

# *Numerical Methods and Calculations Involved:*

A fourth order Runge-Kutta Method is used in this simulation to determine the new positions and velocities of the particles. The calculations that determine where the particles go in a small increment of time ( $dt$ ) include the external field forces on each particle, the electrostatic force between particles as well as the gravitational forces between each of the particles.

This simulation only deals with one possible elastic collision on a particle with another particle in one increment of time ( $dt$ ). This means that if, in one increment of time, three particles or two

particles and a boundary are close enough to collide then only one collision will occur for a single particle and it will look like the second collision that should have occurred will not. Collisions with particles and boundaries are done before collisions between the particles themselves but the simulation calculates multiple boundary collisions in one increment of time ( $dt$ ). The only restriction on collisions then, is that only one particle-particle collision can occur in one increment of time ( $dt$ ) and if, in the previous increment of time ( $dt$ ), a particle bounces another particle past a boundary, it will go through. This will be fixed in a later version of this program.