Classical statistical physics - microcanonical ensemble

configuration space Γ of microstates ν

N units with Hamiltonian $\mathcal{H}(\nu)$

volume of microcanonical ensemble - closed system ⬌ fixed total energy

$$\omega(E) = \sum_{\nu\in\Gamma}{}' \, 1 \qquad \text{with} \qquad E \leq \mathcal{H}(\nu) \leq E + \delta E$$

density $\rho(\nu) = \begin{cases} \frac{1}{\omega(E)} & E \leq \mathcal{H}(\nu) \leq E + \delta E \\ 0 & \text{otherwise} \end{cases}$ ➡ $\langle A \rangle = \sum_{\nu\in\Gamma} A(\nu)\rho(\nu)$

entropy $S(E, \ldots) = k_B \ln \omega(E)$ ➡ thermodynamics

Classical statistical physics - canonical ensemble

configuration space Γ of microstates ν

N units with Hamiltonian $\mathcal{H}(\nu)$

Partition function - coupled to heat reservoir ⬌ fixed temperature

$$Z = \sum_{\nu \in \Gamma} e^{-\beta \mathcal{H}(\nu)} \quad \text{with} \quad \beta = 1/k_B T$$

density $$\rho(\nu) = \frac{1}{Z} e^{-\beta \mathcal{H}(\nu)}$$ ➡ $$\langle A \rangle = \sum_{\nu \in \Gamma} A(\nu) \rho(\nu)$$

free energy $$F(T, ...) = -k_B T \ln Z$$

internal energy $$U(T, ...) = \langle \mathcal{H} \rangle = -\frac{\partial}{\partial \beta} \ln Z$$

➡ thermodynamics