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Memo No.
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2-3 A Trivial Generalization

Sup we have N uncoupled harmosc.

$$\hat{H} = \sum_{k=1}^{N} \hat{H}_k$$

$$\hat{H}_k = \frac{\hat{p}_k^2}{2m_k} + \frac{1}{2} m_k \omega_k \hat{x}_k^2$$

$$\hat{a}_k^\dagger |n_1, n_2, \cdots, n_N\rangle \propto |n_1, n_2, \cdots, n_k+1, \cdots\rangle$$

$$\hat{a}_k |n_1, n_2, \cdots, n_N\rangle \propto |n_1, n_2, \cdots, n_k-1, \cdots\rangle.$$

$$[\hat{a}_k, \hat{a}_q] = 0$$

$$[\hat{a}_k^\dagger, \hat{a}_q^\dagger] = 0$$

$$[\hat{a}_k, \hat{a}_q^\dagger] = \delta_{kq}$$

$$\rightarrow \hat{H} = \sum_{k=1}^{N} \hbar\omega_k (a_k^\dagger a + \frac{1}{2})$$

$$|n_1, \cdots, n_N\rangle = \frac{1}{\sqrt{n_1! n_2! \cdots n_N!}} (a_1^\dagger)^{n_1} (a_2^\dagger)^{n_2} \cdots (a_N^\dagger)^{n_N} |0, 0, \cdots, 0\rangle$$

$|n_1, \cdots, n_N\rangle$ called ~~occupation~~ number representation.

or $|\{n_k\}\rangle = \prod_{k=1}^{N} \frac{1}{\sqrt{n_k}} (a_k^\dagger)^{n_k} |0\rangle.$