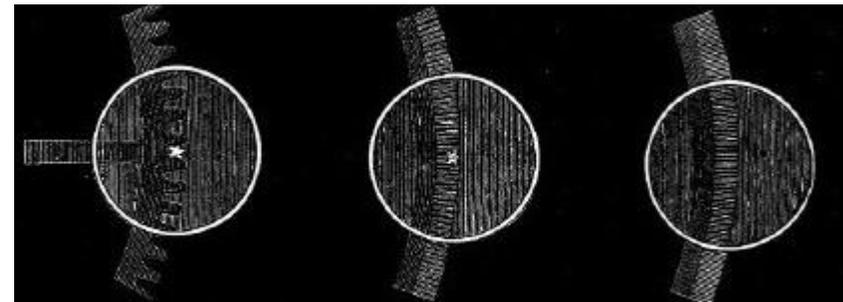


Mesure de la vitesse de la lumière en 1850 par la technique de la roue dentée



Armand Hippolyte Louis Fizeau
(1819-1896)
Physicien français

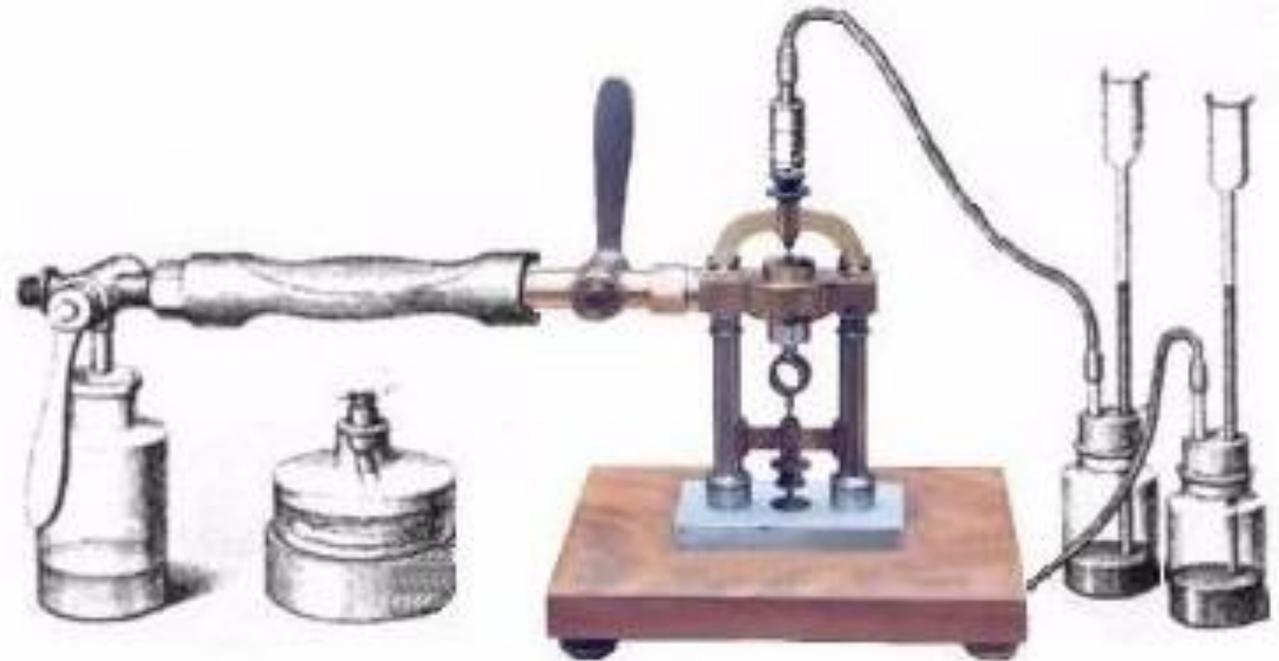


Ce que Fizeau voyait dans son oculaire d'après l'Astronomie populaire de François Arago.

Mesure de la vitesse de la lumière en 1850 par la technique du miroir tournant



Léon Foucault 1819- 1868
physicien et astronome français.



le miroir de Foucault, avec la turbine de Gustave Froment

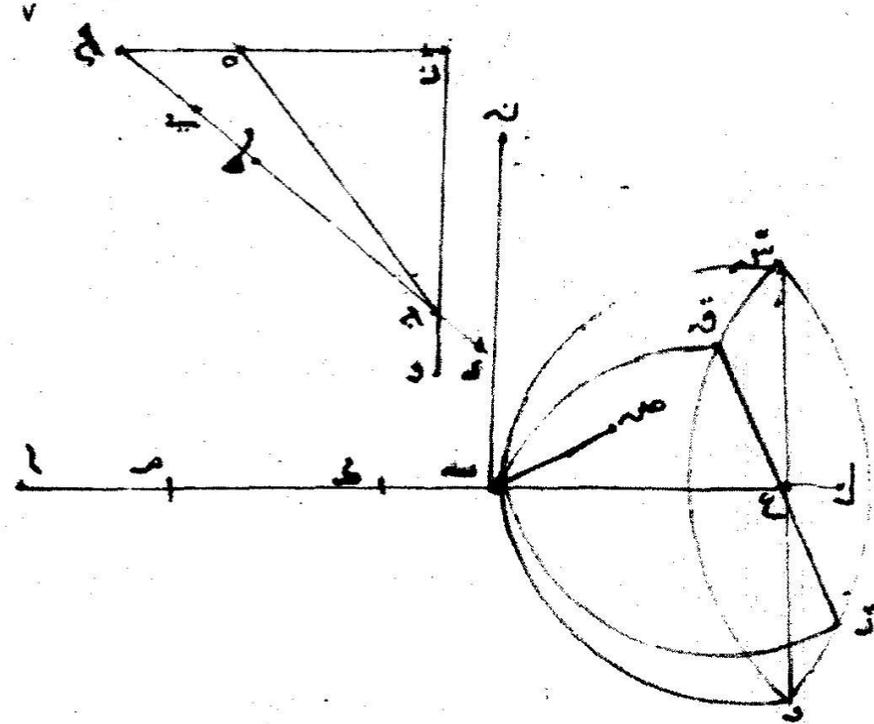
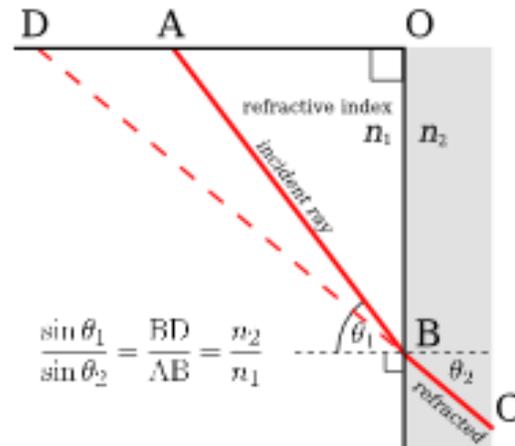
Thèse de Foucault: Sur les vitesses relatives de la lumière dans l'air et dans l'eau. 1853

<https://www.bibnum.education.fr/sites/default/files/foucault-texte.pdf>

Reproduction des expériences de Foucault : « Les expériences de Foucault relatives à la vitesse de la lumière »
par Jacques Foiret <http://sabix.revues.org/837#tocto1n2>

