Research & Reviews: Journal of Pure and Applied Physics ISSN: 2320-2459

Properties of Thermal Radiation in Applied Physics

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Opinion Article

Received: 07-Nov-2022 Manuscript No. JPAP-22-82459; **Editor assigned:** 10-Nov-2022, Pre QC No. JPAP-22-82459(PQ); **Reviewed:** 24-Nov-2022, QC No. JPAP-22-82459; **Revised:** 01-Dec-2022, Manuscript No. JPAP-22-82459(A); **Published:** 08-Dec-2022, DOI:10.4172/2320-2459.10.7.005.

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ABOUT THE STUDY

Thermal radiation is electromagnetic radiation produced by the thermal motion of matter particles. Thermal radiation is produced when heat from the movement of charges in a material (in common forms of matter, electrons and protons) is converted to electromagnetic radiation. Thermal radiation is emitted by all matter with a temperature greater than absolute zero. The majority of the emission at room temperature is in the Infrared (IR) spectrum. Particle motion causes charge acceleration or dipole oscillation, both of which generate electromagnetic radiation.

Thermal radiation includes infrared radiation emitted by animals (detectable with an infrared camera) and cosmic microwave background radiation.

When a radiation object has the physical properties of a black body in thermodynamic equilibrium, it is referred to as blackbody radiation. Planck's law describes the spectrum of blackbody radiation, which is solely determined by the temperature of the object. The most likely frequency of the emitted radiation is determined by Wien's displacement law, and the radiant intensity is determined by the Stefan-Boltzmann law. Thermal radiation is also one of the fundamental heat transfer mechanisms

Thermal radiation is distinguished by four main properties

- Thermal radiation emitted by a body at any temperature has a wide frequency range.
- As the temperature of the emitter rises, the dominant frequency (or color) range of the emitted radiation shifts to higher frequencies. A red hot object, for example, radiates primarily in the visible band's long wavelengths (red and orange). Even at a white hot temperature of 2000 K, 99% of the radiation's energy is still infrared. Wien's displacement law determines this. As the temperature rises, the peak value for each curve shifts to the left.
- As the temperature rises, the total amount of radiation of all frequencies increases sharply; it grows as T4, where T is the absolute temperature of the body. On the absolute temperature scale, an object at the

temperature of a kitchen oven (600 K *vs.* 300 K) radiates 16 times as much power per unit area. An object at the temperature of an incandescent light bulb's filament-roughly 3000 K, or 10 times room temperature-radiates 10,000 times the amount of energy per unit area. According to the Stefan-Boltzmann law, the total radioactive intensity of a black body increases as the fourth power of the absolute temperature. The area under each curve in the plot grows rapidly as the temperature rises.

- Reciprocity means that the rate of electromagnetic radiation emitted at a given frequency is proportional to the amount of absorption experienced by the source. As a result, absorbing more red lights thermally radiates more red lights. This principle applies to all wave properties, including wavelength (color), direction, polarization, and even coherence, so it is entirely possible to have polarized, coherent, and directional thermal radiation, though polarized and coherent forms are relatively rare in nature far from sources (in terms of wavelength).