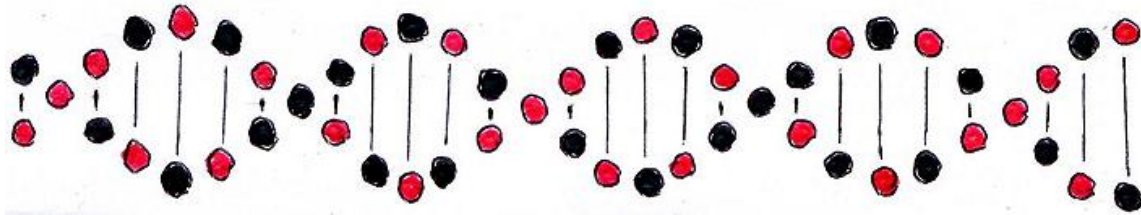


The Apparent Dual Nature of Cathode Rays

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Abstract. The purpose here is to investigate why under certain conditions, cathode rays, being a stream of particles, can be diffracted in a crystal as if they were X-rays, hence apparently exhibiting wave behaviour.



The de Broglie Wavelength

I. In the previous article entitled “*The Apparent Dual Nature of Electromagnetic Waves*”, [1], it was proposed that the reduced Planck’s constant, \hbar , be understood as an angular momentum, and this was illustrated using the equation,

$$\hbar = 2mcr \tag{1}$$

for the special case of the tiny rotating electron-positron dipoles that densely pervade all of space, and which serve as the medium for the propagation of light, [2], [3]. In equation (1), m is the mass of the electron, and also of the positron, c is the speed of light, and r is the radius of the rotating dipole. In the vicinity of an atomic nucleus, a gamma ray photon can split a rotating electron-positron dipole and liberate the two individual particles from the luminiferous medium, providing that its wavelength, λ , is not greater than 1.213 picometres, [4]. This is half of the Compton wavelength of an electron, and if this equals the circumference of one of these rotating dipoles, the frequency of the gamma photon will be equal to the frequency of the rotating dipole itself, and a state of resonance will be reached. In this circumstance, since $\lambda = 2\pi r$, equation (1) becomes,

$$h = 2mc\lambda \tag{2}$$

The reverse process can occur in space, far from any atomic nuclei, and this gives the superficial impression that the electron and the positron have annihilated each other, rather than having merely bonded back into the luminiferous medium again.

In 1924, Louis de Broglie proposed that electrons have an associated wavelength. The equation,

$$h = mv\lambda \tag{3}$$

then followed, but it's not altogether clear what exactly it means that an electron should have a wavelength. We could perhaps make some sense out of equation (3) if it applies to the electron orbitals within an atom or a molecule, and where the angular momentum of the orbit is equal in magnitude to the reduced Planck's constant. In such a case, the transverse speed of an electron will be inversely proportional to its orbital radius, and this radius, through the equation, $\lambda = 2\pi r$, will in turn be related to the wavelength of incident electromagnetic waves which resonate with this particular orbit. When resonance occurs, discrete photons of energy may be absorbed, such as to increase the energy state of the orbit. The reverse can then happen whereby a photon of radiation is re-emitted into space and the electron orbit reduces once again to its lower energy state.

X-Rays and Cathode Rays

II. X-Ray diffraction in a crystal is likely to be a consequence of X-Rays being absorbed and re-emitted again at a different angle due to the swirling effect of the electron orbitals within the atoms or molecules of the crystal, [5]. If we direct a stream of cathode rays directly upon a similar crystal, and if the kinetic energy of the electrons in the beam is in the same order of magnitude as the energy of an X-Ray photon, then these electrons are likely to interact with the same orbital electrons that are involved in the case of the X-Ray diffraction. This cathode ray interaction will be wave-like in that it will involve the incoming electrons swapping places with the orbital electrons. The newly emitted electrons will emerge at a different angle due to the swirling effect of the orbitals. The cathode rays will therefore be diffracted just like the X-rays, but this doesn't mean that the cathode rays possess wave behaviour when outside of the crystal. Diffraction is about momentum being swirled into a different direction and it will be due to the vortex nature of the atoms and molecules that comprise the diffracting crystal, [5].

While the diffraction of cathode rays in a diffracting crystal indicates wave behaviour inside the crystal, it doesn't necessarily follow that a stream of cathode rays in space possesses such wave behaviour. There does however

remain the possibility that the electrons in a cathode ray in space might engage in swaps with the bound electrons in the tiny rotating electron-positron dipoles that fill all of space and serve as the medium for the propagation of light. This would have the effect of producing wave-like characteristics in the actual cathode rays themselves. A single projected electron could get lost in the crowd and its momentum dispersed in a wave-like manner in the wider electron-positron sea. On encountering a double slit diffractor, the momentum could split, and then interfere with itself on the other side.

References

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“All space, according to the younger Bernoulli, is permeated by a fluid aether, containing an immense number of excessively small whirlpools. The elasticity which the aether appears to possess, and in virtue of which it is able to transmit vibrations, is really due to the presence of these whirlpools; for, owing to centrifugal force, each whirlpool is continually striving to dilate, and so presses against the neighbouring whirlpools. It will be seen that Bernoulli is a thorough Cartesian in spirit; not only does he reject action at a distance, but he insists that even the elasticity of his aether shall be explicable in terms of matter and motion. This aggregate of small vortices, or "fine-grained turbulent motion," as it came to be called a century and a half later, is interspersed with solid corpuscles, whose dimensions are small compared with their distances apart. These are pushed about by the whirlpools whenever the aether is disturbed, but never travel far from their original positions. A source of light communicates to its surroundings a disturbance which condenses the nearest whirlpools; these by their condensation displace the contiguous corpuscles from their equilibrium position; and these in turn produce condensations in the whirlpools next beyond them, so that vibrations are propagated in every direction from the luminous point. It is curious that Bernoulli speaks of these vibrations as longitudinal, and actually contrasts them with those of a stretched cord, which, "when it is slightly displaced from its rectilinear form, and then let go, performs transverse vibrations in a direction at right angles to the direction of the cord." When it is remembered that the objection to*

*longitudinal vibrations, on the score of polarization, had already been clearly stated by Newton, and that Bernoulli's aether closely resembles that which Maxwell invented in 1861-2 for the express purpose of securing transversality of vibration, one feels that perhaps no man ever so narrowly missed a great discovery. Bernoulli explained refraction by combining these ideas with those of his father. Within the pores of ponderable bodies the whirlpools are compressed, so the centrifugal force must vary in intensity from one medium to another. Thus a corpuscle situated in the interface between two media is acted on by a greater elastic force from one medium than from the other; and by applying the triangle of forces to find the- conditions of its equilibrium, the law of Snell and Descartes may be obtained. * Cf. Lord Kelvin's vortex-sponge aether, described later in this work."*