



University
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Department of
MEDICAL BIOPHYSICS



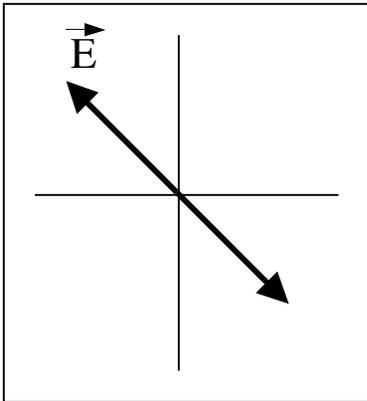
FACULTY OF MEDICINE
**GREAT MINDS FOR
A GREAT FUTURE**
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Polarized Light for Tissue Characterization

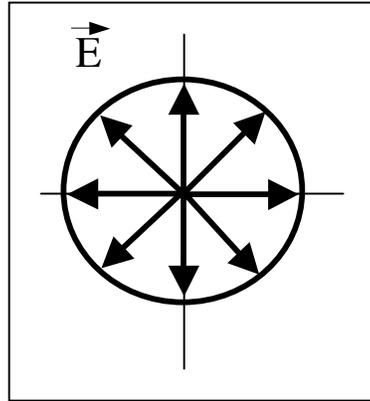
June 23, 2011

