Origin of X-Rays

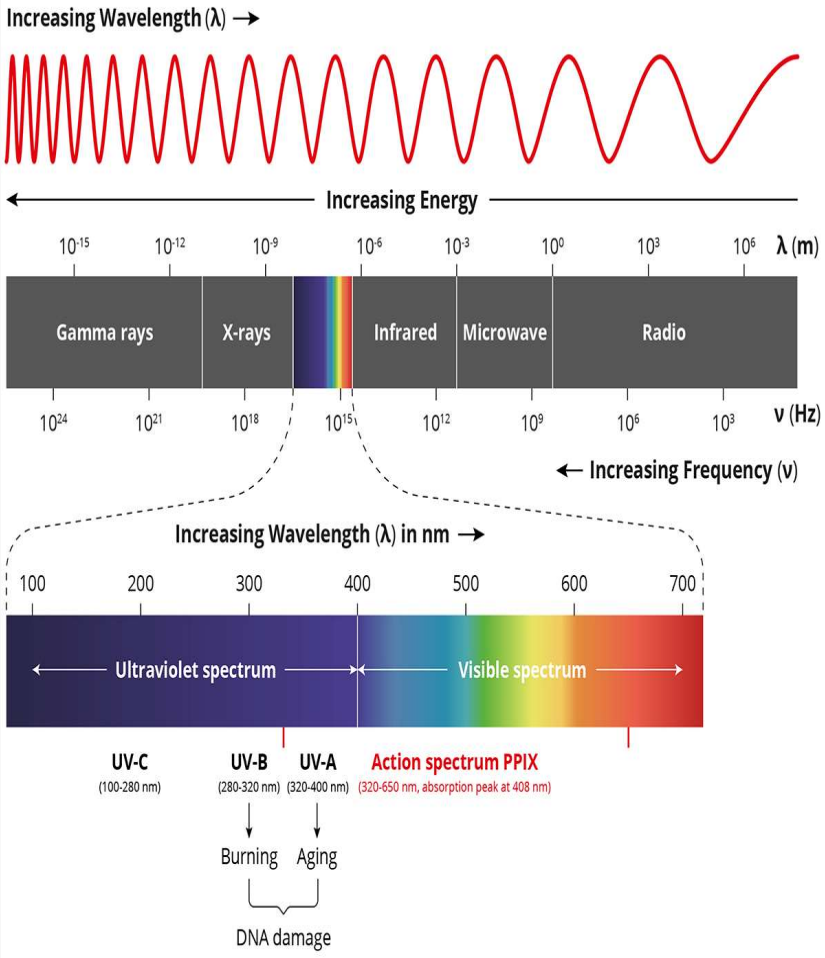
- X-Rays are of electromagnetic waves, The are more energetic so they can penetrate many materials to varying degrees.
- The wave length are shorter than those of UV and Longer than those of Gamma Rays
- When the X-rays hit the film, they expose it just as light would. slice bone, fat, muscle, tumours and other masses all absorb X-rays at different levels, the image on the film lets you see different (distinct) structure inside the body because of the different levels of exposure on the film.
- X-rays have a wavelength in the range of 0.01 to10 nanometres, corresponding to frequencies in the range 30 peta hertz to 30exa hertz ($3x101^{16}$ Hz to $3x101^{19}$ Hz and energy in the range 100eV to 100KeV.

