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X-Rays: Emission & Absorption Spectroscopy

A strong analogy b/w the theoretical curves of (Fig 4) and Expt. curves (Fig 1a)

Shortcomings of Classical Theory: The following shortcomings of classical theory are described in details:

1. For the ratio of $\frac{v}{c}$, the θ_{max} is approximately 65° as suggested by classical theory however, experimentally it is approximately 55°. So Sommerfeld consider that the electrons are fetch completely to rest in the target while in thin targets, the electrons are not retarded while passing through them.

2. Intensity is found to be zero at $\theta = 0°$ and $\theta = 180°$ for all frequencies. Experementally it is not zero, $I \neq 0$ at $\theta = 0°$, and $\theta = 180°$. However, for thin targets, the 'I' at $\theta = 0°$ is minimum for the cut off frequency ν_{max} and found to be increases for lower frequencies. In case of thick targets, 'I' is almost larger at $\theta = 0°$ as at $\theta = 90°$. for this, Sommerfeld again consider the direction of motion. that the electrons are decelerated in the direction of motion. that not all electrons do so and some of shows It shows that not all electrons do so and some of shows transverse motion due to the collisions with the target atoms. These kind of transverse motions of the electrons are least likely to occur in the first few atomic layers of the target at which the radiation near to ν_{max} is emitted.

3. classically the polarization must be complete in the plane of the incident electron beam while the experimental data suggested a partial polarization. It means that ~~are~~ all electrons are not decelerated in the direction of motion.

4. According to classical theory, no sharp high frequency limit is observed. However, experimental data exhibited a sharp high frequency limit, ν_{max}, evaluated by employing the voltage V ~~and~~ on the X-ray tube. So, for the proper explanation of this cut off frequency, ν_{max} the quantum theory is required for this cut off frequency, ν_{max}

So, based on these shortcomings, it is concluded that classical theory only provide the qualitative consistency with experimental

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against the low frequency spectral distrubution, spatial distribution and polarization. Therefore, classical theory is fails to explain the observed cutoff frequency, ν_{max}. Hence, there is a confelict to solve it we have to leave the classical theory and have to use the quantum theory.

For example, when an electron is deflected from its original path or has its velocity changed, it emits radiation with amplitude proportional to its acceleration(is), This is because of

m is $= \frac{Ze^2}{r^2}$, the acceleration of an electron created through

a nucleus $eZ \propto \frac{e^2 Z}{m}$.

So, the intensity is $(I) \propto (e \times \text{amplitude})^2$

i.e $\frac{e^6 Z^2}{m^2}$.

Thus, the total bremsstrahlun per atom varies as Z^2 and as $\frac{1}{m^2}$. which is million times weaker for incident protons than for electrons. Moreover, for individual deflection of electron by a nucleus, the incident electrons may radiate any amount of energy from zero up to its total K.E. i.e.

$\frac{mv^2}{2} = eV$, or $h\nu_{max} = eV$.

Hence, these observed parameters can be used to establish a quantum theory of bremsstrahlung.

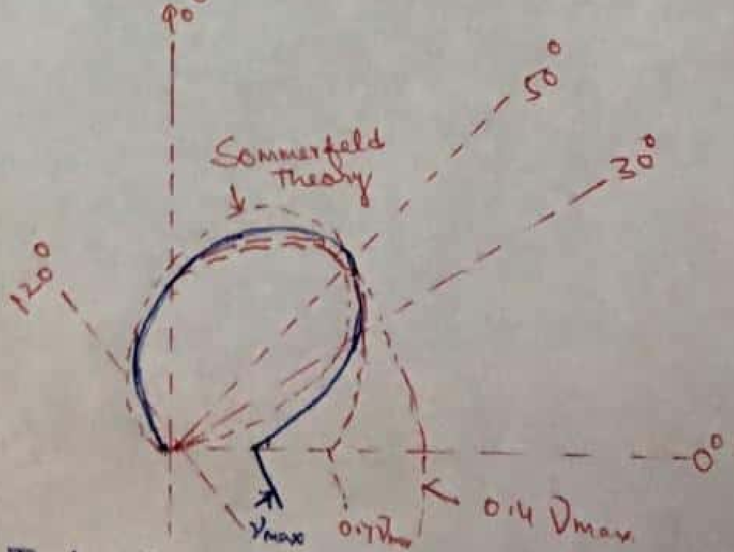

Fig 1 (a) Intensity as a function of direction in polar coordinates. [Theoritical circle (dotted ---)].

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