Synchrotron and its applications

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Synchrotron

Key components of a synchrotron source are;
(1) An electron gun
(2) A linear accelerator
(3) A booster synchrotron,
(4) A storage ring,
(5) Beam lines
(6) Experiment stations
These are shown in the following Fig. 1

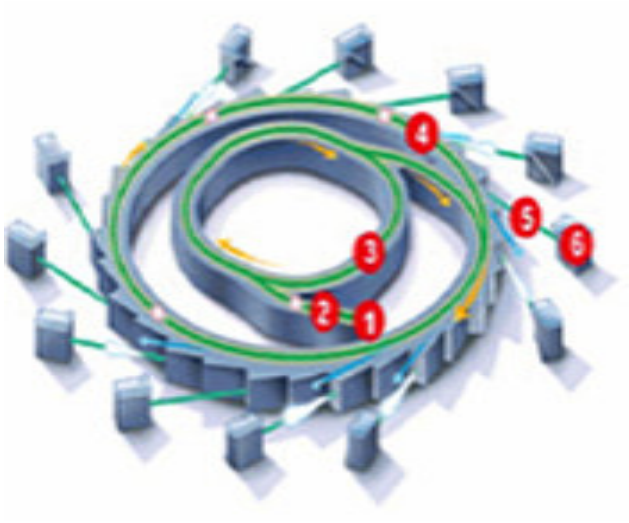

Fig. 1

Bending Magnets: The**y** produce intense, energetic radiation over a wide range of energies.

Wiggler magnets: produce intense, energetic radiation over a wide range of energies with a brightness 100 times that of bending magnets.

Undulators: produce radiation of selected energies (harmonics) at high brilliance with a brightness 1,000 times that of bending magnets

Synchrotron radiation

Synchrotron radiation refers to a continuous band of the electromagnetic spectrum, including infrared, visible light, ultraviolet, and X-rays as shown in the following Fig. 2. This emission has been called synchrotron radiation, since it was accidentally discovered in 1947 in an electron synchrotron of the General Electric Company, USA.

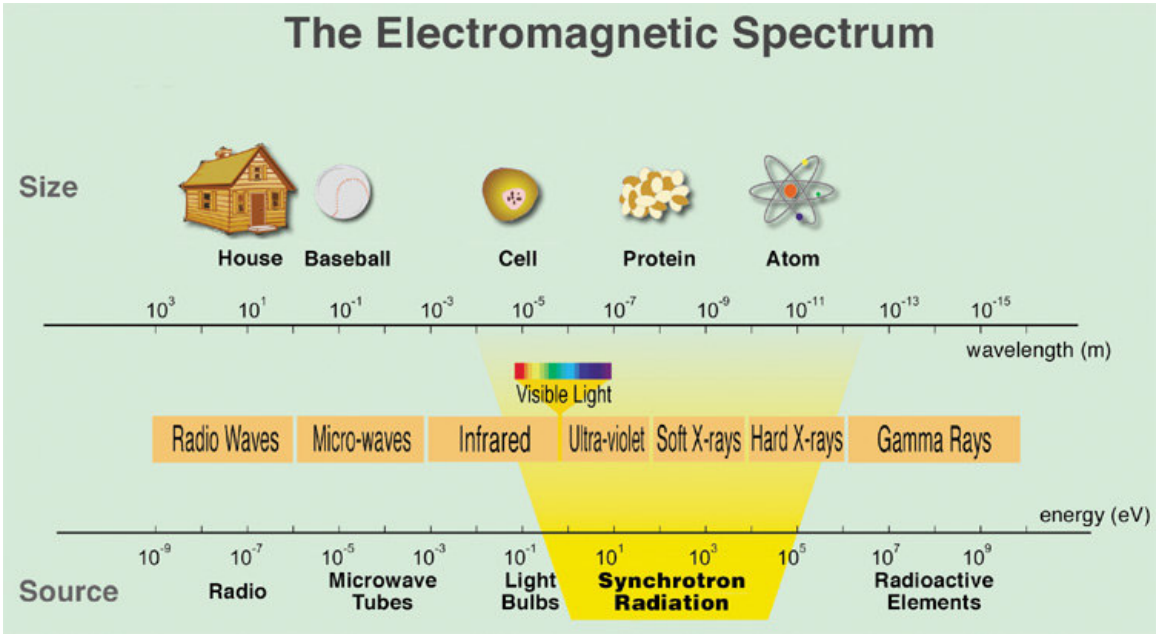

Fig. 2.

