Experimental Physics 3 - Em-Waves,Optics, Quantum mechanics

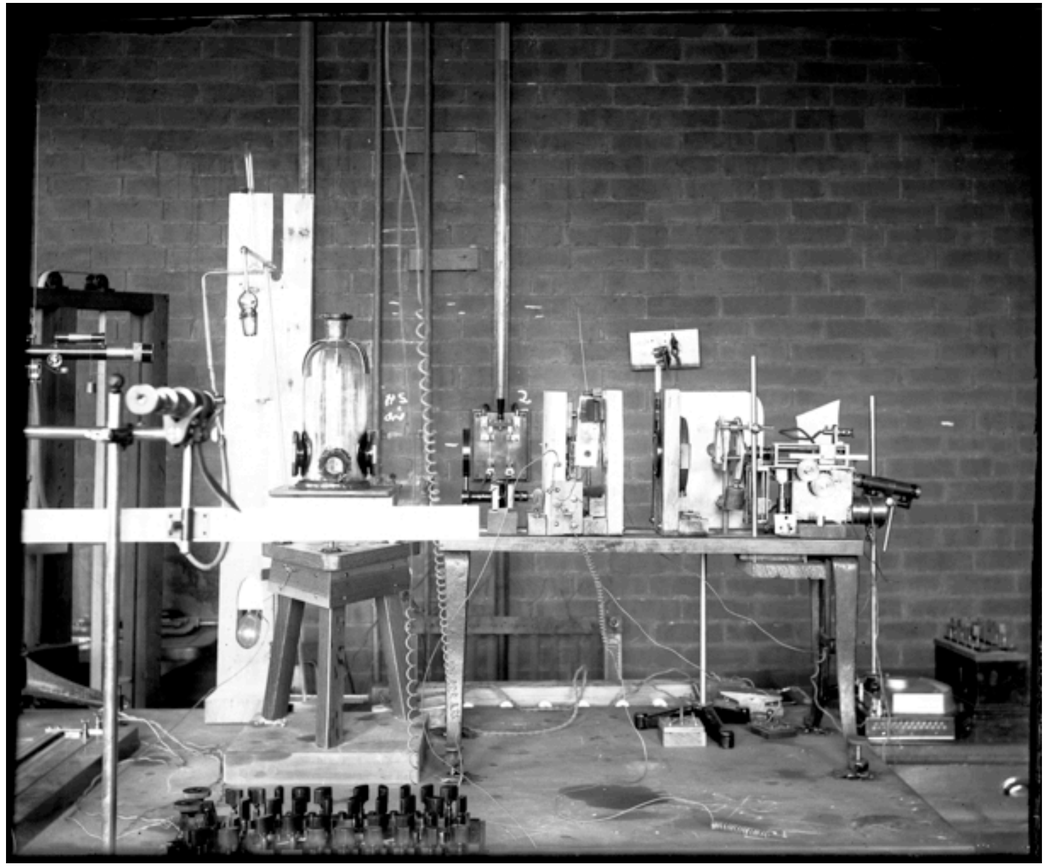
Lecture 14

Prof. Dr. Frank Cichos
WS 2022/23

Radiation Pressure

A PRELIMINARY COMMUNICATION ON THE PRESSURE OF HEAT AND LIGHT RADIATION.

By E. F. Nichols and G. F. Hull.



