# Medical Biophysics

Why do we learn it?

**Reasons**:

1. The structure and function of human body,

2. the methods, techniques, equipment of medical diagnosis and therapy have bases of natural science.

   φυσιζ = nature
   physics = natural science

   It is interesting that the meaning of
   „physic” = „art of healing, medical science”

3. Medical mentality
   logical, analyzing, systematic,
   an important peculiarity is the continual skepticism.

**Purposes**:

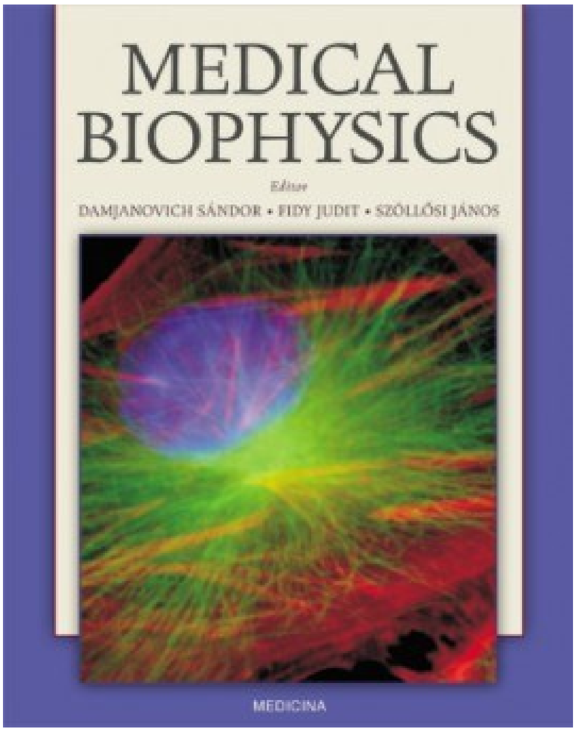
I. To get knowledge

II. **Solving problems**, methods

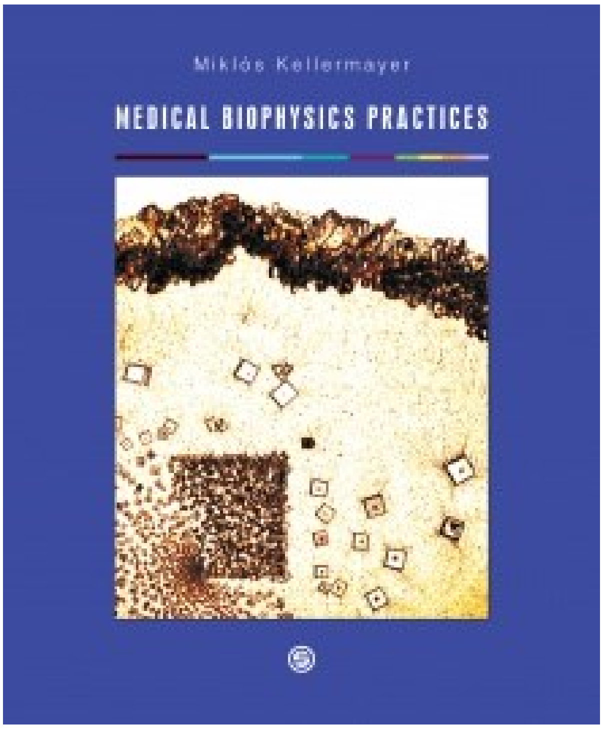
III. Approach, attitude of mind

Suggested textbook and manual:

**Medical Biophysics**
Editors: Damjanovich Sándor, Fidy Judit, Szöllősi János
Medicina




**Medical Biophysics Practices**
Authors: staff of the Institute of Biophysics and Radiation Biology

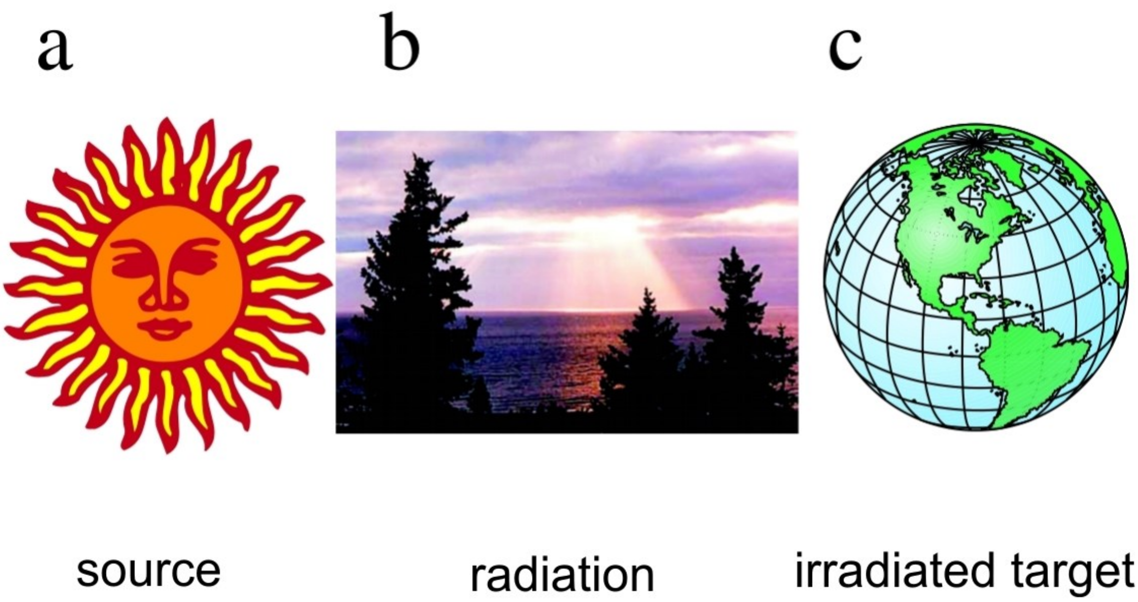


# Radiations

Sunshine, x-ray, sound, radio-waves, radioactive radiation

Sensation, detection

## Basics of radiometry



# Energy propagation

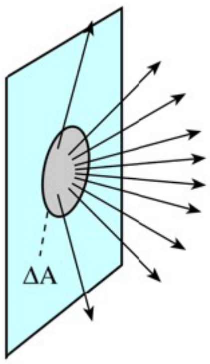
Emitted power ($P$), intensity ($J_E$), (Flux density)

$$P = \frac{\Delta E}{\Delta t} \qquad I_E = \frac{\Delta E}{\Delta t} \qquad J_E = \frac{\Delta E}{\Delta t \Delta A} \qquad M = \frac{\Delta P}{\Delta A}$$

## Parameters of radiometry

**Radiance**

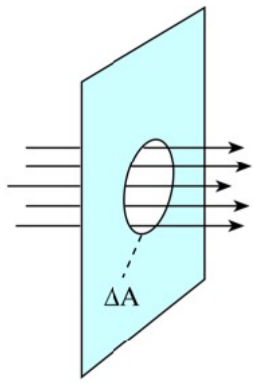
$$M = \frac{\Delta P}{\Delta A} \quad \left[\frac{\mathrm{W}}{\mathrm{m}^2}\right]$$




Power radiated by unit area into a solid angle of 2π.

**Radiation intensity**

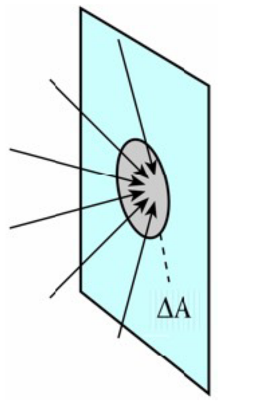
$$J_E = \frac{\Delta I_E}{\Delta A} \quad \left[\frac{\mathrm{W}}{\mathrm{m}^2}\right]$$




Power propagating through unit area.

