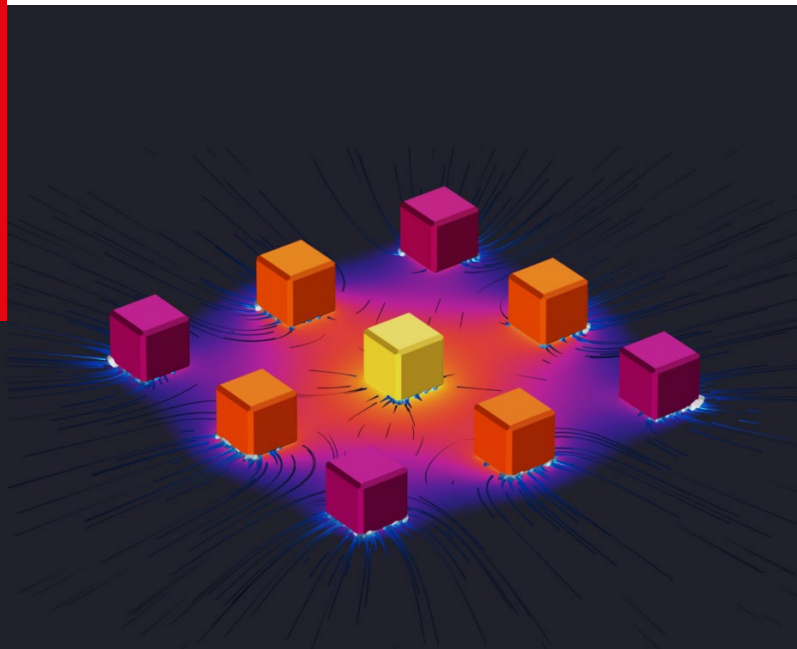


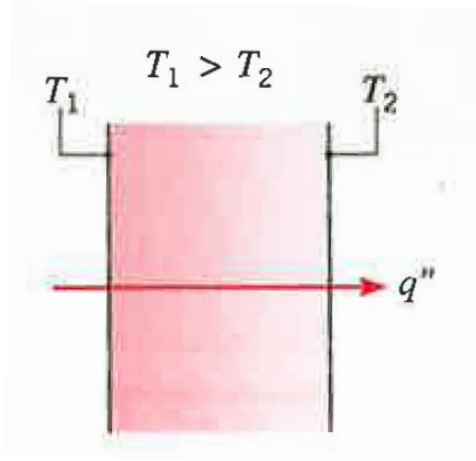
Heat and Mass Transfer ME-341

Instructor: Giulia Tagliabue

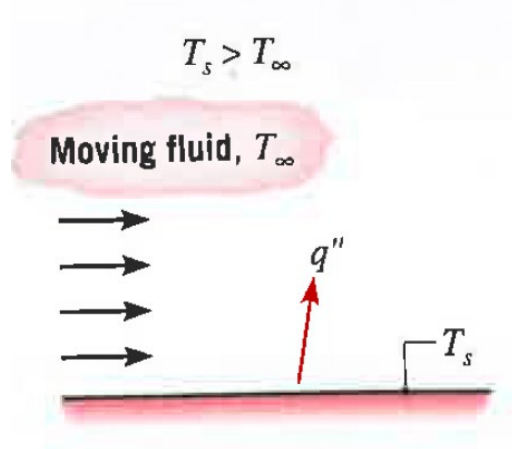


Heat Transfer Mechanisms

Conduction

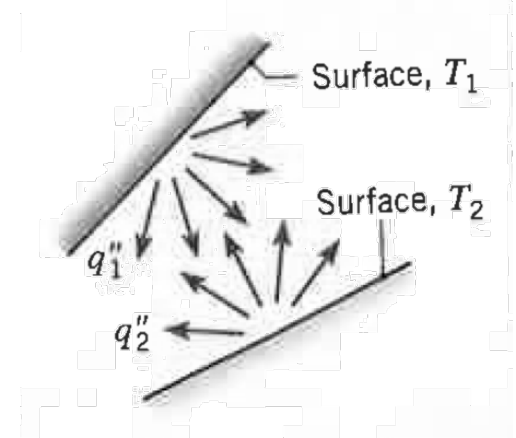


Convection



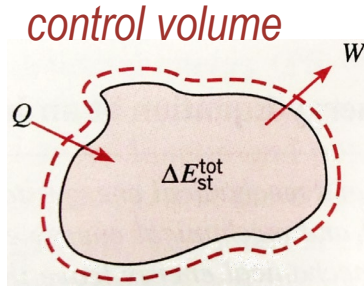
Involves mass transport

Radiation



Involve physical contact

Part I – Fourier's Law and Heat Conduction

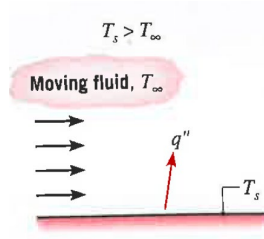


- ☐ Heat Diffusion Equation (HDE) 3D
- ☐ HDE Steady-state 1D Solutions with/without Heat Sources
