

Lecture 1

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800 ANNI UNIVERSITÀ DELL'UNIVERSITÀ
DEGLI STUDI DI PADOVA

Optics and Laser Physics

Tiziana Cesca

Master degree in Materials Science
AA. 2020-2021

**Video course online (Moodle DiSC)
asynchronous mode**

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 Dipartimento di Fisica
e Astronomia
Galileo Galilei

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800 ANNI UNIVERSITÀ DELL'UNIVERSITÀ DEGLI STUDI DI PADOVA		Time schedule					Optics and Laser Physics T. Cesca
		L.M. SCIENZA DEI MATERIALI – 2° ANNO 1° SEMESTRE - A.A. 2020/21 Tutto il semestre, a partire dal 21 settembre 2020					MODALITÀ TELEMATICA
ORE	LUNEDI	MARTEDÌ	MERCOLEDÌ	GIOVEDÌ	VENERDI		
8.30 – 9.15	Optics of Materials MENEGETTI		Tecnologia dei Materiali MARTUCCI				
9.30 – 10.15				Elettrochimica dei Materiali DURANTE			
10.30 – 11.15	Elettroch. Materiali DURANTE	Nanofabbricazione ROMANATO					
11.30 – 12.15			Ott. Fisica Laser CESCA	Tecnologia dei Materiali MARTUCCI			
12.30 – 13.15	Ott. Fisica Laser CESCA						
12.30 – 13.15							
14.30-16.15	Brevettazione e Sviluppo di Prodotti MARETTO, FACHINI, STOCCHIO			ROMANATO			
15.30-16.15		Nanofabbricazione					
16.30-17.15		Brevettazione e Sviluppo di Prodotti MARETTO, FACHINI, STOCCHIO					
17.30-18.15		Zoom Meeting Moodle DiSC 17:00-19:00					

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Nobel Prize in Physics 2018

The Nobel Prize in Physics 2018 was awarded
“for groundbreaking inventions in the field of laser physics”

Arthur Ashkin, born in 1922 in New York, USA.

Gérard Mourou, born in 1944 in Albertville, France.

Donna Strickland, born in 1959 in Guelph, Canada.

“for the optical tweezers and their application to biological systems”

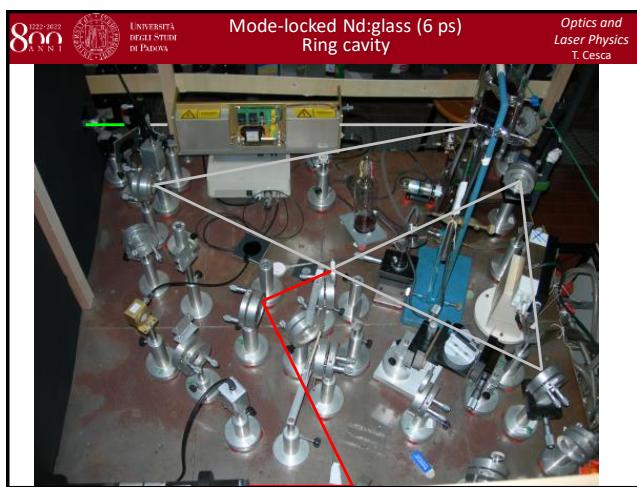
“for their method of generating high-intensity, ultra-short optical pulses”

The Nobel Prize in Physics 2018. NobelPrize.org. Nobel Media AB 2018. Tue, 2 Oct 2018. <<https://www.nobelprize.org/prizes/physics/2018/summary/>>

