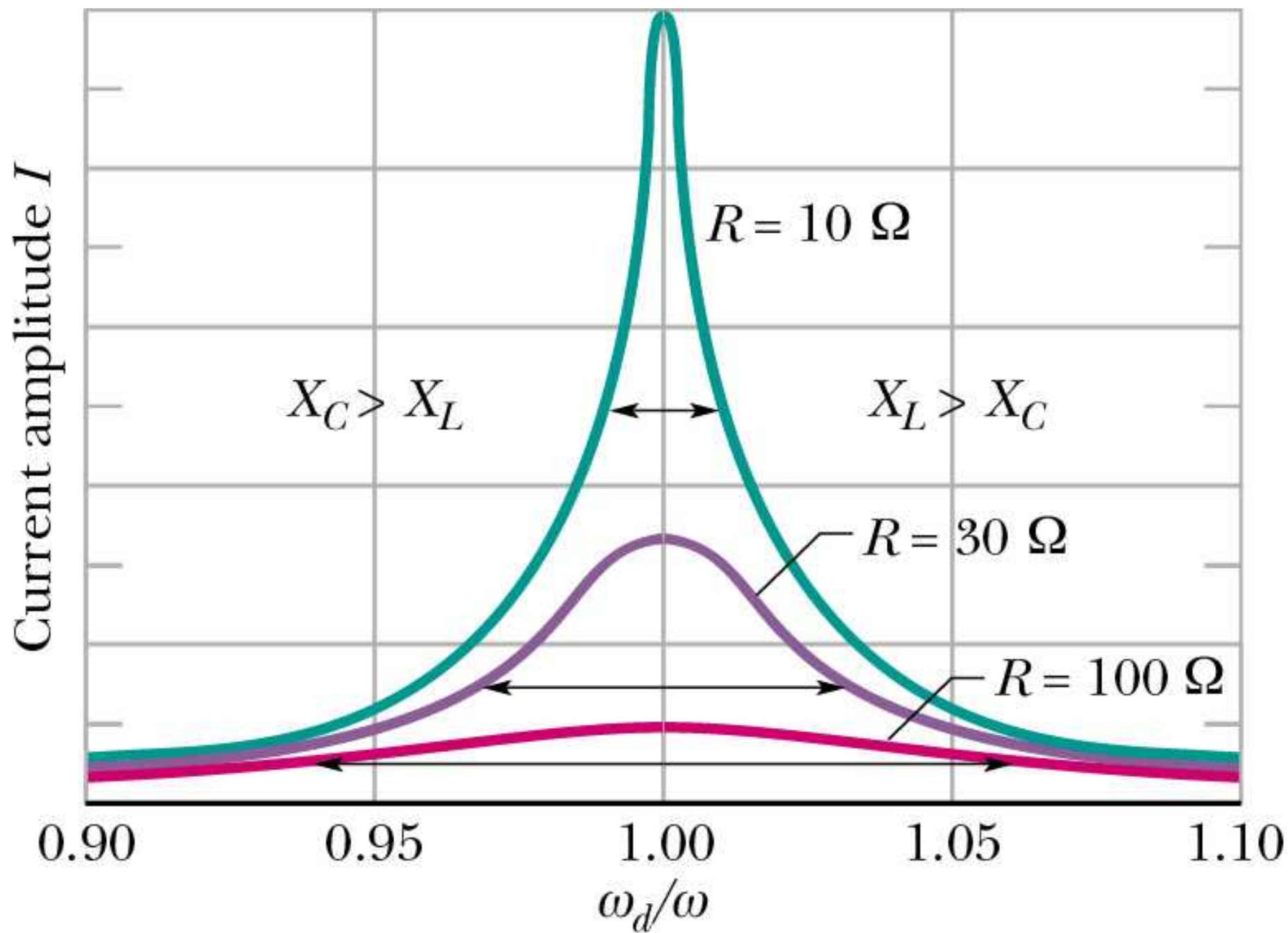
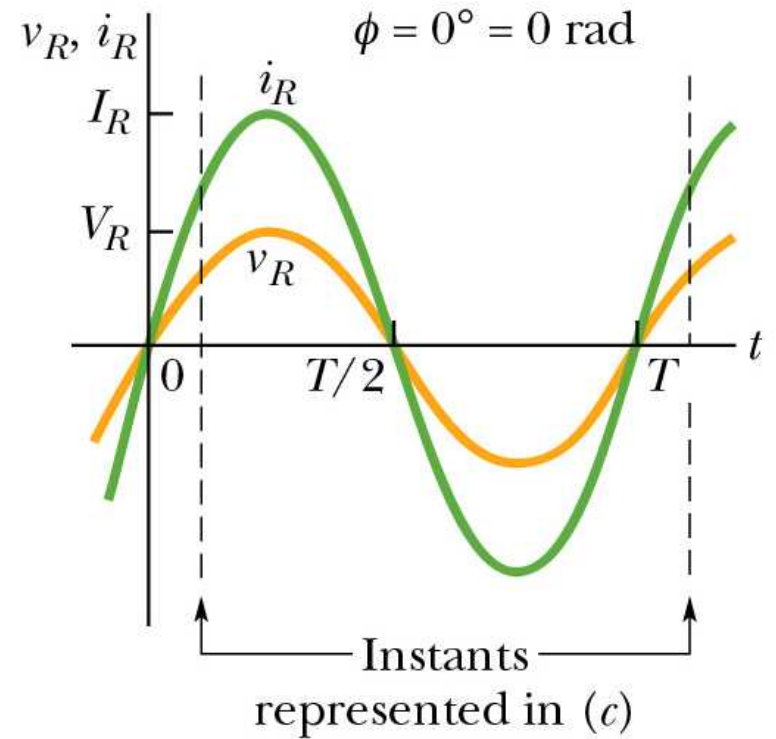
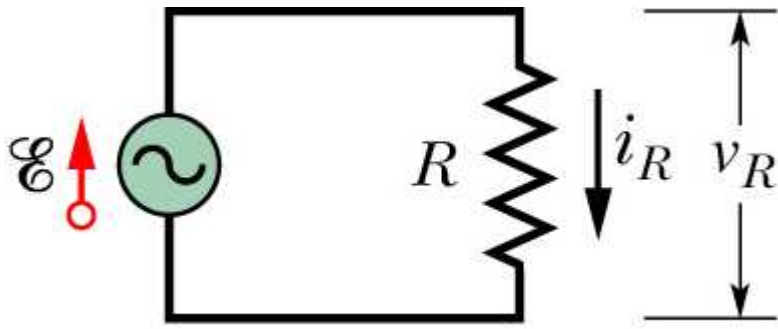


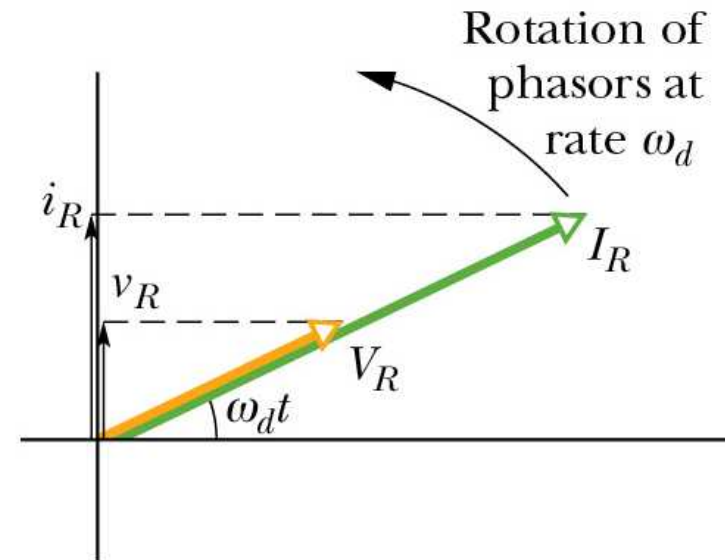
Große Permeabilität:

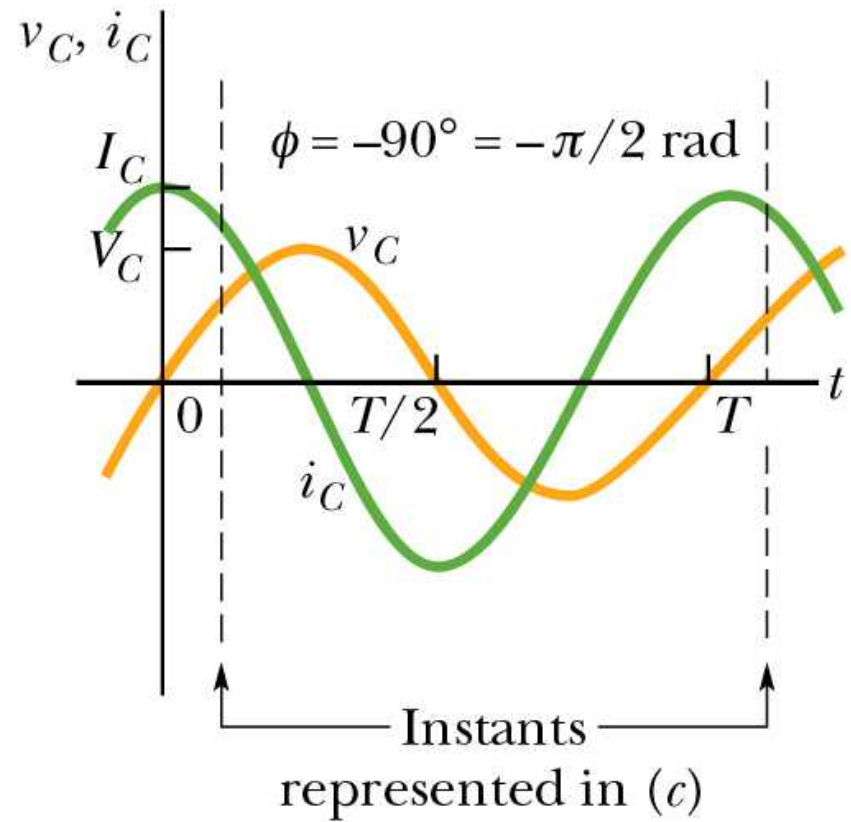
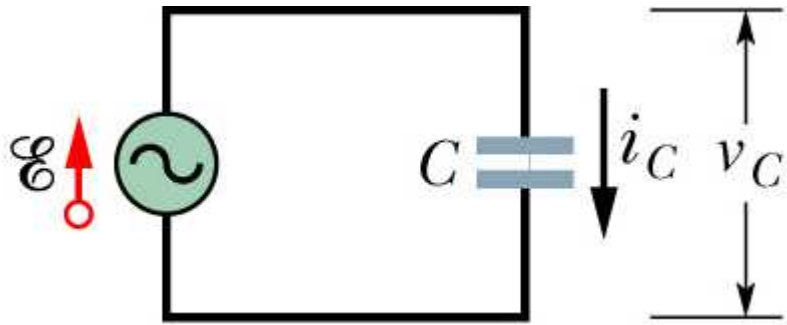
"Eisen leitet die Feldlinien besser als Luft"



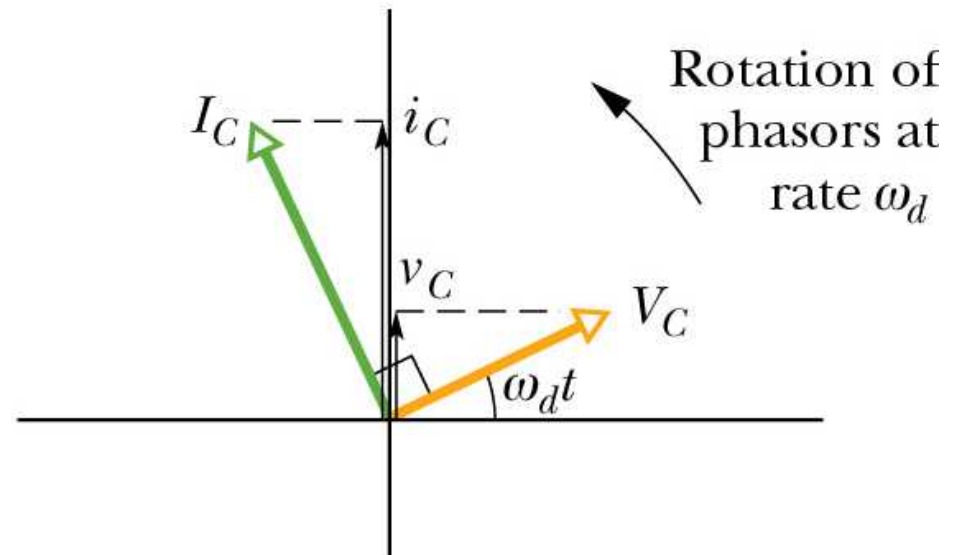


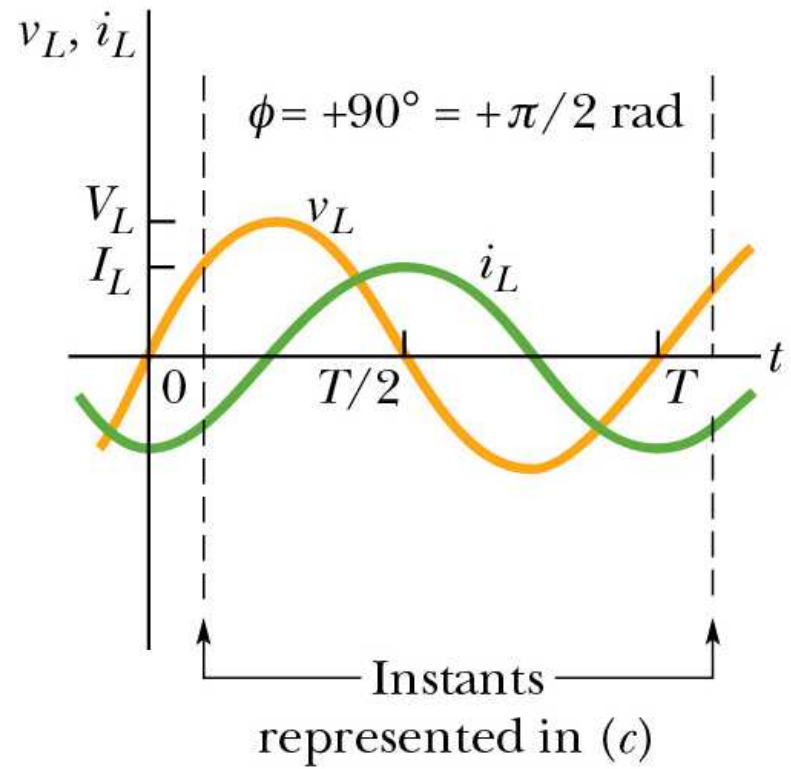
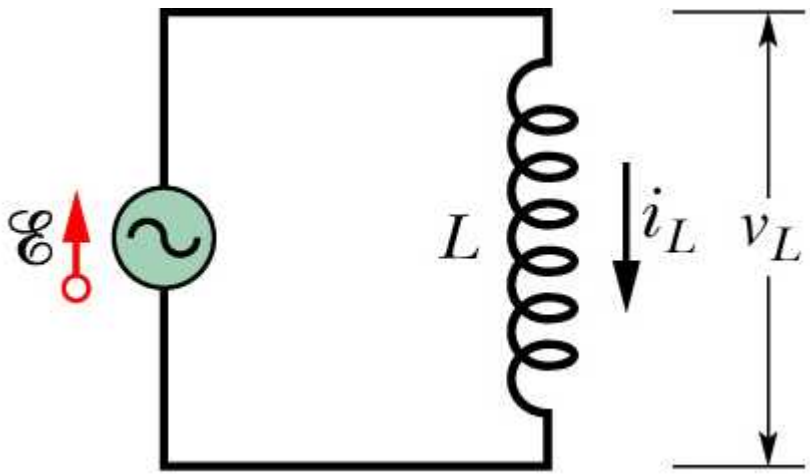
(b)