Origin of X-Rays

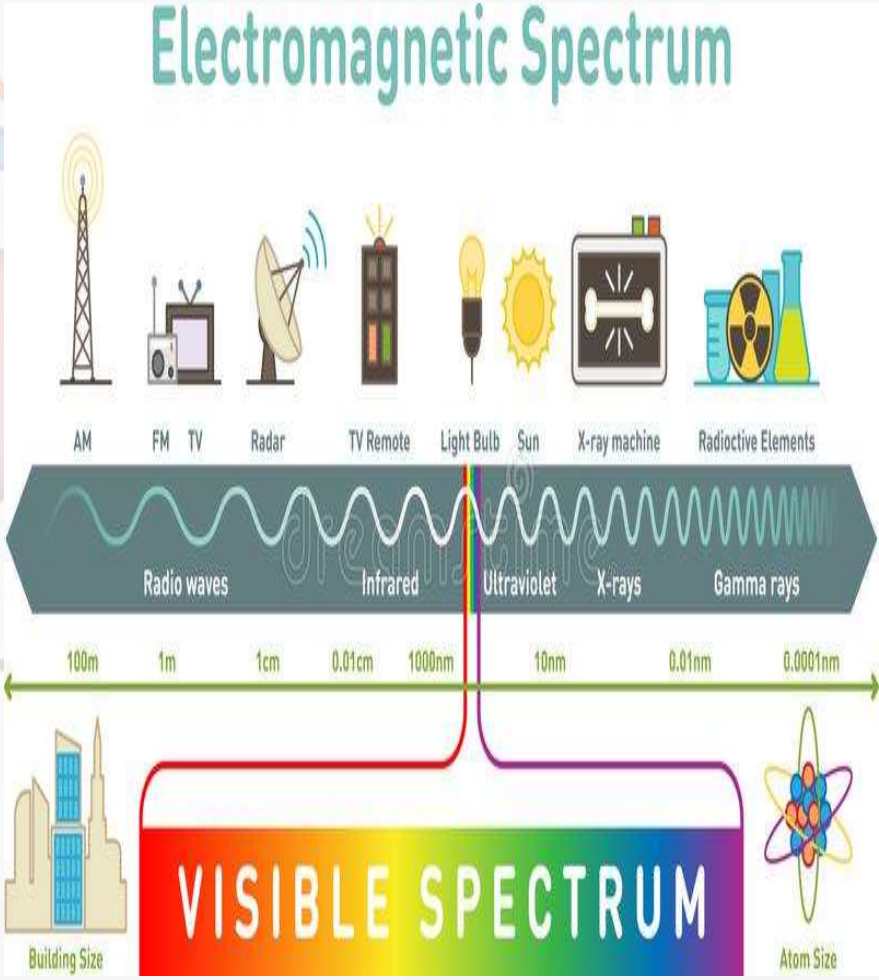
- X-Rays technology was invented completely by accident, in 1895 , A German physicist “Wilhelm Roentgen” made the discovery while experimenting with electron beams in a gas discharge tube.
- Roentgen noticed that a florescent screen in lab started to glow when the electron beam was turned on. This response in itself was not so surprising---fluorescent material normally glows in reaction to electromagnetic radiation----but Roentgen’s tube was surrounded by heavy black cardboard. Roentgen assumed this would heavy blocked most of the radiation
- Roentgen placed various objects between the tube and screen still glowed. Finally, he put his hand in front of tube. And saw the outline of his bones projected onto the fluorescent screen. Immediately after discovering X-rays themselves, he had discovered their most beneficials application.

