X-ray absorption

X-rays is electromagnetic radiation with a wavelength of 10 - 1 pm. X-rays were discovered by the German scientist Wilhelm Conrad Röntgen at the end of the nineteenth century. Today, they are one of the most used methods for detecting various defects in the patient's body, and we would hardly be able to do without them. At the same time, X-rays work on the relatively simple principle of absorption of radiation by tissues. Depending on their composition, these will then appear in various saturated shades of gray.

Principle of X-Ray Absorption


Wilhelm Conrad Röntgen

During the passage of radiation through an absorbing substance, the quantum of radiation interacts with electrons or entire atoms of the substance. The result is a reduction of radiation intensity, either partial (on the basis of the so-called Compton effect) or total (with the photo effect). The probability of absorbing an X-ray quantum increases proportionally to the square of the atomic number Z^4. It follows that hard tissues such as bone absorb radiation to a greater extent than soft tissues with a high water content. The attenuation of X-ray radiation is described by the **total linear absorption coefficient μ**. The amount of energy absorbed per unit mass of the **absorber** (= substance absorbing radiation) is called the **radiation dose** and is expressed in units of *Gray* (Gy). Other units used are the *roentgen* (R) and the *sievert* (SV), which also takes into account the **biological effects of radiation**.

Total linear absorption coefficient μ

We can calculate it as the sum of the linear absorption coefficient for Compton scattering and photoeffect. The form of the photoeffect is absorption at low X-ray energy, Compton scattering is used at higher photon energies. In general, it is clear that the denser the **absorber**, the larger the coefficient μ and the more the radiation is attenuated. Furthermore, the coefficient μ depends on the already mentioned fourth power of the atomic number of the absorbing material and finally also on the wavelength of the radiation. We can therefore express it by the relation: $\mu = \rho \cdot \lambda^3 \cdot Z^4$

Among other things, we derive from the formula the fact that with increasing radiation energy, the absorption coefficient decreases. The energy of the radiation is inversely proportional to the wavelength according to Einstein's equation.

Points of Interest

- The absorption of X-rays in bone is about 16 times greater than in muscle.
- Every year on Earth, we are exposed to "natural" X-ray radiation with a value of 2.5 mSv.

Links

Related Articles

- Electromagnetic spectrum
- X-rays
- X-rays characteristics
- Compton's effect
- Photoelectric effect

Resources

- BENEŠ, Jiří – JIRÁK, Daniel – VÍTEK, František. *Základy lékařské fyziky.* 4. edition. nakladatelství Karolinum, 2015. ISBN 978-80-246-2645-1.

- NAVRÁTIL, Leoš – ROSINA, Josef. *Medicínská biofyzika.* 1. edition. Grada Publishing, 2005. ISBN 80-247-1152-4.