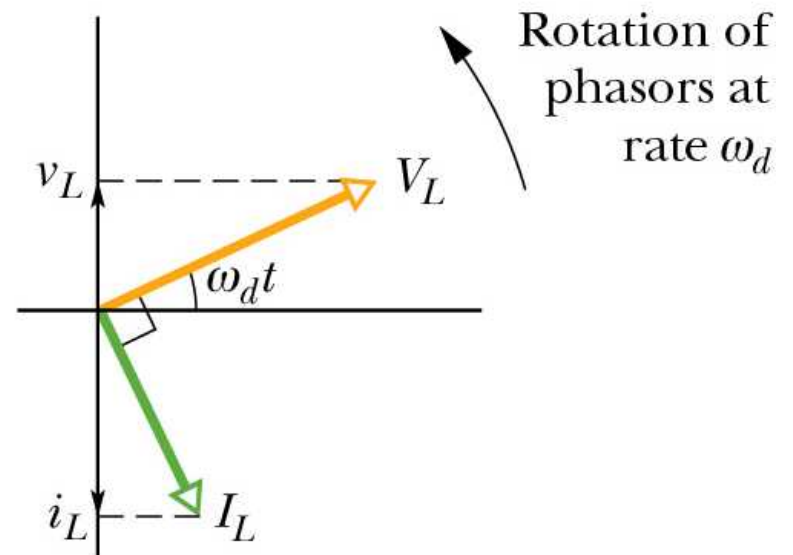


(b)





(b)





