M.Sc. (Physics) Sem-IV · Dated: 8 April, 2020

(X-Rays: Emission ---) By Dr. C.R. Gautam

Experimental spectral and Spatial Distributions:

The study of spectral distribution of continuous X-rays from thin foil targets was carried out by Nicholas. He used the two different metallic materials foils namely ^{13}Al (0.7 µm) thick and ^{79}Au (0.99 µm) thick. The applied voltage on the X-rays tube was 45 kV and angles were 40°, 90° and 140° to the forward direction of the incident electrons. Thus, the results of Nicholas are shown in Fig. 1. The observed data is well consistent with the results of classical theory as shown in my previous Lecture note Fig 1 (freq. spectrum of

(a) (b)

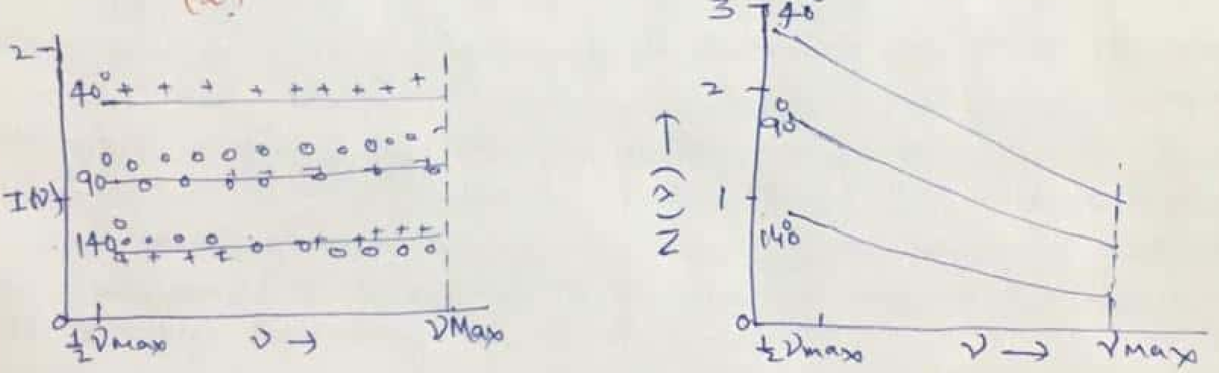

Fig 1 (a and b) Thin target spectra at different angles. O → Al and + Au data are not on the same scale of intensity. (a) Intensity I(ν) in ergs/freq interval (hν × no. of photons) is constant for all photon energies (b) The number of photons/frequency interval N, varies as 1/hν when derived from a.

Further, the spectral and spatial distributions from thin foils were also studied by Kulenkampff, Bohm and etc. The Kulenkampff and Bohm used 0.6 µm (6000 Å) thick foil of Al as a target. Later on Honerjäger have been used a thinner Al foils (100, 350 and 1000 Å) and 28 Ni foil of 150 Å thickness. However, Harworth & Kirkpatrick was used 199 Å thick Ni foil.

PP-1 cont.--

Dated 8 April, ...

They ~~found~~ found that as the radiation from such thin foils is very weak, it is not possible to acheive more reliable analysis of the spectrum with a crystal. Therefore, these researchers used selective absorbers to select out portions of the spectrum and used ionization chambers as detectors.

Experimental set up to study the continuous X-ray spectrum of thin foils: To study the continuous X-ray spectrum of the spectral and spatial distribution of ~~its~~ intensity from an Al foil having thickness 250Å for 34 keV electrons. This study was ~~per~~ experimentally performed by Kerscher and Kulenkampff in 1955.

The experimental set up is shown in fig. 2. It posses a flat brass vacuum chamber transfered between the poles of an electro-magnet. The cathode 'C' emits an electron beam which is accelerated through a voltage of 34 KV, exits through a slit 'S' and moves along a circle that passes by a diaphragm 'D' and the foil 'F' under observations. Eventually, the electron beam is collected by the electrode 'E' placed at the end of curved leg so as to isolate the X-rays that may be emitted by it.

The detector for the X-rays that emitted by the foil 'F' is a proportional counter that moves along an arc that extended from -5^0 to 185^0.

The X-rays from thin foil 'F' comes out of the box from a long slot on one side of the chamber to incident on the counter. The slot is covered by an 'Al' foil to protect the vacuum in the chamber. This counter was used with a single channel pulse hight analyzer, which measures the intensity as well as the energy (frequency) of the X-rays received by it.

