Modern Physics

01/24/2005

Content

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Literature

Required:

An Introduction to Quantum Physics, French and Taylor, Norton, W. W. & Company, Inc., 1990, ISBN: 0393091066

Optional:

Concepts of Modern Physics, Arthur Beiser, McGraw-Hill, sixth edition, 2003, ISBN 0-07-244848-2

Related material:

The Quantum Challenge - Modern Research on the Foundation of Quantum Mechanics, George Greenstein and Arthur G. Zajonc, Jones and Bartlett publishers, 1997, ISBN 0-7637-0216-1

Modern Physics, Raymond A. Serway, Clement J. Moses, and Curt A. Moyer, Books/ColeTomson Learning, second edition, 1997, ISBN 0-03-001547-2

Quantum Physics, Stephen Gasiorowicz, John Wiley & Sons, Inc., second edition, 1996, ISBN 0-471-85737-8

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Modern Physics

Everything deviating from Newtonian Mechanics has traditionally been considered as modern physics:

- Special Relativity
- General Relativity
- Quantum Mechanics
- Other things discovered in the 20th Century

In Physics 316 we will mostly be concerned with Quantum Mechanics, more specifically non-relativistic quantum mechanics. The course can therefore also be considered an Introduction to Quantum Mechanics and will be the basis for understanding the phenomena covered in Physics 317 and in many courses during a Physics education.

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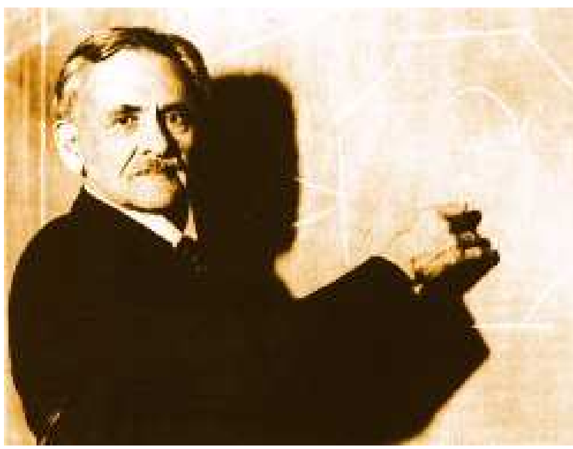
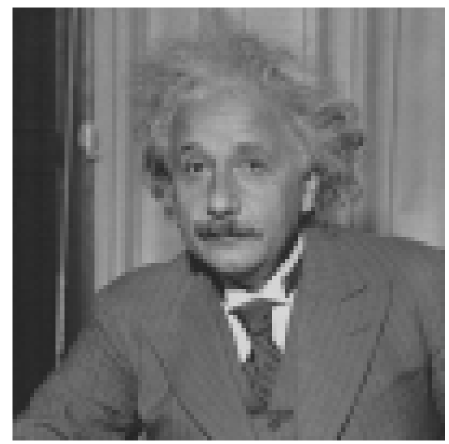
Physics around 1900:

1. Newtonian mechanics and Maxwell’s laws of electromagnetism work very well to describe macroscopic objects.
2. The Michelson-Morley experiment (1887) showed that the speed of light does not depend on the direction of the light which was explained by Einstein’s special relativity (1905).
3. The properties of glowing hot bodies could not be explained.
4. The atomic structure of matter was not know and several experiments proved the existence of atoms, among them Einstein’s Brownian motion experiment and his explanation of the photoelectric effect (1905).



Albert A. Michelson, 1852-1931, First American to win Nobel Prize in Physics, 1907



Albert Einstein, 1879-1955
Nobel Prize in Physics, 1921
Time Magazine Man of the Century

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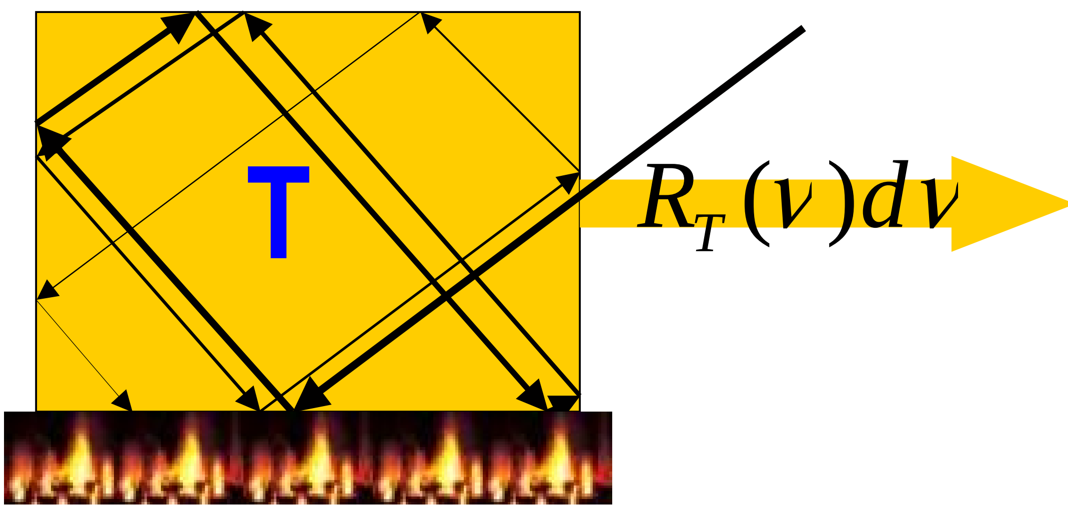
Light and photons

According to James Maxwell's theory, light was just an electromagnetic wave. After the creation of electromagnetic waves by Heinrich Hertz in 1888, this seemed certain. But this certainty only lasted a dozen years and was shattered when the radiation from glowing bodies could not be described.

