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Safety and Health — Safety in the SAXS laboratory

of the Faculty of Physics

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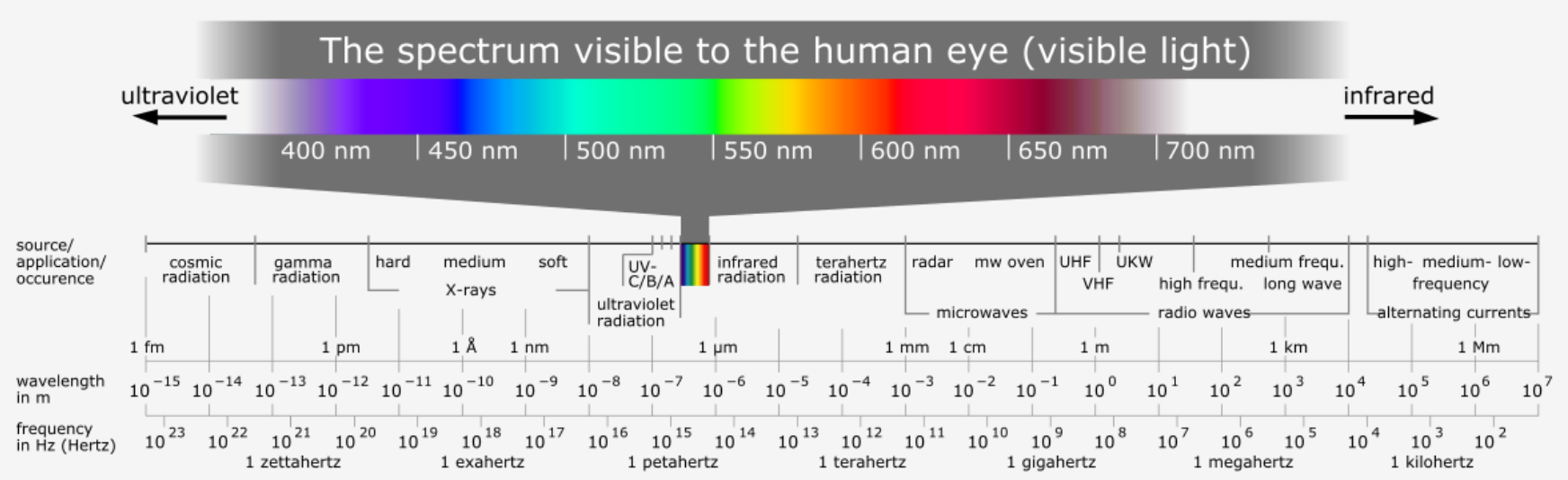
Electromagnetic spectrum



X-rays are electromagnetic waves with energies between 5 and a few hundred keV.

Image source: Wikimedia (CC-BY-SA), translated by K. Prochazka

X-radiation (X-rays)

X-rays are typically produced in two ways:

1. Through the acceleration of charged particles. This type is also called “Bremsstrahlung” and has a continuous spectrum.
2. Through the transitions in the electron shells of atoms or molecules. This type is also called “characteristic X-ray emission” and has a discrete line spectrum.

Interaction with matter

Absorption in matter occurs through photoelectric absorption, Compton scattering or elastic scattering, depending on the energy of the X-ray photon.

- Photoabsorption: The X-ray photon knocks out an electron in the electron shell of an atom. The “hole” is filled by an electron from an electron shell with a higher energy level. During this process, characteristic X-ray radiation is emitted.
- Compton scattering: The X-ray photon is scattered by an electron. During this process, the photon loses energy. Compton scattering only occurs at higher X-ray photon energies.

Interaction with matter

- Elastic scattering: e.g. Thompson scattering or Rayleigh scattering. The X-ray photon does not change its energy.

Biological effects

- X-rays are ionizing and can cause changes in living organisms.
- For this reason, radiation protection measures must be observed when working with X-rays.
- X-rays cannot be detected by the human eye. It is invisible.
- Therefore, it is measured with dosimeters.

Safety in the X-ray laboratory

- X-ray laboratories must be marked by the warning sign on the right.
- Entering these rooms is **strictly forbidden** for unauthorized personnel who are not accompanied by an authorized member of staff.
- Wearing a dosimeter is mandatory while the system is running.
- The dosimeter must be worn on the body at beam height—not on your pants and not as a permanent fixture on your desk lamp.

Image source: Wikimedia (Public domain)

Operating the Bruker NANOSTAR

The Bruker NANOSTAR system is a fully radiation-protected unit. Still, some precautions need to be taken during operation:

- First press the green button, then open the door of the sample chamber.
- Only open the door when the shutter is closed.
- When modifying the build of the system (e.g. from long to short configuration), always leave the door open as an additional safety measure.
- Do not bypass or bridge security features (i.e. circuits).

Measuring with the Bruker NANOSTAR

- Before modifying the build of the system, disable the high voltage of the detector using the green on-off switch. Otherwise there is danger of death by electrocution!
- Do not damage the beam stop during the modification—it is only suspended by thin threads.
- After the modification, re-adjust the beam stop. To do this, fit a nickel or copper filter in the sample chamber to protect the detector.
- Remove all set-ups from the sample chamber if you need to recalibrate the table position.

Measuring with the Bruker NANOSTAR

- Measurements involving ovens **must** always be supervised.
- Report damages or problems **immediately** to the lab supervisor in your own interest.
- The air conditioning is necessary for correct operation. Report a failure immediately to the lab supervisor.
- Re-order consumable materials when stock runs low.
- Do not remove the current lab notebook from the lab.
- Clean up after yourself. The university cleaning service only empties the waste-paper basket.

Handling the samples

- Never store samples in a fridge used for food.
- Every sample in the lab must be labeled.
- Do not remove samples in the sample chamber without consulting the owner first.
- Make notes in the lab notebook so that it is clear which samples are in the sample chamber, who is the owner and what dangers the samples pose. (Example: any chemical substance)
- Store away the samples correctly and leave the lab clean and tidy after the measurement.

Design and content

Design:	Katharina Prochazka, Stephan Puchegger
Content:	Johanna Akbarzadeh, Stephan Puchegger, Christoph Schuster-Bourgin, Nina Weinmann
Proofreading:	Alexander Müllner