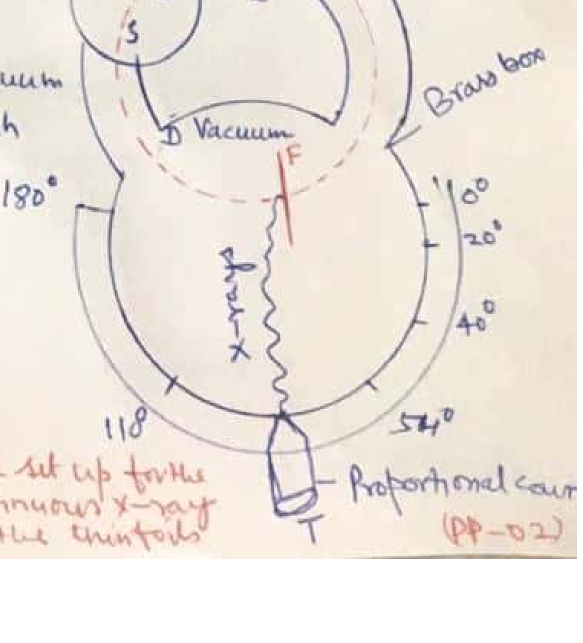

Fig 2: Experimental set up for the study of continuous X-ray spectrum of the thin foils (PP-02)

Dated: 08 April, 2020

The recorded distribution of intensity along with the spectrum is shown in Fig 3. In this Fig the straight lines were observed at different angles θ to the forward direction of the bombarding electrons. The slopes of the lines almost agreed with the results of Nicholas within the range of $40° < \theta < 140°$. Out side of this range, particularly at small angles, the lines becomes slanting

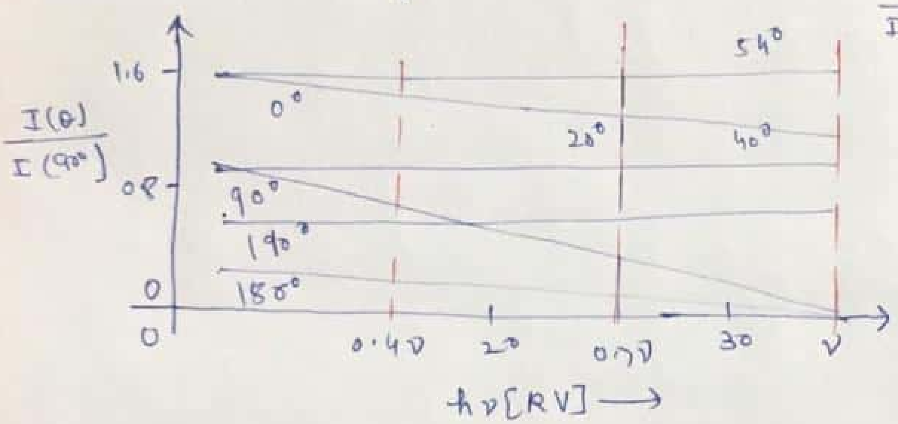

Fig 3: The distribution of spectral intensity for 250 Å Al foil at V = 34 KV for various angles.

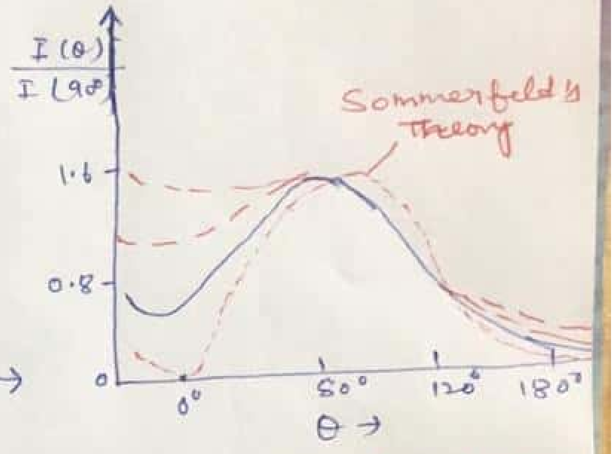

Fig 4: Angular distribution (shape function) from the observed curves at various angles

Further, Kerscher & Kulenkampff obtained ~~angle~~ angular distribution curves from Fig 3. by reading intensity at selected frequencies value ν = νmax, 0.7 νmax and 0.4 νmax. The resulting curves are depicted in Fig 4 and are in good agreement with the results of Honerjäger. These curves can also be plotted on a polar diagram as discussed in my earlier class.

Concluded---