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Invited article

Vedic Analysis Of Photoelectric Effect

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Abstract

This paper is about light. The paper ponders around the theories of light and various aspects that are discussed about light with reference traditional literature, and modern works in the area. The paper starts with the discussion on definition of light, colour, radiations of a variety of bodies with parallel discussions on their explanation in traditional literature.

Keywords: Photons, magnetic field, colour, black bodies, radiation

What is light?

Light is NOT the same as the electromagnetic radiation, but is a small segment of the electromagnetic spectrum that is reflected from an object and reaches our eyes to make the object ocularly measurable (आलोकः - आङ् + लोक् - लोकृँ दर्शने). If an object is heated sufficiently and it becomes red hot, it doesn't emit LIGHT at the red end of the visible spectrum (thermal radiation). Photon is not the light quanta, but the tip of the locus of the intersection line of electric and magnetic fields.

The universe is electromagnetic in nature (अग्नीषोमात्मकं जगत्) – the hot electric part (अग्निम्) that flows from high to low concentration and the cool magnetic part (सोम) that confines everything to form structure (पिण्ड). All particles have this property. In solids, these are in a confined and compact state (निबिडावयव). In currents, it flows from high concentration to low concentration (तरलावयव). In space, it spreads out (विरलावयव). When the radiation spreads within a confined area, it makes the exterior parts of other particles facing the observer "visible" through transition of states (रजसा उद्घाटितम्). That is light (प्रकाश – प्र उत्कर्षे केन - क देहे - अश्यते व्याप्यतेऽत्र - अशूँ व्यांप्तौ सङ्घा॒ते चं - आधारे घञ्). While the interior of a room looks lighted, space is dark (not visible), even though electromagnetic radiation is present there also.

What is colour?

Colour is neither a property of the object nor of radiation emitted by a body (तेजः - तेजयति तेज्यतेऽनेन वा । तिजँ नि॒शानें - तीक्ष्णीकरणे -

शारीराग्निसम्भूतपदार्थविशेषः). It has no independent existence either, as it ceases to be emitted when the body emitting radiation ceases to exist (आश्रयविनाशादेव विनश्यतीति). What we see is not colour, but form (रूपम्). Some object to be visible, it must fulfil three conditions. The object must have a specific form (रूपवत्त्व). It must have spread (विस्तार - dimensions) beyond the mesons (महत्त्व – त्राणुक – hadron onwards). There must be multiple objects present (अनेकद्रव्यवत्त्व).

When the emitted radiation hits an object, some of it are absorbed or deflected. The wavelengths of such reflected radiation vary for different objects. The changes in these reflected radiations reaching our eyes,

appear different (सर्वकार्यद्रव्येषु कारणगुणपूर्वकम्) due to the obstruction or absorption or deflection (द्रव्याद्युपलम्भकम् - like X-rays produce visible fluorescence in crystals). The spread of different wavelengths is described as different colours (वर्णँ वर्णक्रियाविस्तारगुणवत्नेषुं). We can't describe an object fully solely based on the radiation emitted by it (अनवर्णे इमे भूमी). The object we hold is not the same as what we see. What we hold is the object's mass that reflects radiation. But what we see is the radiation emitted by the object in our direction only and not the object proper. Both are different.

Measurement is a comparison between similars, one of which is the unit. Since our eyes emit radiation (तेजः), the different wavelengths received are measured only by our eyes that have this property (तेजस्त्वाभिसम्बन्धात्तेजः - नयनसहकारि) and the results appear as colours (शुक्लाद्यनेकप्रकारम्). Measurement returns scalar quantities, with fixed, but different values. Those values are the different colours. Depending upon the nature of radiation in our eyes, the capability of seeing different colours is determined for different species.

Black (कृष्ण) is not the same as dark (अन्धकारः or ध्वान्तम्). Total absence of any radiation is dark (अन्धकारः - अन्धमन्धकवत् करोति, अन्धँ दृष्ट्युपघाते – तेजःसामान्याभावः). Where there is no motion except sound, it is called dark (ध्वान्तम् - ध्वनँ शब्दें + ध्वान्तमस्त्यस्य अच् । ध्वनित). But the absence of the visible spectrum only is black (कृष्ण - कृषँ विलेखंने + नक् । कृषिर्भूवाचकः शब्दः णश्च निर्वृतिवाचकः । कर्षति आत्मसात् करोति अथवा कर्षति सर्व्वान् स्वकुक्षौ । कर्षणात् कृष्णः), just like the totality of the visible spectrum is white, which symbolizes purity (शुक्ल – शुच + लक्, कुत्वम्, शुच् पूतीभावे, पूयते स्म येनेति).
Heating a red-hot object further causes the colour to change from red to yellow, white, and blue, as it emits radiation at increasingly shorter wavelengths (higher frequencies). A perfect emitter is NOT a perfect absorber. The Sun is a perfect emitter that emits at all wave-lengths. A black hole (ऋक्षविल) is a perfect absorber, which absorbs all radiation. When an object is cold, it doesn't look black - ice is not black. Temperature is NOT directly related to colour, which is related to the wavelength of emitted radiation that reaches our eyes. If the eye is defective, colour may change. Incidentally, the interior of a black hole is NOT hot, but cold. Otherwise, it can't have a strong magnetic field that it has. A black body can be hot.