- ☐ Thermal Resistances and Equivalent Electrical Circuits
- ☐ Fins and Arrays of Fins
- ☐ Transient HDE
 - ☐ Lumped Capacitance Model $T(t)$
 - ☐ 1D Spatial Effects $T(X,t)$
 - ☐ Semi-Infinite Solid
 - ☐ Periodic BC

$$\frac{dE_{st}}{dt} = \dot{U} = Q - W + \dot{E}_{gen}$$

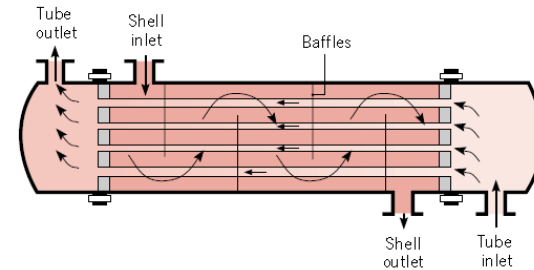
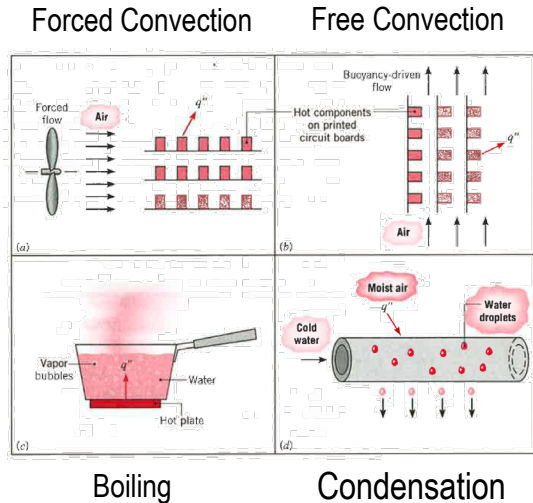
$$q'' = -k \frac{dT}{dx}$$

Part II: Newton's Law and Heat Convection



$$q'' = \bar{h} (T_s - T_\infty)$$

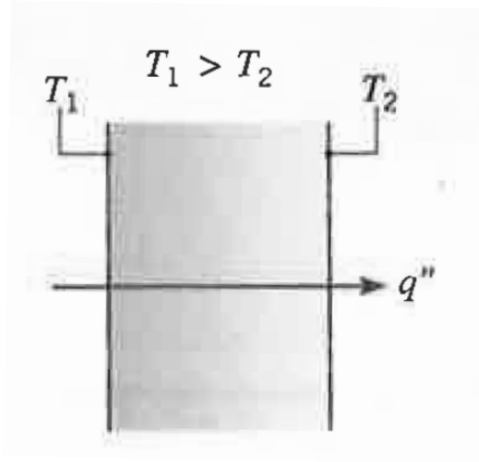
h = convective heat transfer coefficient,
[W/m²K]