School of Basic and Applied Science

Curse Code : MSCP6002 **Course Name: ATOMIC AND MOLECULAR PHYSICS**

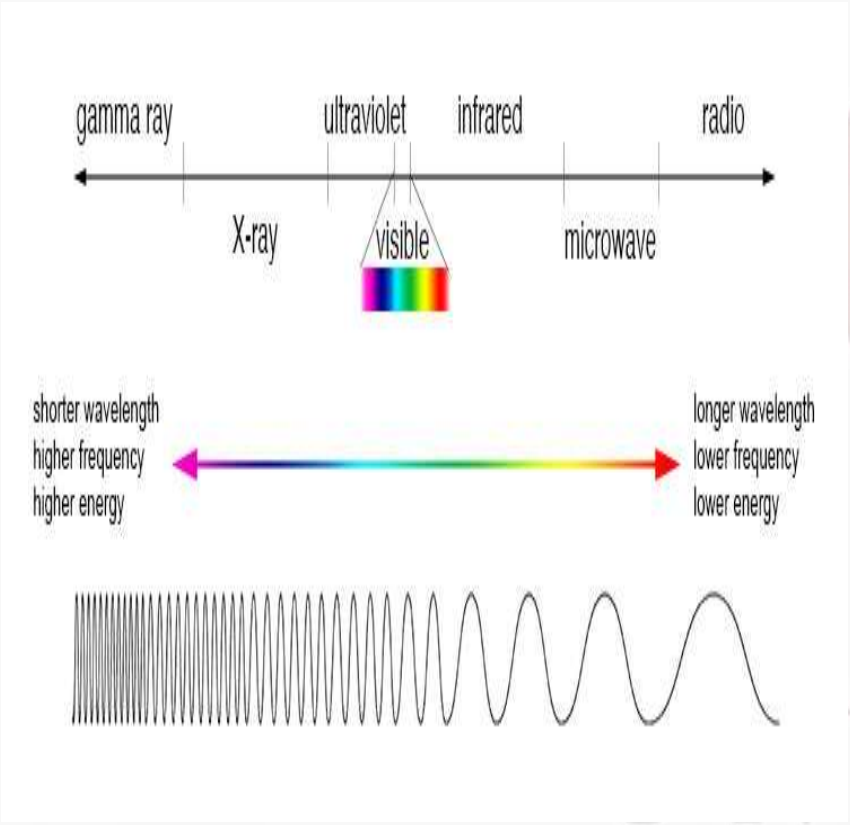


Electromagnetic Spectrum

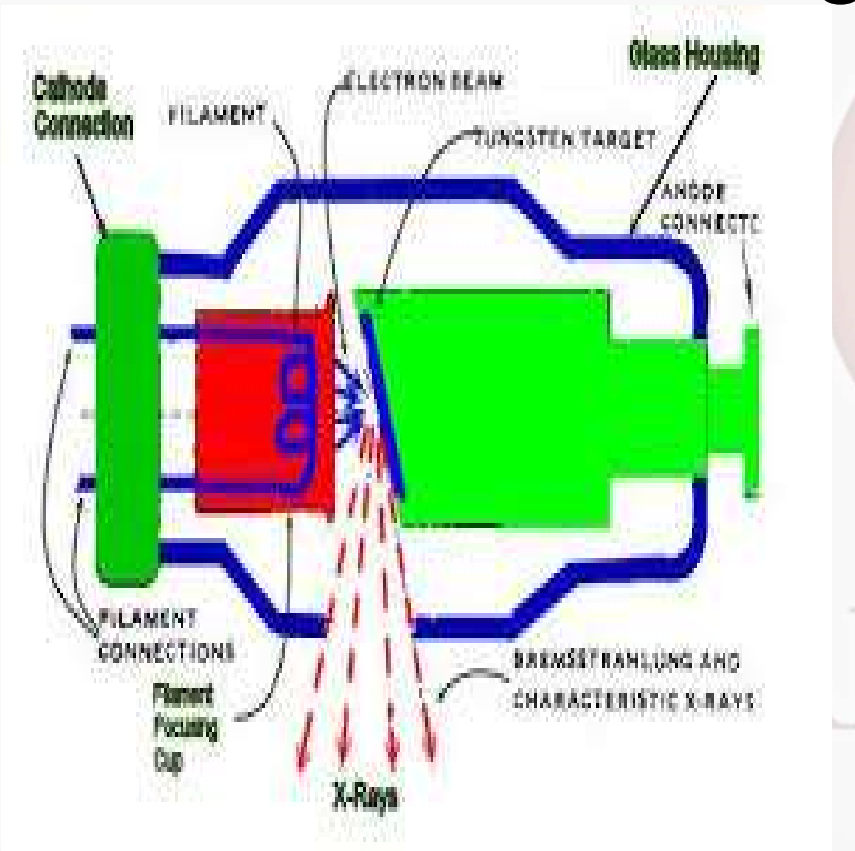


Name of the Faculty: Dr. ANIS AHMAD **Program Name: M.Sc. Physics**

Electromagnetic Spectrum



Origin Of X-Rays



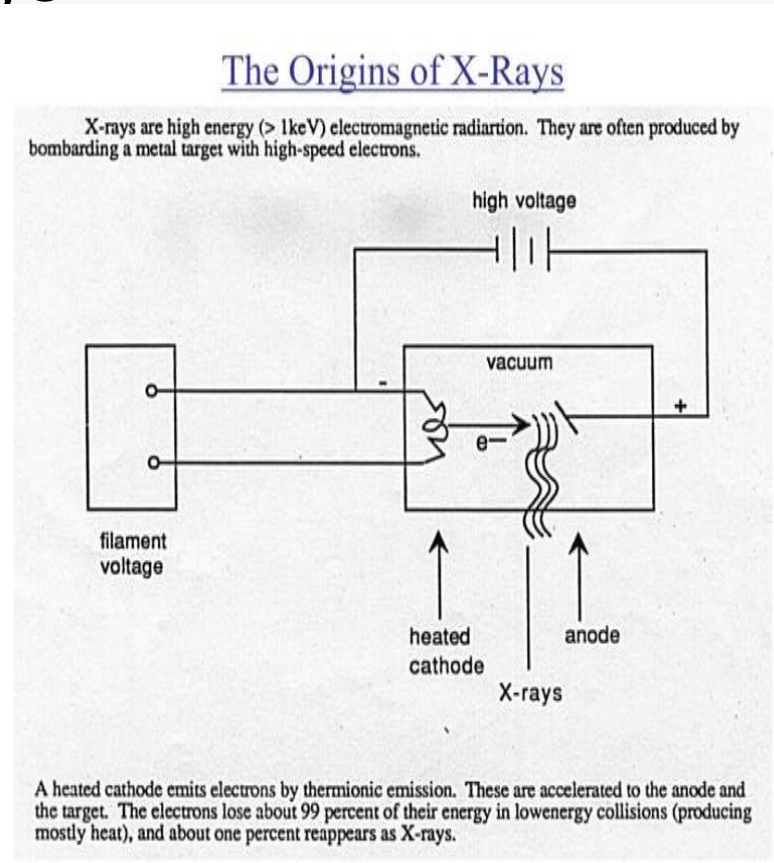
Working

- X-rays were found to be able to penetrate through materials of light atoms like flesh. The heavier atoms like metal absorb them.
- A beam of high energy electrons crashes into a metal target and x-rays are produced. A filter near the x-ray source blocks the low energy rays so only the high energy rays pass through a patient toward a sheet of film.
- Along with the sheet of film, a second sheet of film prevents the scattered x-rays from fogging the picture.

Origin Of X-Rays

- Calcium in bones is considered a type of metal and when photographic film is placed on the body, this allows the technician to take the picture and an x-ray is developed to solve or analyze the problem.

- The soft tissue in your body is composed of smaller atoms, and so does not absorb X-ray photons particularly well. The calcium atoms that make up your bones are much larger, so they are better at **absorbing X-ray photons**.



