

7.4: General Correlation Functions

A general correlation function can be defined in terms of the probability distribution function $p^{(n)}(r_1, \dots, r_n)$ according to

$$\begin{aligned} g^{(n)}(r_1, \dots, r_n) &= \frac{1}{p^n} p^{(n)}(r_1, \dots, r_n) \\ &= \frac{V^n N!}{Z_N N^n (N-n)!} \int dr_{n+1} \dots dr_N e^{-\beta U(r_1, \dots, r_N)} \end{aligned}$$

Another useful way to write the correlation function is

$$\begin{aligned} g^{(n)}(r_1, \dots, r_n) &= \frac{V^n N!}{Z_N N^n (N-n)!} \int dr'_1 \dots dr'_N e^{-\beta U(r_1, \dots, r_N)} \delta(r_1 - r'_1) \dots \delta(r_n - r'_n) \\ &= \frac{V^n N!}{Z_N N^n (N-n)!} \langle \prod_{i=1}^n \delta(r_i - r'_i) \rangle_{r'_1, \dots, r'_N} \end{aligned}$$

i.e., the general n -particle correlation function can be expressed as an ensemble average of the product of δ -functions, with the integration being taken over the variables r'_1, \dots, r'_N .

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