Synchrotron beam line permits much higher resolution than conventional X-ray systems

Conventional XRD tubes generate X-rays with: multiple wavelengths (Kα1, Kα2, Kβ), leading to complex diffraction peak profiles as shown in the following Fig. 3.

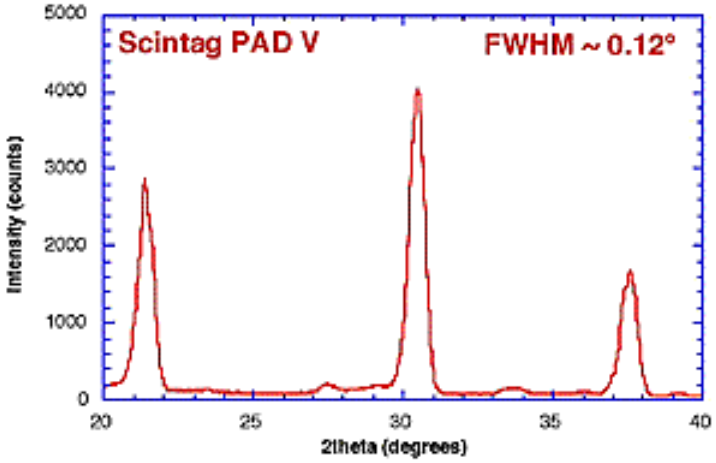

Fig. 3

Synchrotron XRD sources generate X-rays with narrow Gaussian line shapes, single wavelengths and very high intensity which allows fast data collection as shown in Fig. 4 below.

