Week	Dates	Book chapters	Topic
1	February 28 – March 3	**1 and 2**	Electromagnetic model, field concepts. Vector algebra, vector analysis.
2	March 7–10	**3**	Electrostatics. Coulomb's law, scalar potential, electric dipole, permittivity, conductors and insulators, capacitance, electrostatic energy and forces.
3	March 14–17	**4 and 5**	Static electric currents, Ohm's law, conductivity. Magnetostatics, Biot-Savart's law, vector potential, permeability, magnetic dipole, inductance.
4	March 21–24	**6**	Faraday's law, Maxwell equations for dynamic electromagnetic fields. Complex representation of time-harmonic fields.
5	March 28 – 31	**7**	Plane waves in lossless and lossy media. Attenuation of waves, Wave reflection from planar interfaces. Brewster angle.
6	April 4–7	**(8,9) 10**	Electromagnetic radiation. Fields generated by a Hertzian dipole.


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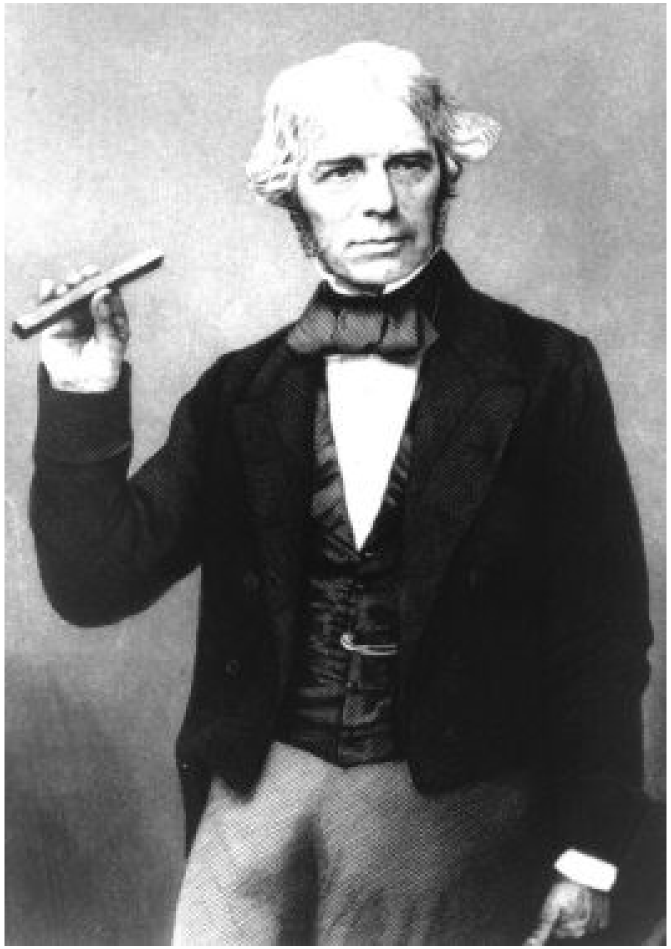
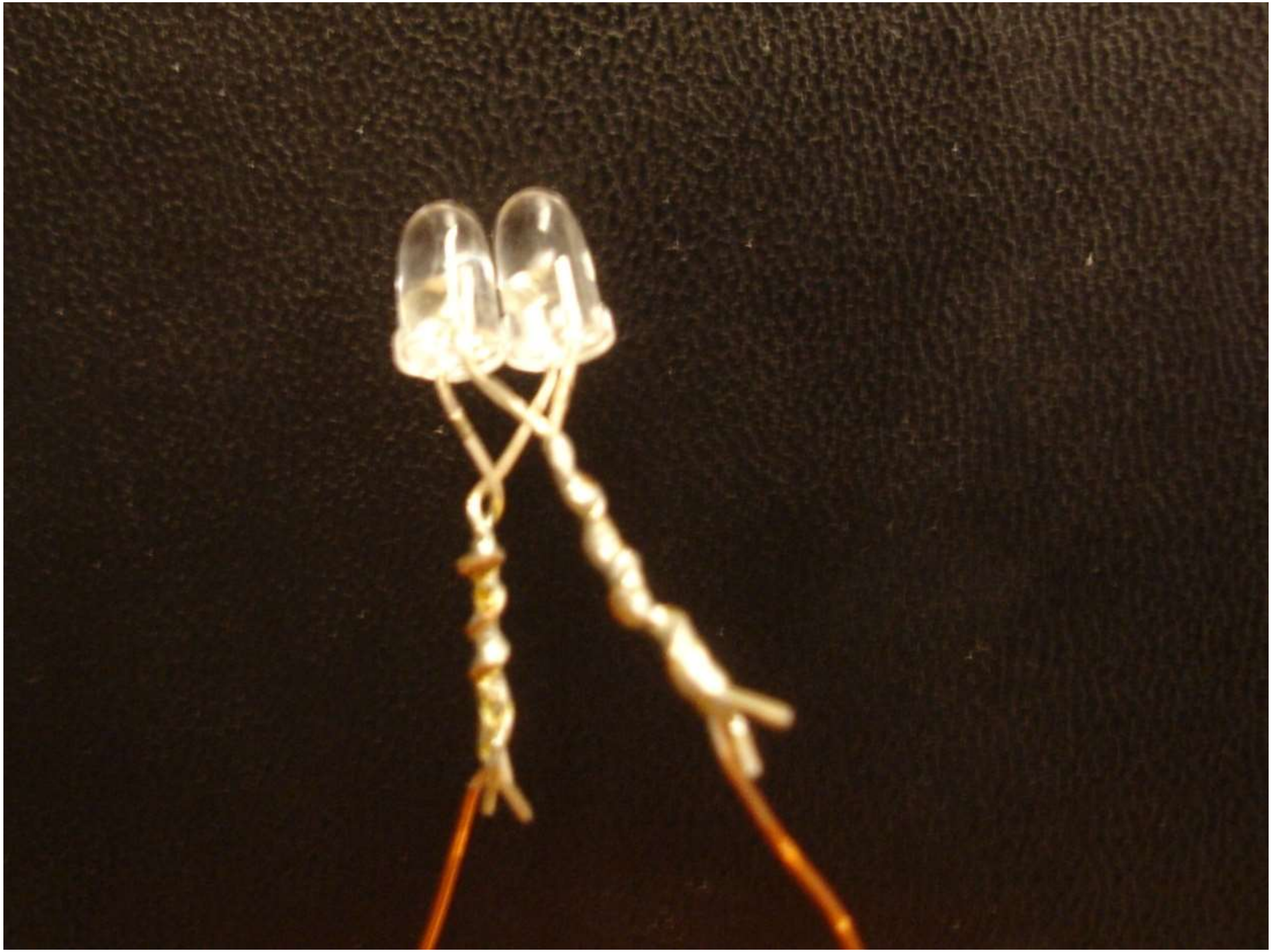
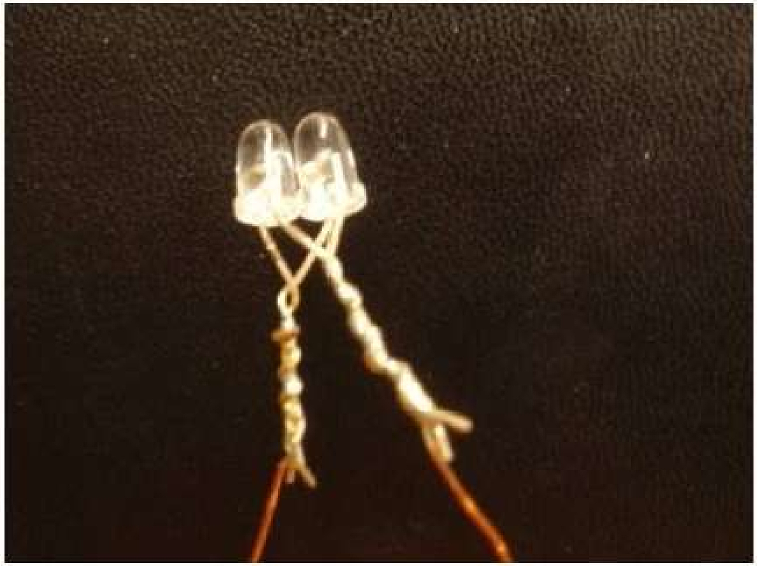
H.C. Ørsted
Danish physicist

