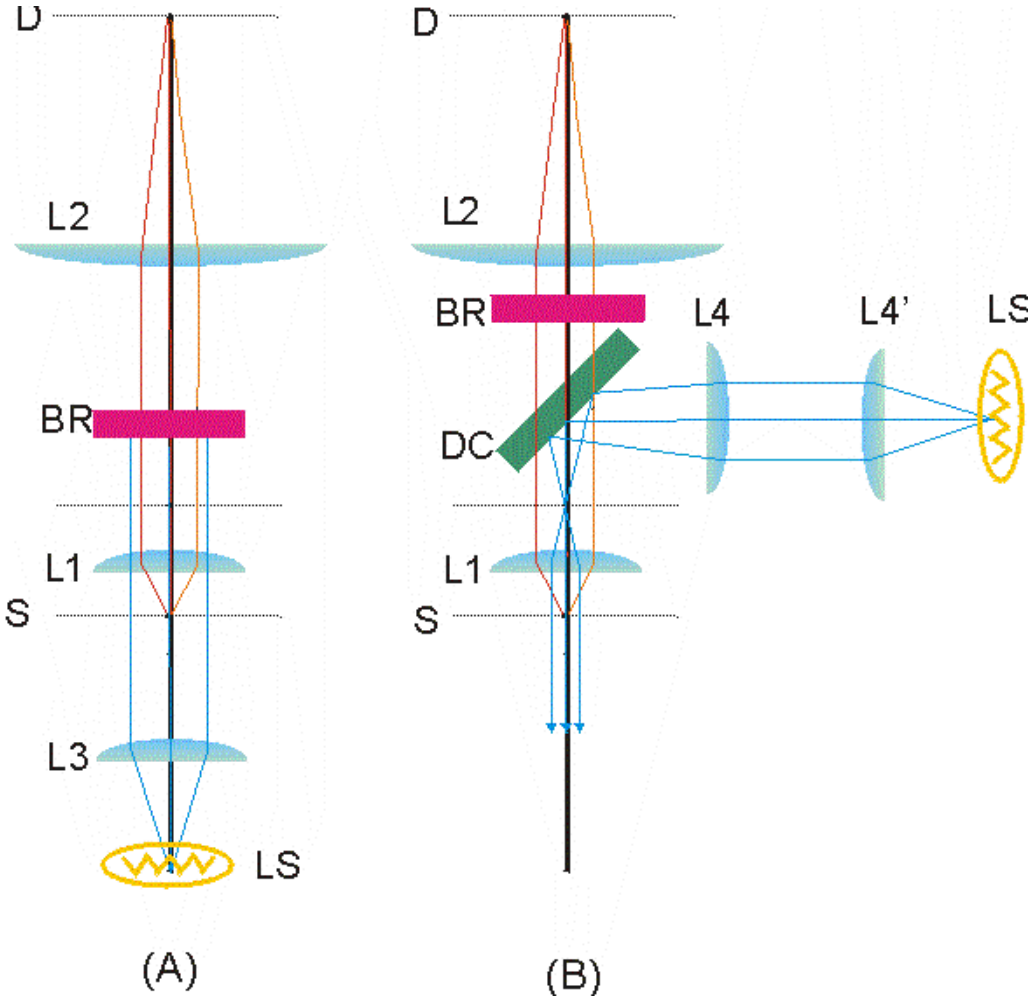
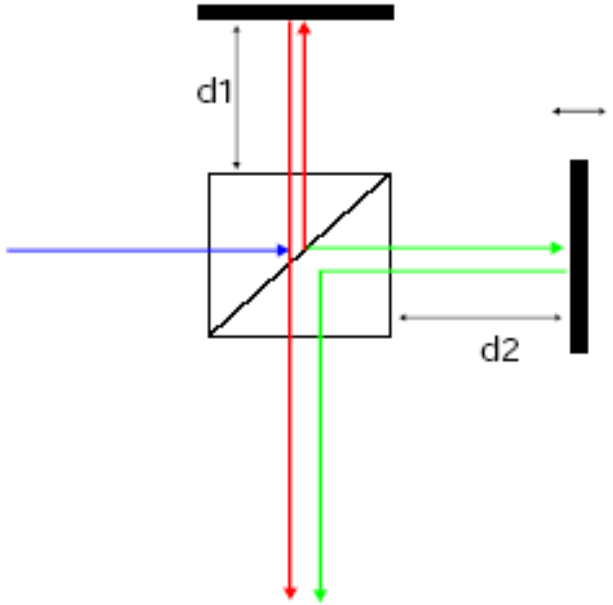
Optics & Microscopy III



What have we learned last lecture:

1. Microscope design: trans vs epi
2. Optical aberration
3. Interference: double slit, Michaelson
4. Fourier transform interferometer

Optical application of interference – Michaelson Interferometer



One of the most common use of interference is in the construction of interferometers (device that generate interference). They are a class of instrument that has provide some of the most precise measurement of distance and the wavelength of light.