Michael Wood

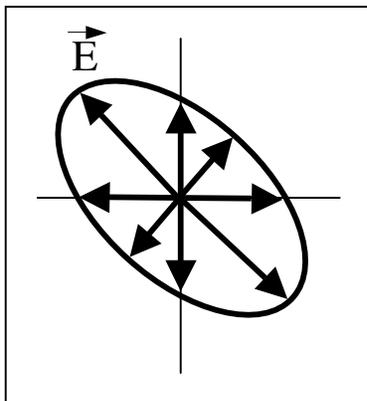
Polarized Light



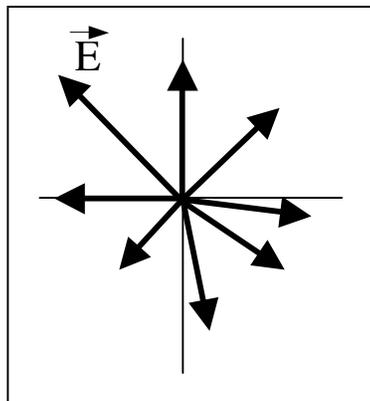
Linear



Circular



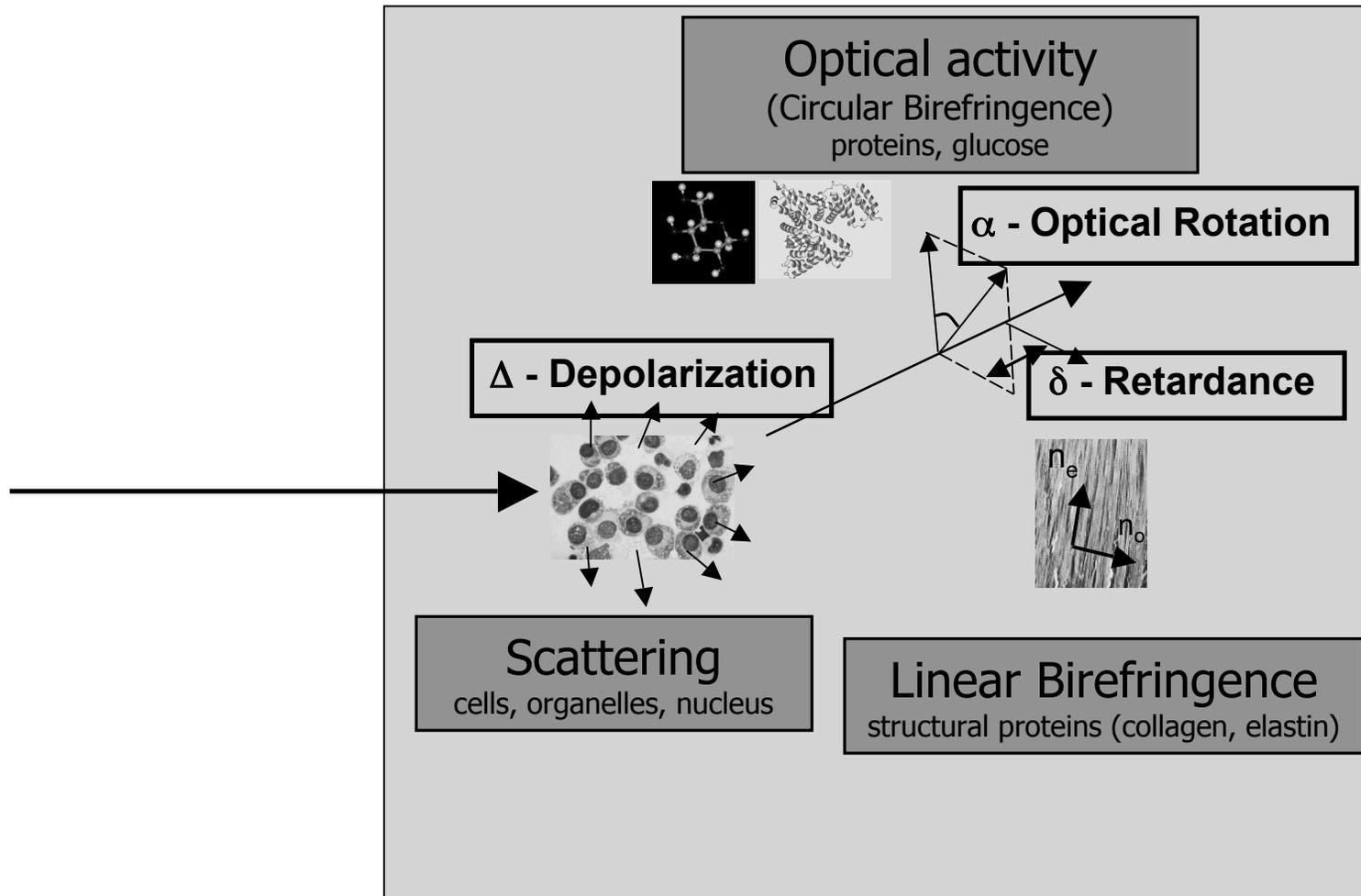
Elliptical



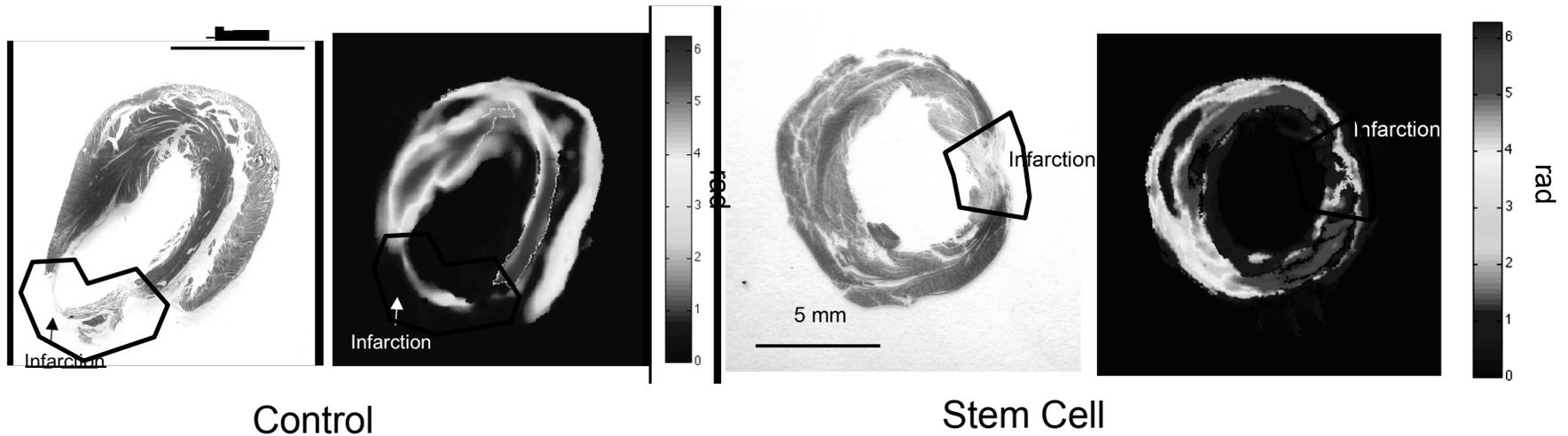
Unpolarized

- Electromagnetic wave
- Fields have orientation
- Orientation of electric field is polarization