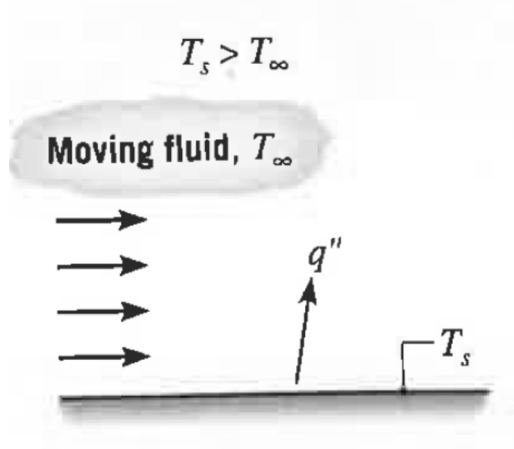
Heat Exchanger Design and Performance Analysis

Heat Transfer Mechanisms

Conduction

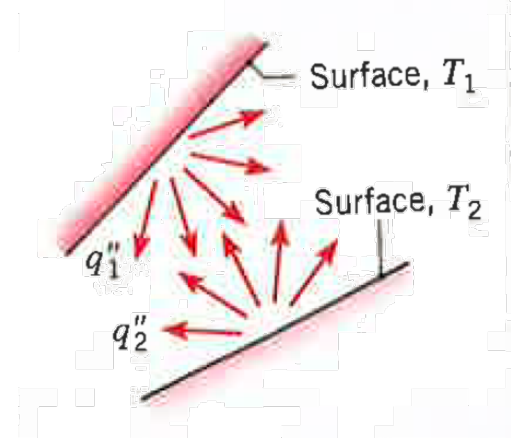


Convection



Involves mass transport

Radiation



Involve physical contact

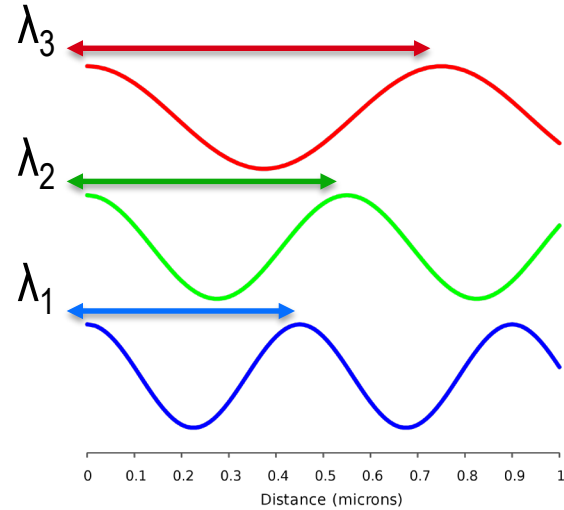
This Lecture

