# 1.3: The Microscopic Laws of Motion

Consider a system of $N$ classical particles. The particles a confined to a particular region of space by a "container" of volume $V$. The particles have a finite kinetic energy and are therefore in constant motion, driven by the forces they exert on each other (and any external forces which may be present). At a given instant in time $t$, the Cartesian positions of the particles are $r_1(t), \cdots, r_N(t))$ ) . The time evolution of the positions of the particles is then given by Newton's second law of motion:

$$m_i \ddot{r}_i = F_i(r_1, \cdots, r_N)$$

where $F_1, \cdots, F_N$ are the forces on each of the $N$ particles due to all the other particles in the system. The notation $\ddot{r}_i = \frac{d^2 r_i}{dt^2}$ .

$N$ Newton's equations of motion constitute a set of $3N$ coupled second order differential equations. In order to solve these, it is necessary to specify a set of appropriate initial conditions on the coordinates and their first time derivatives, $\{r_1(0), \cdots, r_N(0), \dot{r}_1(0), \cdots, \dot{r}_N(0)\}$. Then, the solution of Newton's equations gives the complete set of coordinates and velocities for all time $t$.