Key points 04/06 lecture

For 3D non-relativistic classical gas with spherically symmetric interaction potential $v_{ij} = v(|\vec{r}_i - \vec{r}_j|)$.

Define f_{ij} through $e^{-\beta v_{ij}} = (1 + f_{ij})$.

Cluster expansion yields:

$$\frac{1}{V} \log(\mathcal{Q}(z, V, T)) = \frac{1}{\lambda^3} \sum_{l=1}^{\infty} b_l z^l$$

where

$$b_l(V,T) = \frac{1}{l!\, \lambda^{3(l-1)} V} \times \left(\text{sum over all possible } l\text{-clusters} \right)$$

$$b_1 = \frac{1}{V} [①] = \frac{1}{V} \int d^3\vec{r}_1 = 1$$

$$b_2 = \frac{1}{2\lambda^3 V} [①—②] = \frac{1}{2\lambda^3 V} \iint f_{12}\, d^3\vec{r}_1\, d^3\vec{r}_2$$

$$= \frac{2\pi}{\lambda^3} \int_0^{\infty} f_{12}\, r_{12}^2\, dr_{12}$$

$$b_3 = \ldots$$

Alternatively

$$\frac{Pv}{kT} = \sum_{l=1}^{\infty} a_l(T) \left(\frac{\lambda^3}{v}\right)^{l-1}$$

virial coefficients

the key idea is that we might be able to find a good description if the sum $\sum_{l=1}^{\infty}$ is replaced by $\sum_{l=1}^{l_{max}}$, with l_{max} as small as 2 or 3.