Classification of bodies based on emission pattern.

There are no separate laws for quantum physics. The macro and the micro worlds share the same set of physical laws (यद्ब्रह्माण्डे तत्पिण्डे). Every object in the universe is at motion (गच्छतीति जगत्). Rest is the mutual cancellation of different forces acting on a body. From a body at rest, if one force is removed, it will continue to be in motion. The magnitude of the forces acting on a body at quantum level is too small. Thus, they are perpetually in motion – within the confinement (like the quarks) or outside their confinement (like electrons). This is described as probabilistic nature of their position.

Electromagnetism is not uniquely quantum, but is a universal phenomenon. All matter at temperatures above absolute zero emit radiation, which represents a redistribution of its external energy like changing clothes (यथा वासः शरीरगम्) following the exclusion principle (स्थानावरोध), or a crystal getting the colour of a flower placed near it (उपाश्रित - यथा स्फटिके लालिमा). This way, we get electricity, when electrons are redistributed. At quantum scales, it is called the weak nuclear interaction (beta decay part). Objects float on water due to this principle (यथाप्सु नौस्तृणं काष्ठम्) – by acquiring buoyancy - a secondary base (उपाश्रित). Matters absorb electromagnetic radiation to some degree and become visible by their emitted radiation. Hence, we can see black bodies, but not black holes.

Object which absorbs ALL radiation falling on it, at ALL wavelengths, are called black holes (ऋक्षविल – literally, bear pits – that are surrounded by a high fence to prevent the inside bear to move out). Such a body doesn't emit any radiation. The so-called Hawking radiation is a myth and has never been detected. Only when black holes collapse (like a neutron transforms into proton etc.), they emit radiation. Neutron stars are detected from the emission of electromagnetic radiation as radio waves and other radiation. Those observed from their emitted pulses, are called pulsars. Since around 1900

AD, black holes were not known to the West, the scientists were confused.

There are five types of bodies based on emission pattern (ज्योतिः – emission - ज्युङ्ऽ गतौ, that lights up - द्युतँ दीप्तौ): The first categories are self-luminous bodies like stars and galaxies that reveal other objects by their emission (आदित्यज्योतिः or स्वज्योतिः). The second are bodies like Moon that reveal other bodies by their reflected emission (चन्द्रमाज्योतिः or परज्योतिः). The third are bodies like objects on Earth that reveal themselves by other emissions, but cannot reveal other bodies (अग्निज्योतिः or रूपज्योतिः). The fourth are bodies that do not emit at all like black holes (वाग् ज्योतिः or अज्योतिः) or space itself. The fifth are conscious functions (आत्मगुण) leading to revelation of objects through our senses (आत्मज्योतिः or ज्ञानज्योतिः) based on memory and recollection (स्मृतिप्रत्यभिज्ञानहेतुर्भवति).

The black-body radiation belongs to the third category – that are revealed by their emissions, but do not reveal other bodies by that emission (रूपज्योतिः). When the description of black-body itself is wrong, the Wien's displacement law, Stefan-Boltzmann law and the Rayleigh-Jeans law are wrong application of different principles.

Action theory.

Each action is momentary and discreet (भूतभावोद्भवकरो विसर्गः कर्मसंज्ञित – the discharge that reveals inherent properties of objects is called action - the duration of a moment may vary) and follows the sequence: -

• Action (क्रिया) starts due to weight, fluidity, application of force or contact with something (गुरुत्वद्रवत्वप्रयत्नसंयोगजत्वं).
• This leads to decoupling of the particle in which action starts from the space occupied by it or from other substances (क्रियातो विभागः).
• Such decoupling leads to cessation of its previous position or from other substances (विभागात् पूर्वसंयोगः नाशः).
• This leads to coupling with the adjacent space (ततो उत्तरसंयोगः) in a continuum of positions.

An action ends with work done (कार्यविरोधि कर्म). This makes it one quantum (पारिमाण्डल्य) – now known as Planck's constant h. Then the next action starts due to inertia (प्रथमक्रियानाशः → द्वितीयक्रियोत्पत्तिः). This sequence is treated as the universal characteristic of action or work done at one time. What is seen as continuous action is not one action, but a series of actions (hence hv). All motions are in waves only (तिरश्चीनो विततो रश्मिरेषाम्) because there is no void and everything moves ahead by shifting sideways like pushing through a crowd. The more energetic you are relative to the medium (frequency), the less will be your displacement (wave-length) while moving forward. Because of our inability to differentiate between the particle and its motion due to scale factor, we confuse it as wave-particle duality. Wave function has no physical meaning.