Nichols-Hull experimental apparatus

1900-1903 Wilder Physical Laboratory, Darthmouth College

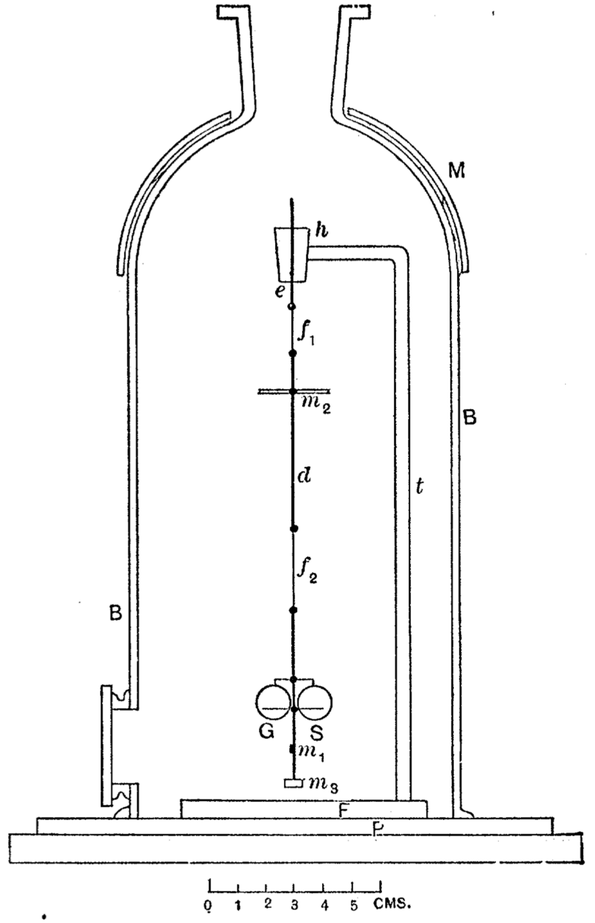
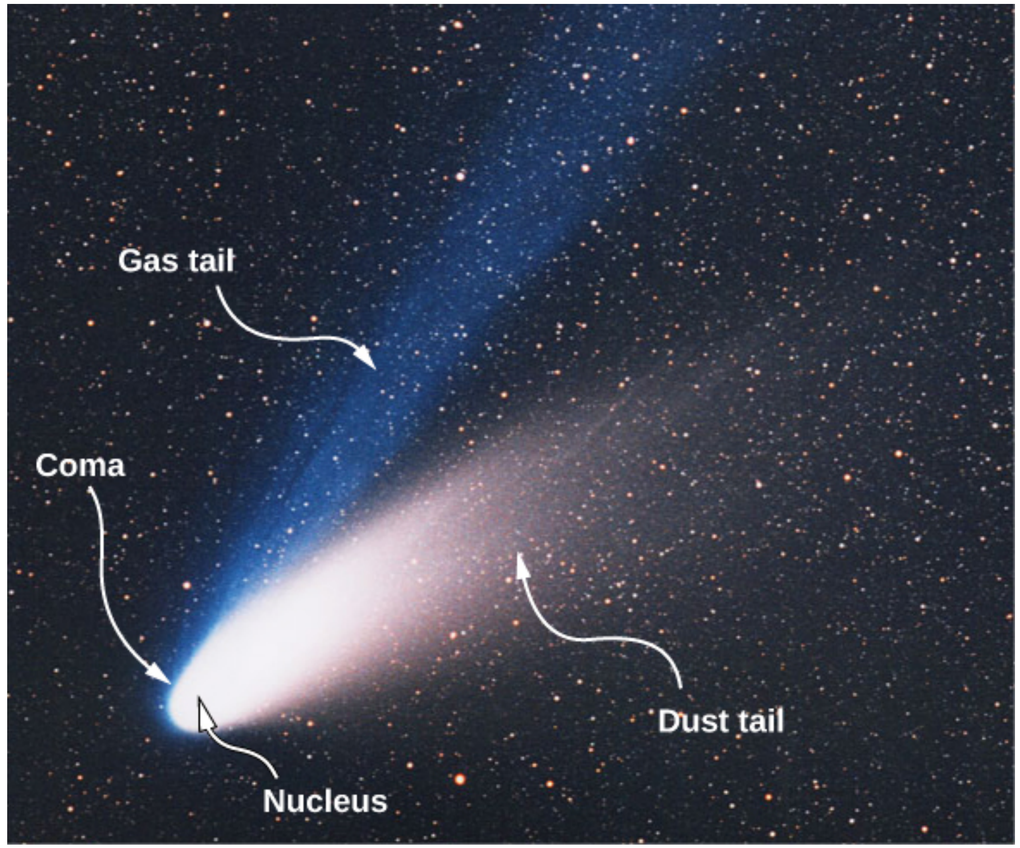


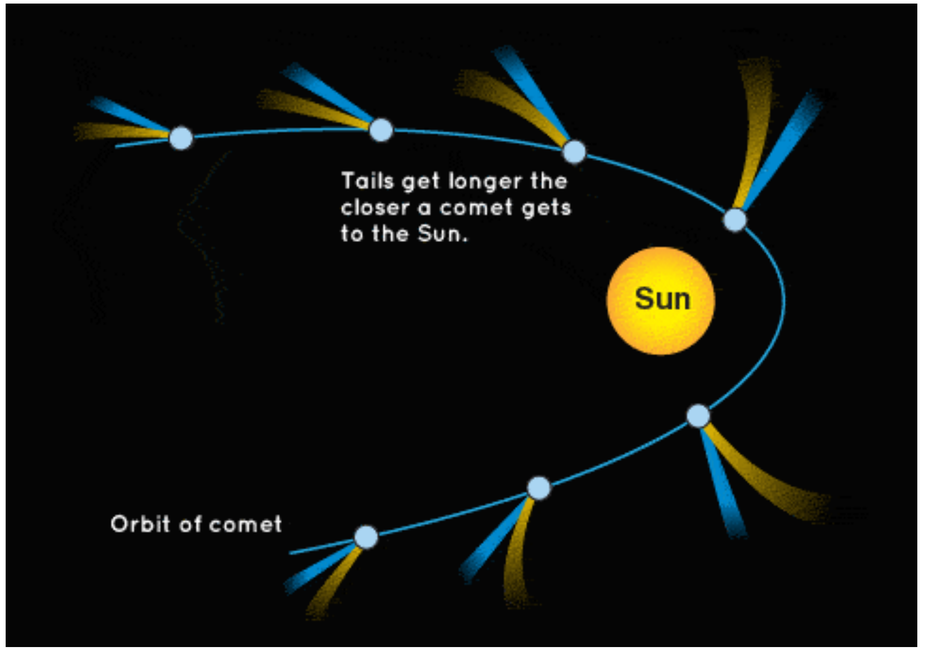
Fig. 2.