Let's consider what is the interference effect of the red & green light rays:

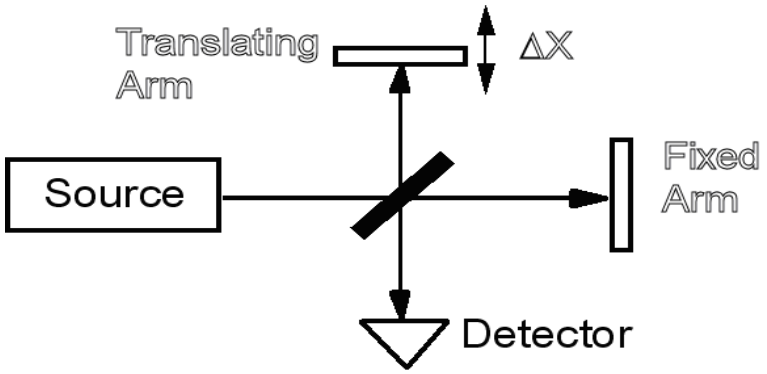
$$I = (E_R + E_G)^2 = 2I[1 + \cos(\frac{2\pi}{\lambda} 2(d_1 - d_2))] =$$

If we keep one mirror constant, we will see intensity variation with the travel of the second mirror as:

$$d_1 - d_2 = \frac{(n-1)\lambda}{2}; \text{ n=1,2,3…} \quad \text{maxima}$$

$$d_1 - d_2 = \frac{(2n+1)\lambda}{4}; \text{ n=0,1,2…} \quad \text{minima}$$

Fourier Transform Spectroscopy



For single frequency

$$E(k) = A(k)\exp[ik(x-ct)]$$

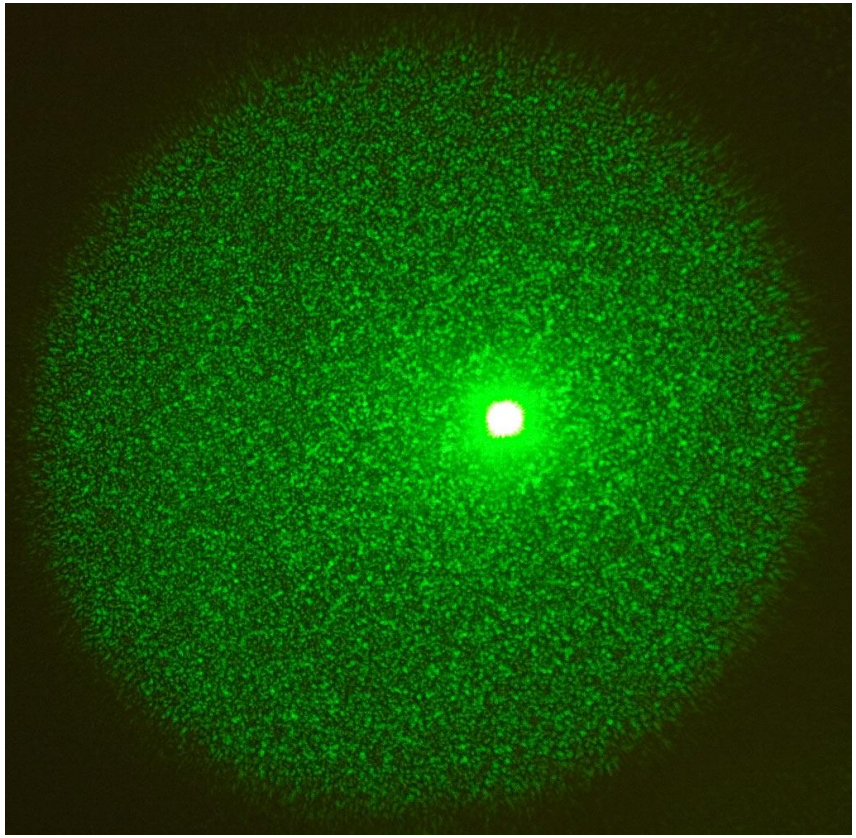
$$E_1(k) + E_2(k) = A(k)(\exp[ik(x-ct)] + \exp[ik(x+\Delta x-ct)])$$

For a “sum’ of frequency

$$I_{ac}(\Delta x) \propto \int |A(k)|^2 \cos(k\Delta x)dk$$

The spectrum is the inverse Fourier transform of measured intensity at different Δx (interferrogram)