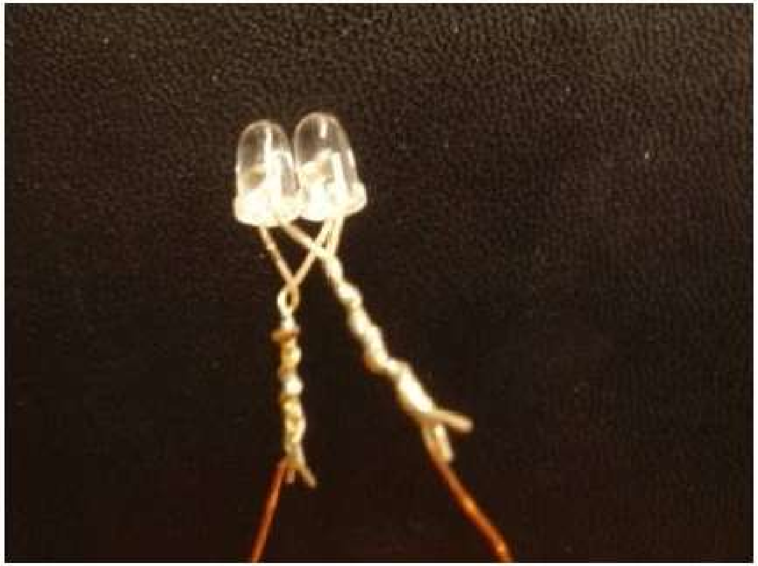
André-Marie Ampère (1775–1836)

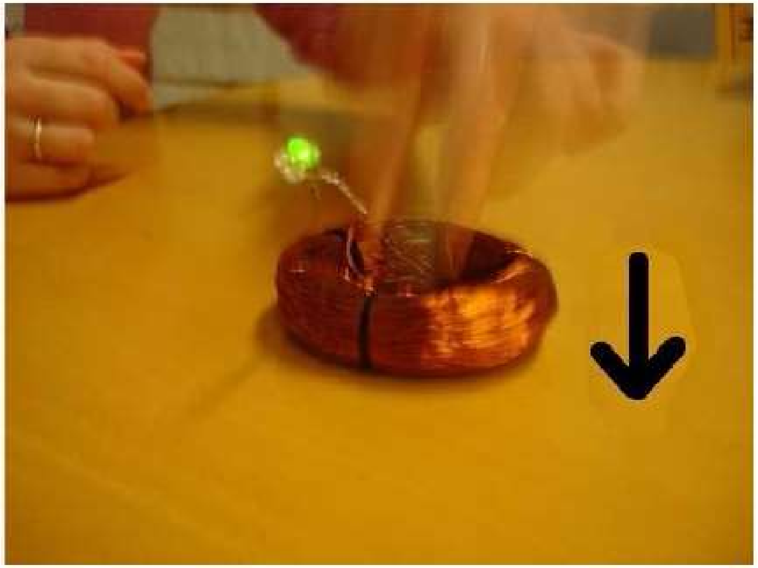
Michael Faraday (1791–1867)



