The ideal gas is a gas of noninteracting atoms in the limit of low concentration. The limit is defined below in terms of the thermal average value of the number of particles that occupy an orbital. The thermal average occupancy is called the distribution function, usually designated as $f(\varepsilon,\tau,\mu)$, where ε is the energy of the orbital.

An **orbital** is a state of the Schrödinger equation for only one particle. This term is widely used particularly by chemists. If the interactions between particles are weak, the orbital model allows us to approximate an exact quantum state of the Schrödinger equation of a system of N particles in terms of an approximate quantum state that we construct by assigning the N particles to orbitals, with each orbital a solution of a one-particle Schrödinger equation. There are usually an infinite number of orbitals available for occupancy. The term "orbital" is used even when there is no analogy to a classical orbit or to a Bohr orbit. The orbital model gives an exact solution of the N-particle problem only if there are no interactions between the particles.

It is a fundamental result of quantum mechanics (the derivation of which would lead us astray here) that all species of particles fall into two distinct classes, fermions and bosons. Any particle with half-integral spin is a **fermion**, and any particle with zero or integral spin is a **boson**. There are no intermediate classes. Composite particles follow the same rule: an atom of ^{3}He is composed of an odd number of particles—2 electrons, 2 protons, 1 neutron—each of spin $\frac{1}{2}$, so that ^{3}He must have half-integral spin and must be a fermion. An atom of ^{4}He has one more neutron, so there are an even number of particles of spin $\frac{1}{2}$, and ^{4}He must be a boson.

The fermion or boson nature of the particle species that make up a many-body system has a profound and important effect on the states of the system. The results of quantum theory as applied to the orbital model of noninteracting particles appear as occupancy rules: ONDO ZENBATU

1. An orbital can be occupied by any integral number of bosons of the same species, including zero.
2. An orbital can be occupied by 0 or 1 fermion of the same species.

The second rule is a statement of the **Pauli exclusion principle**. Thermal averages of occupancies need not be integral or half-integral, but the orbital occupancies of any individual system must conform to one or the other rule.