Polarized Light in Tissue

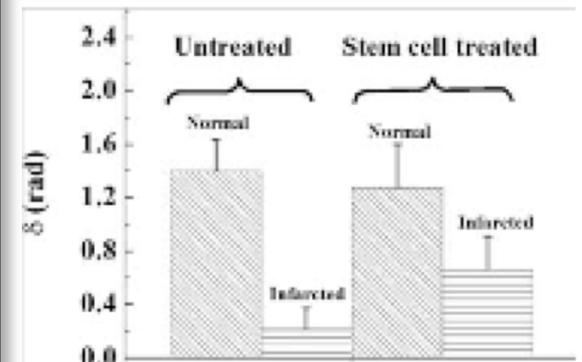


Myocardial Regeneration



Retardance Imaging

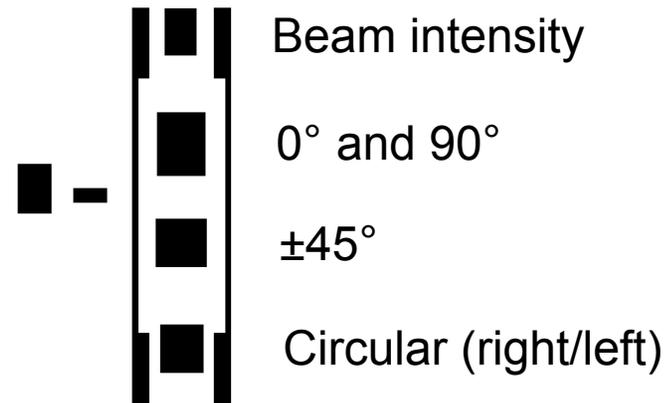
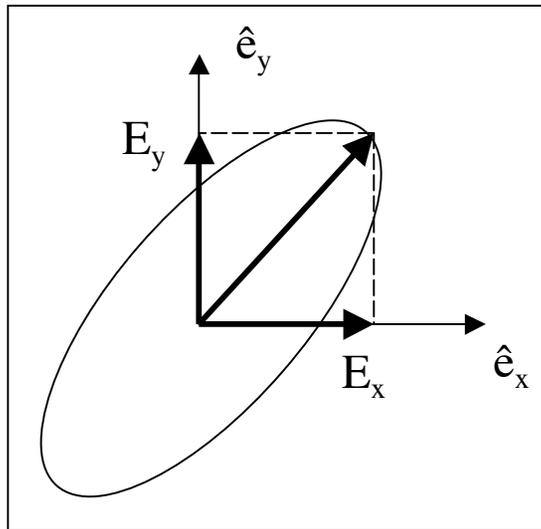
- Retardance images, decreased retardance in infarct
- Histology: muscle in red, collagen in blue (Masson's trichrome)
- Healthy muscle, increased collagen in scar
- Higher retardance in stem cell treated infarct (increased organization)



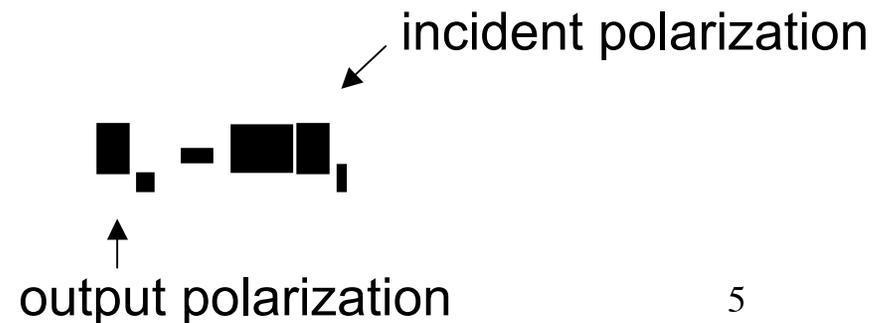
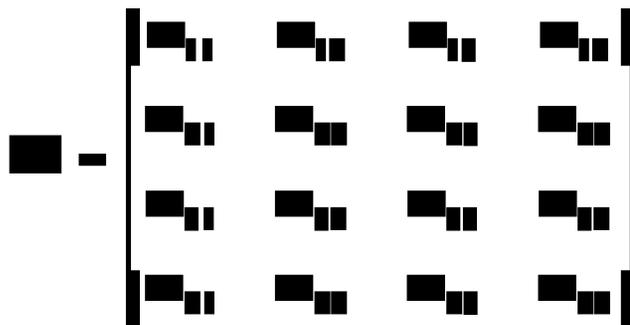
Wood *et al*, *J. Biomedical Optics* (2010).