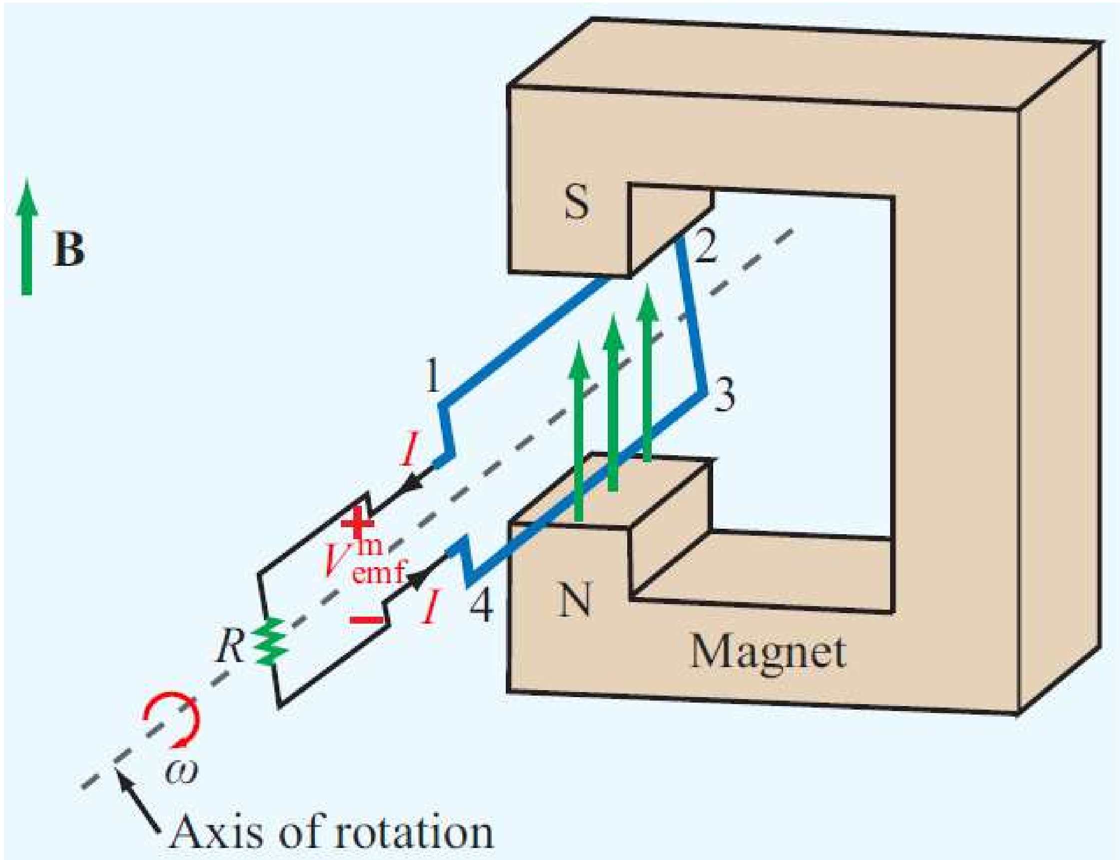






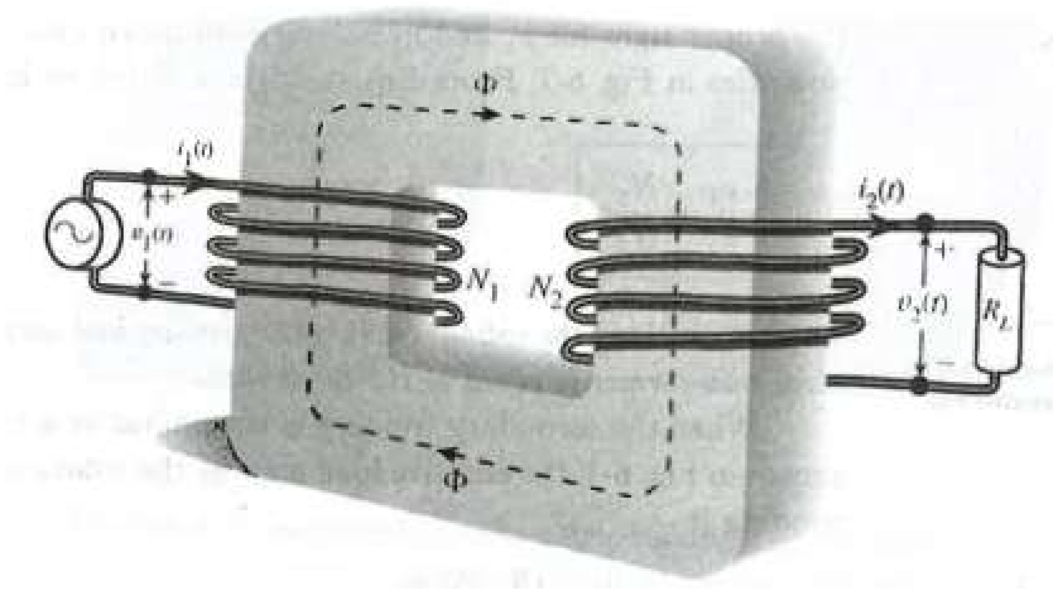


Generator: alternating current

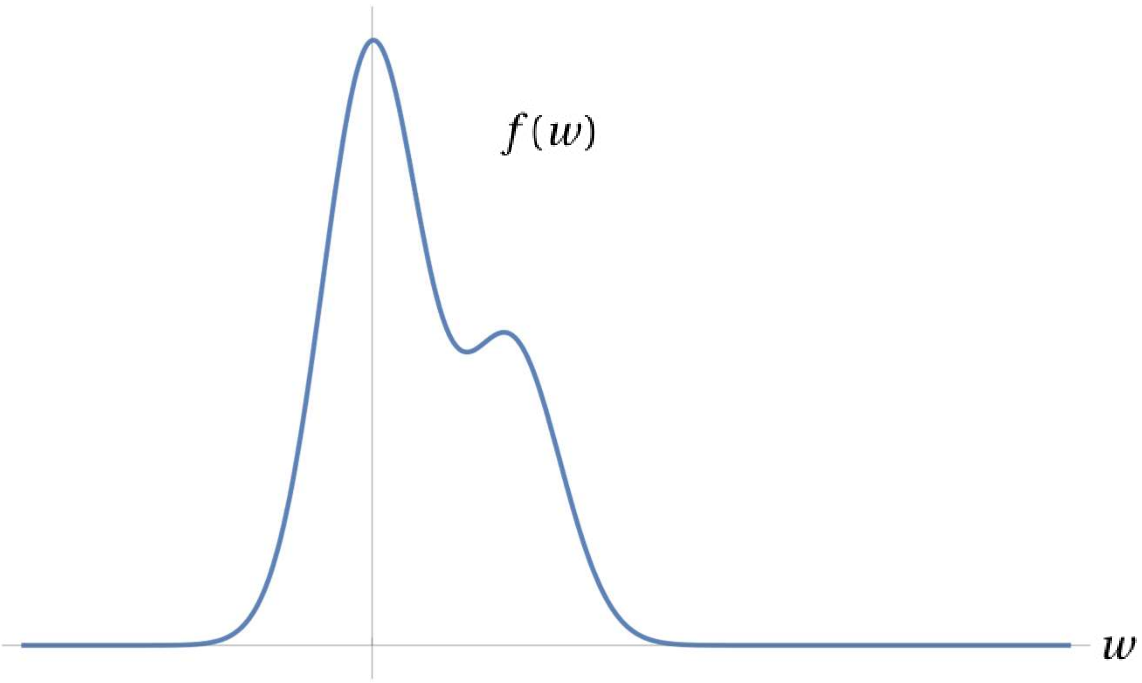


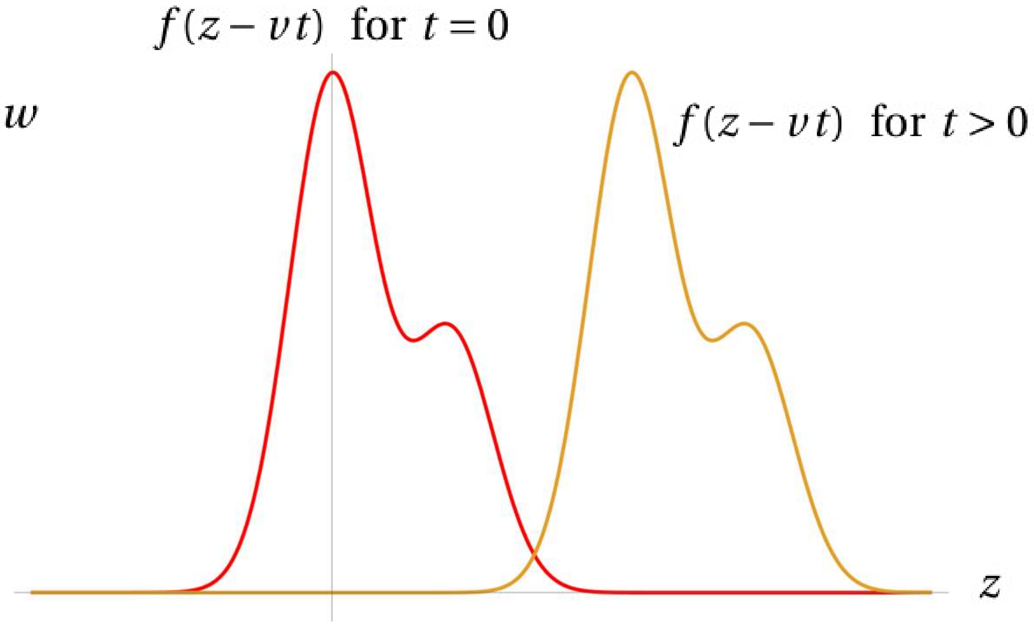
from: Ulaby, p. 316)

Transformer



from: Cheng, p. 233)


$f(w)$
w


$f(z-vt)$ for $t=0$
$f(z-vt)$ for $t>0$
z

Speed of light

- Ole Römer (1644–1710)
  - 220000 km/s
- James Bradley (1693–1762)
  - 304300 km/s (?)
- Hippolyte Fizeau (1819 – 1896)
  - 313000 km/s
- Léon Foucault (1819–1868)
  - 297000 km/s

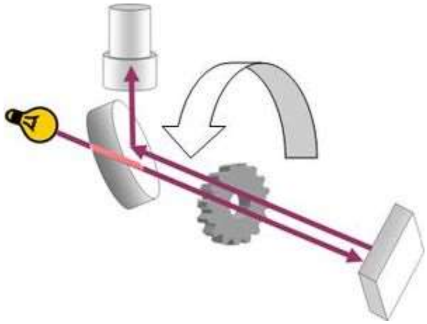