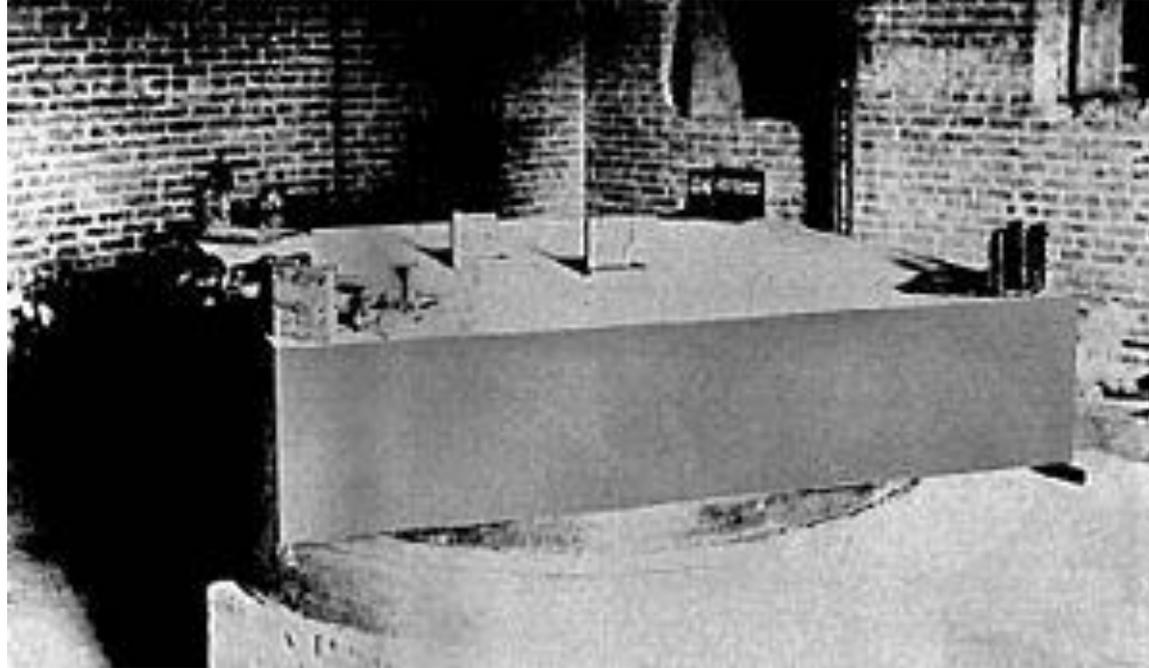
Abou Sa'd al-'Ala' ibn Sahl (940-1000) mathématicien perse la cour de Bagdad qui a écrit un traité vers 984 sur les miroirs ardents et les lentilles.

(Al Hassan) Ibn al Haytham (965-1039), physicien, mathématicien et philosophe irakien, connu par l'Occident médiéval sous le nom d'Alhazen

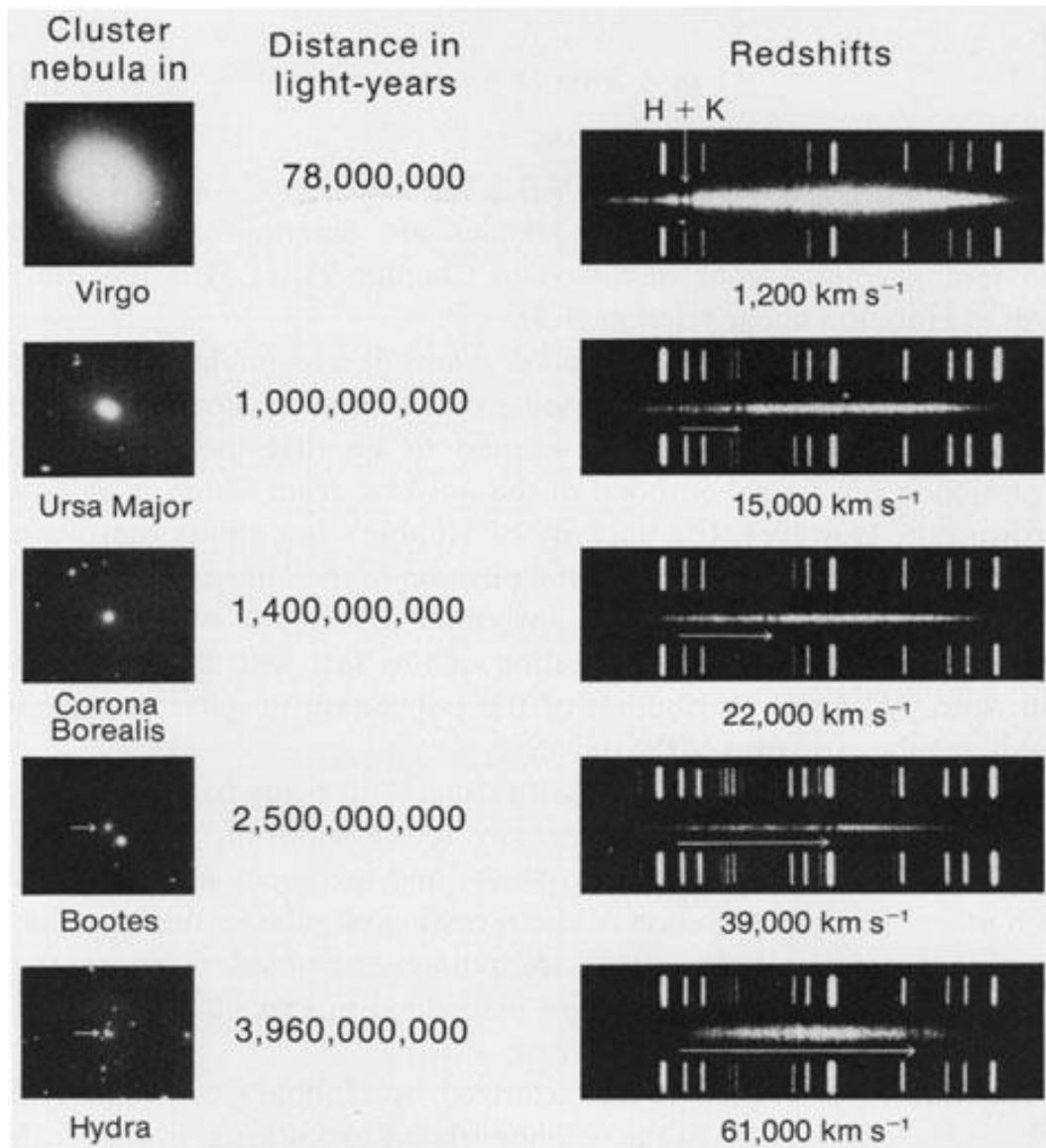


لانه ان ماسه عليها سطح مستوي غيره فلان هذا السطح يقطع سطح بنصر
 على نقطة ب فلا بد من ان يقطع احد خطي ب ن بص فليكن ذلك
 الخط بص والفصل المشترك بين هذا السطح وبين سطح قطع ق ر
 خط ب ش فلان هذا السطح يماس على نقطة ب فخط
 ب ش سطح قطع ق ب ر على نقطة ب وكذلك خط ب ص وهذا حال
 فلا يماس على نقطة ب سطح مستوي غيره سطح ب ن ص

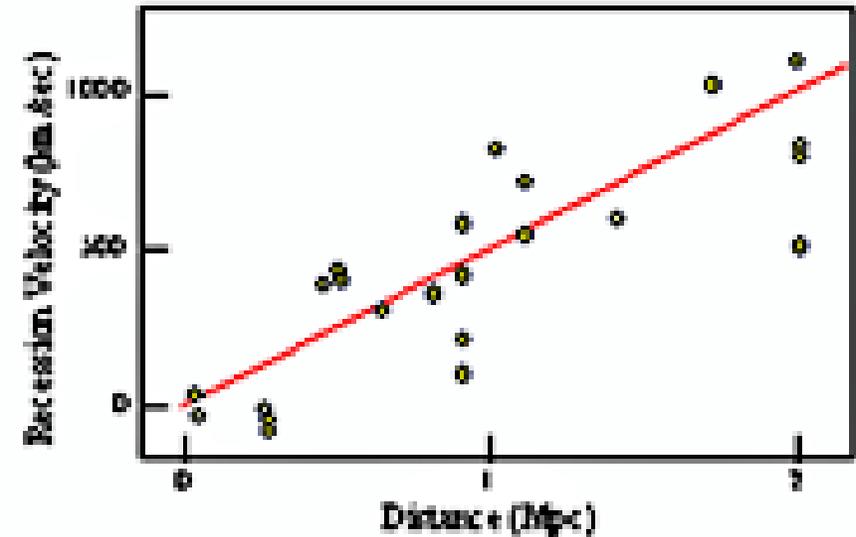
Experience de Michelson-Morley (1881)

