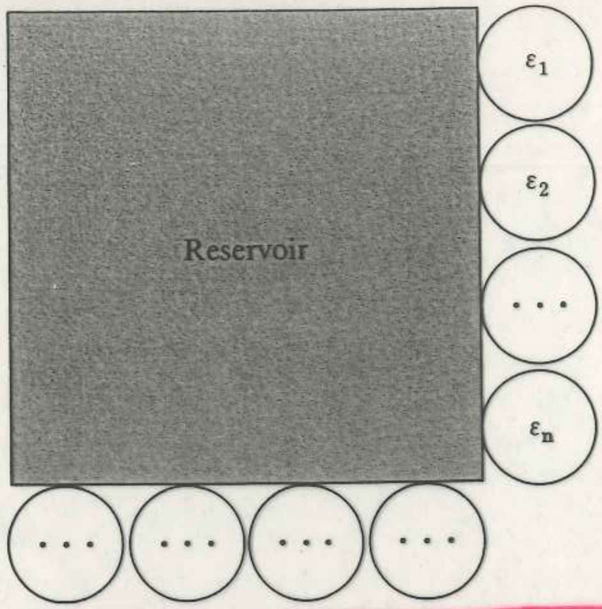

Figure 6.4 A convenient pictorial way to think of a system composed of independent orbitals that do not interact with each other, but interact with a common reservoir.

interacting bosons, and then we establish the ideal gas law for both fermions and bosons in the appropriate limit.

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A boson is a particle with an integral value of the spin. The occupancy rule for bosons is that an orbital can be occupied by any number of bosons, so that bosons have an essentially different quality than fermions. Systems of bosons can have rather different physical properties than systems of fermions. Atoms of ^{4}He are bosons; atoms of ^{3}He are fermions. The remarkable superfluid properties of the low temperature ($T < 2.17\,\mathrm{K}$) phase of liquid helium can be attributed to the properties of a boson gas. There is a sudden increase in the fluidity and in the heat conductivity of liquid ^{4}He below this temperature. In experiments by Kapitza the flow viscosity of ^{4}He below 2.17 K was found to be less than 10^{-7} of the viscosity of the liquid above 2.17 K.

Photons (the quanta of the electromagnetic field) and phonons (the quanta of elastic waves in solids) can be considered to be bosons whose number is not conserved, but it is simpler to think of photons and phonons as excitations of an oscillator, as we did in Chapter 4.

We consider the distribution function for a system of noninteracting bosons in thermal and diffusive contact with a reservoir. We assume the bosons are all of the same species. Let ε denote the energy of a single orbital when occupied by one particle; when there are N particles in the orbital, the energy is $N\varepsilon$, as in Figure 6.5. We treat one orbital as the system and view all other orbitals