

# Loss Of Energy Due To Collision Of Ions With Other Charged Particles

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## Introduction

In industrial physicals, energy conservation is one of the most critical aspects and important procedures. Whenever involved in the manufacturing or development of any new electromagnetic component, the loss of energy needs to be conserved to avoid any losses that cannot only be harmful to resource optimization but also to the environment. Since the loss of energy is because of the collision of ions and charged particles, it needs to be better understood for further control and management.

The Amount of Energy is released as the result of the processes carried out by the ions (Johnson, 2002). The respective paper is being formulated to discuss briefly the process of release of energy when the interaction takes place between the ionization radiations. The paper will only present an overview of the basic theories, phenomena, and processes that result in the production of energy as the product of the reaction. By the naked eye and as per the conventional mind of the layman, this energy loss is so insignificant that it can be barely felt or noticed. However, it is essential for physicists and nuclear scientists to observe and study this phenomenon of the release of energy since “the detection of radiation is based on its interaction and the energy deposited in the material of which the detector is made; therefore, to be able to build detectors and interpret the results of the measurement” (Tsoulfanidis, pg. 121), it is essential to have efficient knowledge of this phenomenon. Furthermore, it is also essential to gain an insight into how harmful or harmless these reactions can be if carried out artificially or naturally on a larger scale.

Generally, ionization radiations are categorized into three main types. These types are Charges (this category includes the electrons, protons, positrons, deuterons, alphas, and heavy ions); photons (this includes the gamma rays or the X rays); and Neutrons (Tsoulfanidis, pg. 121). This classification is done on the basis of the exclusive and unique properties of these ions.

## Why Do Ionization Radiations Interact?

When a charged particle starts moving in space, it starts interacting with the positive and the negative compositions of the atom as well. These composition particles are electrons (i.e., negative in nature) and protons (i.e., positive in nature). Every time the charged particle has an interaction with any of these particles, it loses some of the energy that was charged into it. After the continuous loss of energy, the charged particle stops. This finite distance covered by this article is known as the *range*

(Tsoulfanidis, pg. 122). This range is dependent on three factors. The factors are the type of the particle, the energy charged into the particle, and the medium through which the particle was transversing. Logically, there is no probability for the charged particle not to interact with any other atom while transversing through any medium. However, here, it is essential to know that since the neutron and the gamma rays are physically neutral, they may go through the matter while revealing no interaction. Therefore, their range can also not be measured (Tsoulfanidis, pg. 122).

## How The Energy Is Lost By The Charged Particles

### Coulomb Interactions

The first mechanism that explains the loss of energy is the Coulomb Interaction. This interaction generally takes place between the electrons and the nuclei. As per the researchers, the interaction carried out between the charged particle and the electrons is more significant as compared to the interaction taking place with the nuclei. In the process of Coulomb Interactions, the Coulombs' force is exerted. As a result of this force, often the energy is transferred from the mobile particles to the bound electrons (Tsoulfanidis, pg. 123). Consequently, excitation or the ionization phenomenon can occur in the bound, quantized electrons. The collisions or the interactions that result in the excitation or the ionization are known as the Inelastic Collisions (Tsoulfanidis, pg. 123).

### Bremsstrahlung Energy

The Second mechanism of energy loss is known as the Bremsstrahlung phenomenon. This emits energy as the result of electromagnetic radiation. This process takes place during the deceleration or the acceleration of the charged particle. As a result of this motion, the particle is bound to produce electromagnetic emissions and the Kinetic energy is lost (Tsoulfanidis, pg. 124). The particles involved in this process are photons having the energy zero to the level where it equals the kinetic energy of the charged particle. Another interesting observation is that the energy produced by the light particle is greater in case both of the particles are traveling through the same medium. Moreover, if the medium through which the particle is transversing has a higher atomic number, more energy will be emitted. Furthermore, energy loss is also observed as the result of the Bremsstrahlung emissions (Tsoulfanidis, pg. 129).

### Energy Due To Ionization And Excitation

The third mechanism deals with the loss of energy due to the ceasing power exerted as a result of the ionization and excitation processes. It is previously described, that ionization and excitation happen as the result of the exertion of the Coulomb's Force (Johnson, 2002). As a result of ionization and excitation, the charged particles start colliding with several hundred million electrons. Each of these

millions of interactions has a different amount of energy loss, which is practically impossible to measure individually. Therefore, the average of the energies is measured per distance transversed (Tsoulfanidis, pg. 129). It is essential to view the designated formulas required to find the type of interaction being carried on.

## Conclusion

The ions are constantly in motion in the free space; however, they are not visible to the naked eye. As they transverse through space, they collide and interact with several other matter and charged particles. As a result of the collision and the interactions, energy is lost from the moving ions. This continues to happen until the ions stop at a finite distance. This distance is known as the range of the ion. The collision and the interaction can be of several types, most of which are beyond the scope of the paper. However, some basic mechanisms of interactions and causes of energy loss are Coulomb Interactions, Brehmsstrahlung, excitation, and ionization. Furthermore, the types of interactions the photon has with the matter are the Photoelectric effect, Compton Effect, and pair production. There are many other mechanisms as well that are well beyond the scope of the paper.

## References

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