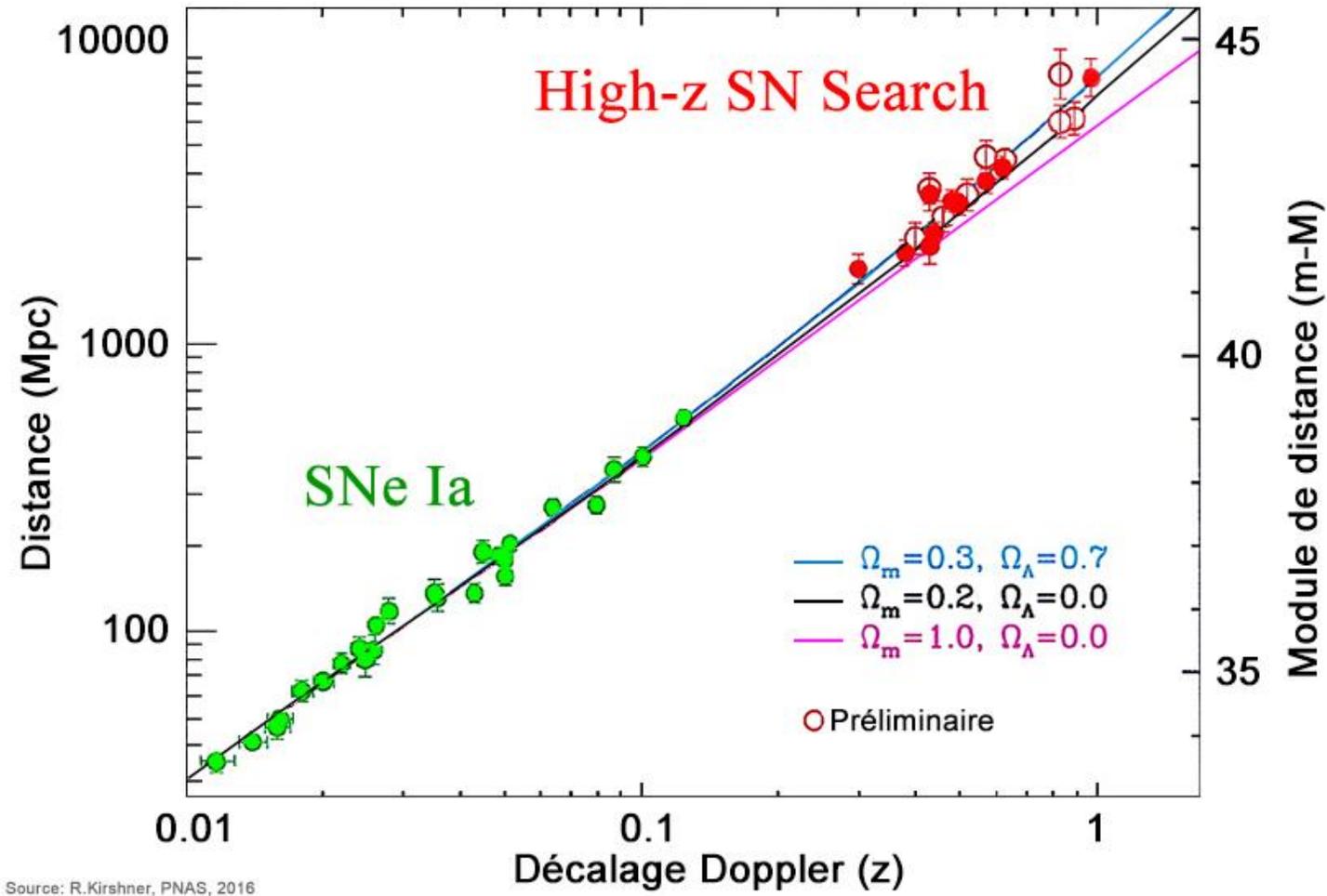


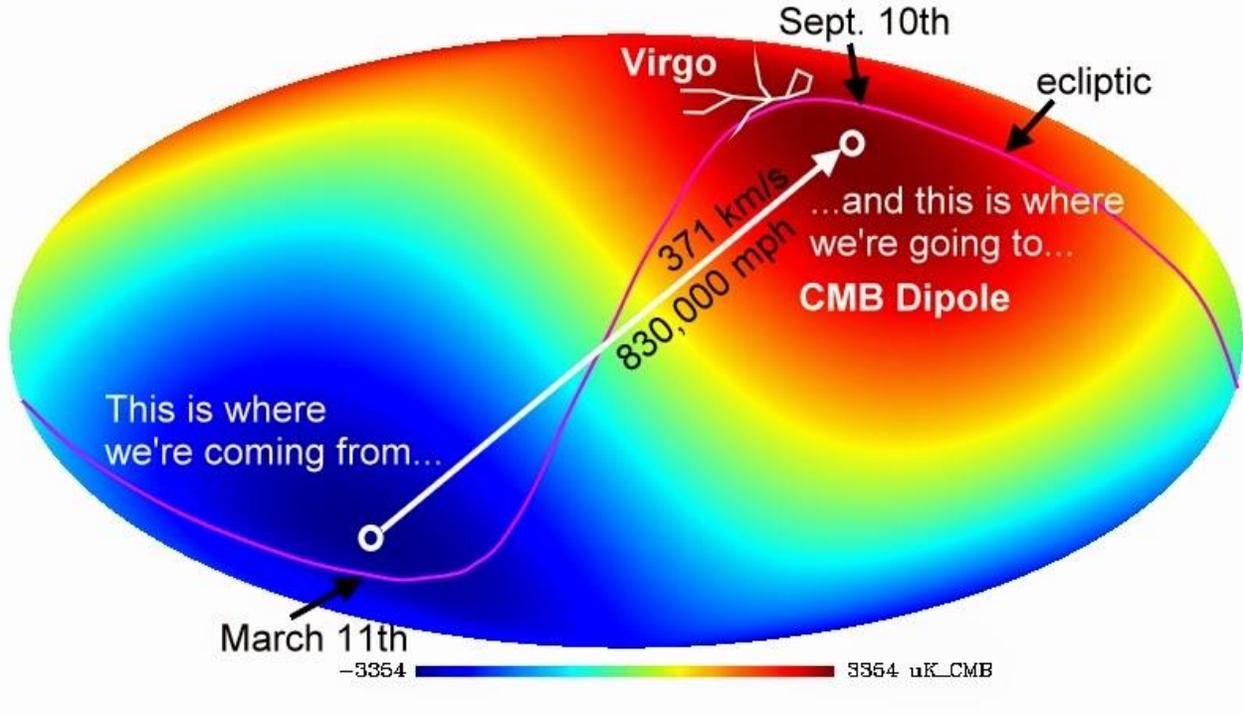
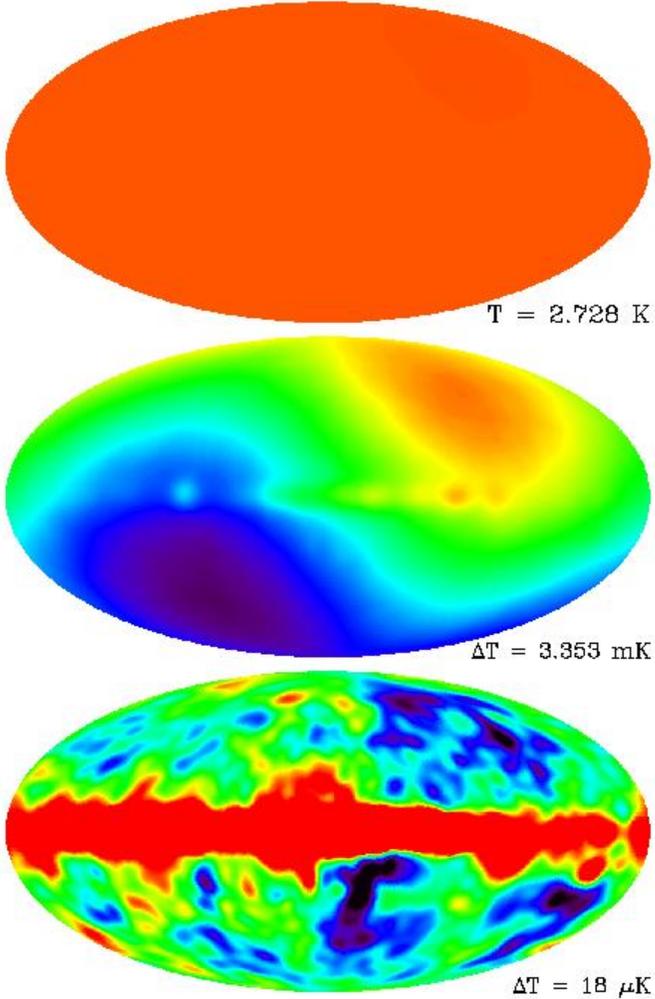
Michelson and Morley's interferometric setup,
mounted on a stone slab that floats in an annular trough of mercury.