Heinrich Hertz und Frau Elizabeth
1886

chem.ch.huji.ac.il/history/hertz.htm

Heinrich Rudolf Hertz

* 22.2.1857 in Hamburg

1883 - 85 Privatdozent an der CAU

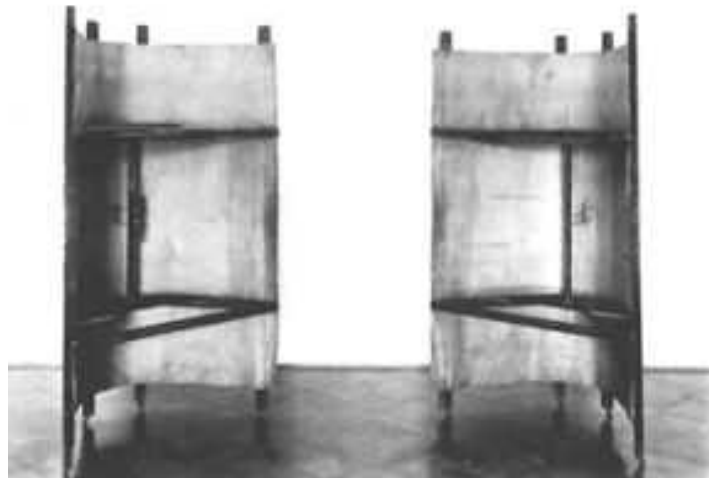
† 1.1. 1894 in Bonn

experimentelle Beobachtung von Radiowellen

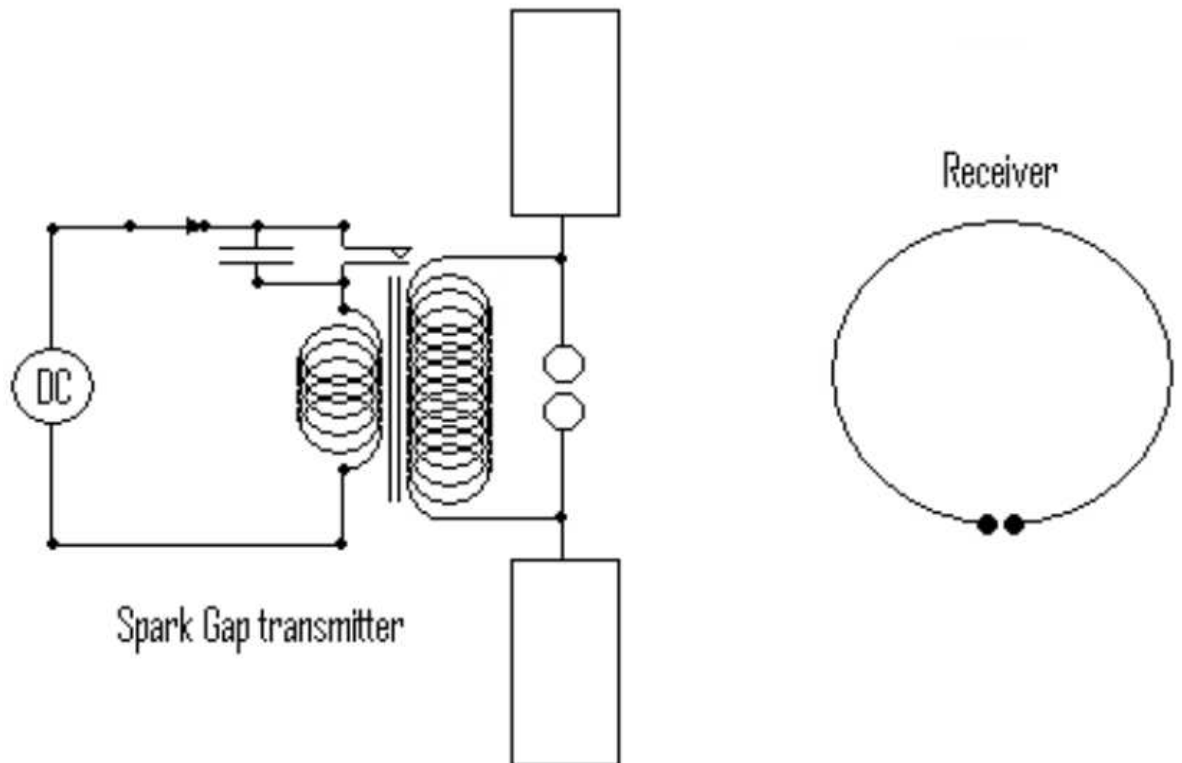
erzeugt mit Funkeninduktor

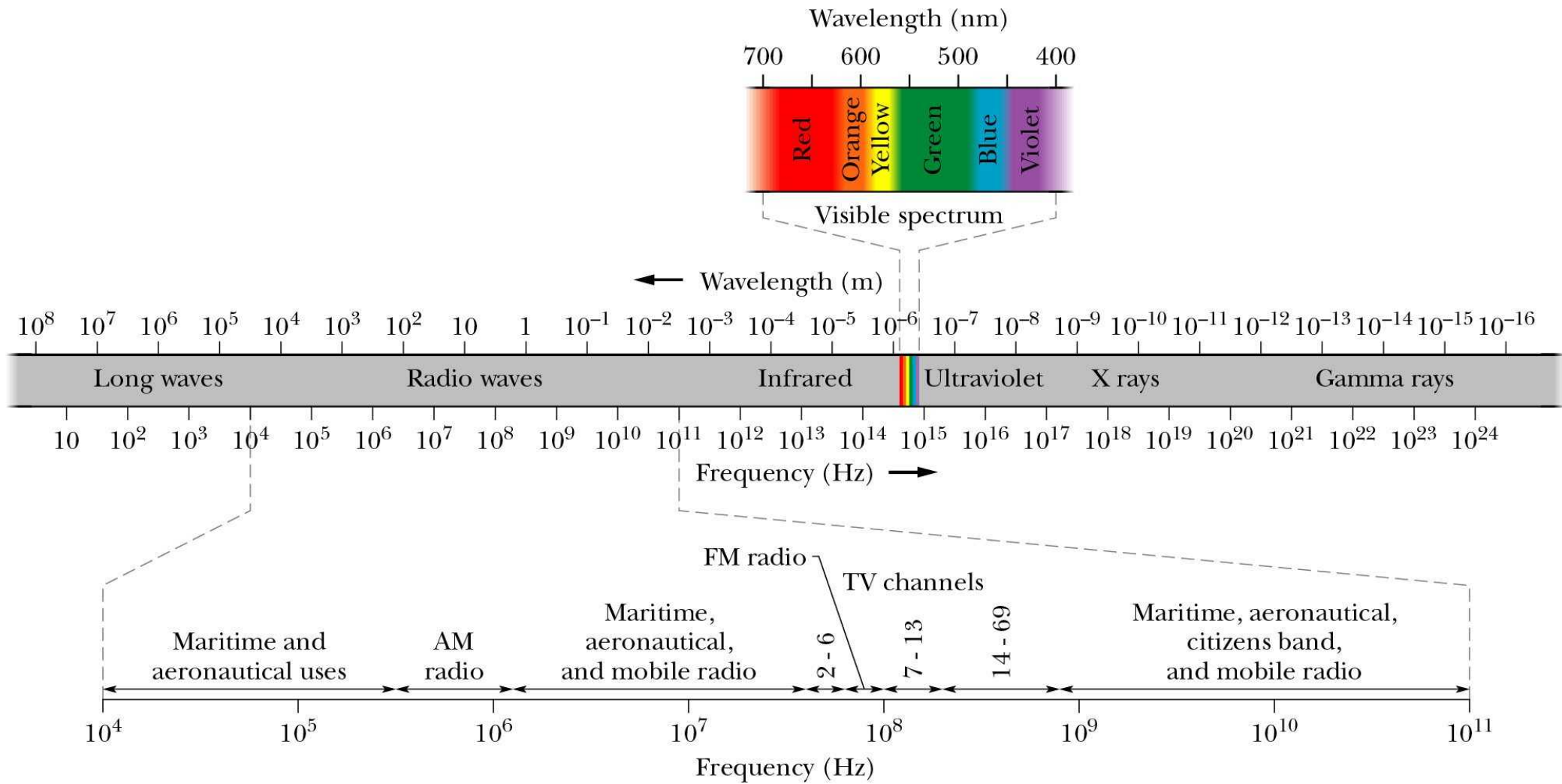
stehende Wellen mit Zinkspiegel

nachgewiesen mit Dipoldetektor



Hertz's transmitter
and receiver, 1886





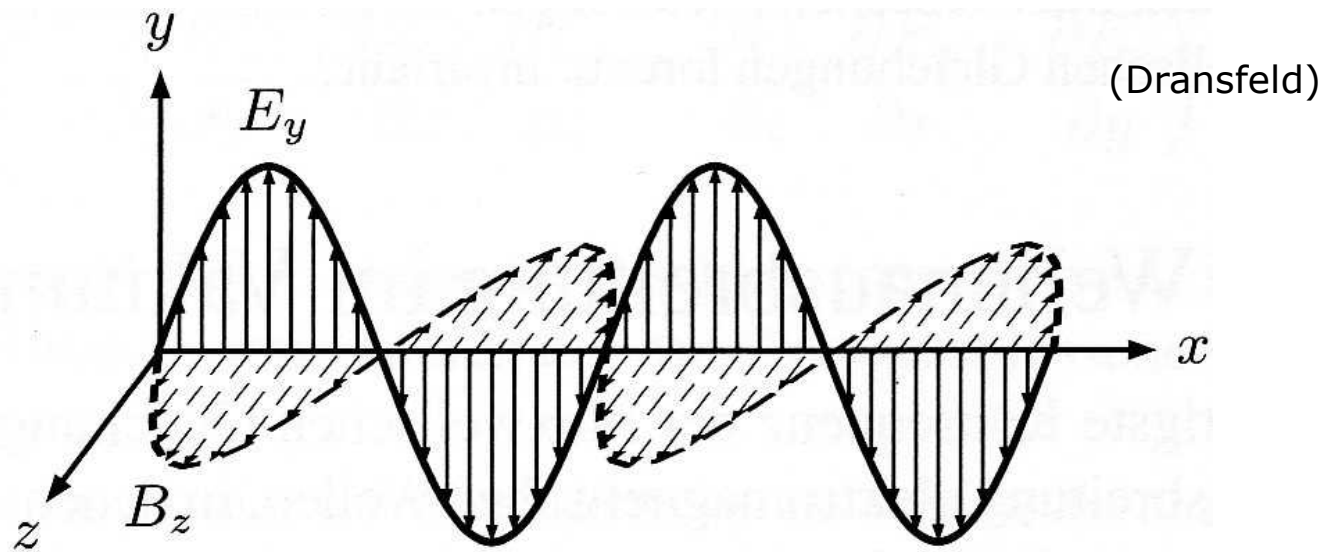
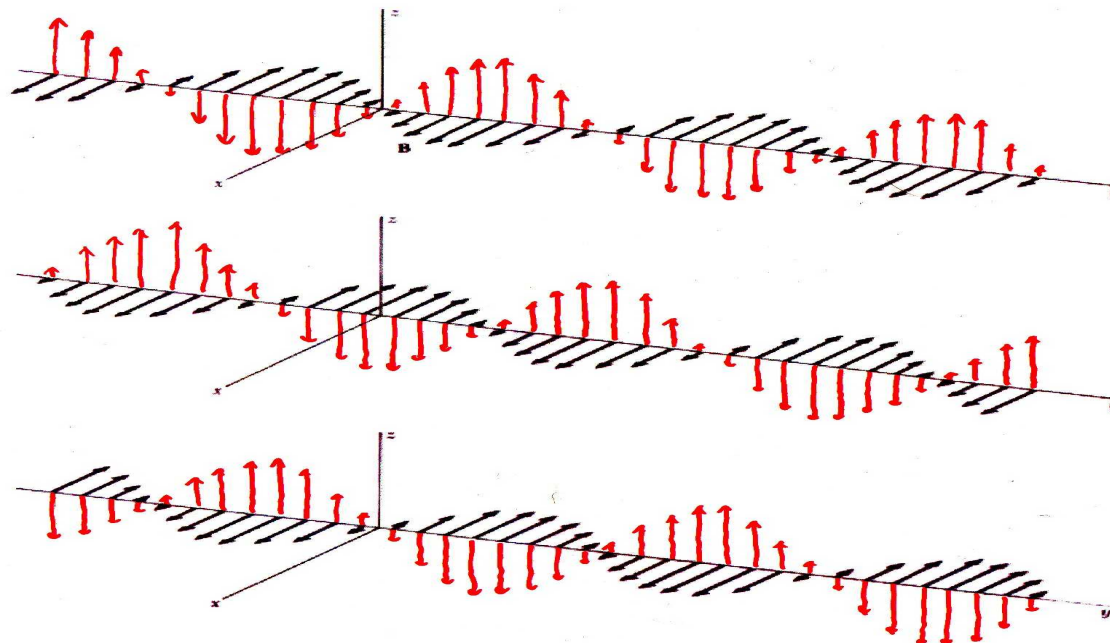


Bild 10.4: Harmonische, ebene elektromagnetische Welle in x -Richtung.



Ergänzung zur Herleitung der Wellengleichung

$$\text{III} \quad \oint \vec{E} \cdot d\vec{S} = -\dot{\Phi}_B$$



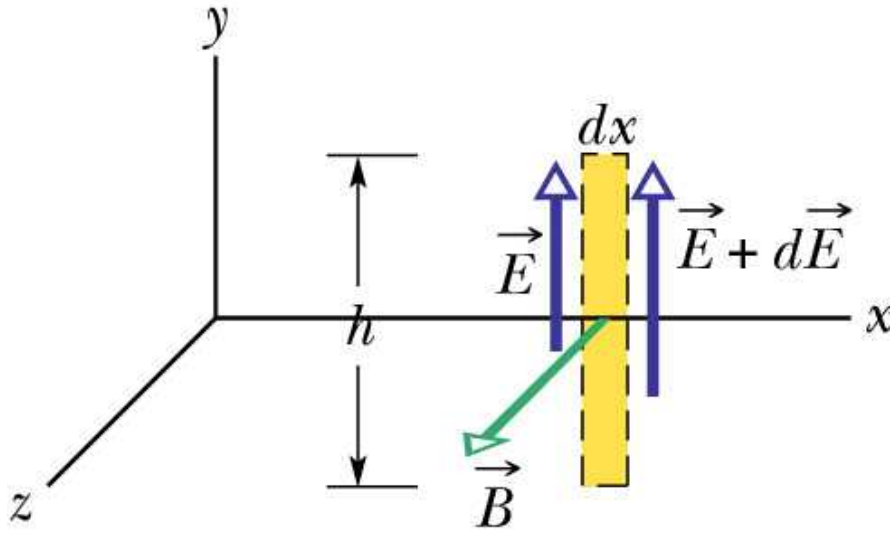
Flächenelement in yz -Ebene:

Auf Weg ist $E_y = \text{const}$ (weil Welle in x läuft)

