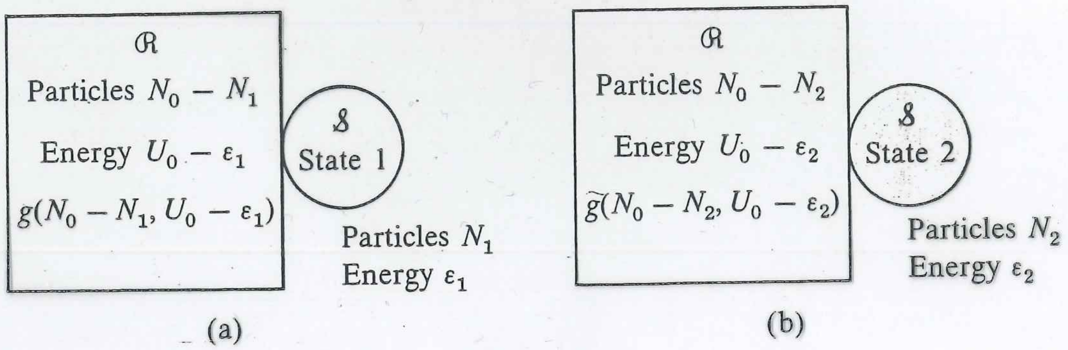

Figure 5.9 The reservoir is in thermal and diffusive contact with the system. In (a) the system is in quantum state 1, and the reservoir has $g(N_0 - N_1, U_0 - \varepsilon_1)$ states accessible to it. In (b) the system is in quantum state 2, and the reservoir has $g(N_0 - N_2, U_0 - \varepsilon_2)$ states accessible to it. Because we have specified the exact state of the system, the total number of states accessible to $\mathcal{R} + \mathcal{S}$ is just the number of states accessible to $\mathcal{R}$.

Here g refers to the reservoir alone and depends on the number of particles in the reservoir and on the energy of the reservoir.

We can express (42) as a ratio of two probabilities, one that the system is in state 1 and the other that the system is in state 2:

$$\frac{P(N_1,\varepsilon_1)}{P(N_2,\varepsilon_2)} = \frac{g(N_0 - N_1, U_0 - \varepsilon_1)}{g(N_0 - N_2, U_0 - \varepsilon_2)}\ , \tag{43}$$

where g refers to the state of the reservoir. The situation is shown in Figure 5.9. By definition of the entropy

$\sigma \equiv \frac{S}{k_B}$

$$g(N_0,U_0) \equiv \exp[\sigma(N_0,U_0)]\ , \tag{44}$$

$g \equiv \Omega$

so that the probability ratio in (43) may be written as

$\ln g = \sigma \quad S = k_B \ln \Omega$

$$\frac{P(N_1,\varepsilon_1)}{P(N_2,\varepsilon_2)} = \frac{\exp[\sigma(N_0 - N_1, U_0 - \varepsilon_1)]}{\exp[\sigma(N_0 - N_2, U_0 - \varepsilon_2)]}\ ; \tag{45}$$

or

$$\boxed{\begin{aligned}\frac{P(N_1,\varepsilon_1)}{P(N_2,\varepsilon_2)} &= \exp[\sigma(N_0 - N_1, U_0 - \varepsilon_1) - \sigma(N_0 - N_2, U_0 - \varepsilon_2)] \\ &= \exp(\Delta\sigma).\end{aligned}} \tag{46}$$