Origin of Laser Speckles



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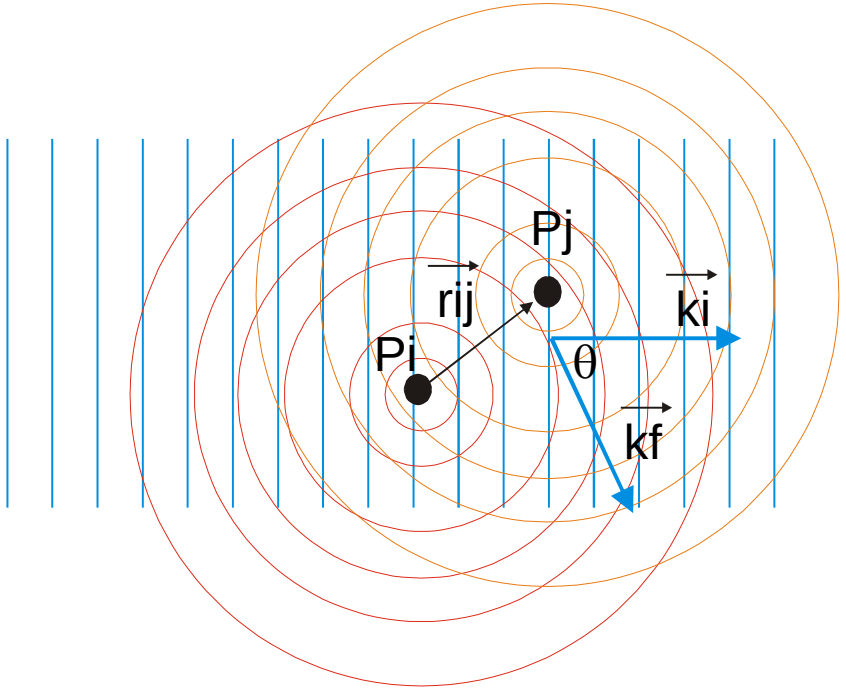
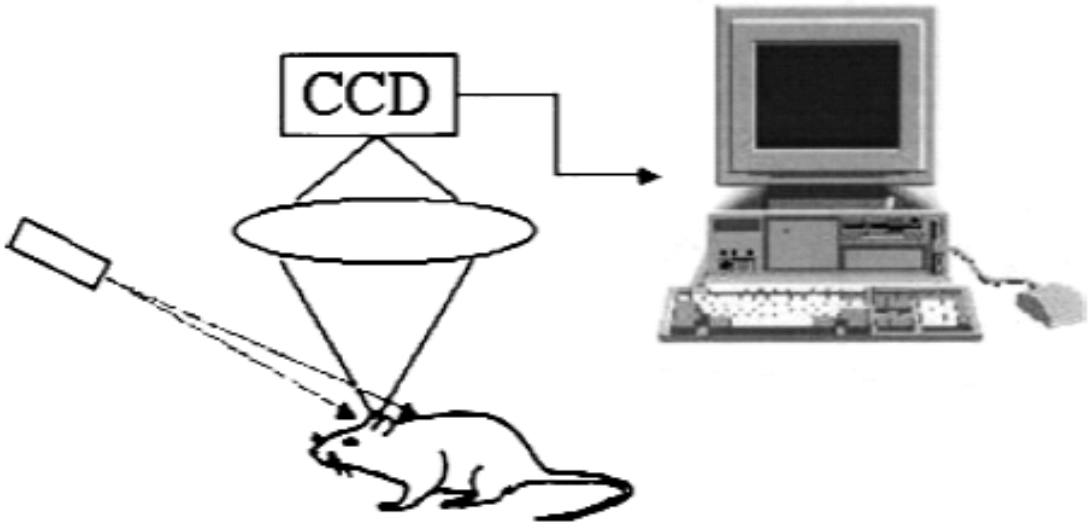
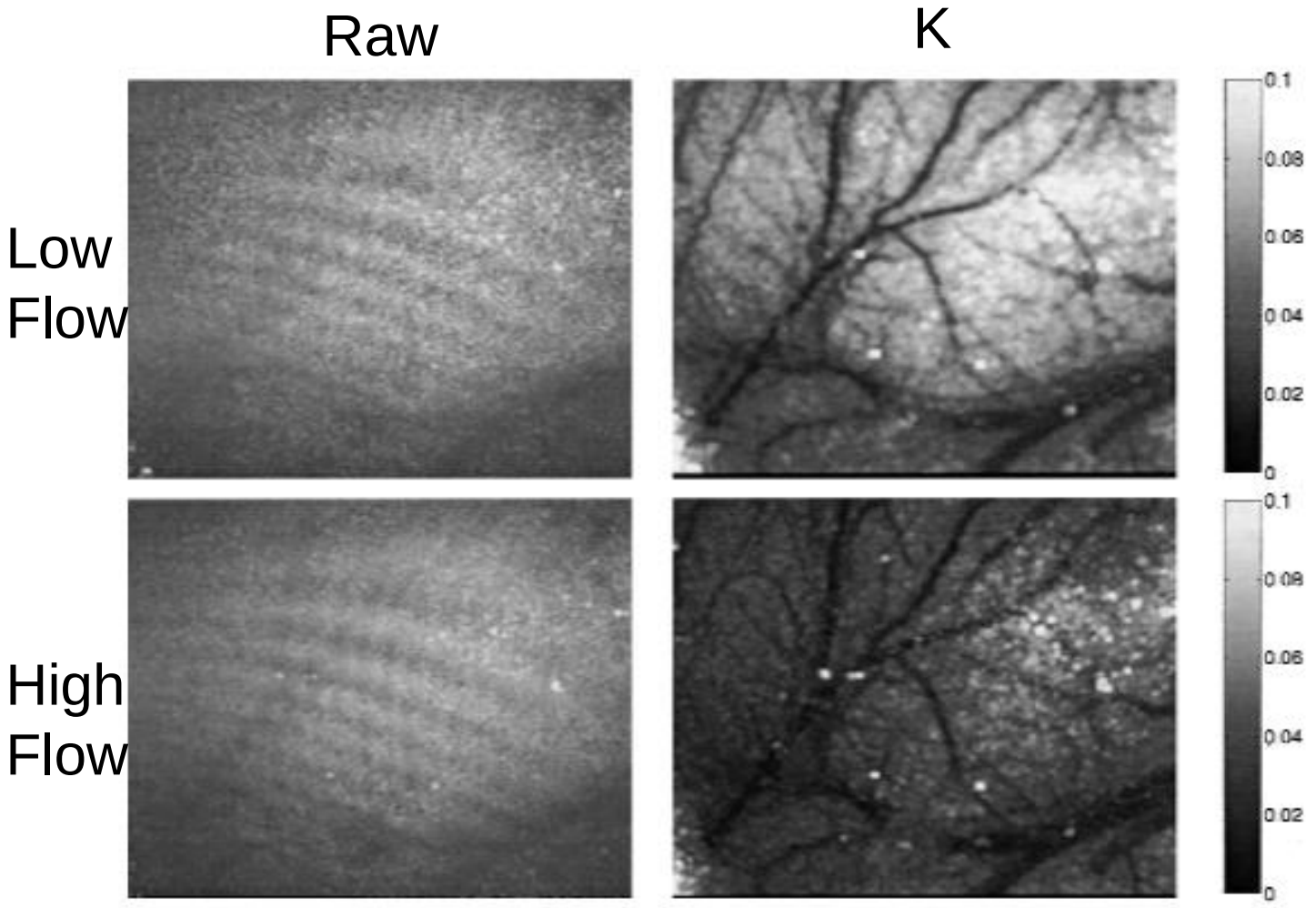