Simplifying idealization

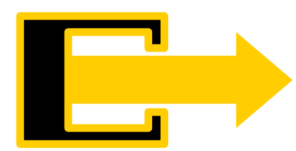
Black body: A body which only radiates, but does not reflect at any frequency. It is therefore black when cool.

The black-body box: heated to temperature T



The radiation properties are those of the used material,

Only that the reflection has been artificially reduced to zero:



$R_T(\nu)d\nu$: Energy/ area/ time in the frequency interval from ν to $\nu+d\nu$

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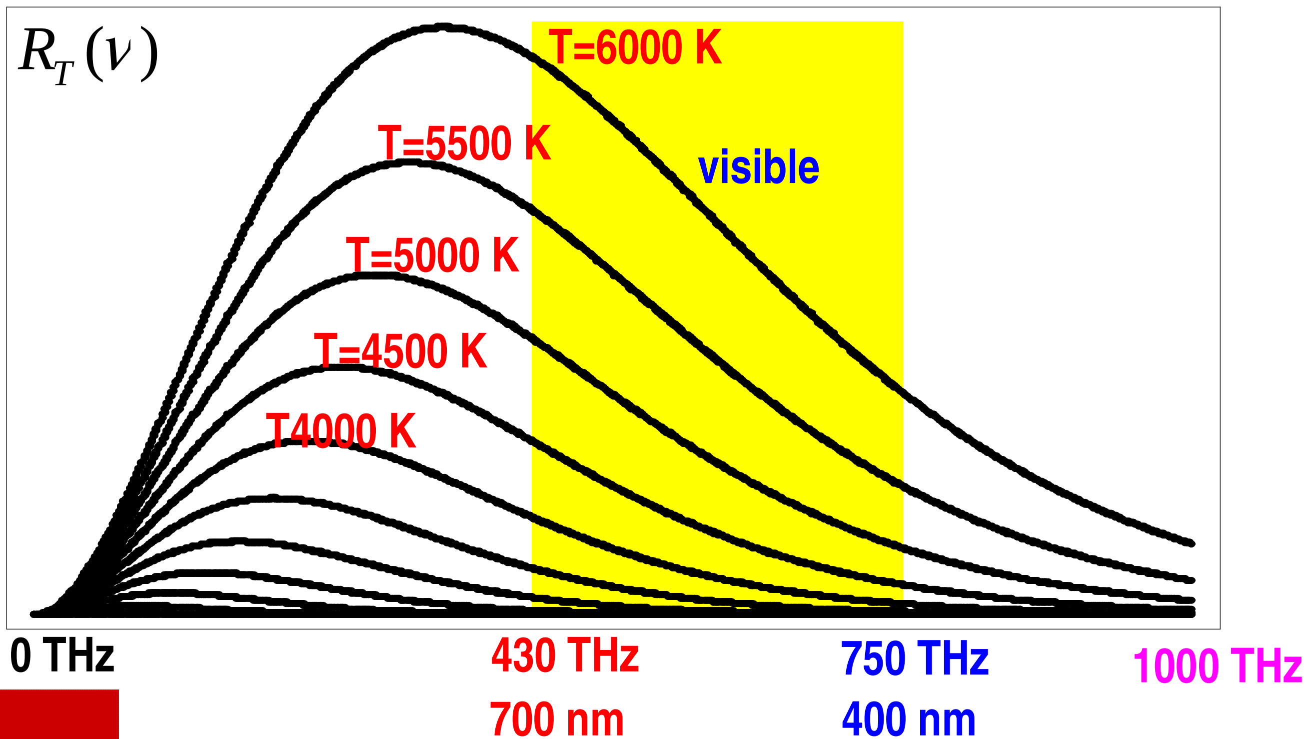
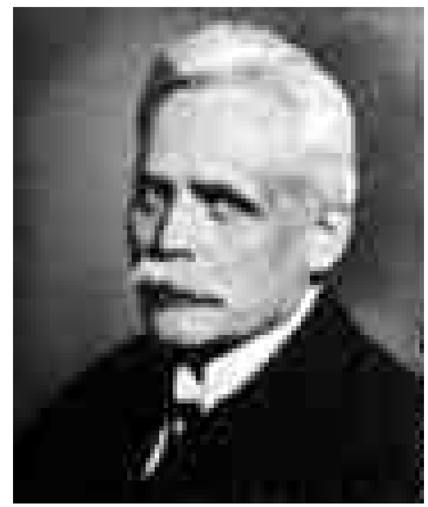
Black body radiation

Stefan's law: Energy/ area/ time = $\int_0^\infty R_T(\nu)d\nu = T^4 \cdot \sigma \,, \quad \sigma = 5.670 \cdot 10^{-8} \frac{1}{K^4} \frac{J}{m^2 \cdot s}$

Wien's displacement law: $R_T(\nu)d\nu = T^4 \cdot f(\frac{\nu}{T})d(\frac{\nu}{T}) \,, \quad \int_0^\infty f(\frac{\nu}{T})d(\frac{\nu}{T}) = \sigma$

➨ $R_T(\nu)/T^3$ only depends on ν / T





Wilhelm C.W.O.F.F. Wien
1864-1928
Nobel Prize in Physics, 1911

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