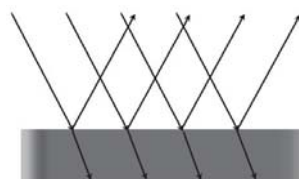


RADIATION PRESSURE

Radiation encompasses the transmission of energy or particles from a source, propagating through space or other mediums. It manifests in two primary forms: ionizing radiation and non-ionizing radiation.

Within this spectrum, various types of radiation exist, including Gravitational Radiation, Electromagnetic radiation, Acoustic Radiation, and Particle Radiation. Electromagnetic radiation, for instance, constitutes an electric and magnetic disturbance traversing space at the speed of light, comprising phenomena like radio waves, X-rays, infrared, visible light, microwaves, gamma rays, and ultraviolet rays. Collectively, these waves form the electromagnetic spectrum.



Radiation pressure emerges as a consequence of electromagnetic radiation interacting with objects, exerting force upon absorption, reflection, or scattering.

This force is quantified by the formula $P = F/A$,

where F represents force and A denotes area. The phenomenon arises due to the transfer of momentum from photons within the radiation to the object.

The magnitude of radiation pressure hinges on factors such as the intensity of radiation, the surface area over which it distributes, and the reflective or absorptive properties of the surface. Its implications span diverse fields, impacting celestial dynamics in astrophysics and enabling propulsion systems, such as solar sails, in space exploration.

The intensity of radiation, the area over which it is distributed, and the reflectivity or absorptivity of the surface determine the magnitude of radiation pressure. This concept finds applications in various fields such as astrophysics, where it influences the dynamics of celestial bodies, and in engineering, where it's utilized in solar sails for propulsion in space exploration.

The exertion of radiation pressure on a surface is contingent upon the surface's nature and the intensity of light employed.

For instance, the total momentum delivered to a surface due to complete absorption can be expressed as $p = U/c$,

where U represents the total energy transferred to the surface over a time period " t ," and c denotes the speed of light.

An illustrative example of radiation pressure is evident when sunlight strikes our hands, resulting in warmth. While electromagnetic waves do transfer momentum, the effect of this transfer is typically imperceptible due to the large speed of light (c), resulting in a minuscule amount of momentum transferred, which is insufficient to elicit a tangible pressure sensation. This phenomenon occurs as the energy from electromagnetic waves is absorbed by the surface of the hands.

Radiation Pressure: - Complete absorption, Complete reflection, Partial reflection,

Radiation pressure can manifest in various scenarios, depending on how radiation interacts with surfaces. These interactions include complete absorption, complete reflection, and partial reflection.

Complete absorption:

In this scenario, the surface absorbs all incident radiation without any reflection. As a result, the momentum carried by the radiation is transferred entirely to the surface, exerting a force known as radiation pressure.

Complete Reflection:

When radiation encounters a surface that reflects all incident radiation, no energy is absorbed, and all momentum is reflected back into space. Despite no net transfer of momentum to the surface, radiation pressure is still exerted due to the momentum imparted to the reflected radiation.

Partial Reflection:

In cases of partial reflection, the surface absorbs some incident radiation while reflecting the rest. This results in a combination of absorbed and reflected energy, leading to a partial transfer of momentum to the surface and consequent radiation pressure.

discusses the calculation of the net force resulting from absorbed and reflected photons, broken down into two components: the average force due to absorbed photons (F_1) and the average force due to reflected photons (F_2). The net force (F_{net}) is determined by the formula:

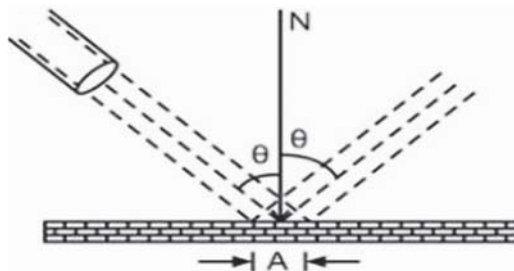
$$\text{Net force, } F_{net} = \sqrt{F_1^2 + F_2^2 + 2F_1F_2 \cos \theta}$$

In each of these scenarios, radiation pressure arises from the transfer of momentum between the incident radiation and the surface, influencing the dynamics and behavior of both the radiation and the surface itself.

Radiation Pressure: - Oblique Incidence

When discussing radiation pressure, "oblique incidence" refers to the situation where radiation strikes a surface at an angle other than perpendicular (i.e., not directly perpendicular to the surface).

In this scenario, the angle of incidence, which is the angle between the direction of the incident radiation and the normal (perpendicular) to the surface, plays a crucial role in determining the magnitude and direction of the radiation pressure exerted on the surface.



When radiation strikes a surface obliquely, the component of the incident radiation's momentum perpendicular to the surface contributes to the radiation pressure. This component is determined by the angle of incidence and can be calculated using trigonometric functions such as sine and cosine.

The concept of oblique incidence is essential in understanding how radiation pressure behaves when radiation interacts with surfaces from different angles. It influences various applications, including the design and optimization of devices that utilize radiation pressure, such as solar sails and optical tweezers.

Radiation Pressure: - on Sphere

When considering radiation pressure acting on a sphere, several factors come into play due to the spherical shape of the object.

Surface Area:

The surface area of the sphere determines the amount of radiation incident upon it. A larger surface area means more photons impinge on the sphere, potentially resulting in higher radiation pressure.

Reflection and Absorption:

Depending on the material properties of the sphere's surface, radiation may be either absorbed or reflected. The ratio of absorbed to incident radiation, as well as the angle of reflection, influences the net radiation pressure experienced by the sphere.

Directionality:

Radiation pressure is directional, meaning it is exerted along the direction of incident radiation. Therefore, the orientation of the sphere relative to the incoming radiation affects the distribution of radiation pressure across its surface.

Shape Factor:

The shape of the sphere affects how radiation pressure is distributed.

For example, a perfectly spherical object may experience more uniform radiation pressure compared to a non-spherical object with irregular surfaces.

Material Properties:

The material composition of the sphere's surface determines its reflectivity, absorptivity, and emissivity, which in turn influence the magnitude of radiation pressure.