E. F. Nichols and G. F. Hull
Phys. Rev. (Series I) **13**, 307 – Published 1 November 1901

Radiation Pressure



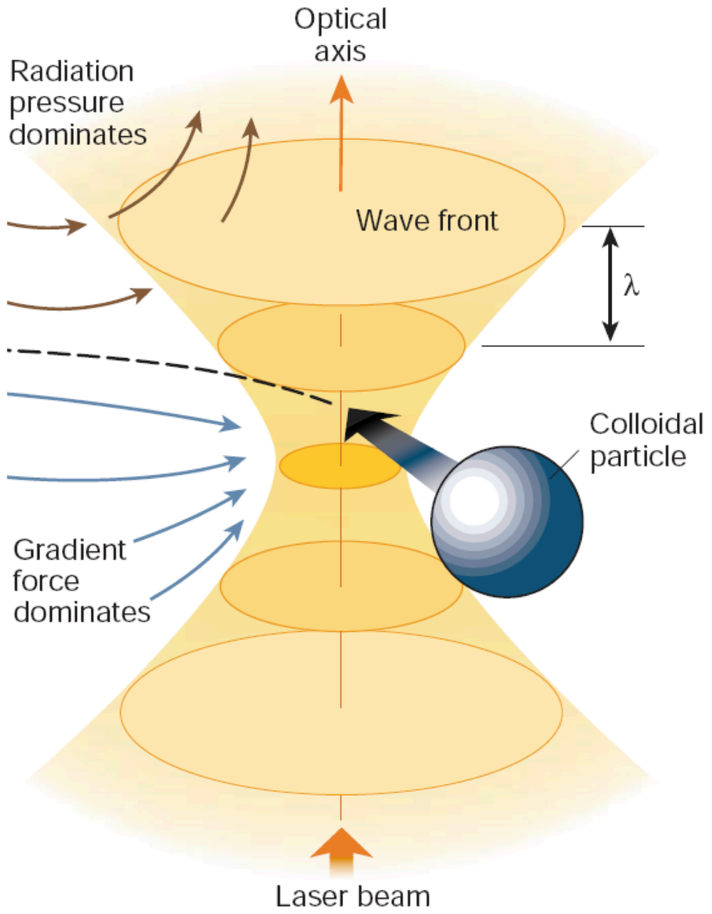
tails of a comet



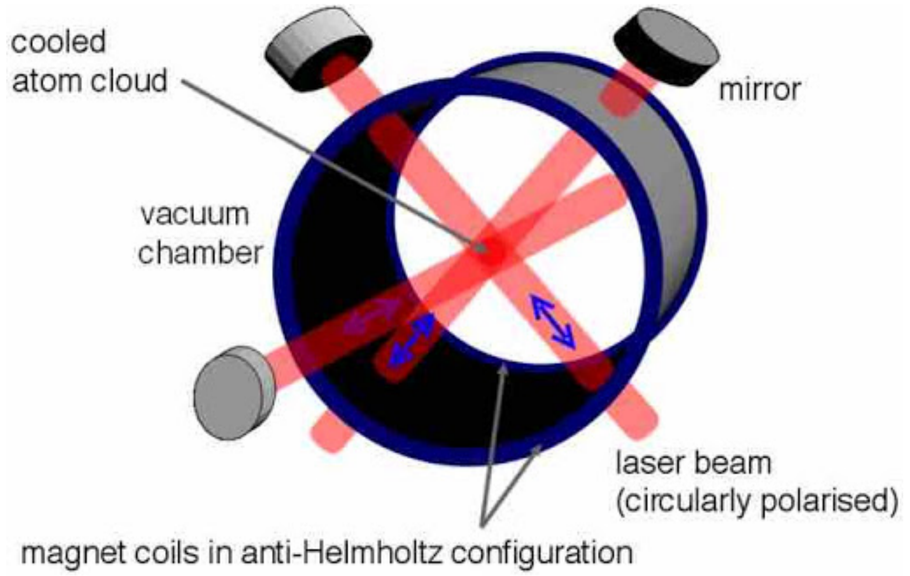

Comet Neowise photographed by B. Cichos 2020

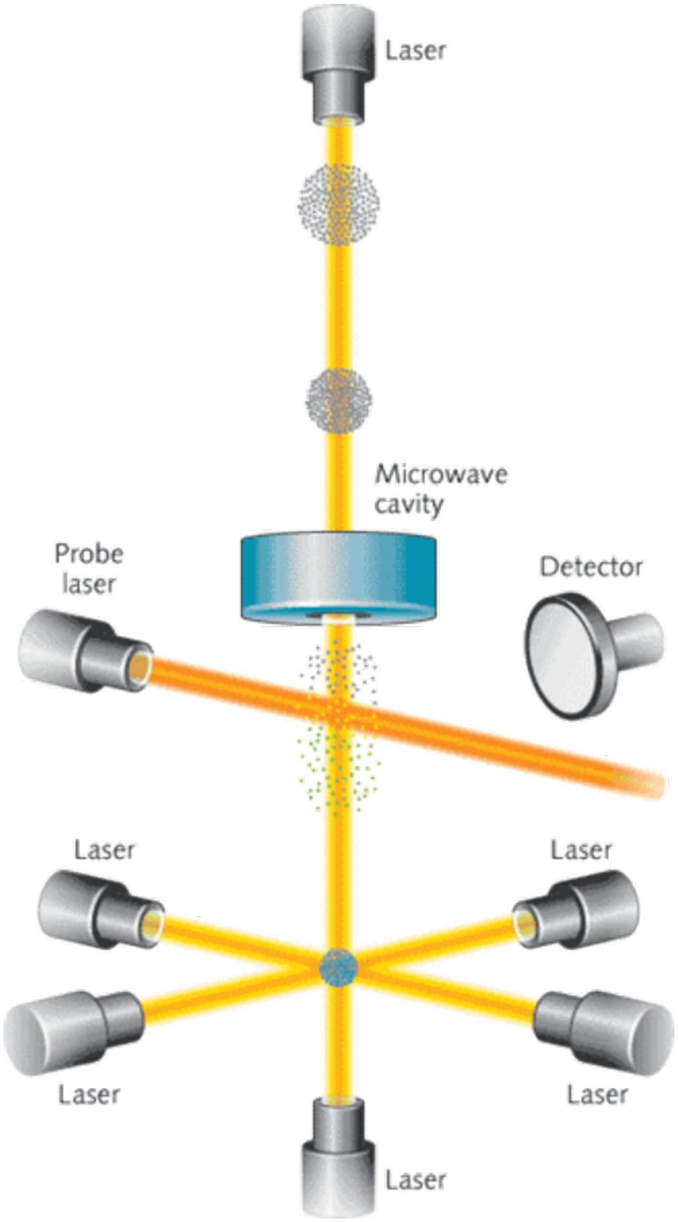