Polarized Light Mathematics

Polarization expressed by Stokes vector



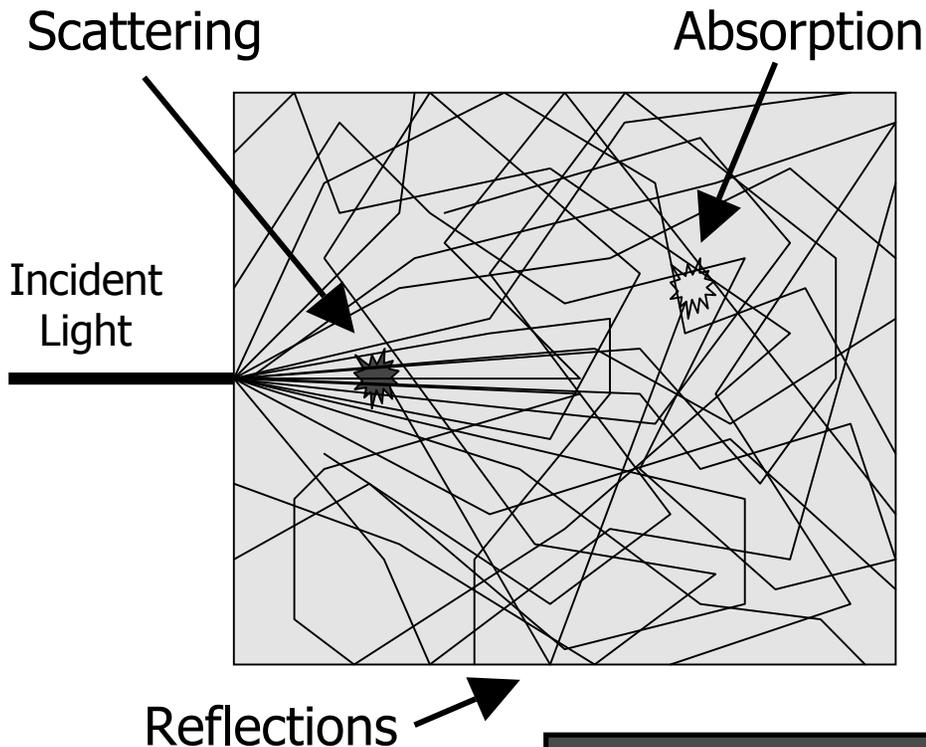
Polarization effects applied by Mueller matrix



Modeling Polarized Light in Tissue

Statistical Method

- Sample known probability distributions for interactions



- Track many photon paths ($>10^8$)
- Alter polarization (apply Mueller matrix)
- Record statistics
- Calculate average properties
- Gives macroscopic properties

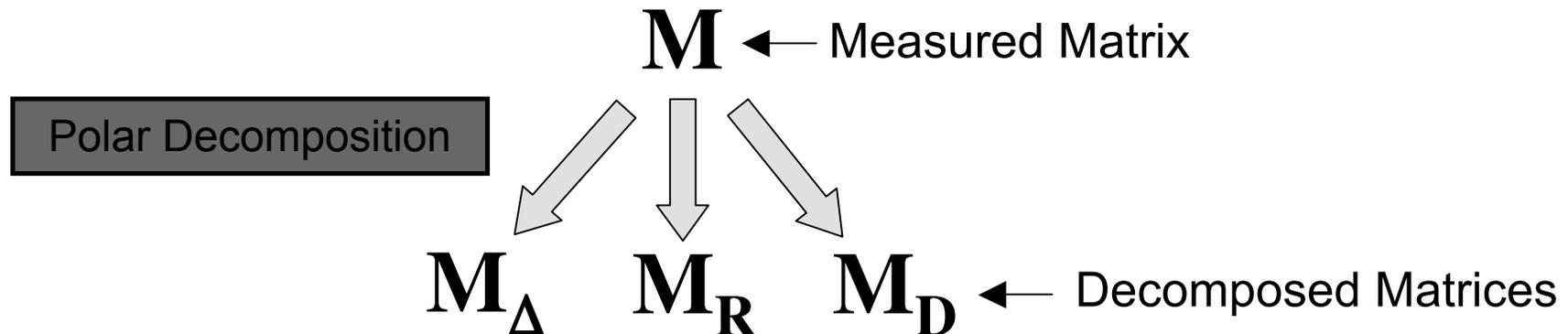
Calculate macroscopic properties from many individual interactions

Combining polarization effects in model
(Mueller matrices non-commutative $AB \neq BA$)

Mueller Matrix Decomposition

We want to measure polarization effects of tissue
(depolarization, birefringence, optical activity, etc)

But Mueller matrix contains *all* effects



Decomposed Matrices

M_Δ: Depolarization Matrix (scattering)

M_R: Retardance Matrix (optical activity and birefringence)

M_D: Diattenuation Matrix (dichroic absorption)

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