Continuous X-rays

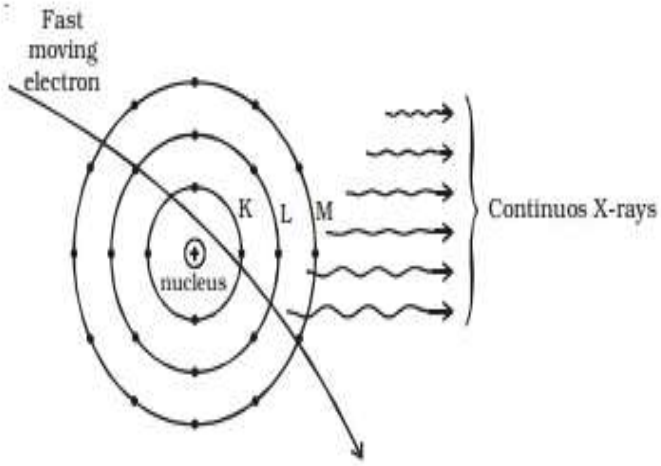
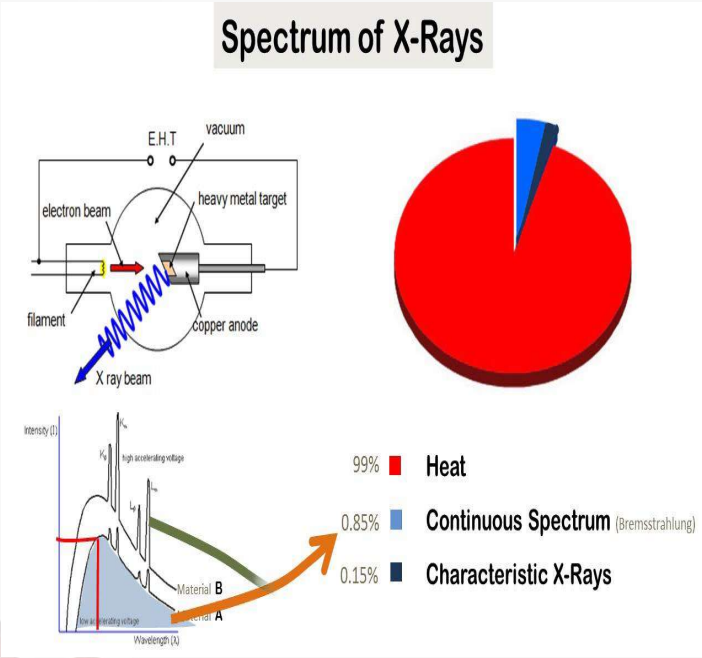
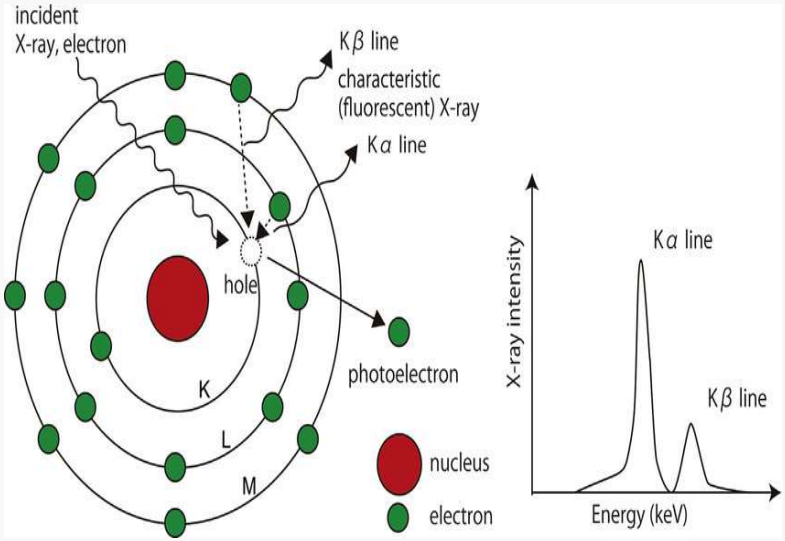


