Sources of Infrared radiation

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2 Sources of Infrared radiation
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1800 Sir Wilhelm Herschel: Discovers IR-radiation
1859 Gustav Kirchhoff: Derives the law of thermal radiation
1893 Wilhelm Wien: Derives the displacement law
1897 Walther Nernst: Invents the Nernst Glower
1901 Max Planck: Derives Planck's Law
classification of the spectral range

- Ultraviolet (UV): UVC, UVB, UVA
- Visible
- Infrared
- Microwaves

Diagram showing the classification of the spectral range with wavelengths in nm and photon energy in J/Photon.
black body radiators

- absorb any incident light
- ideal source for thermal radiation

**Planck's Law:**

\[
I(\lambda, T) = \frac{2hc^2}{\lambda^5} \left( \frac{1}{e^{\frac{hc}{\lambda kT}} - 1} \right)
\]

- \(I\): Intensity of corresponding wavelength at a given temperature
- \(h\): Planck's constant
- \(c\): speed of light
- \(\lambda\): wavelength
- \(k\): Boltzmann's constant
- \(T\): Temperature

**Wiens Displacement Law:**

\[
\lambda_{\text{max}} = \frac{2897.8 \mu m K}{T}
\]
examples for black body radiators

- Humans
  - peak value $= 9.3 \, \mu m$
  - almost no intensity in the visible
  - applications:
    - motion detectors
    - temperature measurement
    - Infrared cameras
examples for black body radiators

- Humans
examples for black body radiators

- Incandescent lamps

  - peak value $= 1.1 \mu m$ ($T = 2700 \, K$)
  - peak value $= 966 \, nm$ ($T = 3000 \, K$)

- main part of radiation in the infrared

- applications:
  - medicine & agriculture
  - photography
Examples for black body radiators

- Incandescent lamps
examples for black body radiators

- The sun
  - peak value = 500 nm (T = 5800 K)
  - real spectrum exhibits Fraunhofer lines
  - applications:
    - solar panels

![IR spectrum of the sun](image-url)
Nernst lamp

- composition
  - Zirconium oxide $\text{ZrO}_2$ 90% wt/wt
  - Yttrium oxide $\text{Y}_2\text{O}_3$ 7% wt/wt
  - Erbium oxide $\text{Er}_2\text{O}_3$ 3% wt/wt

- operating temperature: 2300 K

- preheating necessary

- applications
  - general lighting purposes
  - first functional long distance fax
  - ophthalmology
  - projection
  - microscopy
Nernst lamp

- peak value = 1.3 µm
  \((T = 2300 \text{ K})\)
Nernst glower

- application in Infrared spectroscopy
Globar

- Glow + bar = Globar
- composition
  - Silicon carbide
- operating temperature: 1400 K
- no preheating necessary
peak value = 2.1 µm

(T = 1400 K)
IR-LEDs can be made out of III/V-semiconductors.

Applications:
- Remote controls
- Photoelectric sensors
IR-Lasers

- IR-Lasers utilize the following technologically relevant wavelengths
  - 850 nm, 1300 nm, 1310 nm, 1550 nm and 1625 nm
- applications
  - Telecommunication
Thanks for your attention.