- Introduction to Radiation

Electromagnetic Radiation

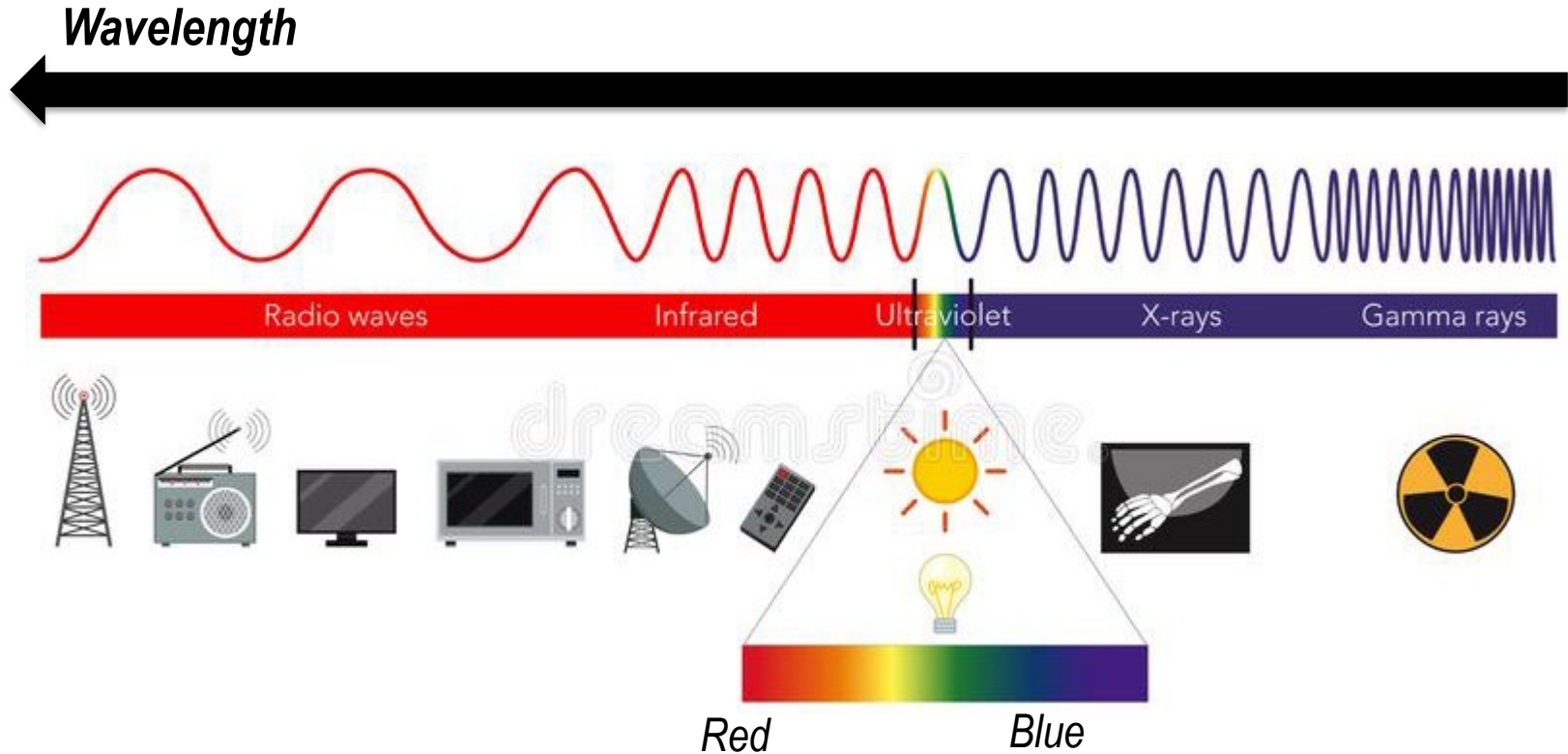


$\lambda = \text{wavelength}$



$$c = \lambda \nu$$

Electromagnetic Radiation



Thermal Radiation

High T



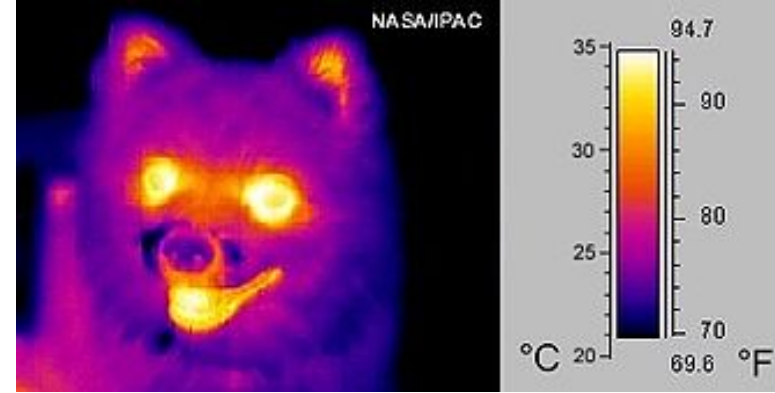
Very Bright Visible Light Emission