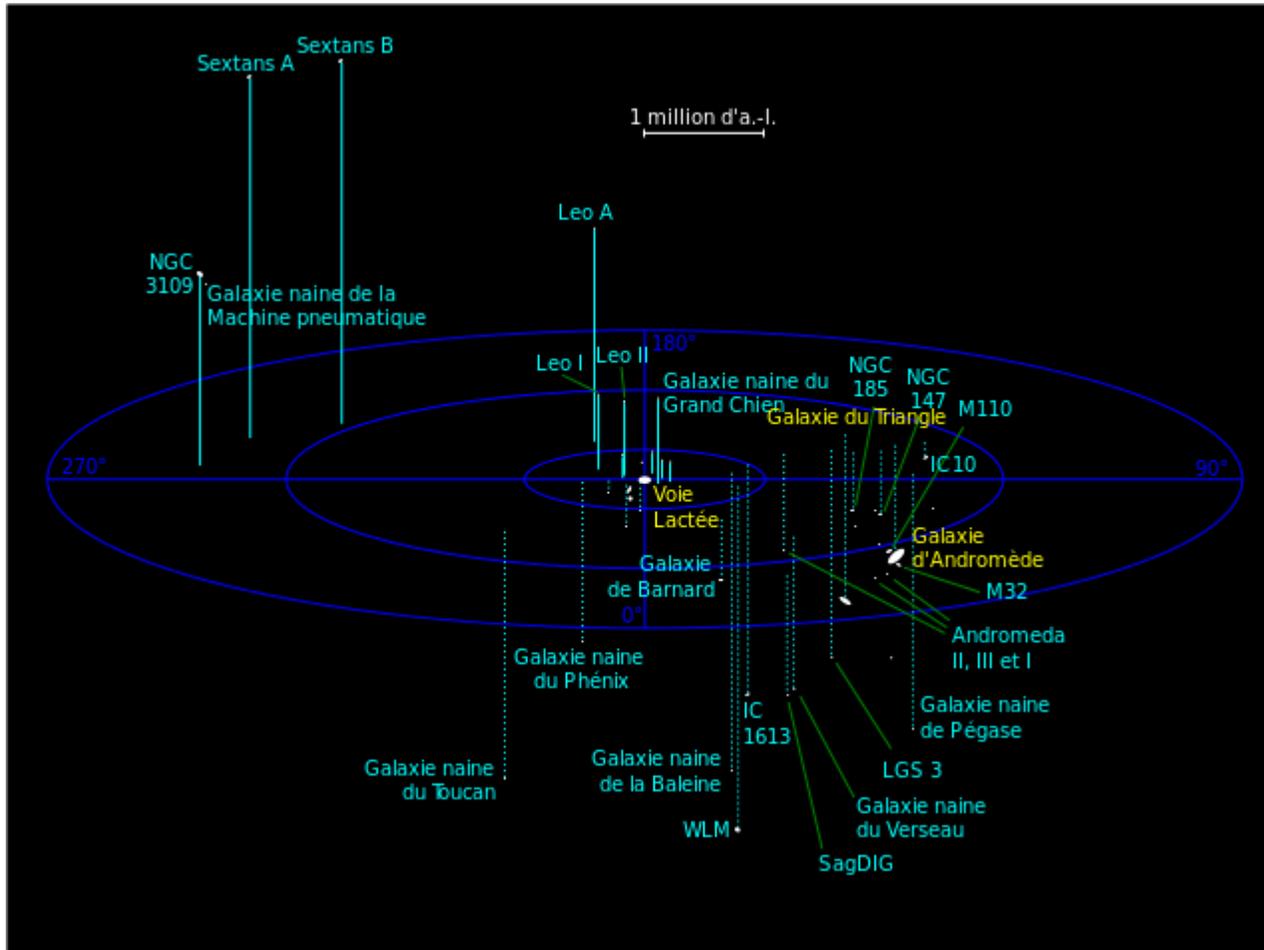


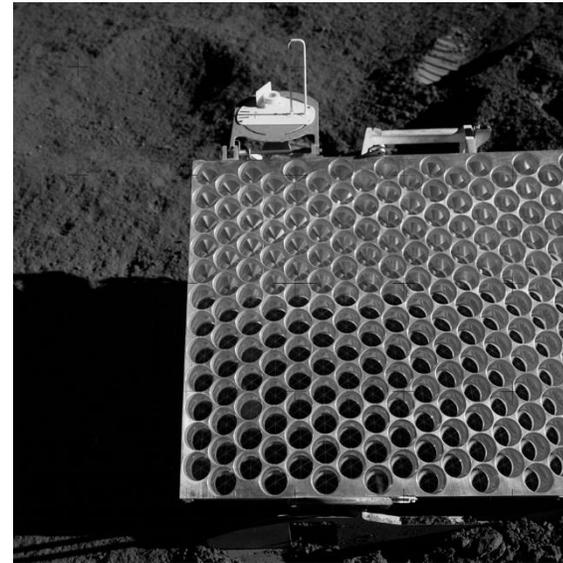
Hubble's Data (1929)



