A quick note about relaxation time and equilibrium:

An isolated many-particle system will eventually reach equilibrium, irrespective of its initial state. The typical time-scale for this process is called the *relaxation time*, and depends in detail on the nature of the inter-particle interactions. The principle of equal *a priori* probabilities is only valid for equilibrium states. It follows that we can only safely apply this principle to systems which have remained undisturbed for many relaxation times since they were setup, or last interacted with the outside world. The relaxation time for the air in a typical classroom is very much less than one second. This suggests that such air is probably in equilibrium most of the time, and should, therefore, be governed by the principle of equal *a priori* probabilities. In fact, this is known to be the case. Consider another example. Our galaxy, the ``Milky Way,'' is an isolated dynamical system made up of about $10^{11}$ stars. In fact, it can be thought of as a self-gravitating ``gas'' of stars. At first sight, the ``Milky Way'' would seem to be an ideal system on which to test out the ideas of statistical mechanics. Stars in the Galaxy interact via occasional ``near miss'' events in which they exchange energy and momentum. Actual collisions are very rare indeed. Unfortunately, such interactions take place very infrequently, because there is an awful lot of empty space between stars. The best estimate for the relaxation time of the ``Milky Way'' is about $10^{13}$ years. This should be compared with the estimated age of the Galaxy, which is only about $10^{10}$ years. It is clear that, despite its great age, the ``Milky Way'' has not been around long enough to reach an equilibrium state. This suggests that the principle of equal *a priori* probabilities cannot be used to describe stellar dynamics. Not surprisingly, the observed velocity distribution of the stars in the vicinity of the Sun is not governed by this principle.

We can discuss this more if needed.