Speckle Imaging of Blood Flow in Mouse Brain
(Dunn et al., Journal of Celebral Blood Flow and Metabolism, 2001)



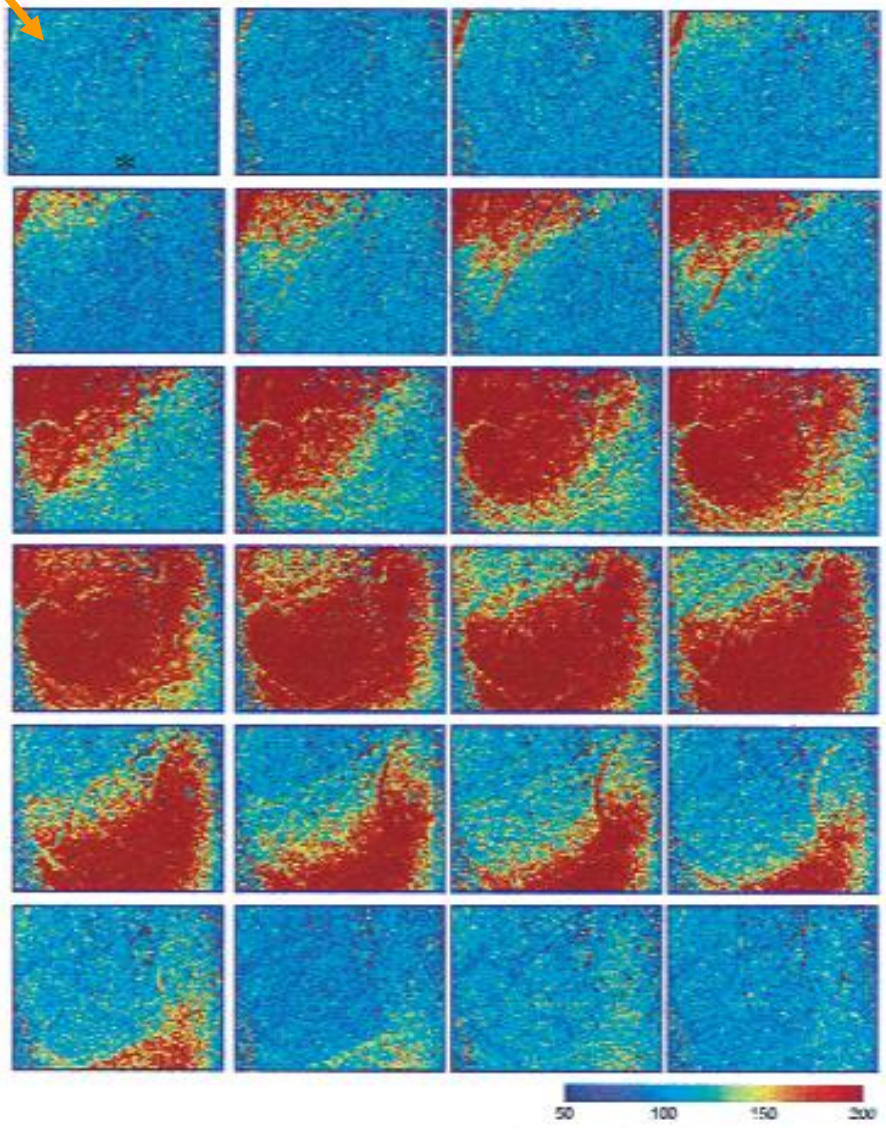
Speckle Contrast: $k = \frac{\sigma_I}{< I >}$