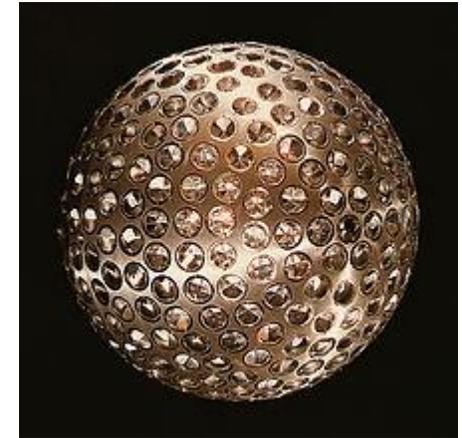




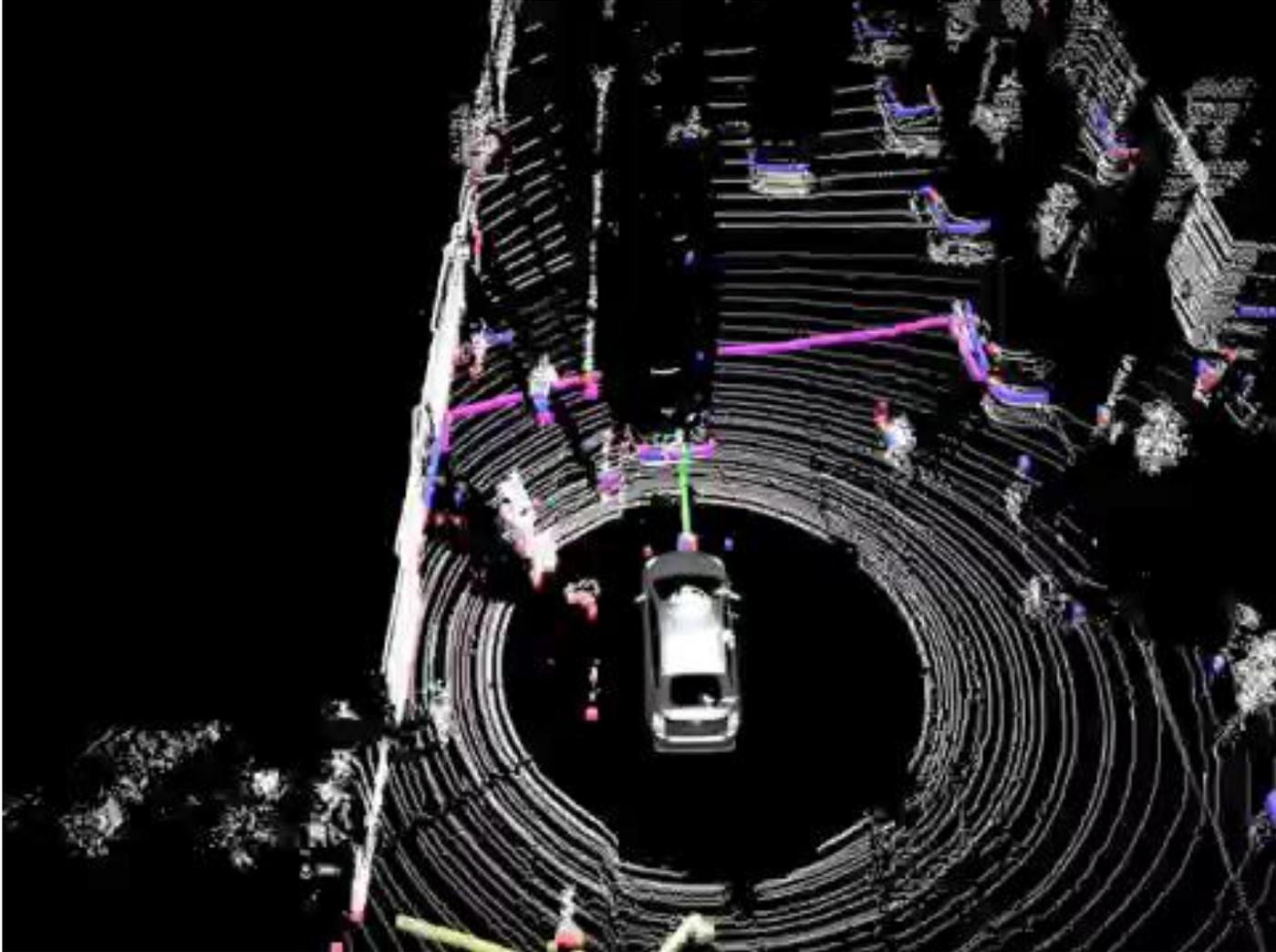
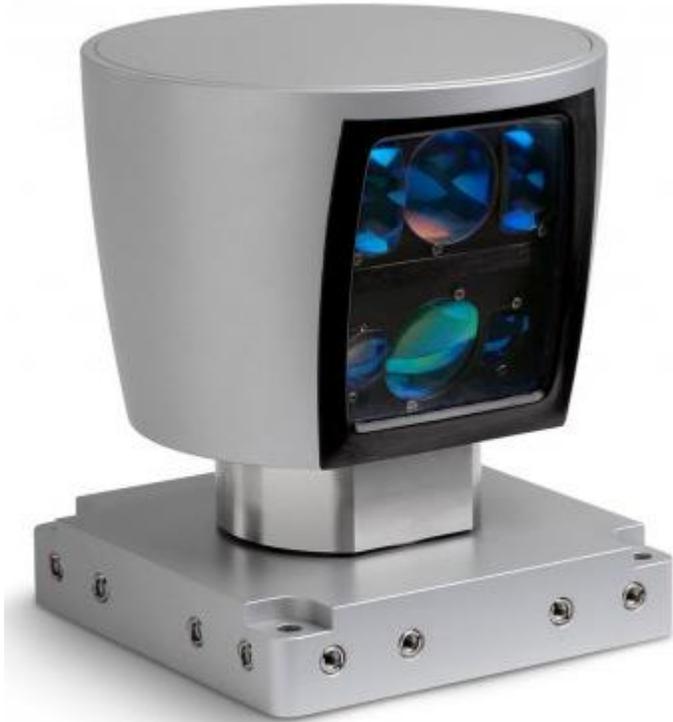




Coin cube sur la lune



Satellite LAGEOS



Lidar (Light detection and ranging)

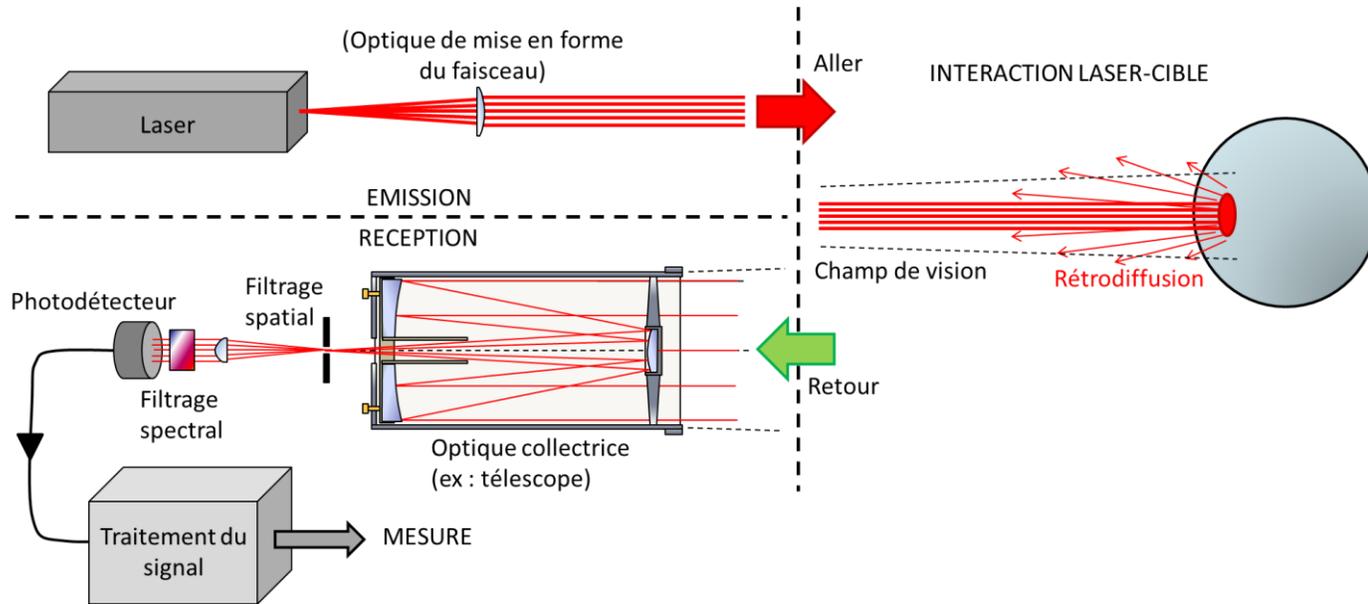
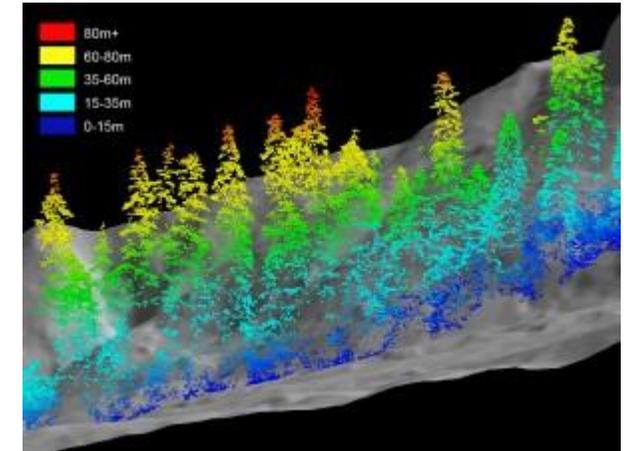
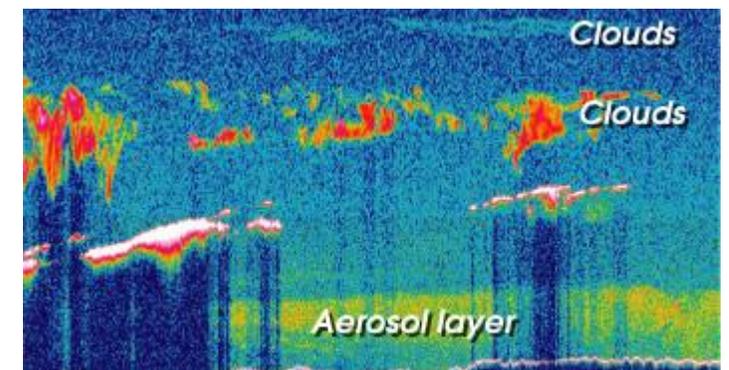