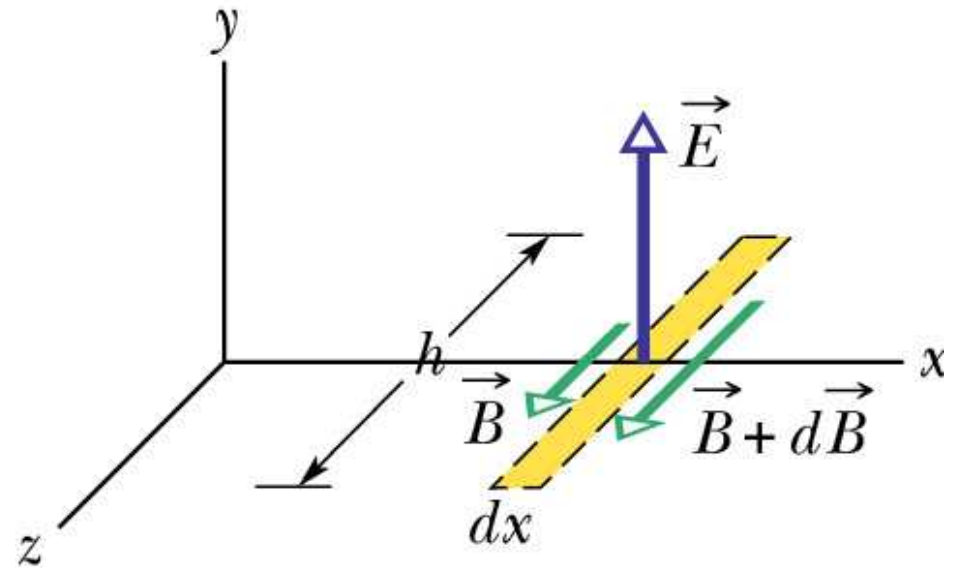
\Rightarrow Linke Seite ist Null

$$\Rightarrow dy dz \dot{B}_x = 0$$

$\Rightarrow B_x = 0$ für Wellenlösung



E läuft durch dA
zeitliche Änderung des
elektrischen Flusses
induziert B



B läuft durch dA
zeitliche Änderung des
magnetischen Flusses
induziert E

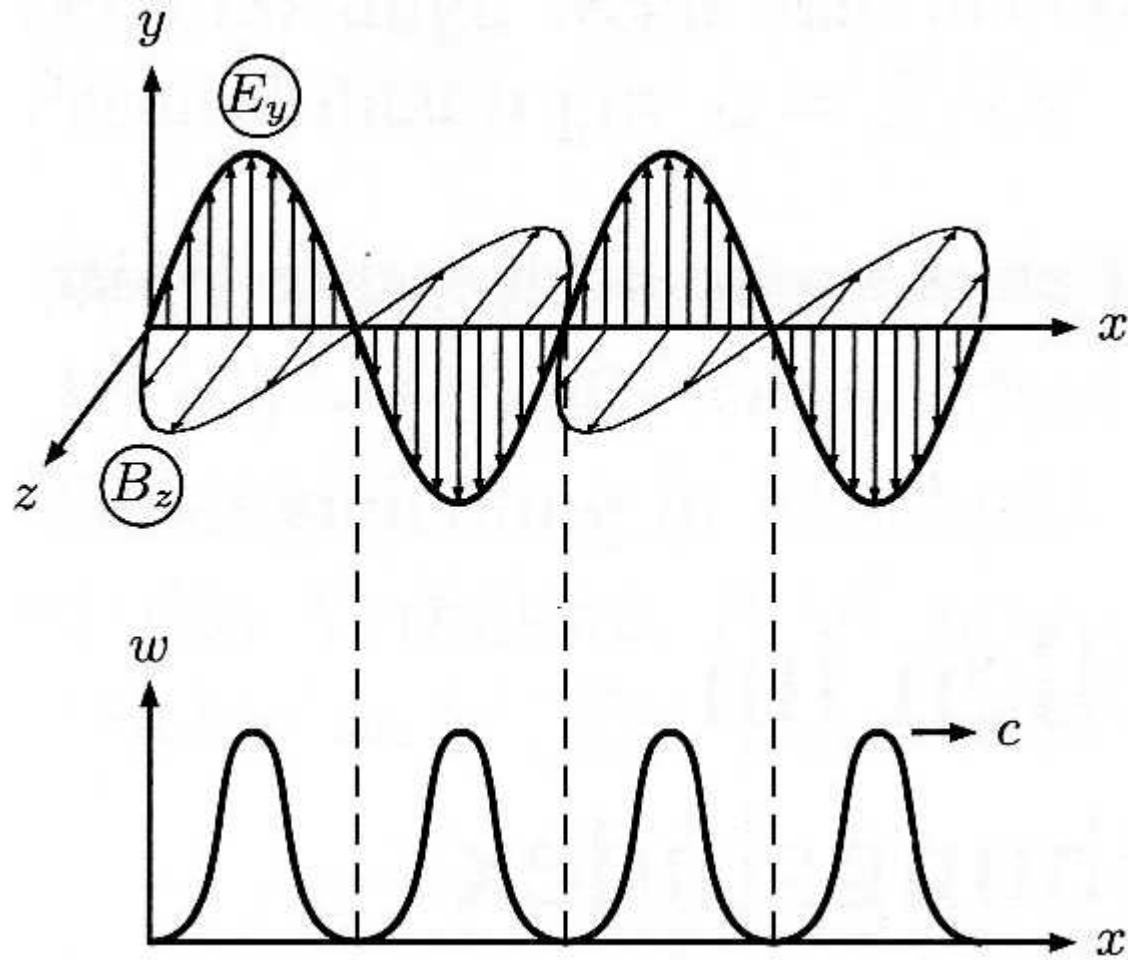
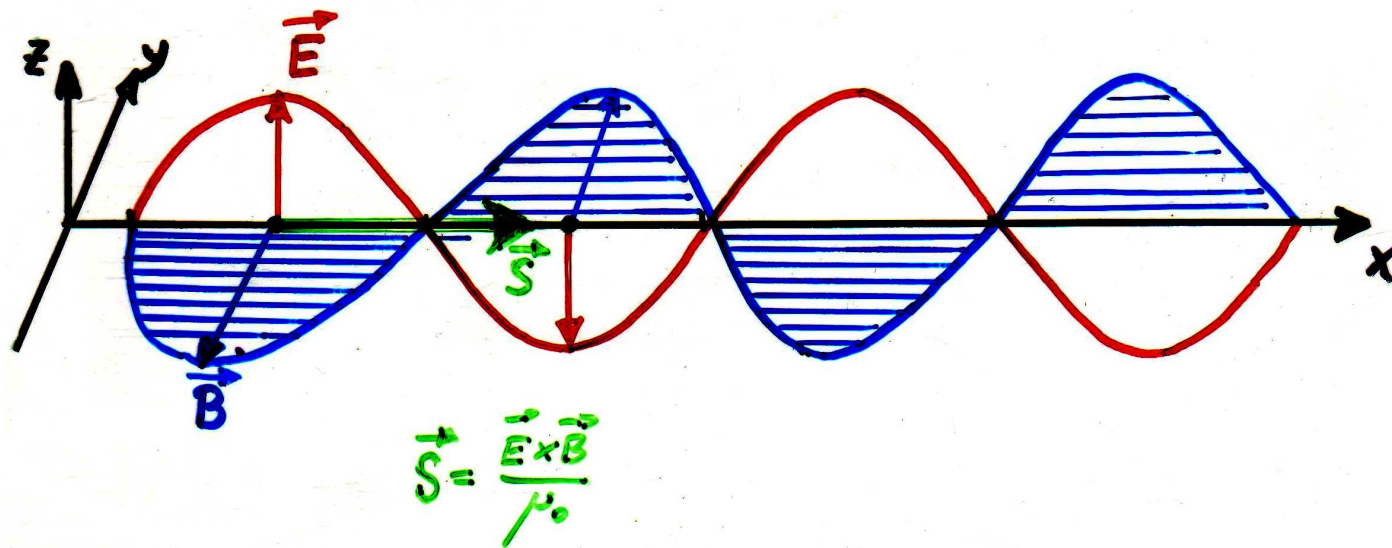