Speckle Imaging of Mouse Brain Blood Flow

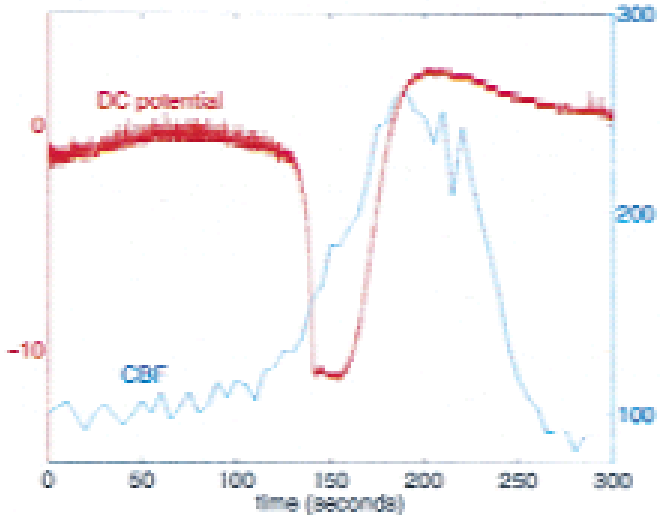


Imaging of Cortical Spreading Depression in Mouse Brain

KCl

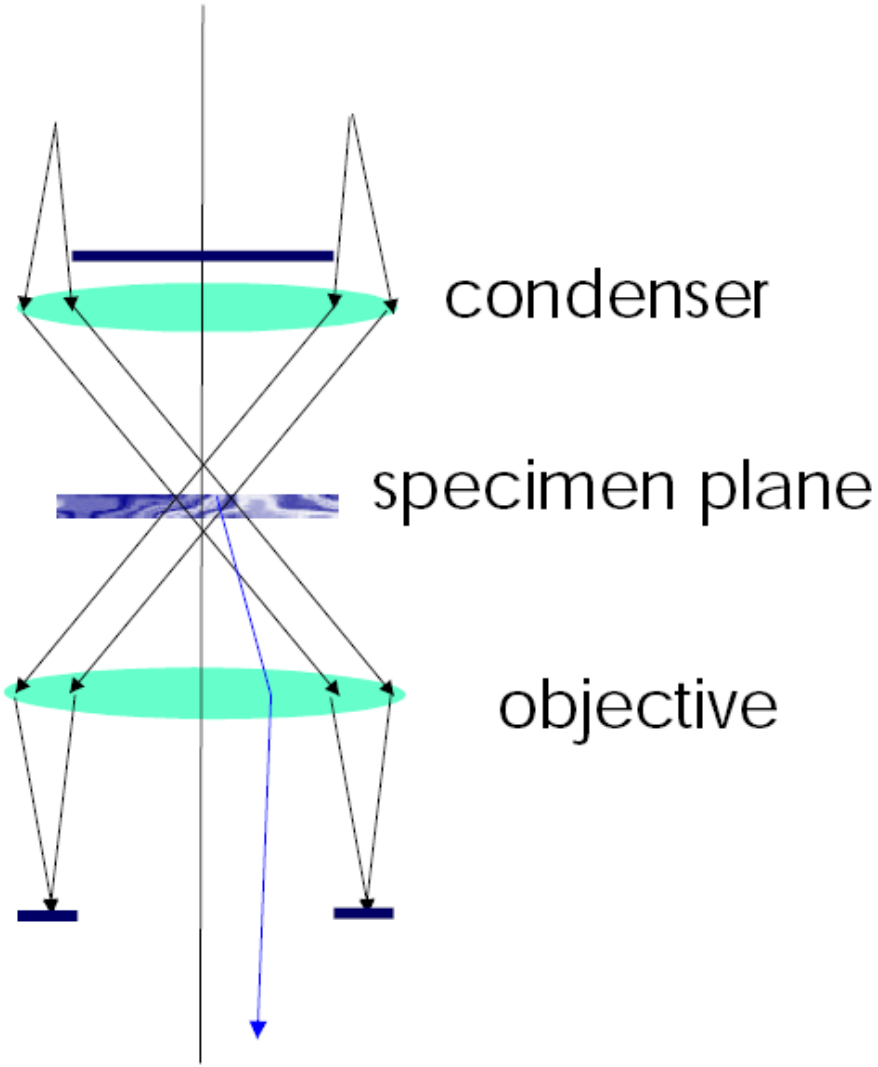


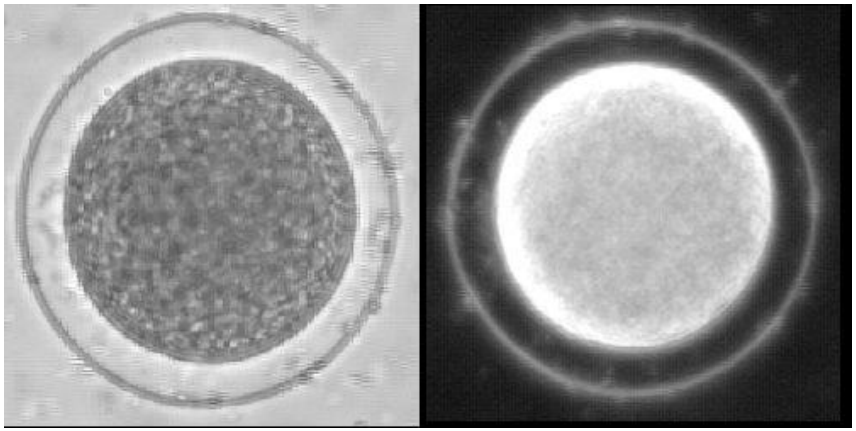
Cortical spreading depression is a local suppression of electrical activity with potential relationship to the onset of migraine headache.