Schéma de principe



Mesure de la couverture forestière

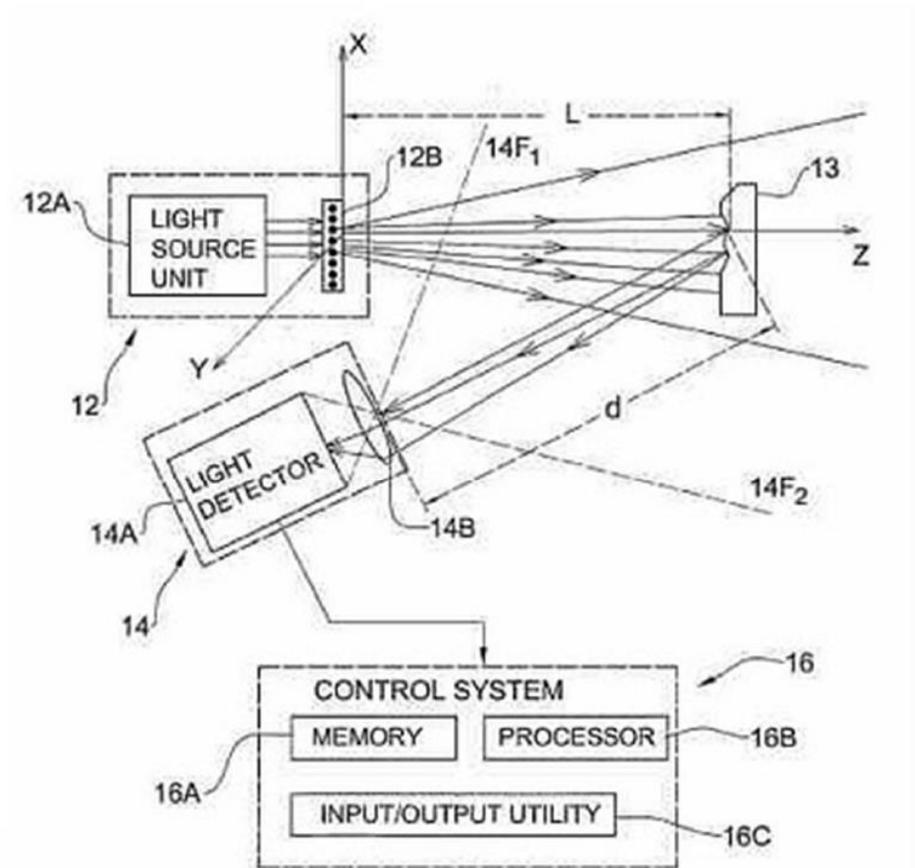


Spectroscopie de l'atmosphère

Illumination structurée

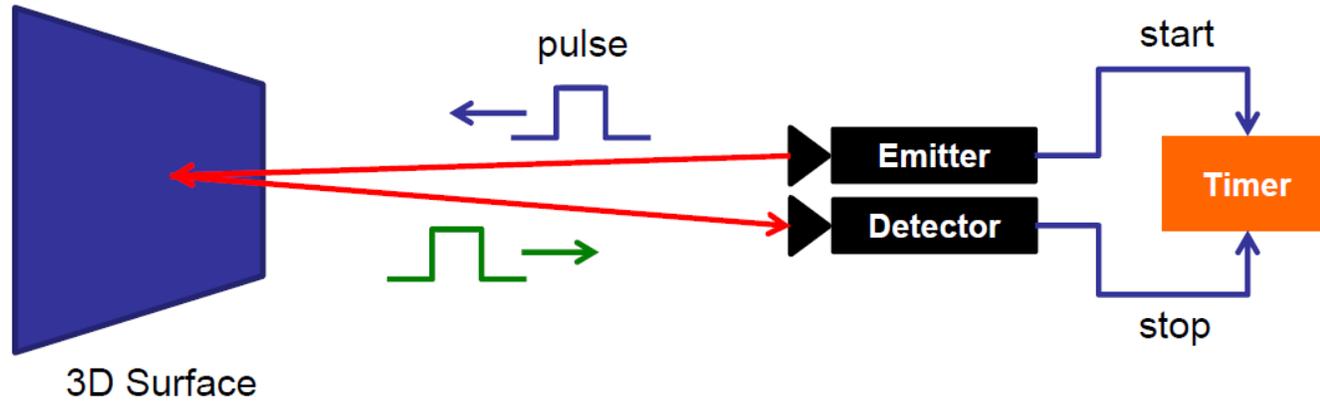


Kinect -primesensor

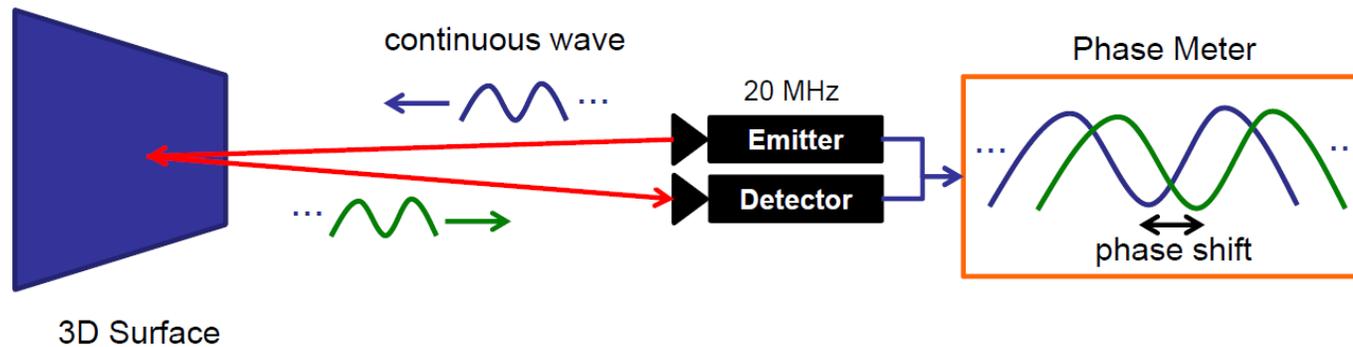


spatial x/y resolution: 3mm @2m distance
depth z resolution: 1cm @2m distance

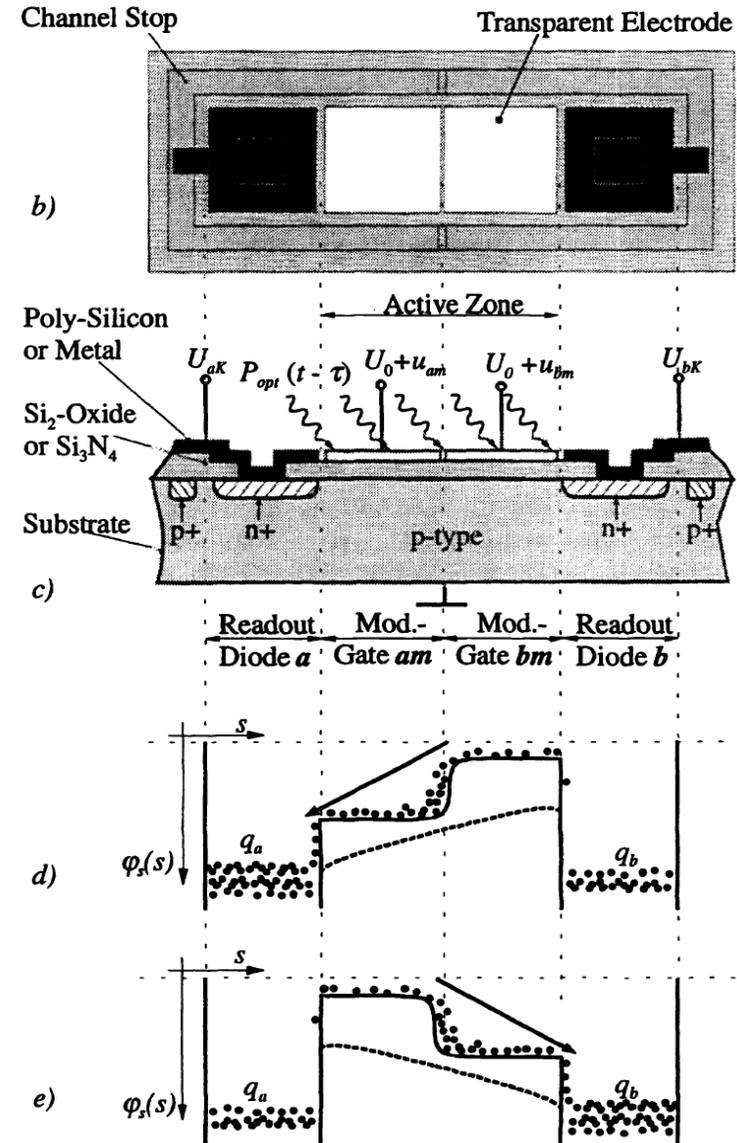
Pulsée



Modulation continue



- Principe du *Photonic Mixer Device*



Imagerie d'intensité de fluorescence

$$I(\eta) \text{ avec } \eta = \Gamma/(\Gamma+k)$$

résolution spatiale

- la structure des échantillons (autofluorescence)
- les sites de fixation de sondes fluorescentes

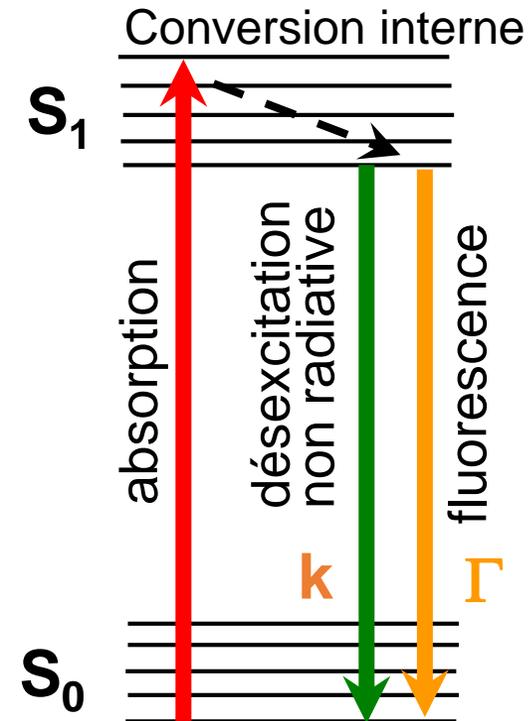
Imagerie de durée de vie de fluorescence

$$\text{Durée de vie } \tau = 1/(\Gamma+k)$$

résolution temporelle

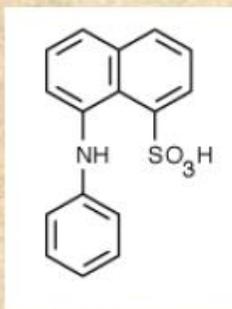
- les interactions moléculaires
- l'environnement physico - chimique des molécules

- mesure relative, indépendante de la concentration