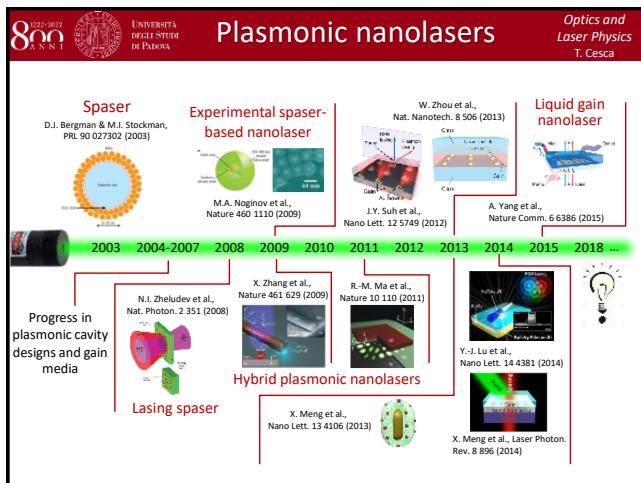
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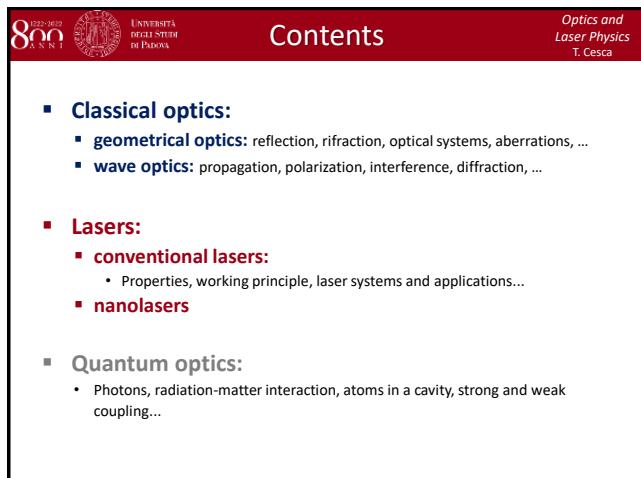
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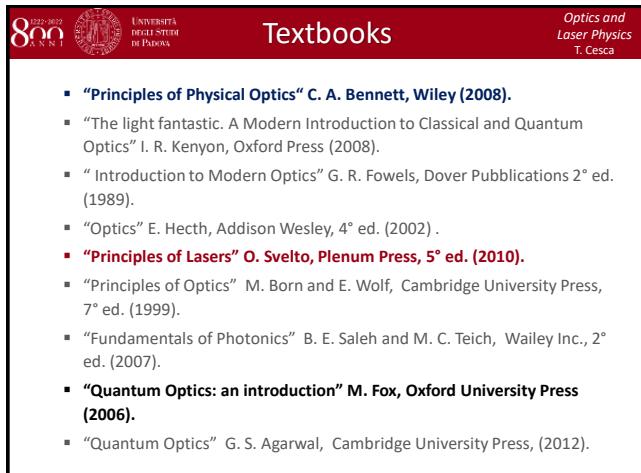
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Maxwell's equations in vacuum

James Clerk Maxwell (1831-1879)

$\vec{\nabla} \cdot \vec{E} = 0$ (I) Gauss' law for field \vec{E}
 $\vec{\nabla} \cdot \vec{B} = 0$ (II) Gauss' law for field \vec{B}
 $\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$ (III) Faraday's induction law
 $\vec{\nabla} \times \vec{B} = \mu_0 \epsilon_0 \frac{\partial \vec{E}}{\partial t}$ (IV) Ampère's circulation law

$\epsilon_0 = 8.854 \times 10^{-12} \text{ F/m}$ $\mu_0 = 4\pi \times 10^{-7} \text{ H/m}$

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Maxwell's equations in a medium

$\vec{\nabla} \cdot \vec{D} = \rho$
 $\vec{\nabla} \cdot \vec{B} = 0$
 $\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$
 $\vec{\nabla} \times \vec{H} = \frac{\partial \vec{D}}{\partial t} + \vec{J}$

Electric displacement vector
 $\vec{D} = \epsilon_0 \vec{E} + \vec{P}$
 Polarization
 $\vec{H} = \frac{\vec{B}}{\mu_0} - \vec{M}$
 Magnetization
 $\vec{D} = \epsilon \vec{E}$
 linear media
 $\vec{J} = \sigma \vec{E}$
 conductivity
 $\chi = \frac{\epsilon}{\epsilon_0} - 1$ Electric susceptibility
 $\epsilon(\omega) = \text{Dielectric function}$

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Equation of the em waves (in vacuum)

$\nabla \times (\nabla \times \vec{A}) = \nabla (\nabla \cdot \vec{A}) - \nabla^2 \vec{A}$
 $\nabla^2 \vec{E} - \mu_0 \epsilon_0 \frac{\partial^2 \vec{E}}{\partial t^2} = 0$
 $\nabla^2 \vec{B} - \mu_0 \epsilon_0 \frac{\partial^2 \vec{B}}{\partial t^2} = 0$

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em waves

Light is a transverse electromagnetic wave.