Induced by a drop of KCl

Contrast Mechanisms in White Light Microscopy I: Dark Field





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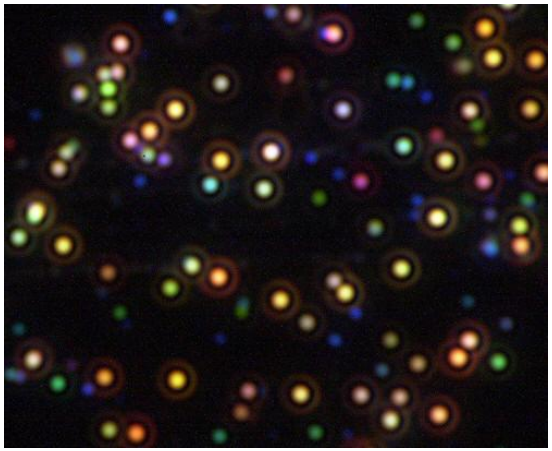
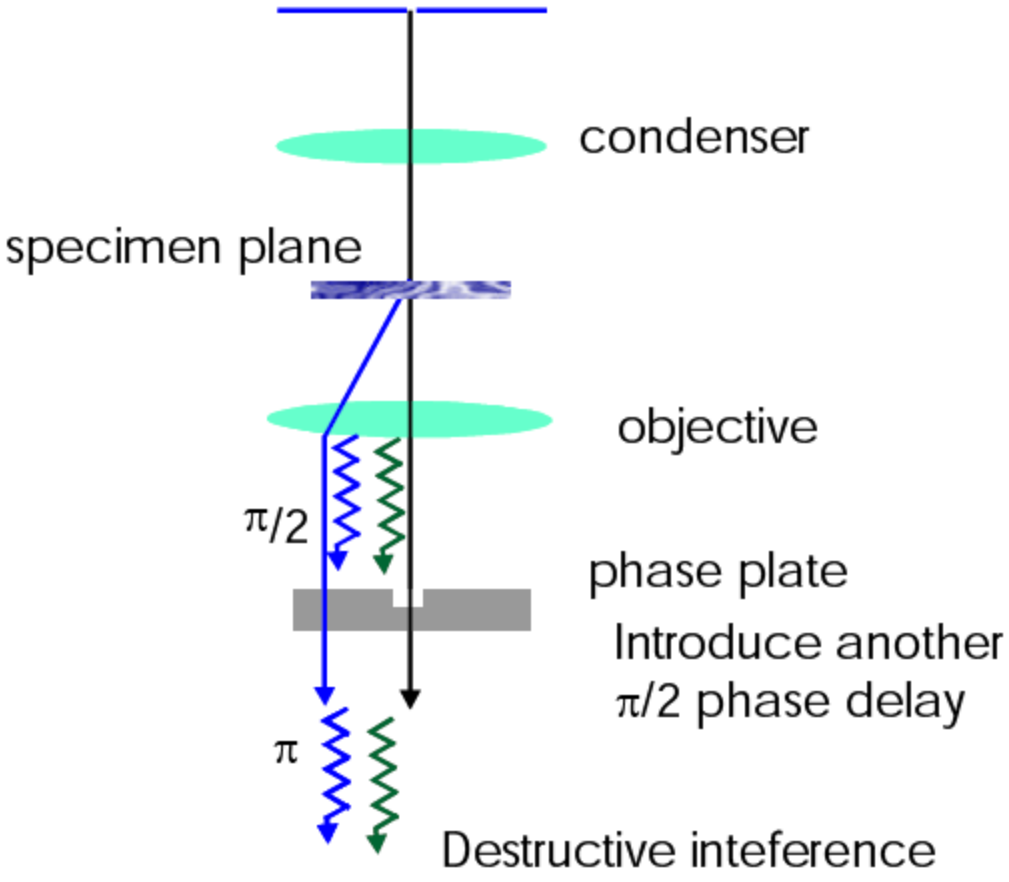


www.westga.edu

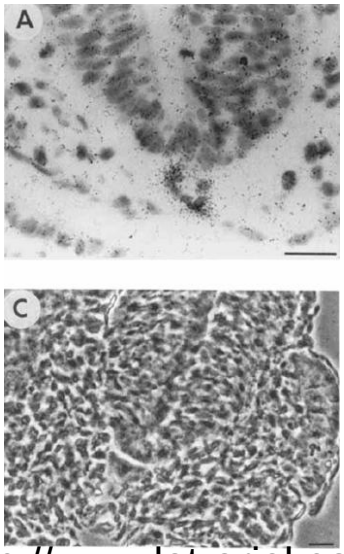
Contrast Mechanisms in White Light Microscopy II: Phase Contrast



Scattering results in π/2
or π/4 phase shift for absorbing
& scattering objects respectively

Phase plate introduce further
phase delay to either enhance or
reduce detected intensity.