Medium T



Visible Light Emission

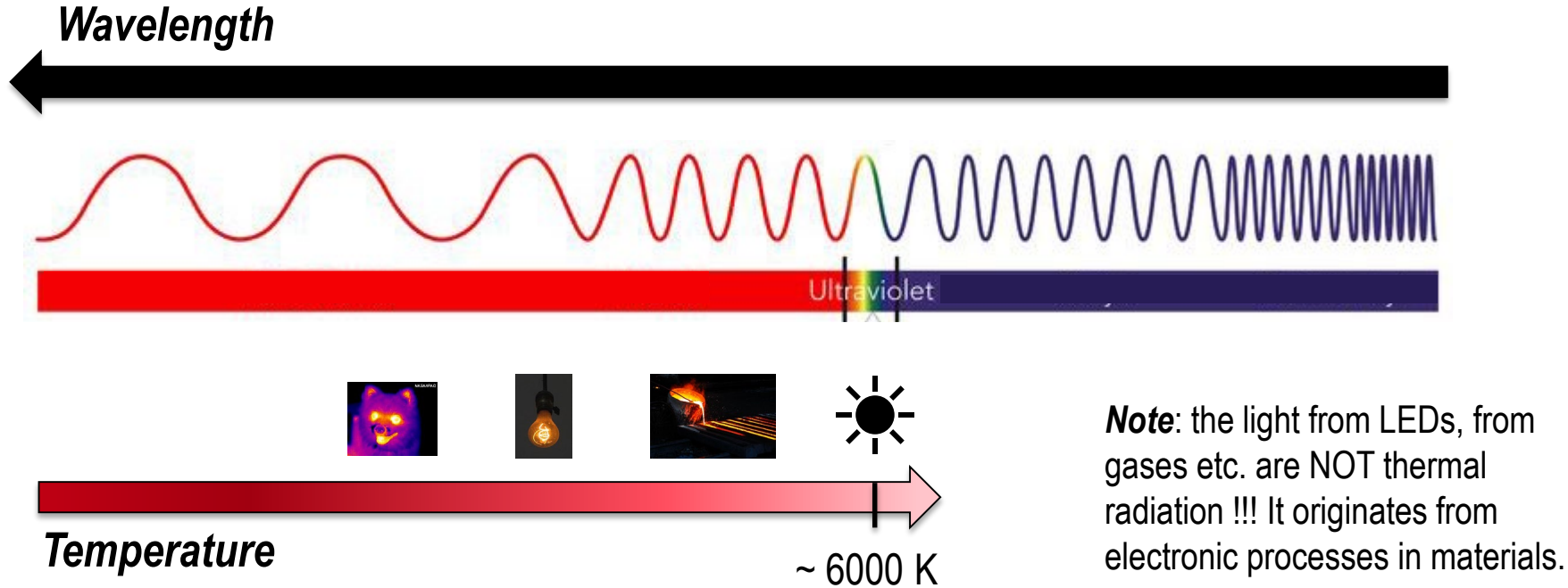
Low T



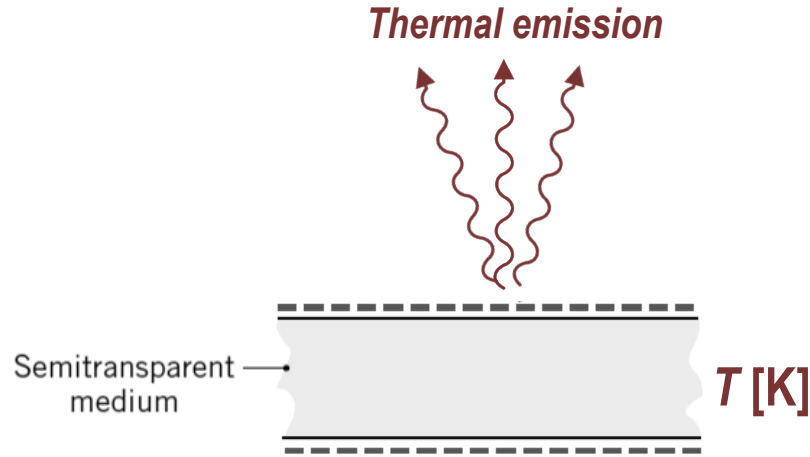
Infrared Light Emission (needs IR camera)

What is the relationship between the temperature of an object and its **emission** of electromagnetic waves (intensity and wavelength)?