Radiation Pressure

Trapping colloidal particles



Trapping & Cooling of atoms

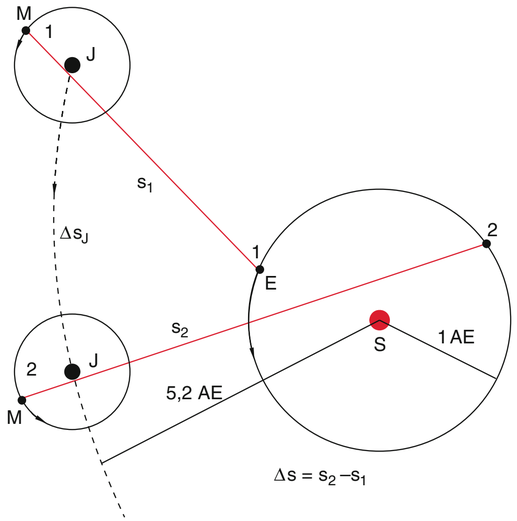




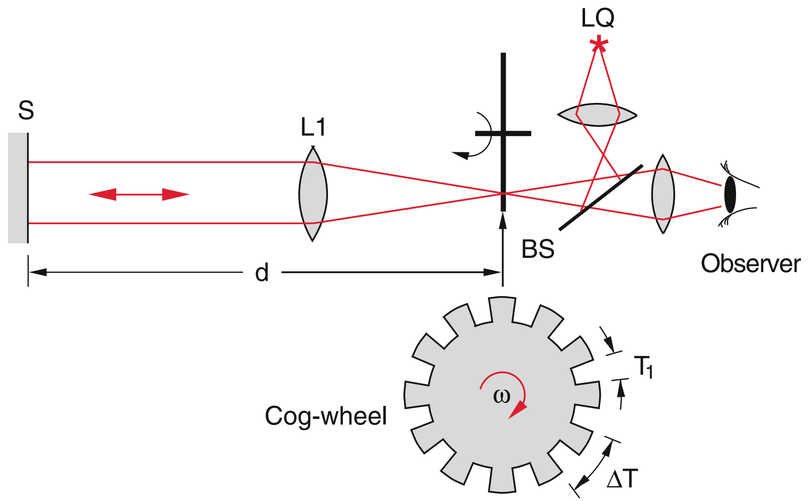
Fountain Atomic Clock

Speed of Light Measurement

Astronomical method (Ole Rømer)

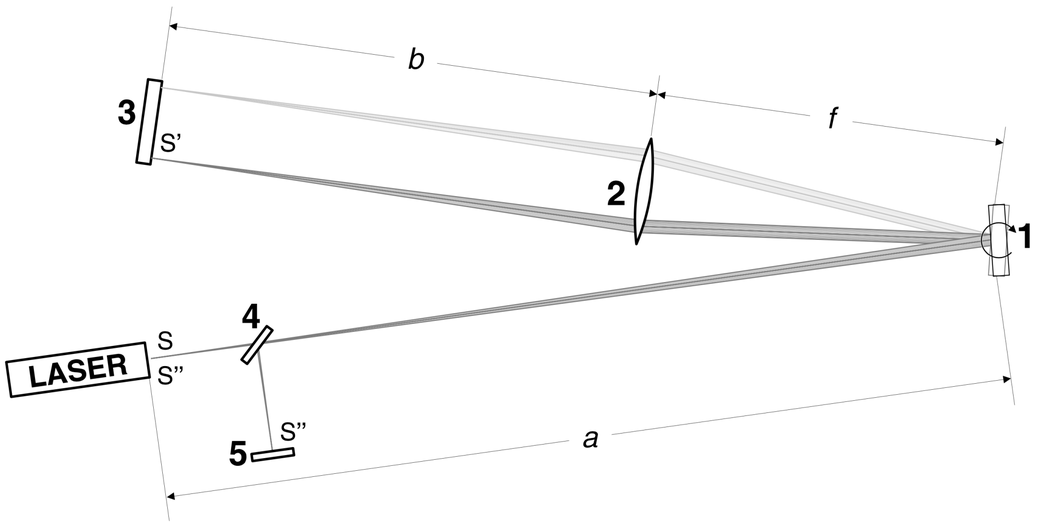


Cogwhell (Fizeau)