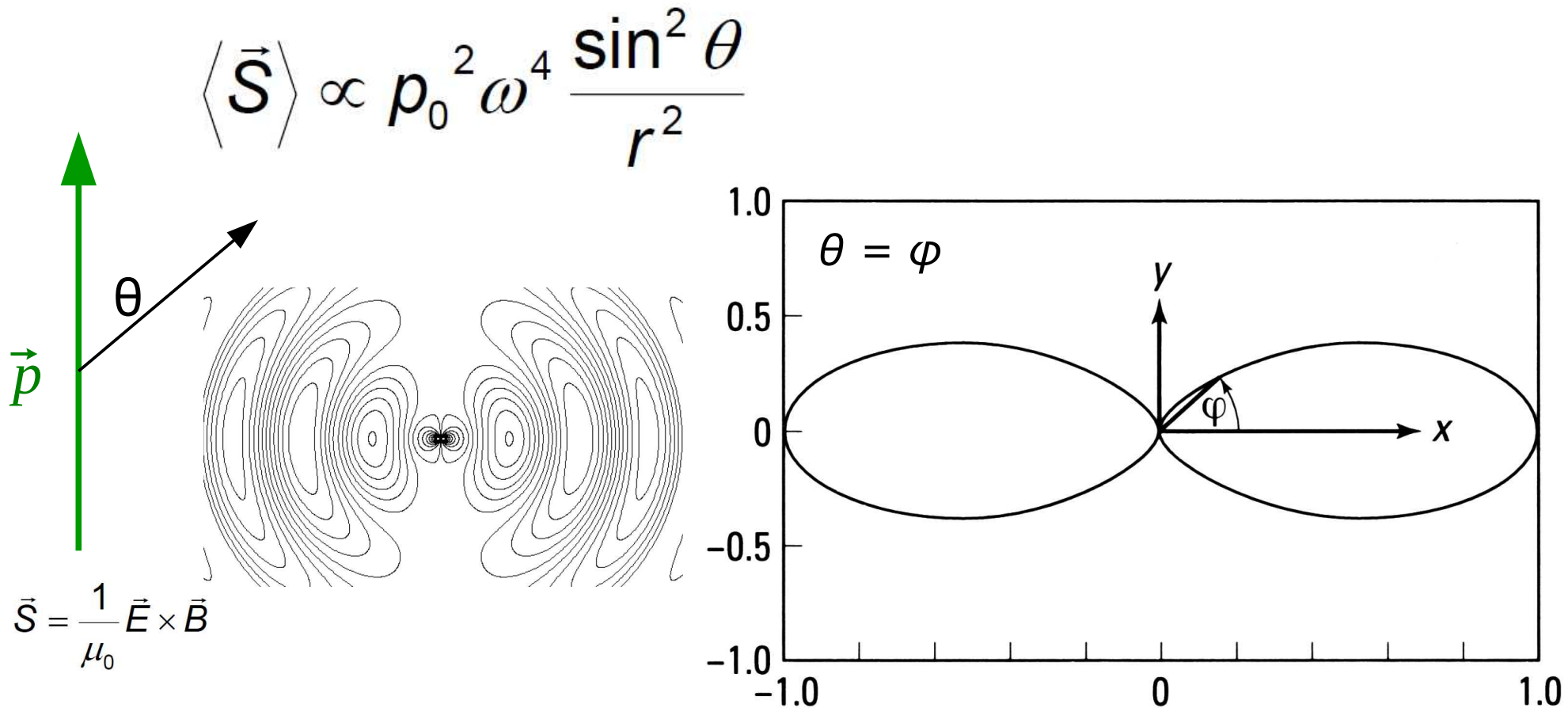
Bild 10.6: Feld und Energiedichte w einer ebenen und harmonischen Welle in Abhängigkeit vom Ort.



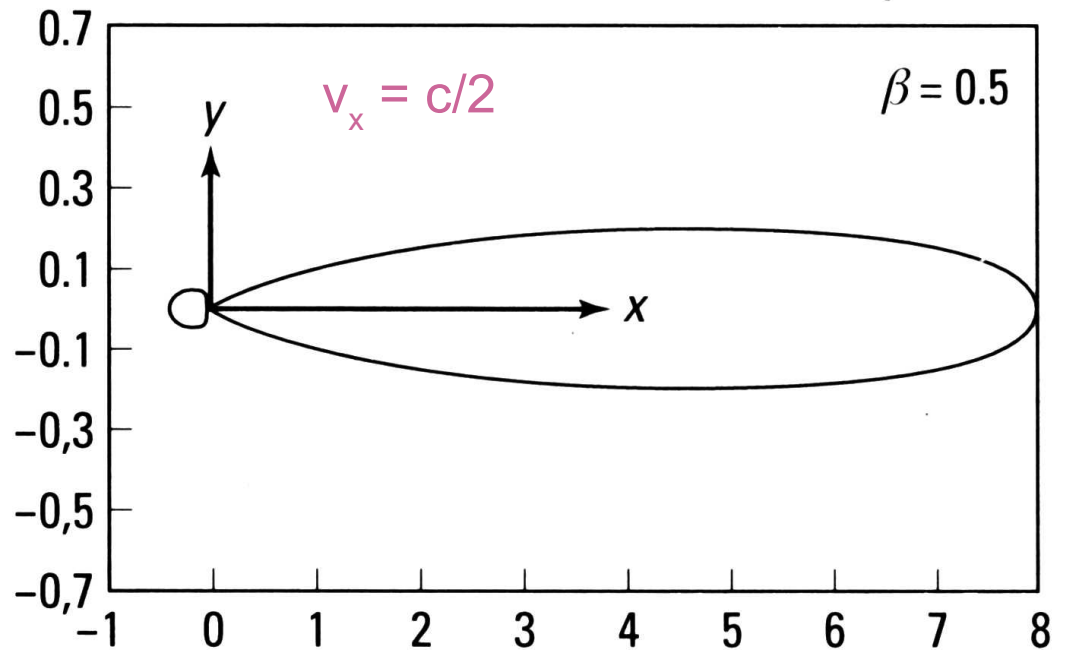
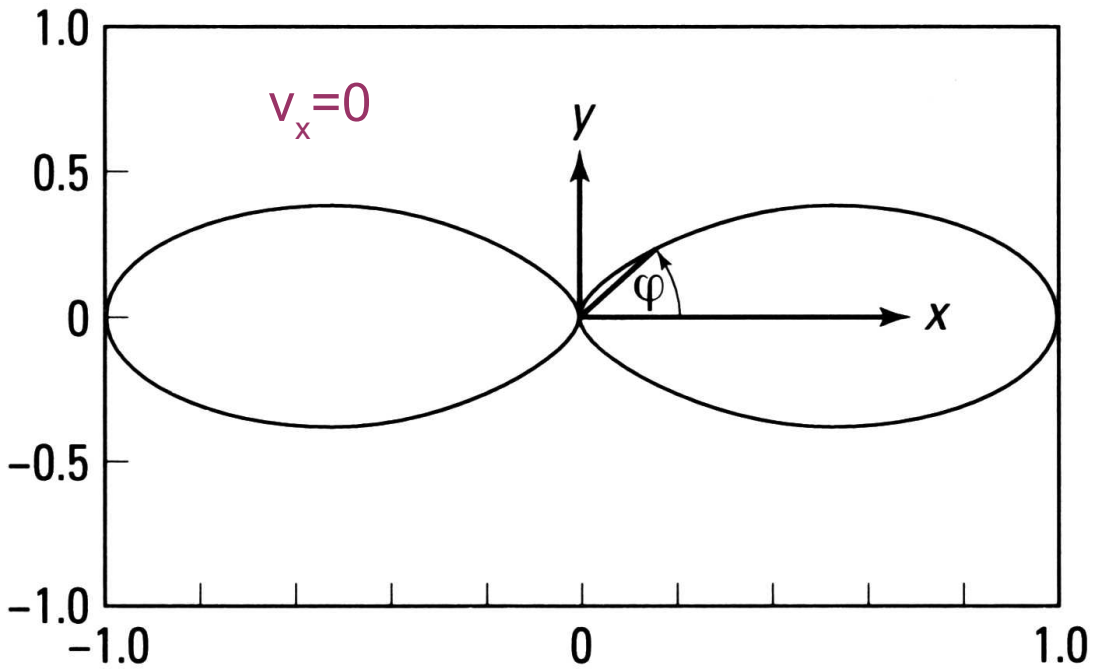
Hertz'scher Dipol - Dipolstrahlung

periodisch bewegte Ladung erzeugt oszillierendes E-Feld
Induktion ergibt dazu gehöriges B-Feld
Abstrahlung elektromagnetischer Wellen