Thermal Radiation



Thermal Radiation



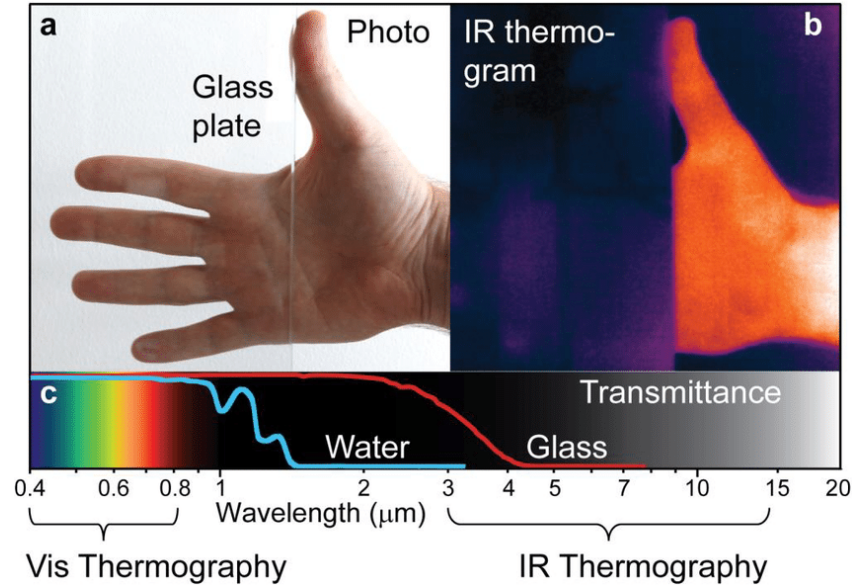
Temperature and material properties determine how an object EMIT thermal radiation.

Thermal Radiation



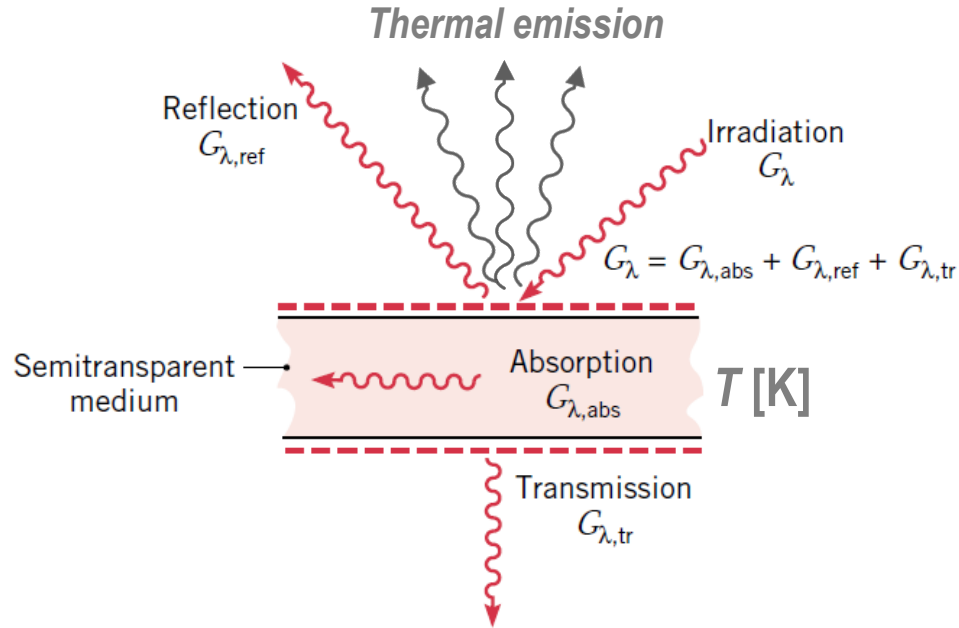
How does thermal radiation **interacts** with various objects?