Propagation of energy.

Energy is ever mobile and generates inertia (पूर्वपूर्वसंस्कारमपेक्षमाणादुत्तरोत्तरस्मात् प्रत्ययात्) unless it is confined or absorbed. It always requires a medium (अधिष्ठानम्). While heat is energy that moves from a center outward, temperature is a measure of the average of such energy in circulation with reference to some standard value, expressed according to a comparative scale and measured by touch (स्पर्शाधिष्ठानभूतः). With the increase in a body's temperature, atoms or molecules vibrate increasingly depending upon the nature of the medium, transferring the motion from one part of the system to another due to inertia. The vibrational energy - its heat content - makes the medium relatively hotter or colder.

Heat flows through solids (compact - निबिडावयव), liquids (loose - तरलावयव) and gases (rare - विरलावयव) through conduction (ध्रुब), convection (धर्त्र) and radiation (धरुण). Thus, the nature of the medium through which heat is transferred becomes important. When the heat moves from its place (अङ्गति ऊर्द्ध्वं गच्छति) not to return (निर्भुज), it is called Agnim (अग्निम्). When heat moves from its place (प्रतृण) while not being separated from the source (न दीयते खण्ड्यते), it is called Aaditya (आदित्य). When it is in an in-between state (उभयमन्तरेण) – moves both ways (वाति) – it is called Vaayu (वायुः).

A so-called blackbody can be at a uniform temperature only under special conditions. A black body is said to absorbs all incident radiation regardless of wavelength or temperature, and re-emits the absorbed energy at the same rate. It is natural. Imagine a cup of tea. Once the cup is full, the amount of tea you pour in will equal the amount of tea going out irrespective of temperature or height from which the tea is being poured. All along the cup remains full and excess tea goes out. Since energy flows through a medium (उपाश्रित), it behaves like a fluid (schools refer to water pipes while explaining electricity).

Einstein's statement:

In his 1905 paper "On a Heuristic Point of View about the Creation and Conversion of Light",

Einstein said something unintelligible and senseless as follows:

"Electricity is the flow of electrons from high concentration to low concentration in the same or a conducive medium. But radiation is different. It doesn't require a specific medium to propagate. When a stone is exposed to summer sunlight, it gradually heats up, but not infinitely. Does the electric current (as different from conductors or its effect on other particles), behave similarly? No – it passes on the excess energy to less dense regions. Unlike conduction or radiation, current behaves like a fluid to redistribute itself both ways and requires a base.

Wien's displacement law gives a relationship between the wavelength of thermal radiation and the temperature at which a blackbody emits the radiation. Stefan-Boltzmann law states how much the amount of radiation is emitted by a black body per unit area. Rayleigh-Jeans law gives the intensity of radiation released by a black body. All these are related to radiation and not current, which flows differently through a suitable base. Hence, this is wrong application of the rule. Photoelectric effect is the ejection pattern of electrons from a metal plate when ultraviolet radiation shines on two metal electrodes with a voltage applied across them. In such cases, the relation between radiation and electricity (hence photoelectric) shows electrically charged "particles" are emitted from a metal surface. The emission pattern is affected not by the intensity of light, but by the frequency of light.

Separating facts from fiction:

When two fields intersect, the intersection is a straight line. When electric and magnetic fields intersect, the intersection is a straight line. If the fields move in a direction perpendicular to both, it forms the locus of this straight line. The tip of this line is called the photon. The speed of photon depends upon the density of the medium".

We have seen a blacksmith using a big hammer, while a goldsmith using small tools to deflate the metals. The hammer will deflate the soft gold too much to be useless. The small tools, even if used in large numbers (intensity), will not be effective for the relatively hard iron. The same principle applies in photo-electric effect. Earlier, it has been explained that action takes place in a discreet manner using some energy. The minimum time taken by the smallest possible particle to leave its position and move to the adjacent position is called a moment (क्षण). Time is the infinite sequence of such momenta (क्षण आनन्तर्यात्मा).

The quantity of energy used to move the smallest particle for one moment (time taken by a quark to leave its position and move to the adjacent position) is now known as the Planck's constant. Hence, the dimension of Planck's constant (h) is the product of energy multiplied by time – a quantity called action. It is called *Paarimandalya* (पारिमाण्डल्य) in Vedas, which is the extent of a quark (परमाणु). Thus, the Planck's constant is defined as the elementary quantum of action. At higher frequencies (more kinetic energy), the unit of action gets multiplied (hence hv). Also, increase in the density of the medium increases the resistance to the motion. This has to be deducted from the total work done - energy required for the electron to escape the metal ($Ek = hf - \phi$). This is the work function. The rest are fiction.