Fig Origin of continuous X – rays



Characteristics X-rays



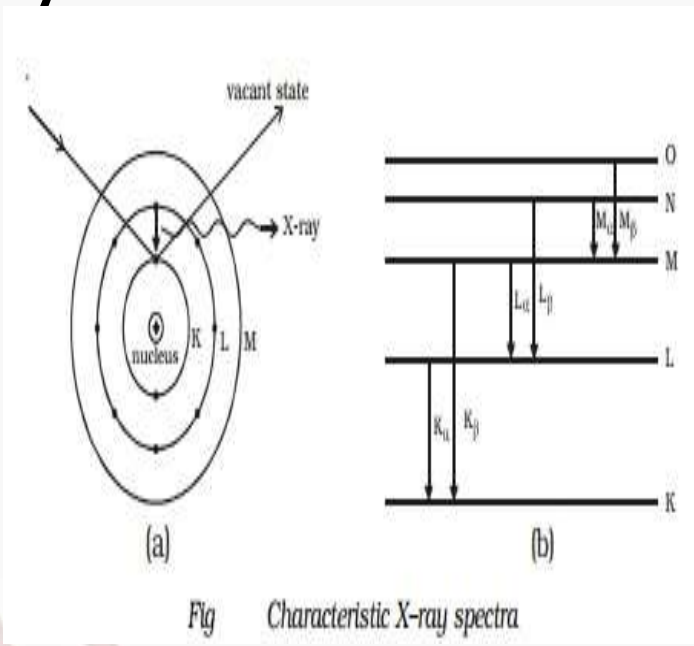
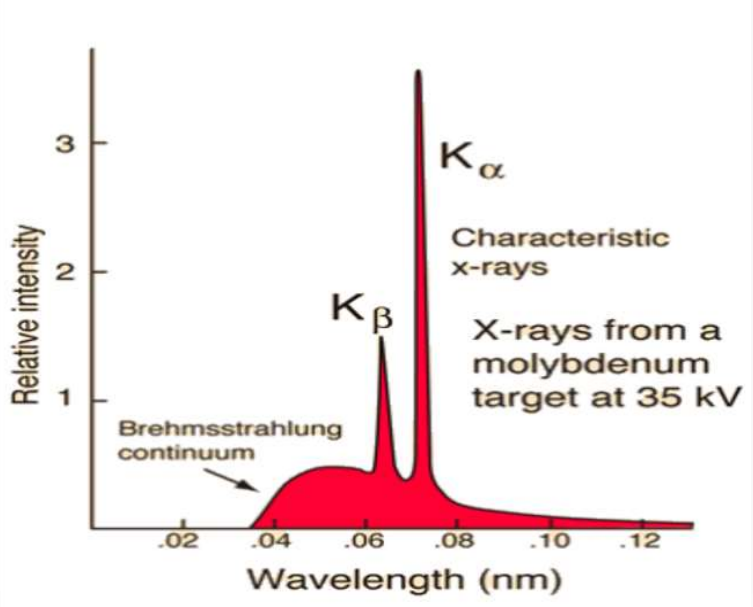


Fig Characteristic X-ray spectra

Origin of X-Rays



Characteristic x-rays are emitted from heavy elements when their electrons make transitions between the lower atomic energy levels. The characteristic x-ray emission which is shown as two sharp peaks in the illustration at left occur when vacancies are produced in the n=1 or K-shell of the atom and electrons drop down from above to fill the gap. The x-rays produced by transitions from the n=2 to n=1 levels are called K-alpha x-rays, and those for the n=3⟶1 transition are called K-beta x-rays.

Transitions to the n=2 or L-shell are designated as L x-rays (n=3⟶2 is L-alpha, n=4⟶2 is L-beta, etc.). The continuous distribution of x-rays which