$\vec{E} \times \vec{B} \propto \vec{k}$

$E = \frac{\omega}{k} B = c B$

phase velocity

Magnetic field

Electric field

$$c = \frac{1}{\sqrt{\mu_0 \epsilon_0}} = (299792458 \pm 1) \text{ m/s} \approx 3 \times 10^8 \text{ m/s} \quad \text{in vacuum}$$

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em waves

Light is a transverse electromagnetic wave.

$\vec{E} \times \vec{B} \propto \vec{k}$

$E = \frac{\omega}{k} B = v B$

phase velocity

Magnetic field

Electric field

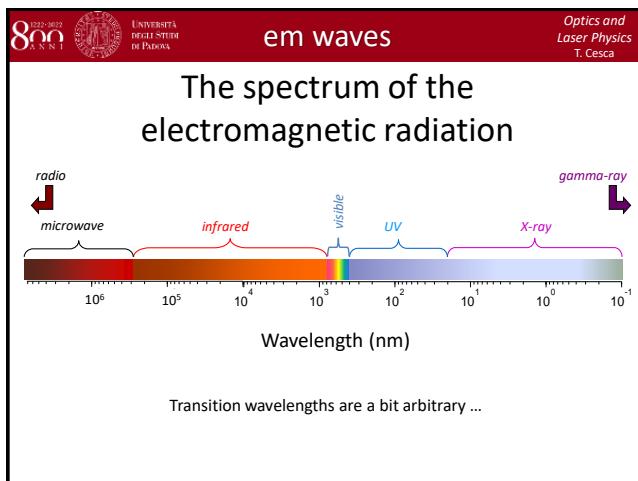
$$c = \frac{1}{\sqrt{\mu_0 \epsilon_0}} \approx 3 \times 10^8 \text{ m/s}$$

$$n = \sqrt{\epsilon_r \mu_r} \approx \sqrt{\epsilon_r}$$

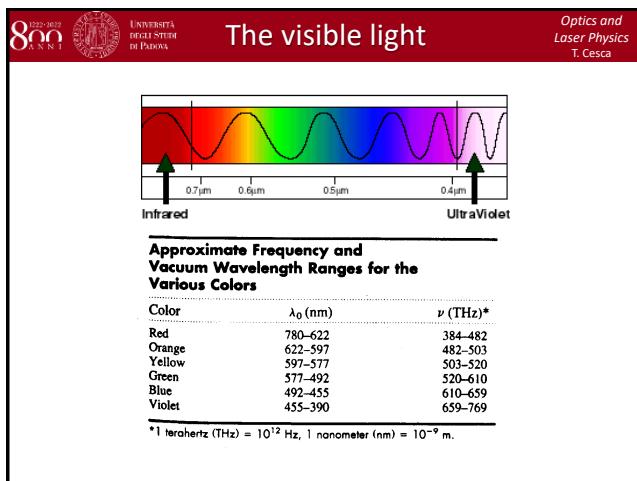
$v = \frac{c}{n}$ in a medium

refractive index

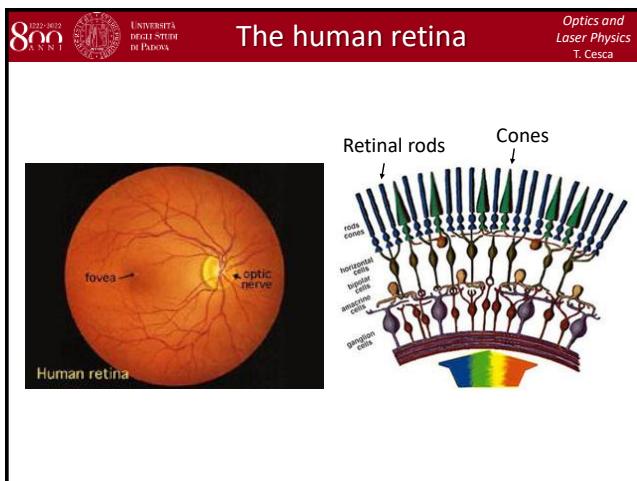
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