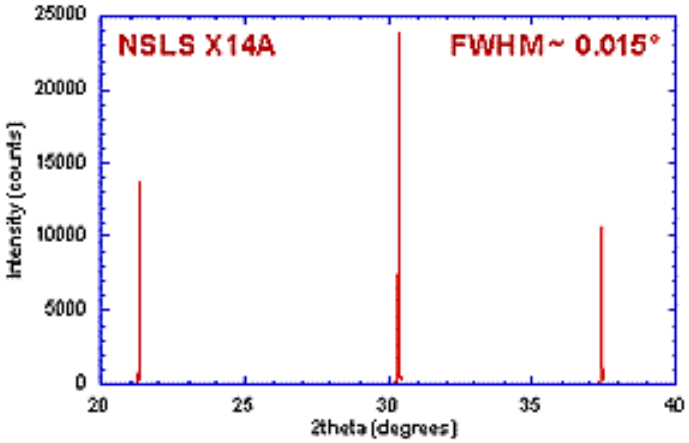

Fig. 4

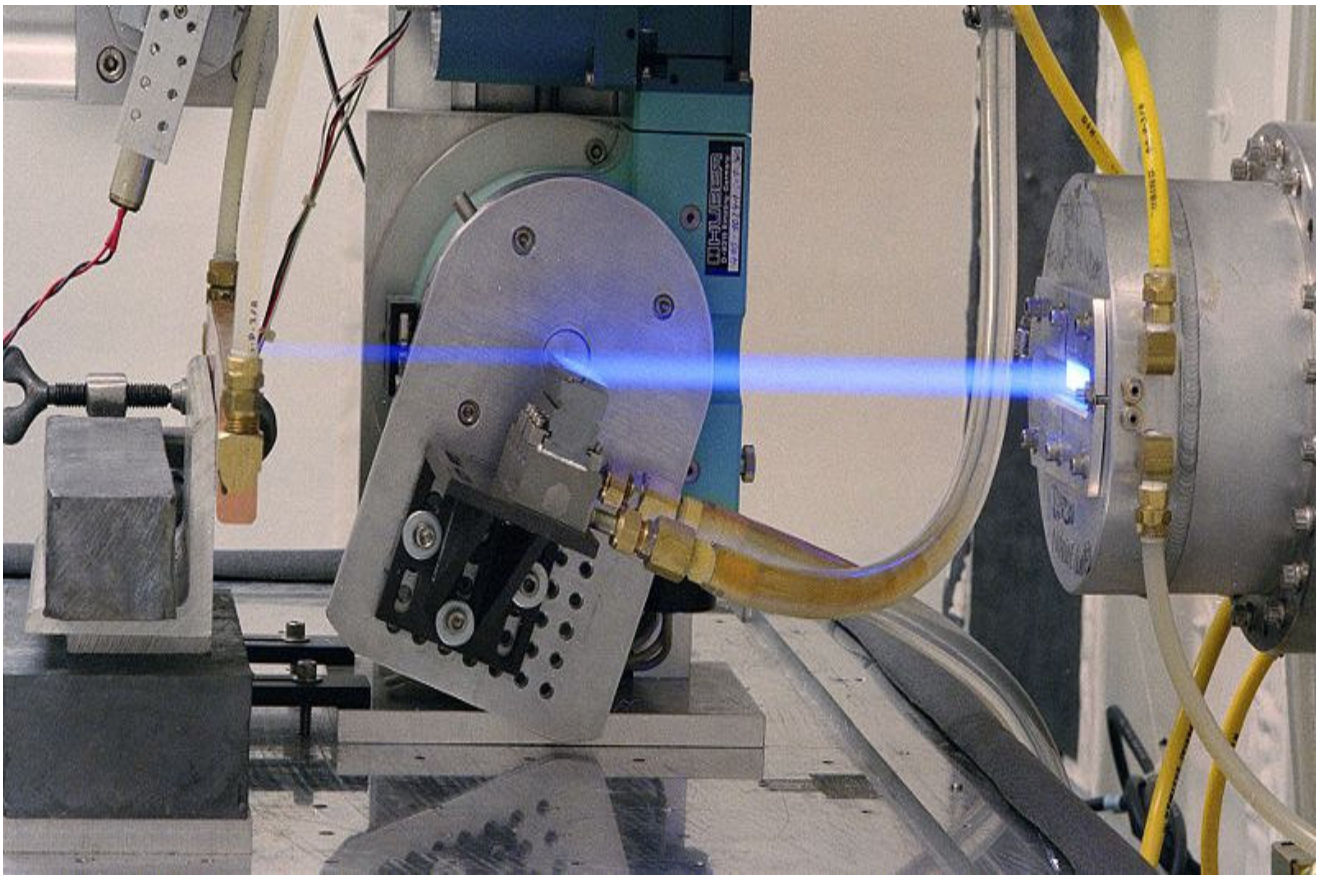

Fig. 5: Synchrotron radiation emerging from a beam port. The blue colour comes from oxygen and nitrogen atoms in the air, ionised by the X-rays

Synchrotron Applications

Synchrotron has its applications in many fields as shown in Fig. 6 below.