Speed of Light Measurement

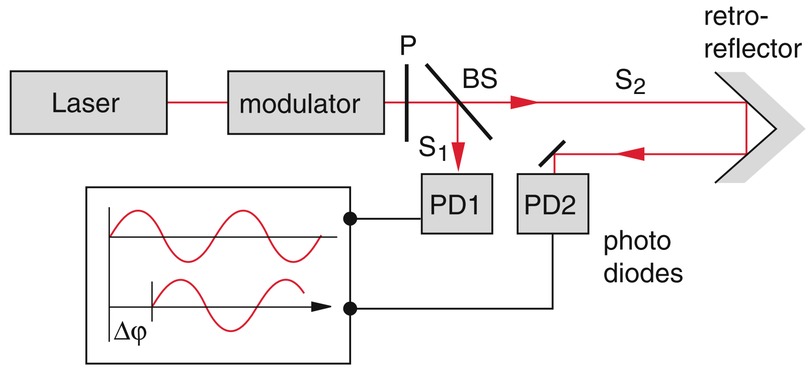
Rotating Mirror (Foucault)



Year	Author	Method	Measured value given in km/s
1677	Ole Rømer	astronomical	finite, no value given
1678	Huygens	Analysis of Romers measurements	220–300 × 10^3
1849	A. Fizeau	cogwheel method	315 000
1862	L. Foucault	rotating mirror method	298 000
1879	A. Michelson	improved rotating mirror technique	299 910
1926	A. Michelson	interferometer	299 791
1950	L. Essen	Microwave cavity	299 792,5
1973	K. Evenson	measurement of wavelength and frequency of a laser transition	299 792,45
seit 1983	–	todays defined fixed value	299 792,458