Thermal Radiation



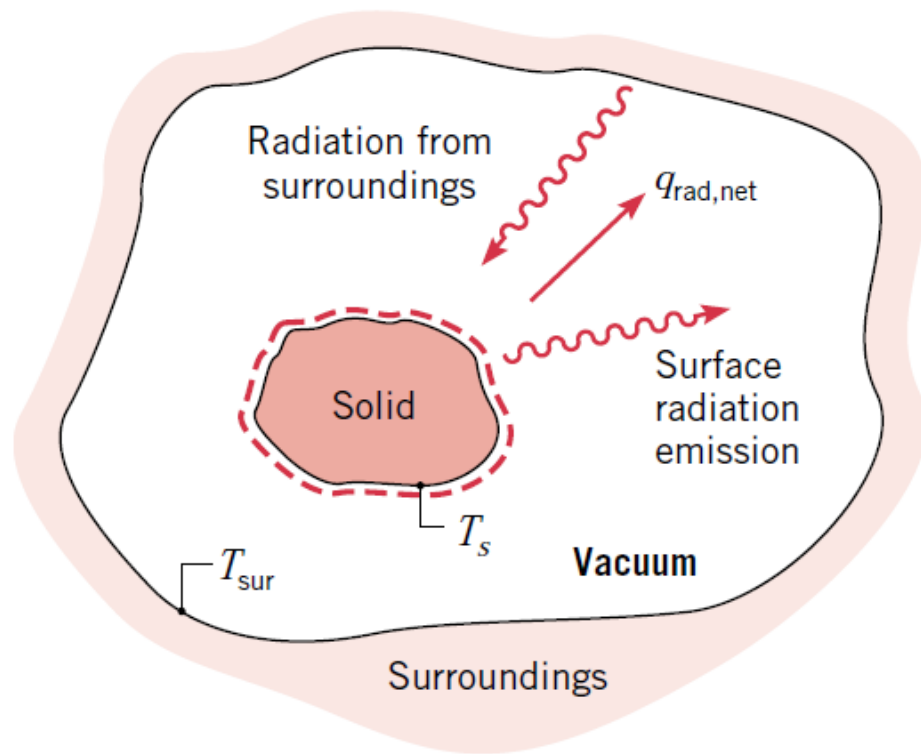
How does thermal radiation **interacts** with various objects?

Thermal Radiation



Wavelength and material properties determine how thermal radiation interacts with objects.

Radiative Heat Transfer



This Lecture



Introduction to Radiation

Next Lectures

- ❑ Emission of Thermal Radiation
 - ❑ Spatial distribution and Diffuse Emitter
 - ❑ Spectral distribution
 - ❑ Stephan-Boltzmann and Wien's laws
- ❑ Interaction of Thermal Radiation with Matter
 - ❑ Absorptivity, Reflectivity and Transmissivity
 - ❑ Irradiation and Radiosity
- ❑ Black-body
- ❑ Real surfaces: Emissivity, Diffuse & Gray Surfaces, Kirchhoff's Laws