Table 1. The determination of "*c*."

	Year	Author	Method	Value of *c*	Ref
Space-Based Measures	Obs. 1671 to 1673, Published 1676	O.C. Rømer (1644-1710)	Moon of Jupiter eclipses	48,023 leagues/second [214,000 km/s]	[7]
	1690	C. Huygens (1629-1695)	Moon of Jupiter Eclipses	1,000 Earth diameters/minute [212,500 km/s]	[11]
	1694	E. Halley (1656-1742)	Moon of Jupiter Eclipses	278,000 km/s	[12]
	1729	J. Bradley (1693-1762)	Parallax aberration	10210 times the speed of Earth in its orbit [304,00km/s]	[13]
Earth-Based Measures	1849	A.H.L. Fizeau (1819-1896)	Toothed wheel	70,948 leagues/s [313,300km/s]	[14]
	1862	J.B.L. Foucault (1819-1868)	Rotating Mirror	298,000[±500]km/s	[15] [16]
	Exp. 1906 Pub. 1907	E.B. Rosa and N.E. Dorsey (1861-1921) (1873-1959)	Measurement of electromagnetic constants	299,788[±30]km/s	[17]
	1926	A.A. Michelson (1852-1931)	Rotating Mirror	299,796[±4]km/s	[18]
	1950	L. Essen (1908-1997)	Cavity Resonator	299,7925.5[±3]km/s	[19]
	1958	K.D. Froome (1921-1995)	Radio interferometry	299,792.50[±0.10]km/s	[20]
	1972	Evenson et al.	Laser interferometry	299,792.4562[±0.0011]km/s	[21]
	1983	17th CGPM	Fixed and used to define the meter	299,792.458km/s	