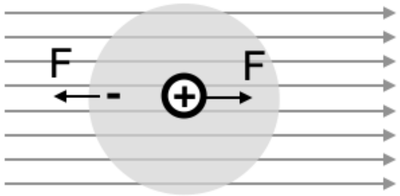
299 792 458 ms^{-1}

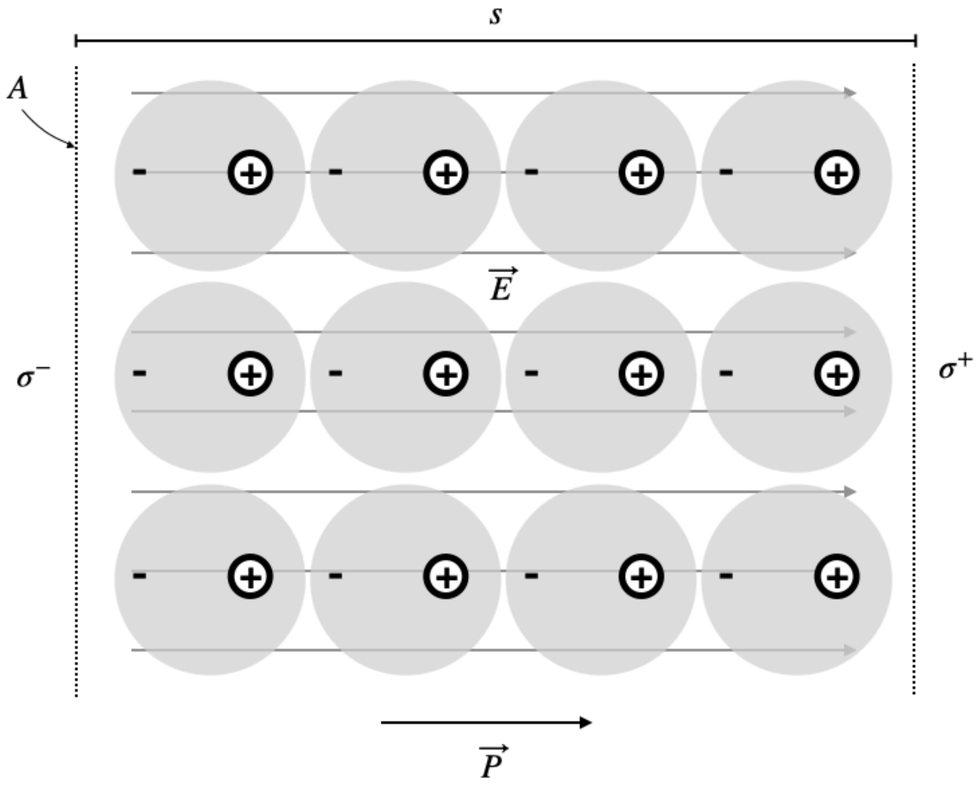
Phase Method



Electric fields in Materials

Electric fields in Materials





Negative Refraction

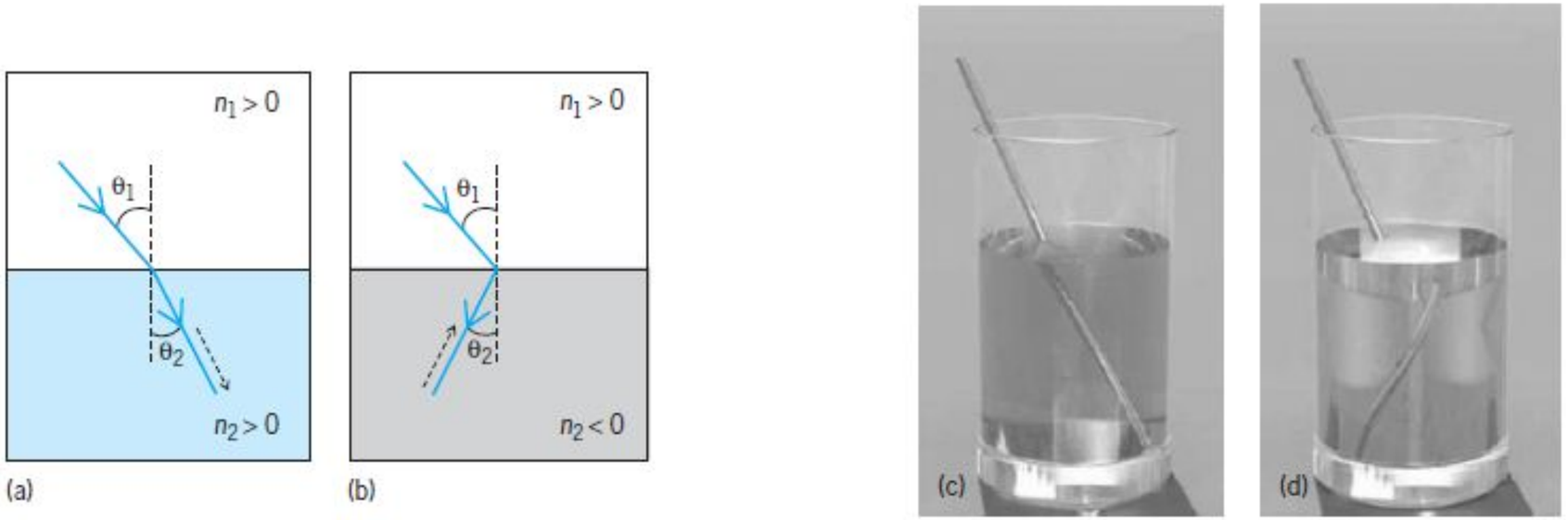
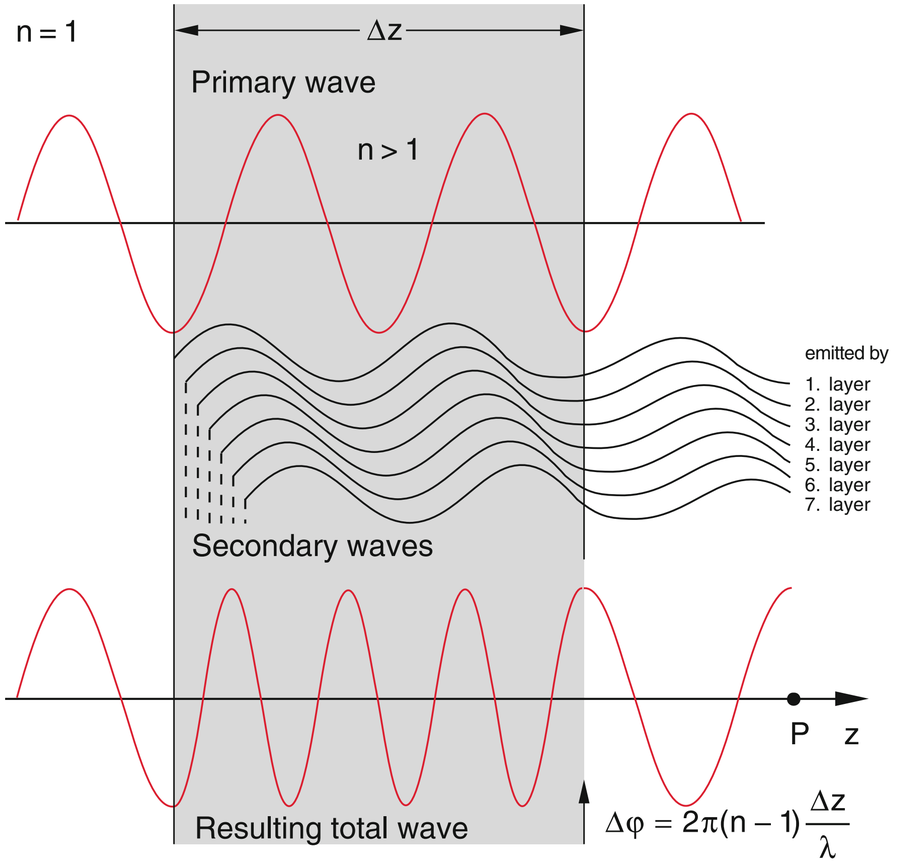


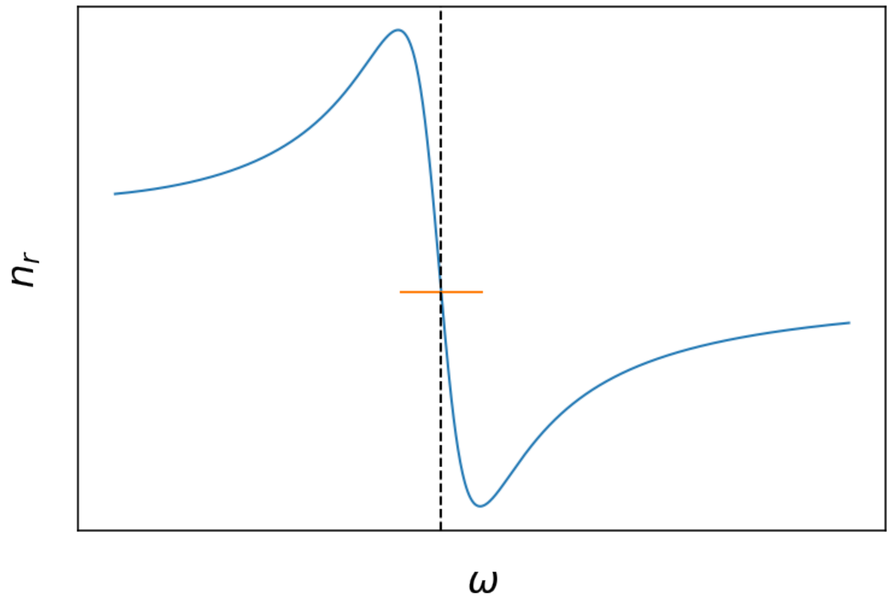
Fig. 1. Refraction: Diagrams of (*a*) positive refraction and (*b*) negative refraction; and calculated images of a metal rod (*c*) in a glass filled with regular water ($n = 1.3$), and (*d*) in a glass filled with "negative-index water" ($n = -1.3$). In parts *a* and *b*, solid lines with arrows indicate the direction of the energy flows, broken lines with arrows show the direction of the wave vectors. (*Parts c and d from G. Dolling et al., Photorealistic images of objects in effective negative-index materials, Opt. Express, 14:1842–1849, 2006*)

