\rangle + (\hat{W} - \varepsilon_1)|0\rangle = 0$$

Orde ke dua

$$\left(H_0-\varepsilon_0\right)\left|2\right\rangle+\left(\hat{W}-\varepsilon_1\right)\left|1\right\rangle-\varepsilon_2\left|0\right\rangle=0$$

Orde ke q

$$\left(H_0-\varepsilon_0\right)\left|q\right\rangle+\left(\hat{W}-\varepsilon_1\right)\left|q-1\right\rangle-\varepsilon_2\left|q-2\right\rangle....\varepsilon_q\left|0\right\rangle=0$$

$$\left|\varphi_n(\lambda)\right\rangle=\left|0\right\rangle+\lambda\left|1\right\rangle+...=\sum\lambda^n\left|\quad\right\rangle$$

$$1.\left\langle 0\middle|\varphi(\lambda)\right\rangle=real$$

$$2.\left\langle 0\middle|0\right\rangle=1$$

$$3.\left\langle\varphi(\lambda)\middle|\varphi(\lambda)\right\rangle=1$$

$$\left\langle\varphi_n\right|\left[\left(H_0-\varepsilon_0\right)\left|1\right\rangle+\left(\hat{W}-\varepsilon_1\right)\left|0\right\rangle\right]=0$$

$$\left\langle\varphi_n\right|H_0-\varepsilon_0\left|1\right\rangle+\left\langle\varphi_n\right|\hat{W}-\varepsilon_1\left|0\right\rangle=0$$

$$\left\langle\varphi_n\right|\hat{W}-\varepsilon_1\left|0\right\rangle=0$$

$$\left\langle\varphi_n\right|\hat{W}\left|0\right\rangle=\left\langle\varphi_n\right|\varepsilon_1\left|0\right\rangle\Leftrightarrow\left\langle\varphi_n\right|\hat{W}\left|\varphi_n\right\rangle=\varepsilon_1\left\langle\varphi_n\middle|\varphi_n\right\rangle$$

$$\varepsilon_1=\left\langle\varphi_n\right|\hat{W}\left|\varphi_n\right\rangle\Rightarrow\lambda\varepsilon_1=\left\langle\varphi_n\right|\hat{W}\left|\varphi_n\right\rangle$$

Untuk orde ke-1 tingkat energi $E(\lambda)$ tak terdegenerasi

$$E(\lambda) = \varepsilon_0 + \left\langle \varphi_n \left| \hat{W} \right| \varphi_n \right\rangle + orde(\lambda^2) + \ldots$$

$$Dimana \left\langle \varphi_n \left| \hat{W} \right| \varphi_n \right\rangle = faktor \;\; koreksi$$

$$E_n(\lambda) = E_n^0 + \left\langle \varphi_n \left| \hat{W} \right| \varphi_n \right\rangle + orde - 2$$

$$Dimana : E_n(\lambda) = pertingkat \;\; energi$$

$$n = 2 \rightarrow Matrik \;\; 2x2$$

$$n = 3 \rightarrow Matrik \;\; 3x3$$