

Functional  
MRI: Part 2 of  
2

Dr. Alexander  
Mark Weber

Housekeeping

Freesurfer and  
DTI Overview

Learning  
Objectives

MRI Physics:  
 $T_1$  and  $T_2$   
Weighted  
Imaging

Freesurfer  
Analysis

Freesurfer  
Tutorial

MRI Physics:  
DWI

DWI Tutorial

# Understanding and Interpreting Functional Magnetic Resonance Imaging

## Precision Health Boot Camp

Alexander Mark Weber

Department of Pediatrics, Division of Neurology  
University of British Columbia

12:00 - 2:00 PM  
August 9th, 2022

# Preamble

Functional  
MRI: Part 2 of  
2

Dr. Alexander  
Mark Weber

Housekeeping

Freesurfer and  
DTI Overview

Learning  
Objectives

MRI Physics:  
 $T_1$  and  $T_2$   
Weighted  
Imaging

Freesurfer  
Analysis

Freesurfer  
Tutorial

MRI Physics:  
DWI

DWI Tutorial



ORIGINAL RESEARCH  
published: 06 August 2018  
doi: 10.3389/fneur.2018.00575



## Pathological Insights From Quantitative Susceptibility Mapping and Diffusion Tensor Imaging in Ice Hockey Players Pre and Post-concussion

Alexander M. Weber<sup>1,2\*</sup>, Anna Pukropski<sup>3†</sup>, Christian Kames<sup>2,4</sup>, Michael Jarrett<sup>1,2</sup>, Shrioy Dadachanji<sup>5</sup>, Jack Taunton<sup>6</sup>, David K. B. Li<sup>2,6,7</sup> and Alexander Rauscher<sup>1,2,8</sup>

Received: 8 April 2019 | Revised: 27 September 2019 | Accepted: 20 October 2019  
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### RESEARCH ARTICLE

NMR  
IN BIOMEDICINE WILEY

### Myelin water imaging and $R_2^*$ mapping in neonates: Investigating $R_2^*$ dependence on myelin and fibre orientation in whole brain white matter

Alexander Mark Weber<sup>1,2</sup>  | Yuting Zhang<sup>3,4,5,6</sup> | Christian Kames<sup>2,7</sup> |  
Alexander Rauscher<sup>1,2,7,8</sup> 

# Overview

Functional  
MRI: Part 2 of  
2

Dr. Alexander  
Mark Weber

Housekeeping

Freesurfer and  
DTI Overview

Learning  
Objectives

MRI Physics:  
 $T_1$  and  $T_2$   
Weighted  
Imaging

Freesurfer  
Analysis

Freesurfer  
Tutorial

MRI Physics:  
DWI

DWI Tutorial

- 1 Housekeeping**
- 2 Freesurfer and DTI Overview**
- 3 Learning Objectives**
- 4 MRI Physics:  $T_1$  and  $T_2$  Weighted Imaging**
- 5 Freesurfer Analysis**
- 6 Freesurfer Tutorial**
- 7 MRI Physics: DWI**
- 8 DWI Tutorial**

# Land Acknowledgement

Functional  
MRI: Part 2 of  
2

Dr. Alexander  
Mark Weber

Housekeeping

Freesurfer and  
DTI Overview

Learning  
Objectives

MRI Physics:  
 $T_1$  and  $T_2$   
Weighted  
Imaging

Freesurfer  
Analysis

Freesurfer  
Tutorial

MRI Physics:  
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I would like to acknowledge that we are gathered today on the traditional, ancestral, and unceded territory of the Musqueam people.



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MRI: Part 2 of  
2

Dr. Alexander  
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Housekeeping

Freesurfer and  
DTI Overview

Learning  
Objectives

MRI Physics:  
 $T_1$  and  $T_2$   
Weighted  
Imaging

Freesurfer  
Analysis

Freesurfer  
Tutorial

MRI Physics:  
DWI

DWI Tutorial

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Functional  
MRI: Part 2 of  
2