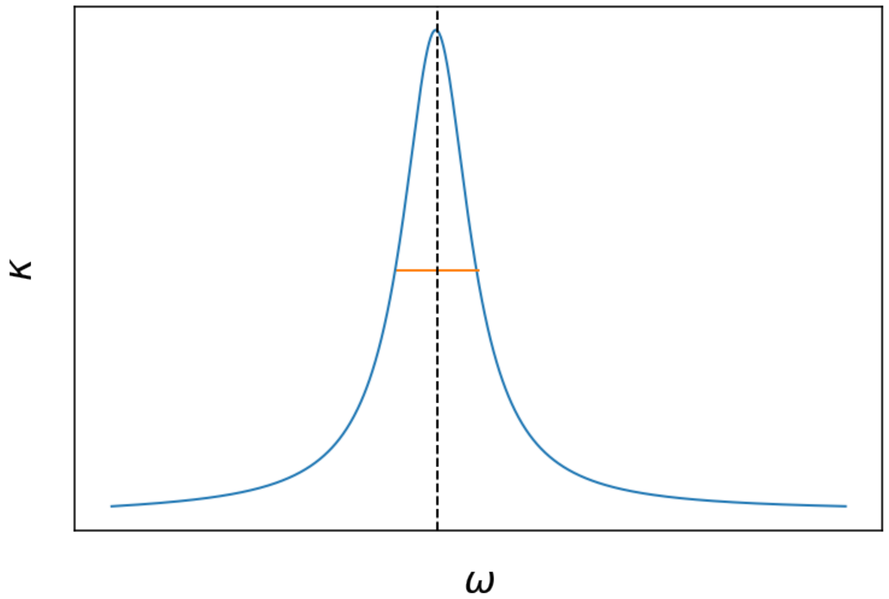
Effect of Materials



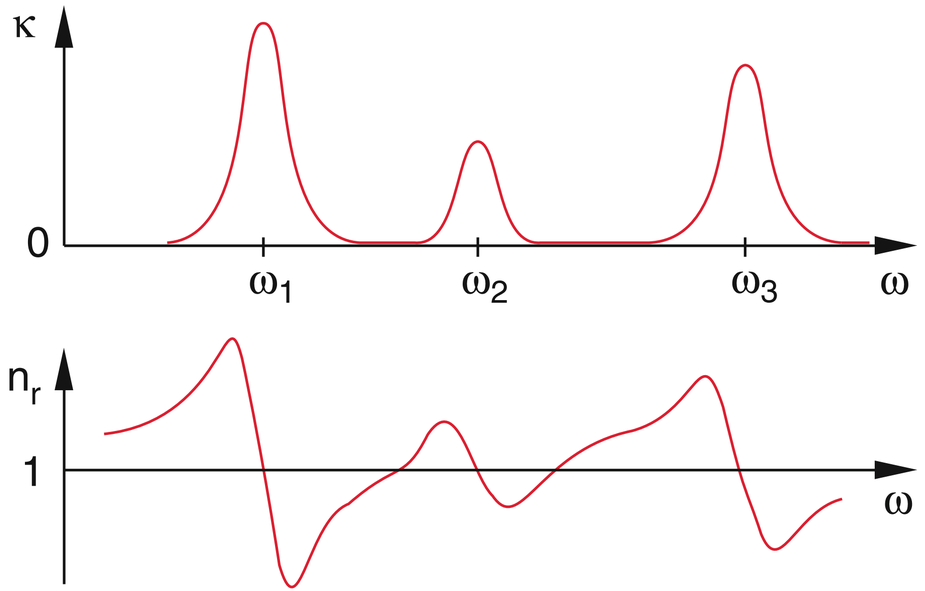
$$E(z) = \underbrace{E_0 e^{i(\omega t - kz)}}_{E_e} - \underbrace{ik(n-1)\Delta E_0 e^{i(\omega t - kz)}}_{E_{\text{medium}}}$$

