On The Kinetic Formulation of Gases

By Deep Jyoti Dutta

* Division of Nuclear Physics (DNP), American Physical Society, College Park, Maryland, United States of America

Abstract

The extensive studies on thermal properties of matter especially in gases, shows the new possible direction and therefore to initiate the new stream in theoretical physics. The subject discussed in this context is somehow important in this field; the paper shows an equation of gases which is enclosed in a metallic container under suitable conditions. The equation which will be described here is valid for the rigorous choice that we have considered to derive it.

The work of studying about thermal properties of matter was dated back to very early centuries, when physicists are interested in some of the abstract curious interactions in gas molecules and their kinetic behavior. The phenomenon of gases allows us to define few quantities such as volume, pressure, temperature and density. In general these quantities must not vary independently, such cases are very familiar ideas in physics. However let us begin with the order whose base will be followed by the equation of state, which is in fact to determine the possible operational relation among these quantities. This relation must therefore defined by

$$V = f(p_x, T, m)$$

This states that the volume of a certain mass will depend on pressure (p_x), temperature (T) and mass. The thermal expansion (cubical expansion) of solid due to temperature will be considered here. The purpose of the present paper is to obtain a relation or an equation of a gas under specific assumptions and relations which will be presented here, the simple core of this hypothesis can be explained as follows.

Let the gases or radiation is enclosed in a metallic spherical vessel (which must have property of thermal elasticity or thermal expansion) of radius r and of volume V, such that it is directly proportional to temperature, the criteria is that the gas particles must be in motion which therefore must possess a momentum given by Newtonian mechanics

$$p = mv$$

The density of the gas inside vessel will hold

$$\rho = \frac{m}{V}$$

As the gas particles are constantly in motion then it must have kinetic energy of definite magnitude

Simply, considering non-relativistic expression one gets

$$k = \frac{1}{2}\, mv^2$$

Introducing physical constant [1] φ such that

$$\varphi = \hbar e$$

Where $\hbar = h/2\pi$ h is Planck's constant and e is the value of fundamental charge.

Furthermore considering the volume of a sphere is equal to volume of gas and increases proportionally with temperature such that

$$V = \frac{4}{3}\, \pi\, r^3$$

The equation can therefore deduced in the form

$$\frac{27}{2}\, \frac{\varphi}{r^2 h^2 e^2 p}\left[\int \frac{2V}{hv}\left(\frac{\partial v}{\partial p}\right)^2 k\;\; \varphi^2 \rho^2 T^2 \pi\; \partial r\,.\int \frac{\rho}{m}\, \frac{\partial T}{\partial V}.V^2\; \partial r\right] - r^3\left(\frac{8\pi\varphi}{h}\right) = 0$$

This equation holds if and only if the condition is

$$\frac{1}{2}\, Tr - V = 0$$

And

$$\frac{1}{2}\sqrt{\frac{3T}{\pi}} \neq 0$$

However it can also be shown that the magnitude of temperature must satisfy the equation

$$T = \frac{8}{3}\, \pi r^2$$

Or

$$r = \sqrt{\frac{3T}{8\pi}} = \frac{1}{2}\sqrt{\frac{3T}{\pi}}$$

Clearly

$$r \neq 0$$

The parameters in the above equation are as follows

$$T = Temperature, \rho = Density\ of\ the\ radiation, p = momentum\ of\ the\ radiation, k = kinetic\ energy\ of\ the\ radiation, e = fundamental\ charge\ of\ electron, h = Planck's\ Constant.$$

However the pressure of the gas is not considered.

The second condition is based on two postulates; however the idea is that the change in kinetic energy of gas particles can be found by the equation

$$\Delta k = \Delta T \frac{\Delta p}{\Delta V} \frac{\Delta \rho}{\Delta V}$$

However the assumptions were considered in deriving this equation are as follows in the form of postulates.

Postulate 1. In gases, with the change in temperature there will be a change in momentum of gas particles which must be directly proportional to the change in volume with the change in temperature

Mathematically

$$\frac{\Delta p}{\Delta T} \propto \frac{\Delta V}{\Delta T}$$

$$\frac{\Delta p}{\Delta T} = K \frac{\Delta V}{\Delta T}$$

If K is the any constant

Postulate 2. With the change in temperature the kinetic energy of gas changes which is directly proportional to the change in gas density due to volume.

$$\frac{\Delta k}{\Delta T} \propto \frac{\Delta \rho}{\Delta V}$$

$$\frac{\Delta k}{\Delta T} = K \frac{\Delta \rho}{\Delta V}$$

If K is the any constant

The constants however depends such that the constants which is taken as equal we therefore deduce an equation

Then taking constants as equal we thus obtains an equation in the form

$$\frac{\Delta k}{\Delta T} - \frac{\Delta p}{\Delta V} \frac{\Delta \rho}{\Delta V} = 0$$

Consequently we get

$$\Delta k = \Delta T \, \frac{\Delta p}{\Delta V} \, \frac{\Delta \rho}{\Delta V}$$

This derived equation seems to be very accurate under the considerations taken to deduce it; the possible results from this equation are however might be weird but far interesting. The fundamental assumptions are the only direction to achieve this beautiful form of mathematical equation, which however shows great influence on the subject. The experimental setup must be designed to test the above mentioned possible fundamental equation according to the hypothesis here advanced.

References

[2] Deep Jyoti Dutta, 2018, International Journal of Research, vol-5, Issue-1, 337