

Worcester Polytechnic Institute

Physics Minor Capstone Project

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# Abstract

The Kinetic Theory of Gasses developed by Maxwell and Boltzmann relates the emergent macroscopic properties of gasses, such as temperature and pressure, to the fundamental kinetic particle interactions as microscopic levels. The Maxwell-Boltzmann distribution for particle velocity is the probability density function that, for a gas with specific macroscopic properties, gives the probability that any given gas particle will have the given velocity. It assumes the components of the three dimensional velocity vector are normally distributed with a mean of zero, such that the gas has zero net momentum in any direction. Related distributions exist for the kinetic energies, momentum, the components of velocity and momentum in a given dimension, and the absolute magnitudes of the velocities and momentums.

# Particle Collisions

Completely elastic collision of ideal gas particles in one dimension are governed by two primary laws: the conservation of momentum and the conservation of kinetic energy. For the two particle case, where particle of mass and initial velocity collides with particle of mass and initial velocity , the conservation of momentum states that the total initial momentum after the collision must equal that before the collision.

Similarly, the conservation of kinetic energy states that the sum of the kinetic energies must be constant before and after the collision.

When the masses and initial velocities are known, this system of equations can be solved for the final velocities for each particle (ignoring the trivial case where there is no collision and the final velocities are the same as the initial velocities.)

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For collisions between particles in two or three dimensions, this one dimensional relation holds for the components of the velocities along the line through the centers of mass of the particles (common normal, assuming spherical particles with uniform density) The other components of each particle’s velocity remain unchanged.

The line is derived from the three dimensional positions of the centers of the particles. The vector connecting the centers is

And the unit in the direction of is then

The component of a particle ’s velocity on to this line is given by vector projection

Or in matrix form for three dimensions