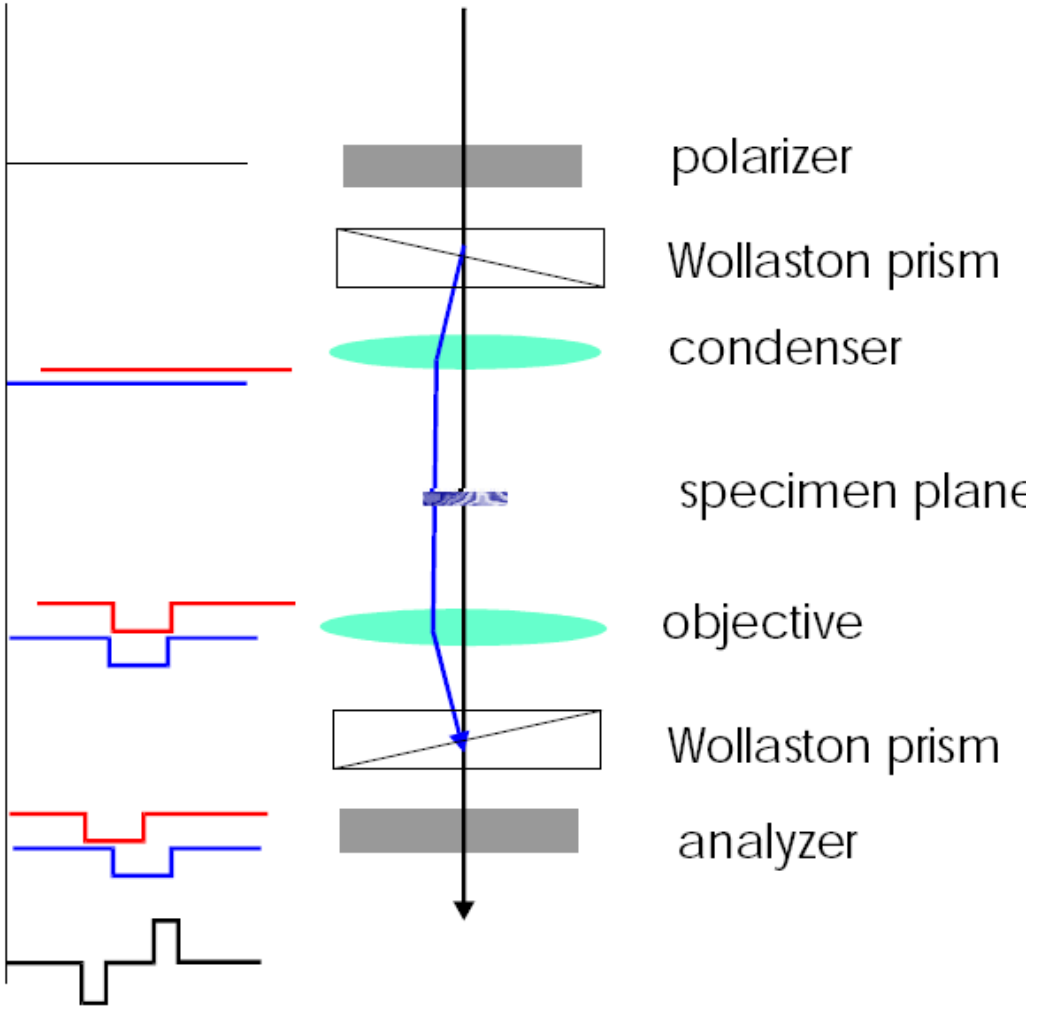
Invited by Zernike
(Nobel in Physics 1953)



Histological slice:
(Top) bright field
(Bottom) phase

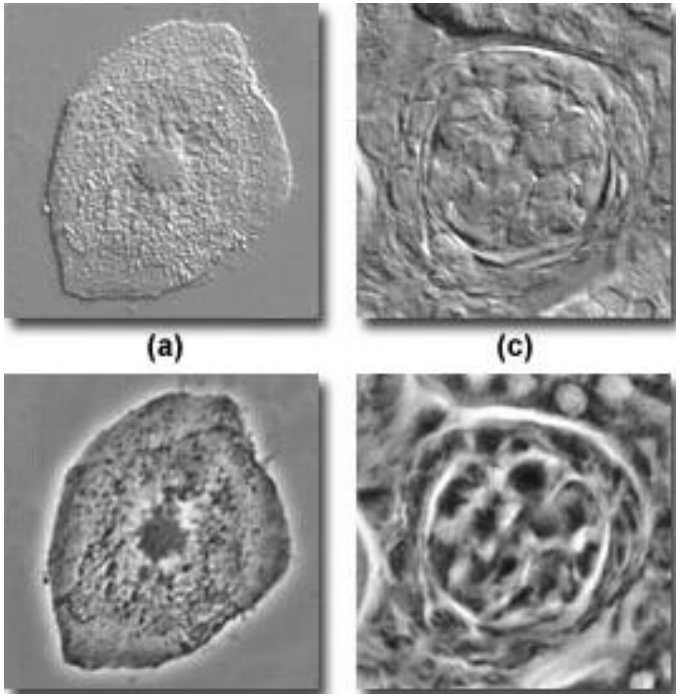
http://www.lot-oriel.com

Contrast Mechanisms in White Light Microscopy III: Differential Interference Contrast (DIC)