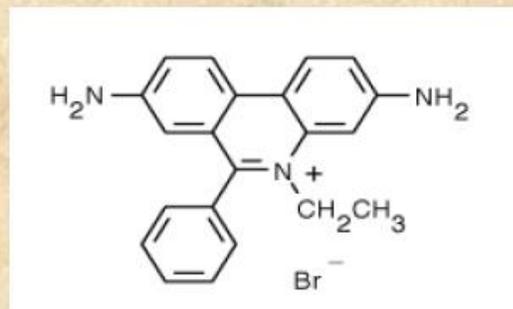


	Lifetime (ns)	solvant	Excitation	Emission
Rhodamine B	1.7	water	400	583
Fluorescein	4.0	PB pH 7.5	495	517
NADH	0.4	0.1 M PB 7.4, 20°C	330-370	400-600
Alexa Fluor 488	4.1	PB pH 7.4	494	519
BODIPY FL	5.7	Methanol	502	510
GFP	3.2	Buffer pH8	498	516
Rhodamine 6G	4.08	Water	525	555

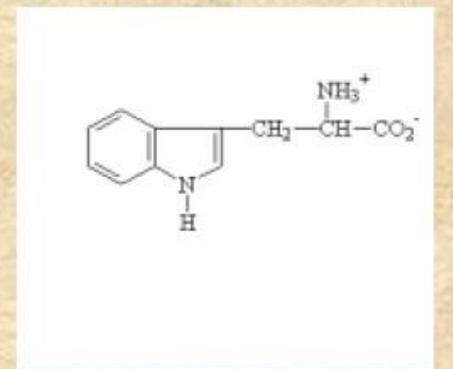
- La durée de vie d'un fluorophore et son rendement quantique dépendent de son environnement moléculaire local
- Exemple: NADH a une durée de vie dans l'eau de ~ 0.4 ns mais attaché à une déshydrogenase 9 ns.



ANS in water is ~ 100 picoseconds but can be 8 – 10 ns bound to proteins



Ethidium bromide is 1.8 ns in water, 22 ns bound to DNA and 27ns bound to tRNA

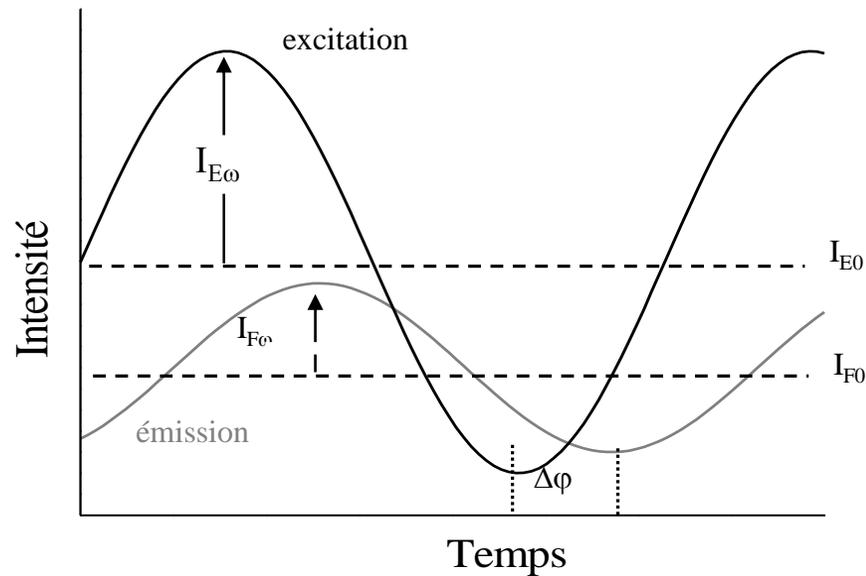


The lifetime of tryptophan in proteins ranges from ~ 0.1 ns up to ~ 8 ns

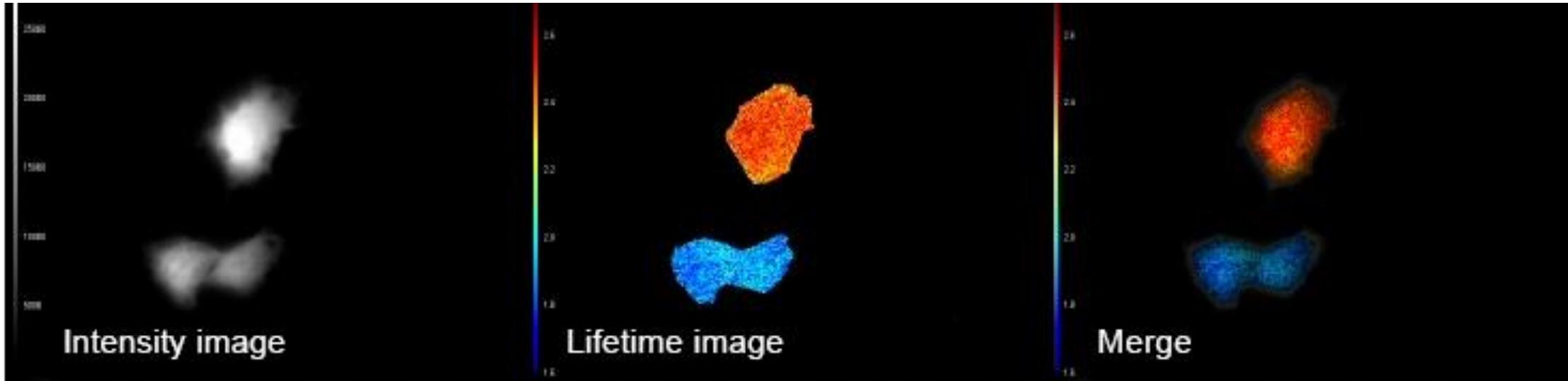
Modulation de l'excitation $I_E(t) = I_{E0} + I_{E\omega} \cos(\omega t + \varphi_E)$