Andere Dipole: z.B. Ladungen in Atomen oder Molekülen



Richtcharakteristiken der Strahlung einer in y beschleunigten Ladung



Jede beschleunigte Ladung strahlt eine EM-Welle ab

Leistung $\sim (dv/dt)^2$

Abstrahlcharakteristik wie bei Dipol

Hohe Beschleunigungen erforderlich

Bremsstrahlung

Synchrotronstrahlung

Definition des Meters:

299792458. Teil der Strecke, die Licht in 1 s zurücklegt.

also: $c = 299792458 \text{ m/s}$

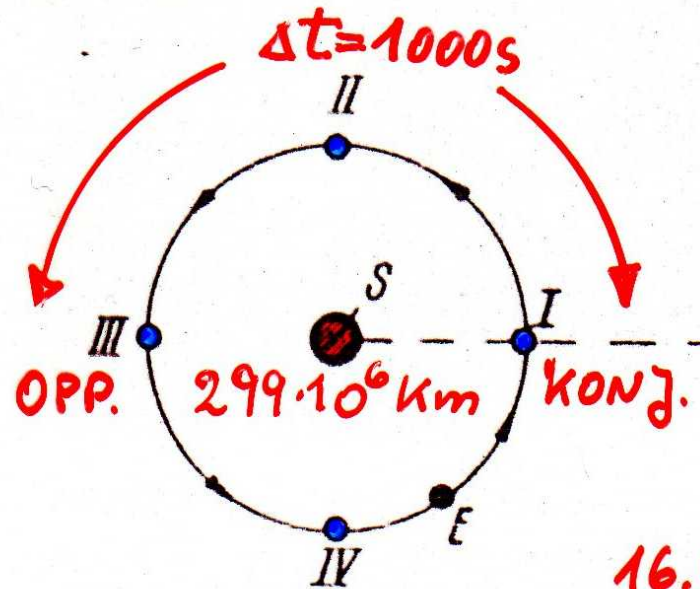
The speed of electromagnetic radiation in free space

Date	Experimenter	Country	Method	Speed (km/s)	Uncertainty (km/s)
1600(?)	Galileo	Italy	Lanterns and shutters	"If not instantaneous, it is extraordinarily rapid"	
1675	Roemer	France	Astronomical	200,000	
1729	Bradley	England	Astronomical	304,000	
1849	Fizeau	France	Toothed wheel	313,300	
1862	Foucault	France	Rotating mirror	298,000	500
1876	Cornu	France	Toothed wheel	299,990	200
1880	Michelson	U.S.A.	Rotating mirror	299,910	50
1883	Newcomb	England	Rotating mirror	299,860	30
1883	Michelson	U.S.A.	Rotating mirror	299,853	60
1906	Rosa and Dorsey	U.S.A.	Electromagnetic theory	299,781	10
1923	Mercier	France	Standing waves on wires	299,782	15
1926	Michelson	U.S.A.	Rotating mirror	299,796	4
1928	Karolus and Mittelstaedt	Germany	Kerr cell	299,778	10
1932	Michelson, Pease, and Pearson	U.S.A.	Rotating mirror	299,774	11
1940	Huettel	Germany	Kerr cell	299,768	10
1941	Anderson	U.S.A.	Kerr cell	299,776	14
1950	Bergstrand	Sweden	Geodimeter	299,792.7	0.25
1950	Essen	England	Microwave cavity	299,792.5	3
1950	Bol and Hansen	U.S.A.	Microwave cavity	299,789.3	0.4

1951	Aslakson	U.S.A.	Shoran radar	299,794.2	1.9
1952	Rank, Ruth, and Ven der Sluis	U.S.A.	Molecular spectra	299,776	7
1952	Froome	England	Microwave inter- ferometer	299,792.6	0.7
1954	Florman	U.S.A.	Microwave inter- ferometer	299,795.1	1.9
1957	Bergstrand	Sweden	Geodimeter	299,792.85	0.16
1958	Froome	England	Microwave interferometer	299,792.50	0.10
1965	Kolibayev	U.S.S.R.	Geodimeter	299,792.6	0.06
1967	Grosse	West Germany	Geodimeter	299,792.5	0.05
1967	Simkin, Lukin, Sikora, and Strelenskii	U.S.S.R.	Microwave interferometer	299,792.56	0.11
1973	Evenson, Wells, Peterson, Danielson, and Day	U.S.A.	Laser techniques	299,792.4574	0.0012

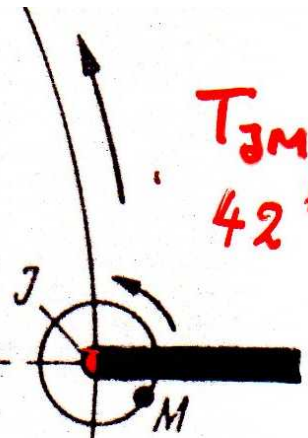
* See "Some Recent Determinations of the Velocity of Light, III" by Joseph F. Mulligan, *American Journal of Physics*, October 1976. Here the 1974 measurements of Blayney et al. at the National Physical Laboratory in England are described. They are in very close agreement with the results of Evenson et al. (1973).

"Jupiter-Monde"



