B

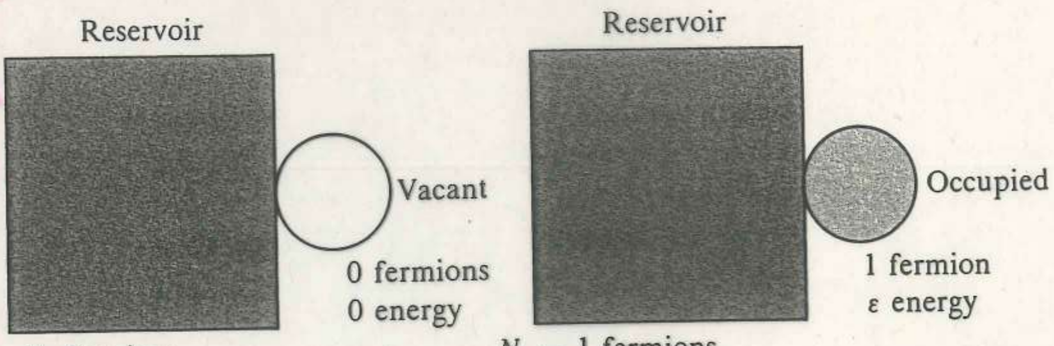

Figure 6.1 We consider as the system a single orbital that may be occupied at most by one fermion. The system is in thermal and diffusive contact with the reservoir at temperature τ. The energy ε of the occupied orbital might be the kinetic energy of a free electron of a definite spin orientation and confined to a fixed volume. Other allowed quantum states may be considered as forming the reservoir. The reservoir will contain N_0 fermions if the system is unoccupied and $N_0 - 1$ fermions if the system is occupied by one fermion.

We introduce for the average occupancy the conventional symbol $f(\varepsilon)$ that denotes the thermal average number of particles in an orbital of energy ε:

$$f(\varepsilon) \equiv \langle N(\varepsilon) \rangle. \tag{3}$$

Recall from Chapter 5 that $\lambda \equiv \exp(\mu/\tau)$, where μ is the chemical potential. We may write (2) in the standard form

$$\boxed{f(\varepsilon) = \frac{1}{\exp[(\varepsilon - \mu)/\tau] + 1}.} \tag{4}$$

This result is known as the Fermi-Dirac distribution function.* Equation (4) gives the average number of fermions in a single orbital of energy ε. The value

* This distribution function was discovered independently by E. Fermi, Zeitschrift für Physik **36** 902 (1926), and P. A. M. Dirac, Proceedings of the Royal Society of London **A112**, 661 (1926). Both workers drew on Pauli's paper of the preceding year in which the exclusion principle was discovered. The paper by Dirac is concerned with the new quantum mechanics and contains a general statement of the form assumed by the Pauli principle on this theory.