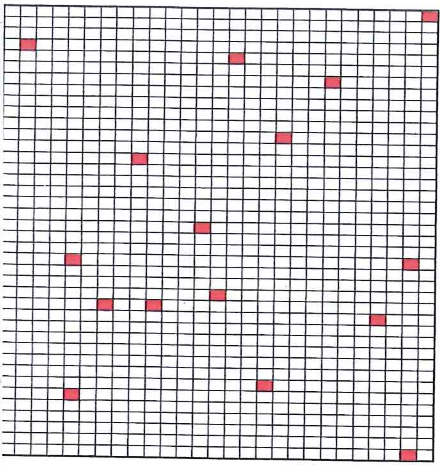
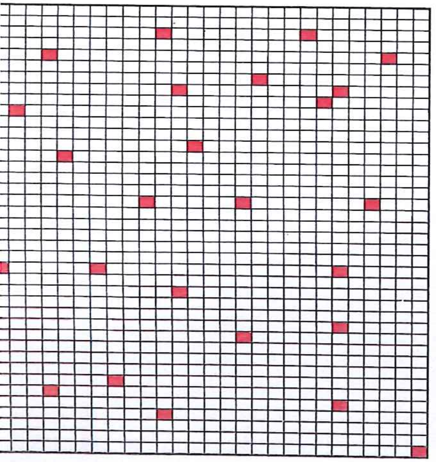


'erse? There is *no* final state for the
.es and migrates forever (there is no
ere is an *apparent* final state for an
he behavior of the individual atoms
.te for the *thermodynamic observer*, not
:nt end of change occurs when there
in the figure below.



The sequence of illustrations on the two preceding pages shows how the universe attains not so much a final state as a *steady state*. In this state the individual atoms turn ON and OFF as they have always done, but, to the casual observer of averages, the redistribution of energy leaves the universe apparently unchanged. We see that the jostling, random migration of energy disperses it. When it is uniformly dispersed over the available universe, it remains dispersed.

That last remark is not quite true, because the random wandering of ON-ness may lead it to accumulate, by chance, in System 1 and leave Sytem 2 completely OFF. However, even with a universe of 1,600 atoms this chance is slight (as may be tested by using one of the programs), and in a real Universe, where each system is a block of Avogadro's numbers of atoms, the chance is so remote that it is negligible. *Lack of rules allied with vastness of domain accounts for the virtual irreversibility of the process of dispersal.*

Temperature

Before we wrap this observation into a neat package, let us notice that we are also closing in on the significance of *temperature*. We have just seen that System 1 heats System 2 as a natural consequence of the dispersal of energy, and that the net transfer of energy continues until, on average, the energy is evenly dispersed over all the available atoms. Now note the following important distinction. When the ON-ness is evenly distributed, there is more *energy* in System 2 than in System 1 (because the former contains more atoms, and therefore more are ON when the ON-ness is uniformly distributed), but the *ratio* of the numbers ON and OFF is the same in both.

All this conforms with common sense about hot and cold so long as we interpret the ratio of the numbers of atoms ON and OFF as indicating *temperature*. First, we know that energy flows as heat from high temperatures to low, and we have seen that System 1 (which initially has a higher "temperature" than System 2) heats System 2. Second, the steady state, when there is no net flow of energy between the two systems, corresponds to their having equal "temperatures," not equal total energies. Finally, "temperature" measures the *incoherent* motion, not the coherent motion, of particles; it is intrinsically a thermodynamic (as distinct from a dynamic) property of systems of many particles. It would be absurd to refer to the temperature of a single particle. When we say that a baseball is warm, we are referring to the excitation of its component particles, not to the whole baseball regarded as a single particle.