1676 O. RÖMER

$16.6' \triangleq 1000s$
 $V = 299000 km/s$



$T_{JM} (Konj.):$
 $42^h 28^m 36s$

Jupiter-bahn

Römer: $22'$

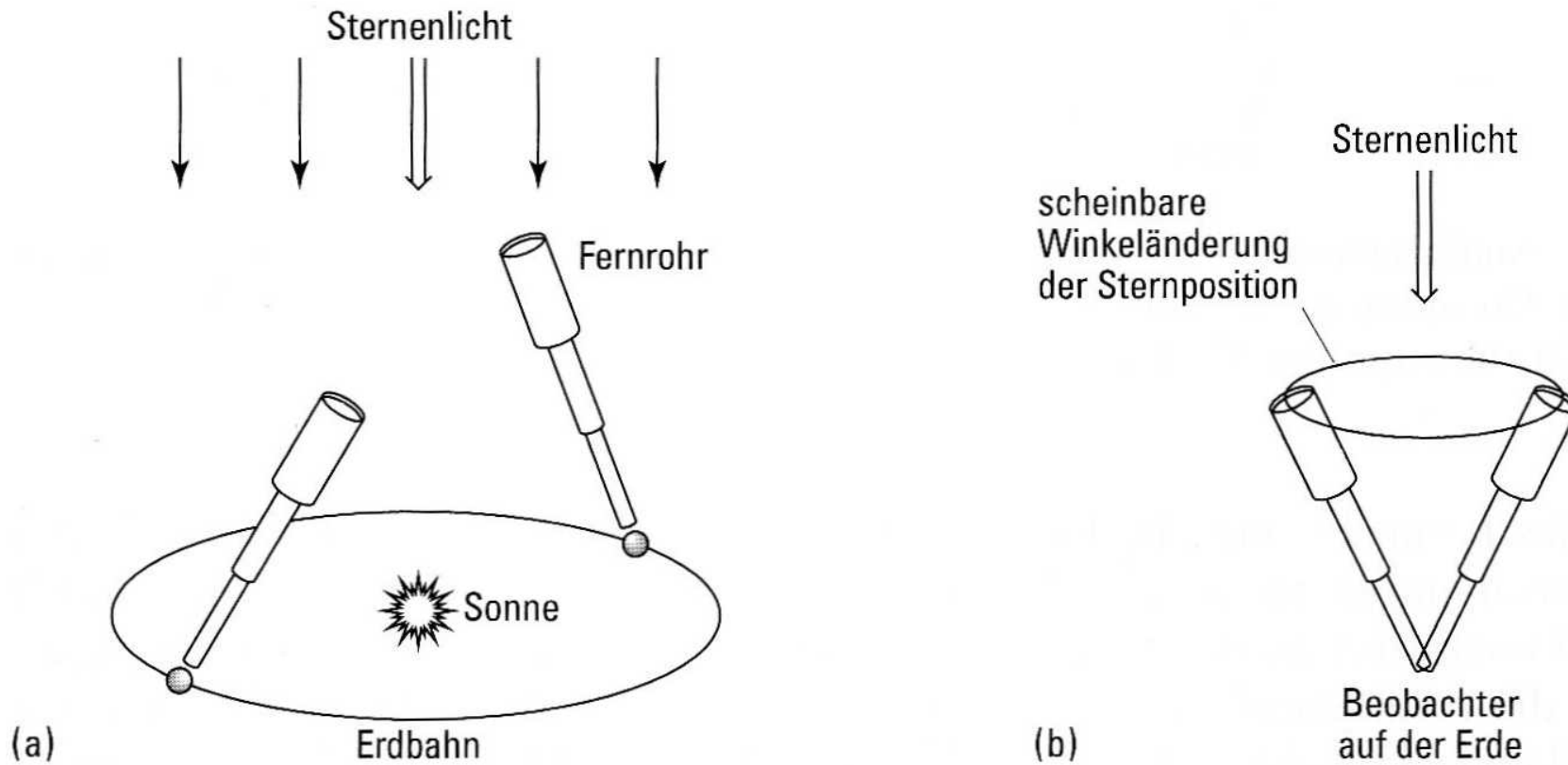
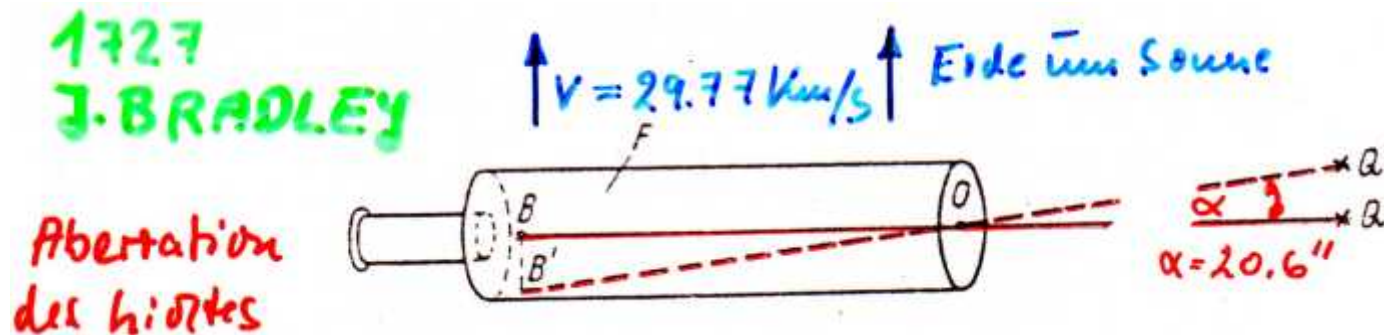
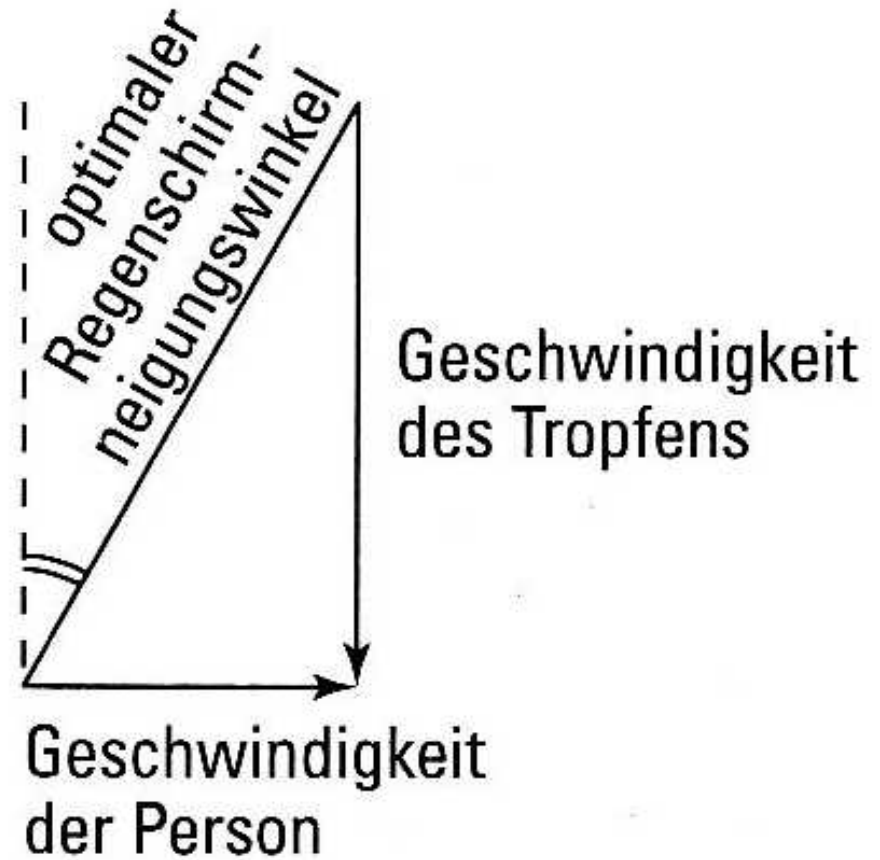


Abb. 6.56 Zur astronomischen Aberration: (a) Beobachtung eines Sterns, der senkrecht auf der Erdbahnebene (Ekliptik) steht; (b) Maximale Positionsveränderung innerhalb eines Jahres.



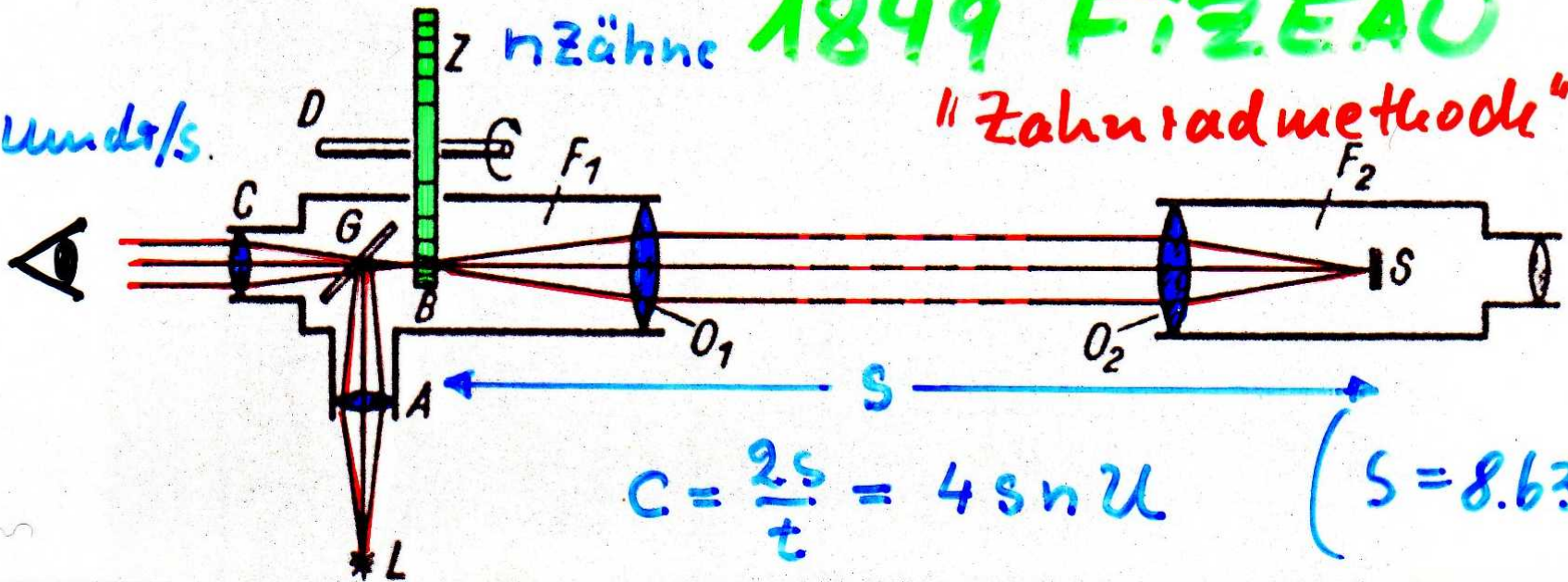
Regen-Aberration



1849 FIZEAU

"Zahnradmethode"

U Umdr/s.



$$c = \frac{2s}{t} = 4snU$$

$$(s = 8.633 \text{ km})$$

Drehspiegelmethode

1851 Léon Foucault

1838 François Arago Vorschlag der Drehspiegelmethode aber keine Messung