 Modulation de la fluorescence, déphasée et amplitude différente

$$I_F(t) = I_{F0} + I_{F\omega} \cos(\omega t + \varphi_F)$$



$$\omega \tau_F = \tan(\Delta\varphi),$$
$$\omega \tau_F = \sqrt{\frac{1}{M^2} - 1}.$$

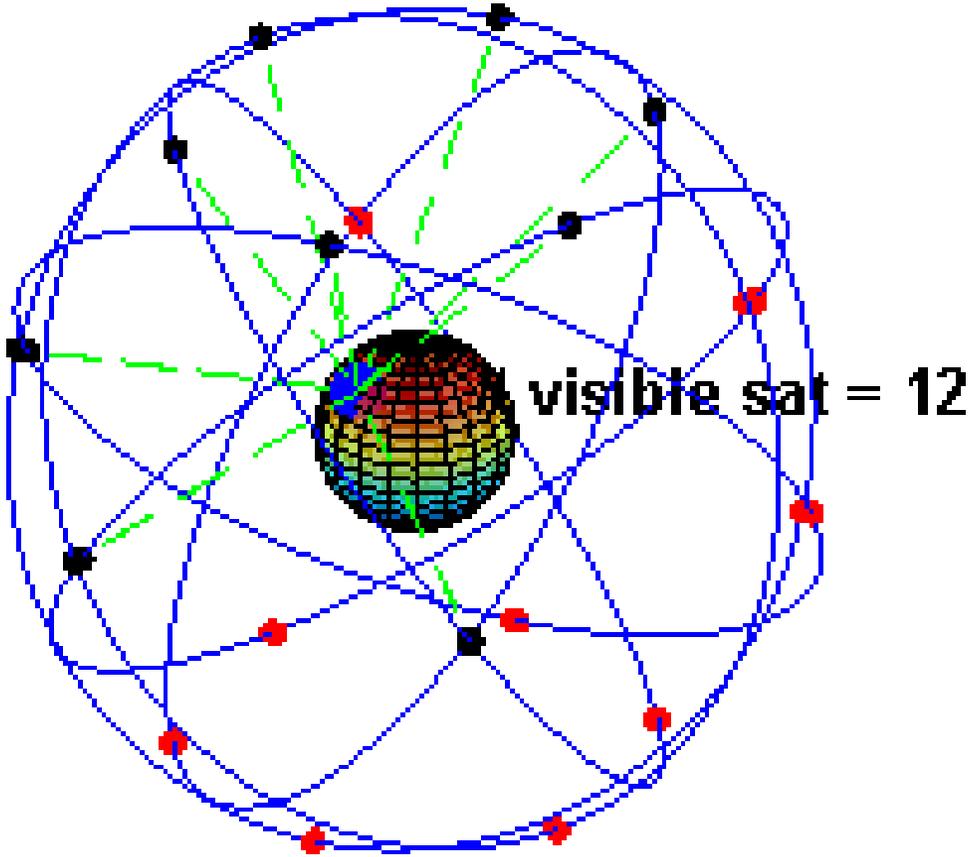


FRET in the cytosol, measured by FLIM.

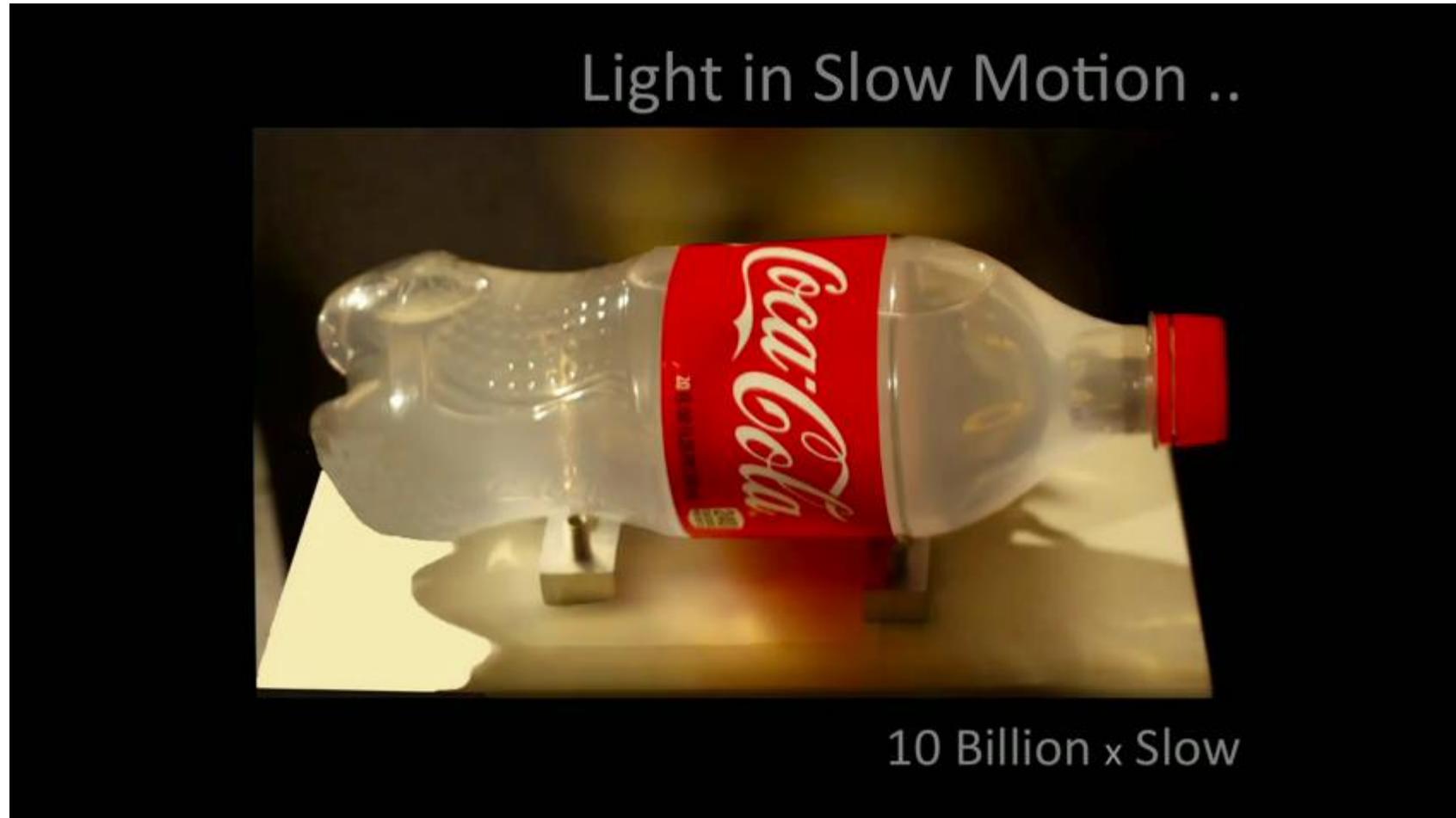
Transiently transfected cells with pCFP (no FRET, upper cell) or with CFP-YFP tandem construct (FRET, other two cells). In case of FRET, the lifetime of the donor CFP is shorter (here: blue, 1,9ns) than in case of no FRET (here: red, 2,4ns).



satellite NAVSTAR (*Navigation Satellite Timing And Ranging*) appartenant à la constellation du GPS



Observation de la propagation de la lumière par caméra rapide



Extrait de TED conférence par Ramesh Raskar