**Irradiance**

$$\varepsilon = \frac{\Delta P}{\Delta A} \quad \left[\frac{\mathrm{W}}{\mathrm{m}^2}\right]$$




Power incident on a surface of unit area (radiation may arrive from all directions).

## Point-like isotropic radiator

Radiation is independent of the direction in the whole solid angle.

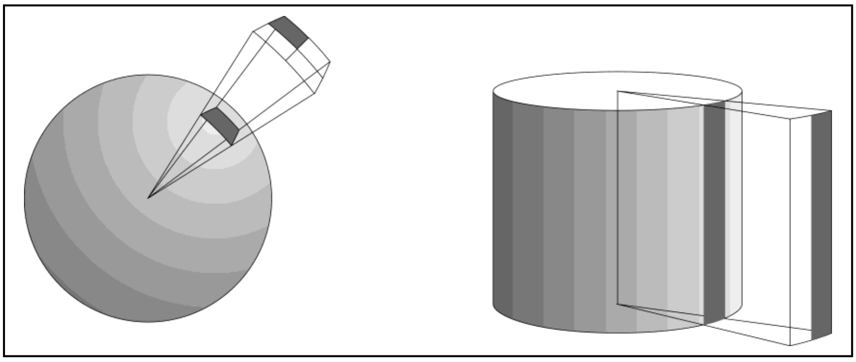
Total emitted power per surface area

**Simple laws:** the roles of symmetry, distances and angles

Spherical symmetry

Cylindrical symmetry

(Planar symmetry)



**Decrease in radiation intensity while passing through matter**

Energy absorption, reflection, dispersion

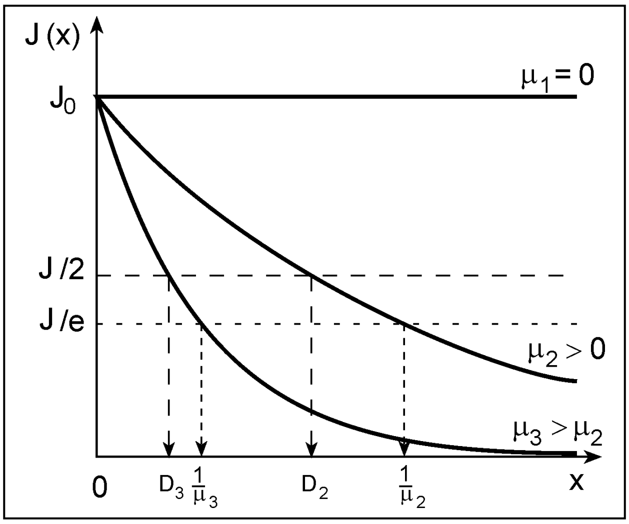
Outgoing intensity ($J$) depends on both the type ($\mu$) and depth ($x$) of the traversed medium, as well as the intensity of the incident radiation ($J_0$).

Small distances linear proportionality holds.

$$\Delta J = -\mu \Delta x J$$

$$\frac{\Delta J}{\Delta x} = -\mu J$$

Solution ($J = J_0$ when $x = 0$)




$$J = J_0 e^{-\mu x}$$

**The validity of the law depends on the interaction between matter and radiation, but in most cases it provides a very good approximation**.

The attenuation coefficient is the inverse of the distance that reduces the intensity by a factor of $1/e$.

$D$ is called the layer thickness for half-intensity.

**Types of radiation**
electromagnetic radiation (such as light and gamma rays)
mechanical radiation (e.g. sound and ultrasound in particular)
particle radiation (such as alpha or beta rays)

**non-ionizing types of radiation**
(electromagnetic radiation 1: light; and mechanical radiation: sound, ultrasound)

**ionizing radiations**
(electromagnetic radiation 2: x-rays, gamma rays; and particle radiations: alpha and beta rays).