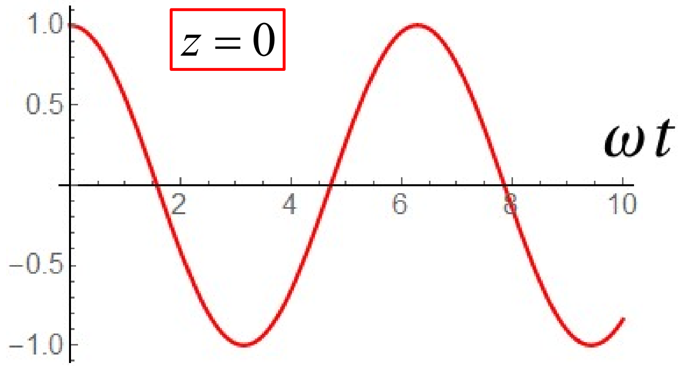
Time-harmonic fields

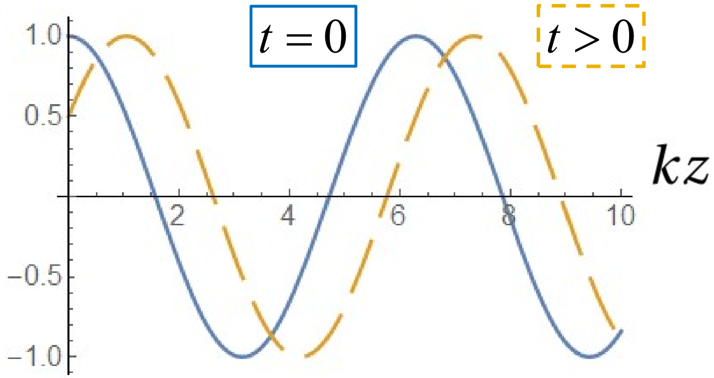
complex

$$\mathbf{E}(\mathbf{r}, t) = \mathrm{Re}\left\{\mathbf{E}(\mathbf{r})\, e^{\mathrm{j}\omega t}\right\}$$

