

## 10.5.1: The microcanonical ensemble

---

Although we will have practically no occasion to use the quantum microcanonical ensemble (we relied on it more heavily in classical statistical mechanics), for completeness, we define it here. The function  $f$ , for this ensemble, is

$$f(E_i)\delta E = \theta(E_i - (E + \delta E)) - \theta(E_i - E)$$

where  $\theta(x)$  is the Heaviside step function. This says that  $f(E_i)\delta E$  is 1 if  $E < E_i < (E + \delta E)$  and 0 otherwise. The partition function for the ensemble is  $\text{Tr}(\rho)$ , since the trace of  $\rho$  is the number of members in the ensemble:

$$\begin{aligned}\Omega(N, V, E) &= \text{Tr}(\rho) \\ &= \sum_i [\theta(E_i - (E + \delta E)) - \theta(E_i - E)]\end{aligned}$$

The thermodynamics that are derived from this partition function are exactly the same as they are in the classical case:

$$\begin{aligned}S(N, V, E) &= -k \ln \Omega(N, V, E) \\ \frac{1}{T} &= -k \left( \frac{\partial \ln \Omega}{\partial E} \right)_{N, V}\end{aligned}$$

etc.

---

This page titled [10.5.1: The microcanonical ensemble](#) is shared under a [CC BY-NC-SA 4.0](#) license and was authored, remixed, and/or curated by [Mark Tuckerman](#).