Boltzmann entropy S

$$S^{(a)} = k_B \sigma^{(a)} = k_B \ln \Delta\Gamma$$

entire system

$$d\Gamma^{system} = \prod_a d\Gamma^{(a)}$$

$$\Delta\Gamma^{system} = \prod_a \Delta\Gamma^{(a)}$$

$$S^{total} = k_B \ln \Delta\Gamma^{total}$$

$$= k_B \sum_a \ln \Delta\Gamma^{(a)}$$

$$= \sum_a S^{(a)}$$

entropy is an additive prop of system

$$\Delta\Gamma = \prod_a \Delta\Gamma^{(a)} = \exp\left(\frac{S^{total}}{k_B}\right)$$

Microcanonical ensemble

$$dw = const.\,\delta(E-E_0)\prod_a \frac{d\Gamma^{(a)}}{dE}\, dE$$

$$= const.\,\delta(E-E_0)\,\frac{\Delta\Gamma^{total}}{\Delta E}\, dE$$

$$= const\,\delta(E-E_0)\,\frac{e^{S^{total}/k_B}}{\Delta E}\prod dE^{(a)}$$

$$\boxed{dw^{total} = const.\,\delta(E-E_0) \times e^{S^{total}/k_B}\prod_a dE^{(a)}}$$

Connect quantum entropy phase space

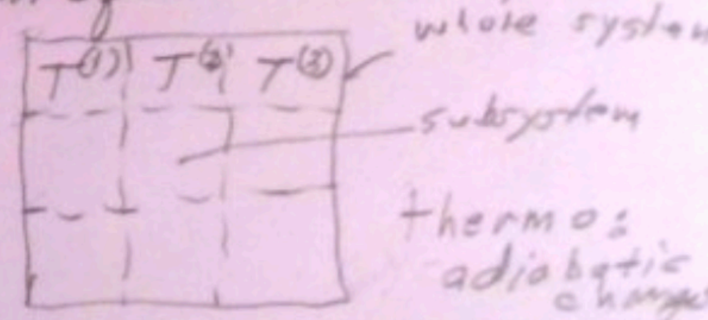
$$\int \rho(E)\,dp\,dq = 1$$

$$d\Gamma = \frac{dp\,dq}{(2\pi\hbar)^s}$$

$$\Delta\Gamma = \frac{\Delta p\,\Delta q}{(2\pi\hbar)^s}$$

$$S^{(a)} = k_B \ln\left[\frac{\Delta p^{(a)}\Delta q^{(a)}}{(2\pi\hbar)^s}\right.$$

Non equilibrium systems



each syst. small enough have well defined T.

But $T^{(1)} \neq T^{(3)}$