Dispersion and Absorption

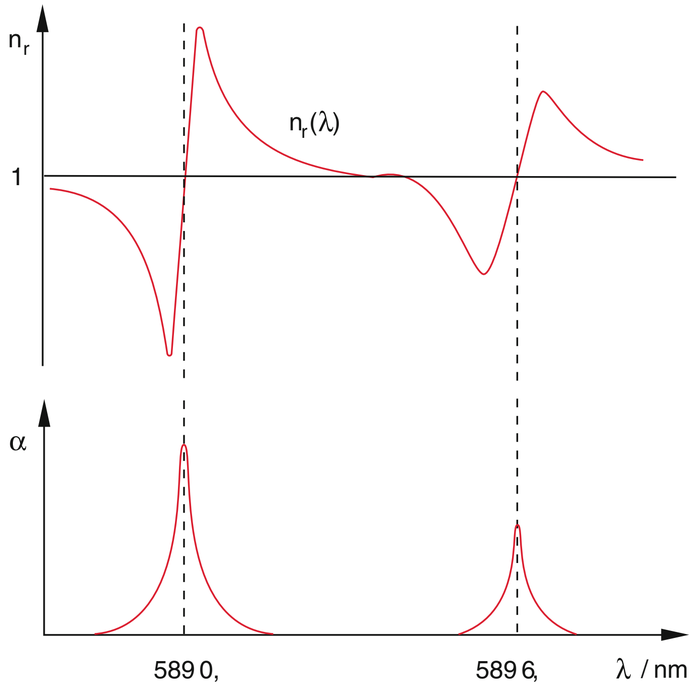


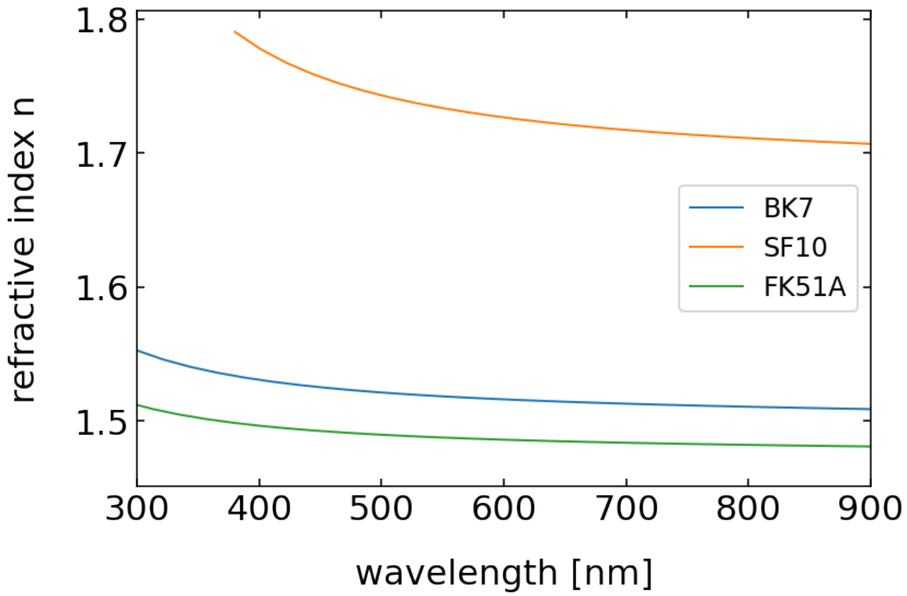


Dispersion and Absorption

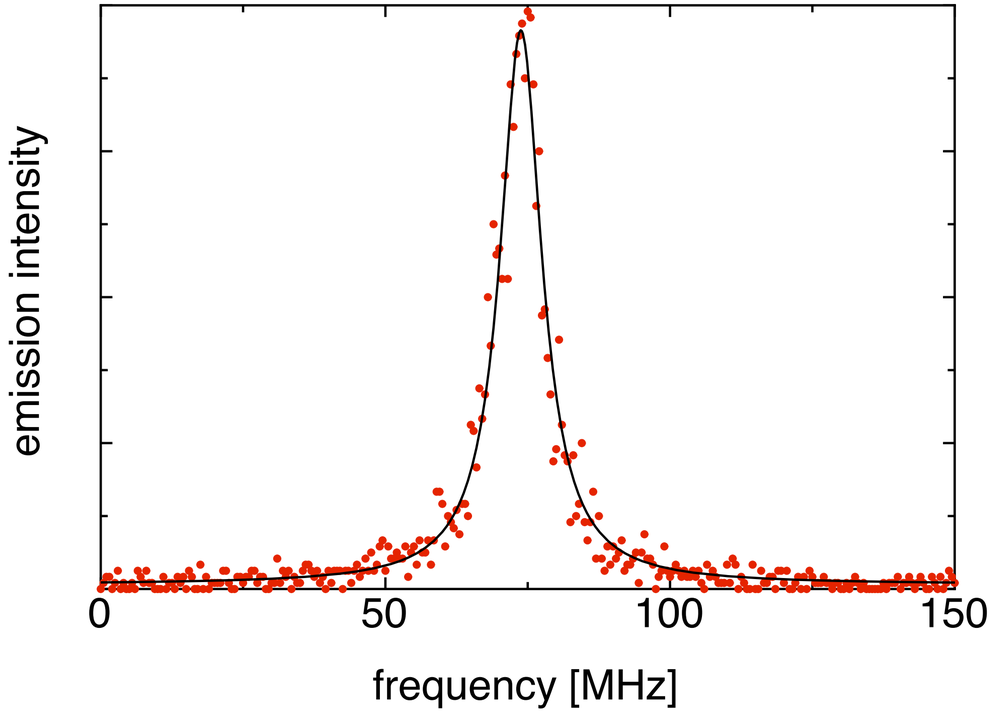


Dispersion and Absorption



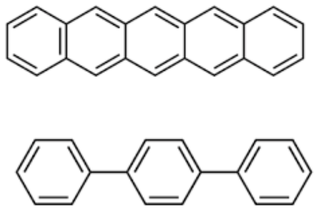


Single Molecule Absorption Line



excitation spectrum
single pentacene molecule in p-terphenyl

T=1.8 K



Absorption Spectra