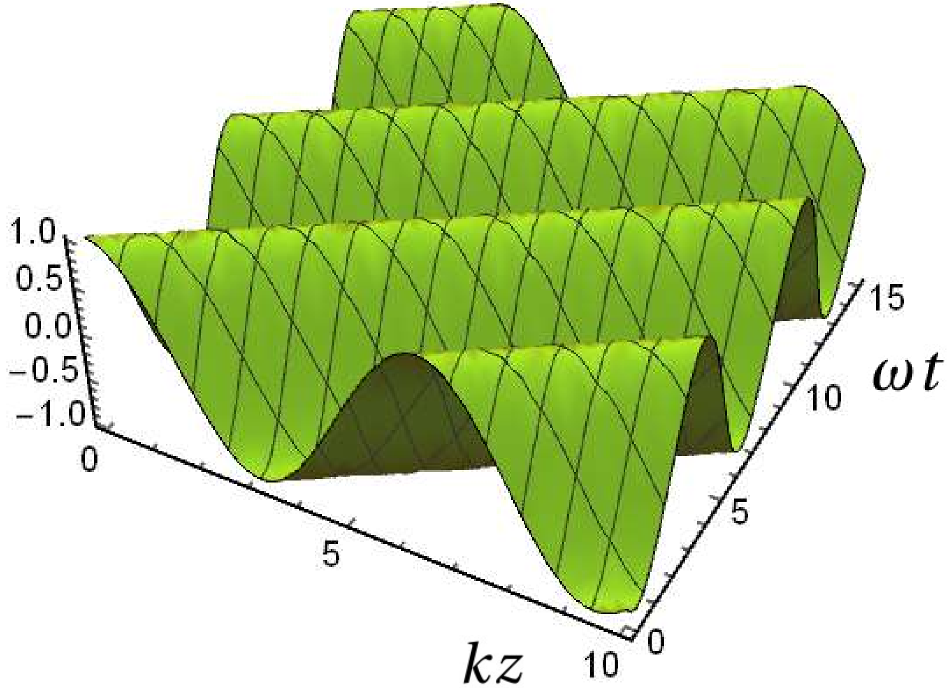
real,
explicitly time-dependent

a sinusoidal wave



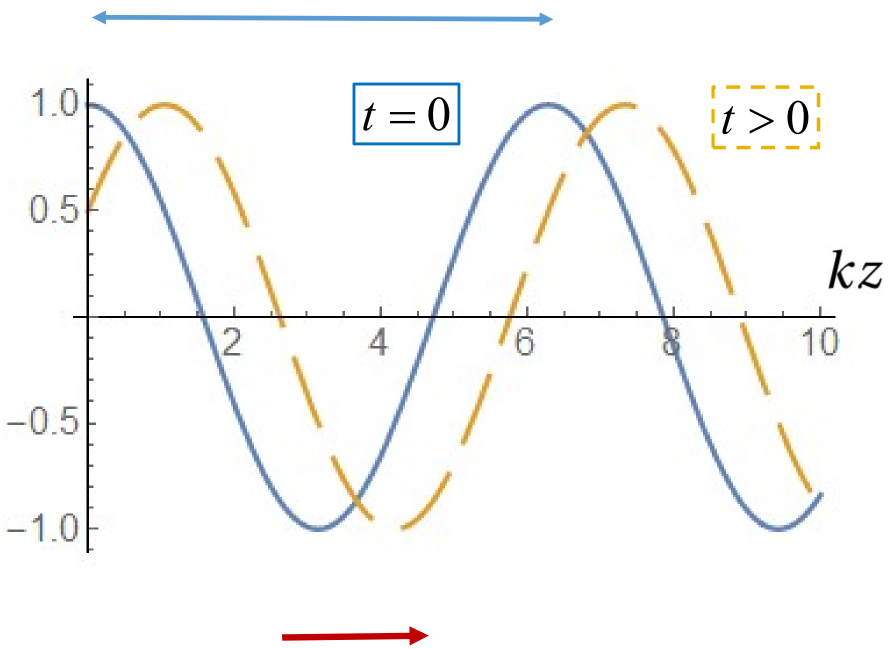


$$A\cos(\omega t - kz)$$



Wavelength and phase velocity

$$k\lambda = 2\pi$$



constant phase: $kz = \omega t$

$$A\cos(\omega t - kz)$$

$$\boxed{\lambda = \frac{2\pi}{k}}$$

$$\boxed{v = \frac{\omega}{k}}$$

Plane wave in free space

$$\mathbf{E}(z) = \mathbf{u}E_0 e^{-jkz}$$

assumed real

$$\mathbf{E}(z,t) = \mathrm{Re}\left\{\mathbf{E}(z)e^{j\omega t}\right\} = \mathrm{Re}\left\{\mathbf{u}E_0 e^{j(\omega t - kz)}\right\} = \mathbf{u}E_0 \cos(\omega t - kz)$$

$$k = \omega\sqrt{\mu_0\varepsilon_0}$$

$$v = \frac{\omega}{k} = \frac{1}{\sqrt{\mu_0\varepsilon_0}} = c$$

$$\boxed{\lambda = \frac{2\pi}{k} = \frac{2\pi}{\omega\sqrt{\mu_0\varepsilon_0}} = \frac{1}{f\sqrt{\mu_0\varepsilon_0}} = \frac{c}{f}}$$

$$f = 100\,\mathrm{MHz} \quad \Leftrightarrow \quad \lambda = 3\,\mathrm{m}$$

$$f = 30\,\mathrm{GHz} \quad \Leftrightarrow \quad \lambda = 1\,\mathrm{cm}$$

Complex vector: time-dependence