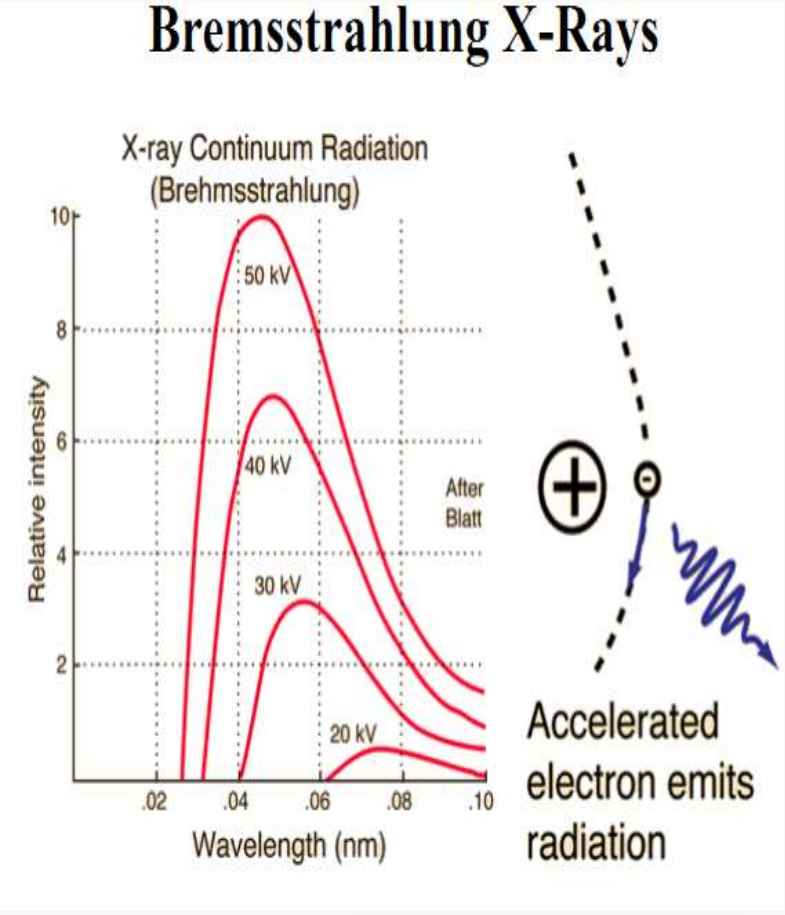
Origin of X-Rays

forms the base for the two sharp peaks at left is called "bremsstrahlung" radiation.

X-ray production typically involves bombarding a metal target in an x-ray tube with high speed electrons which have been accelerated by tens to hundreds of kilovolts of potential. The bombarding electrons can eject electrons from the inner shells of the atoms of the metal target. Those vacancies will be quickly filled by electrons dropping down from higher levels, emitting x-rays with sharply defined frequencies associated with the difference between the atomic energy levels of the target atoms.

The frequencies of the characteristic x-rays can be predicted from the Bohr model. Moseley measured the frequencies of the characteristic x-rays from a large fraction of the elements of the periodic table and produced a plot of them which is now called a "Moseley plot".

Characteristic x-rays are used for the investigation of crystal structure by x-ray diffraction. Crystal lattice dimensions may be determined with the use of Bragg's law in a Bragg spectrometer.



Origin of X-Rays

"Bremsstrahlung" means "braking radiation" and is retained from the original German to describe the radiation which is emitted when electrons are decelerated or "braked" when they are fired at a metal target. Accelerated charges give off electromagnetic radiation, and when the energy of the bombarding electrons is high enough, that radiation is in the x-ray region of the electromagnetic spectrum. It is characterized by a continuous distribution of radiation which becomes more intense and shifts toward higher frequencies when the energy of the bombarding electrons is increased. The curves above are from the 1918 data of Ulrey, who bombarded tungsten targets with electrons of four different energies.

The bombarding electrons can also eject electrons from the inner shells of the atoms of the metal target, and the quick filling of those vacancies by electrons dropping down from higher levels gives rise to sharply defined characteristic x-rays.

- X-rays originate from the energy loss associated with the interaction of high energy electrons or X-rays with atoms
- The spectrum of an X-ray tube shows two types of X-ray radiation
  - Continuous radiation (white radiation or Bremsstrahlung)
  - Characteristic radiation (photoelectric effect)
  - Both types of radiation depend on the anode material
- When a sample is irradiated by the X-rays generated in the X-ray tube, the photo-electric effect of each element present will be observed (if measurable) in the spectrogram
  - This effect is used for the analysis of the sample

USE of X-Rays

- **Medicine:** X-rays are used in medicine for medical analysis. Dentists use them to find complications, cavities and impacted teeth. Soft body tissue are transparent to the waves. Bones also block the rays.
- **Industry:** X-rays are used in industry to inspect products made by various kinds of materials. X-ray machines are used in airports to check luggage etc.
- **Science:** In Science x-rays are used to analyze the arrangement of atoms in many kinds of substances, particularly crystals. Archaeologists used X-rays to examine ancient objects covered by a crust of dirt.
- **Consumer Goods:** X-rays are also used in consumer goods the manufactures treat certain kinds of plastic to check the quality of many mass produced products.
- Used in research involving quantum mechanics theory, crystallography(examine arrangement of atoms in solid) and cosmology(study of the origins and eventual fate of the universe).

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