Mucosal epithelial cells

Kidney Section

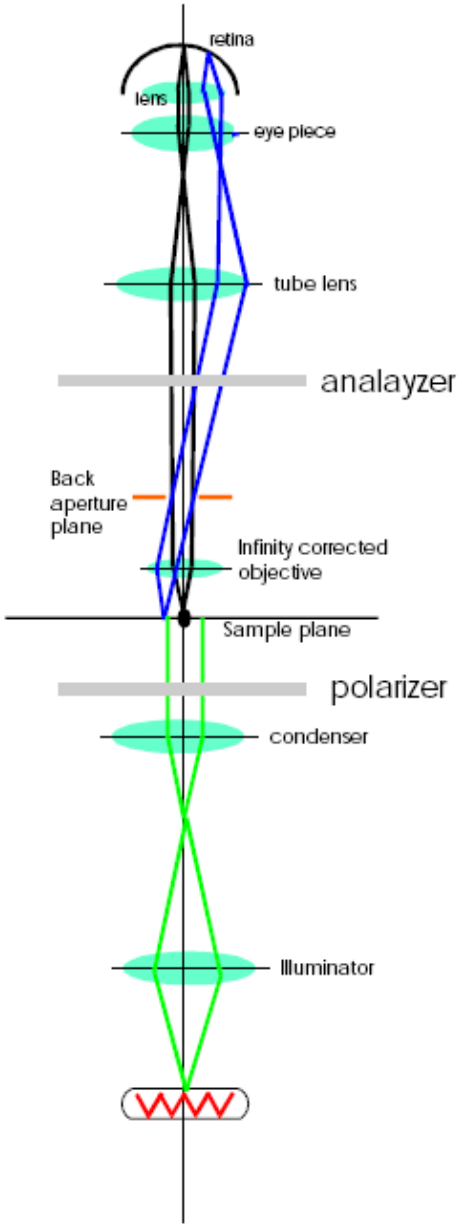


DIC

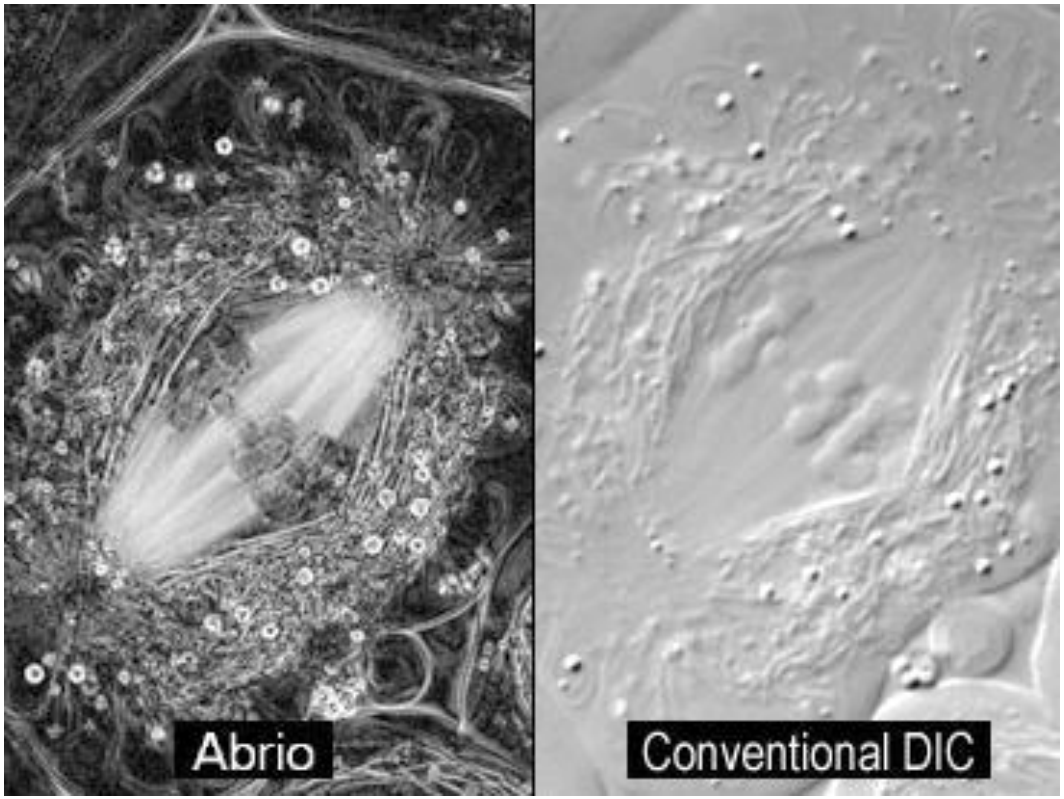
Phase

micro.magnet.fsu.edu

Contrast Mechanisms in White Light Microscopy IV: Polarization



Mitosis



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