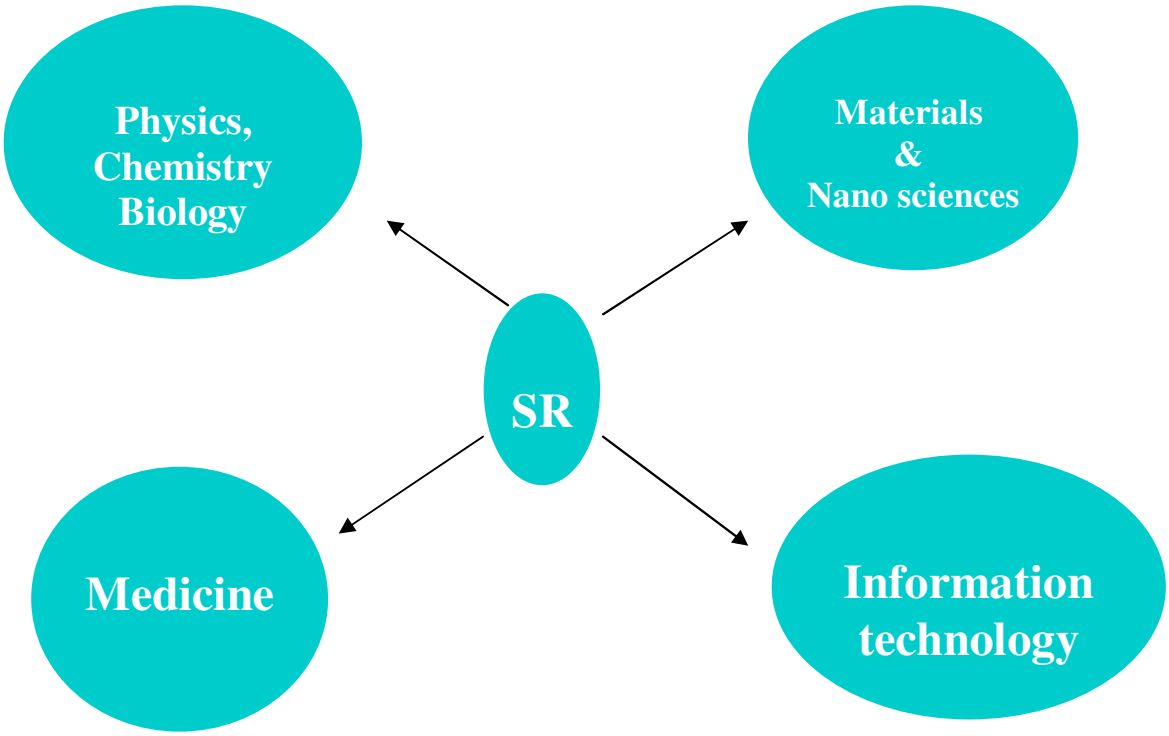

Fig. 6: Synchrotron Applications Diagram

The following are some of the applications of Synchrotron radiations,

1: Structural analysis of crystalline and amorphous materials
2: Powder diffraction analysis
3: Crystallography of proteins and other macromolecules
4: Drug discovery and research
5: Burning computor chip designs in to a metal wafer
6: Chemical analysis and composition
7: Floroscence study of cold bodies
8: Semiconductor material analysis and structural studies
9: Geological material analysis
10: Medical imaging
11: Residual stress analysis
12: Filming chemical reactions with ultra fast laser

Applications in radiation therapy

1: Radio therapy of brain tumors in children
2: Use of small beam dimentions for precise localization
3: High beam intensity enables short irrediation times
4: Reduced risk of unwanted effects on the tumor sorounding

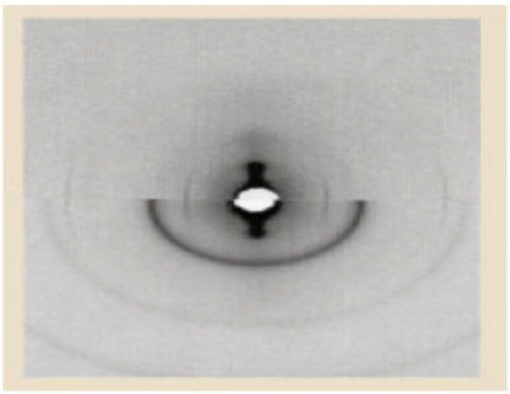

Fig. 7: Breast-cancer diagnosis using hair by split X-ray diffraction pattern. Down, from healthy subject; Up, from breast cancer patient.*(ESRF)*

Synchrotron Radiation for Agriculture & Environmental Management

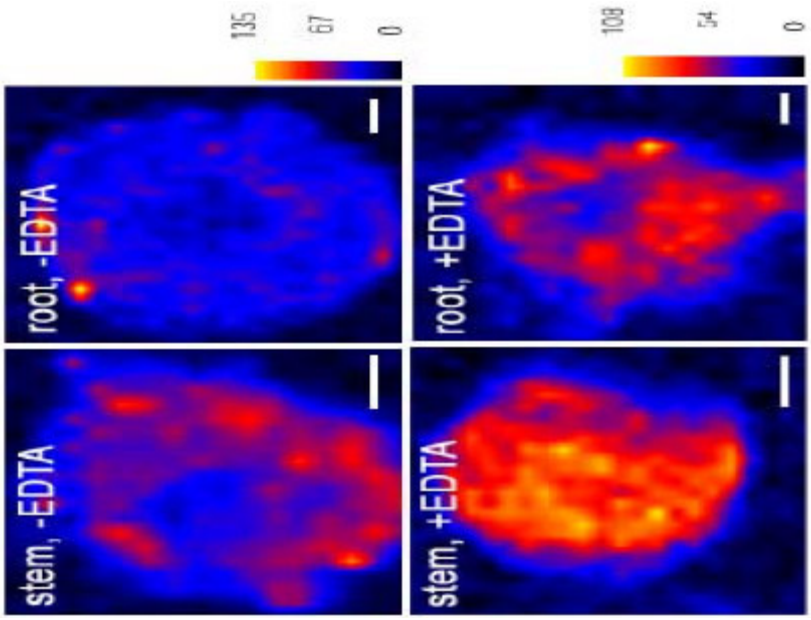

Fig. 8: X-ray images showing the lead concentration in the stem and root of tobacco, *an efficient plant for removing lead from the soil. (NSLS)*

References

1:CATLOW, GREAVES, " Applications of synchrotron radiation "

2:B. CANTOR, " Physical methods for materials characterization "

3:BORDOVITSYN, " Synchrotron radiation theory "

4:http://en.wikipedia.org

5: Last lecture slides of this course