Dr. Alexander  
Mark Weber

Housekeeping

Freesurfer and  
DTI Overview

Learning  
Objectives

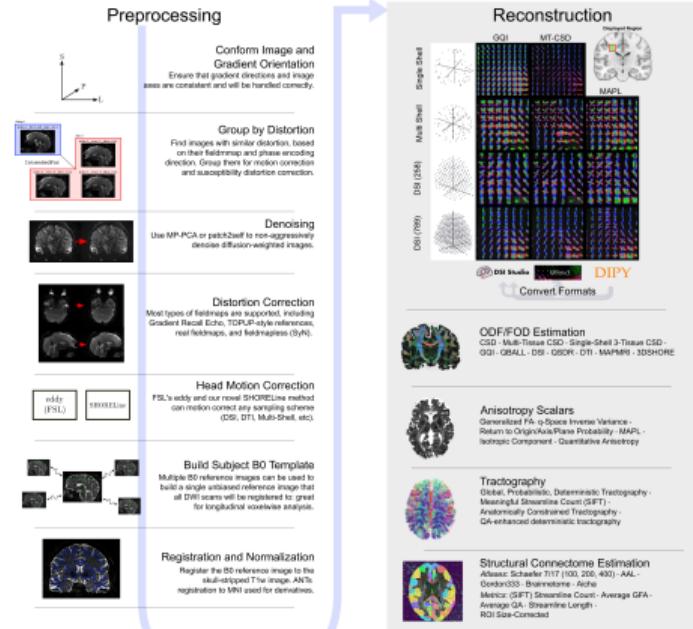
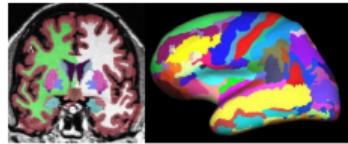
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 $T_1$  and  $T_2$   
Weighted  
Imaging

Freesurfer  
Analysis

Freesurfer  
Tutorial

MRI Physics:  
DWI

DWI Tutorial



# Freesurfer and DTI Overview

Functional  
MRI: Part 2 of  
2

Dr. Alexander  
Mark Weber

Housekeeping

Freesurfer and  
DTI Overview

Learning  
Objectives

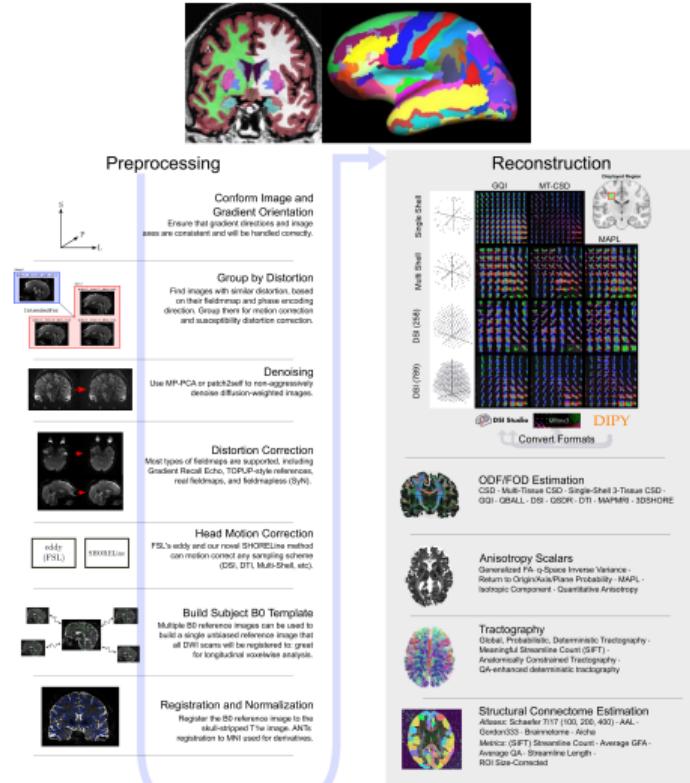
MRI Physics:  
 $T_1$  and  $T_2$   
Weighted  
Imaging

Freesurfer  
Analysis

Freesurfer  
Tutorial

MRI Physics:  
DWI

DWI Tutorial



## Lecture:

- $T_1$  and  $T_2$  weighted imaging

## Tutorial:

- Freesurfer

## Lecture:

- DTI Physics

## Tutorial:

- DTI preprocessing using qsiprep

At the end of this session, students will be able to:

- Describe the difference between  $T_1$  and  $T_2$  weighted images
- How to run Freesurfer on Sockeye
- Describe why water diffusion in the brain can help us understand white matter structure
- Describe how MRIs detect diffusion in different directions
- How to run qsiprep to preprocess DWI on Sockeye

# $T_1$ and $T_2$ Overview

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2

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Housekeeping

Freesurfer and  
DTI Overview

Learning  
Objectives

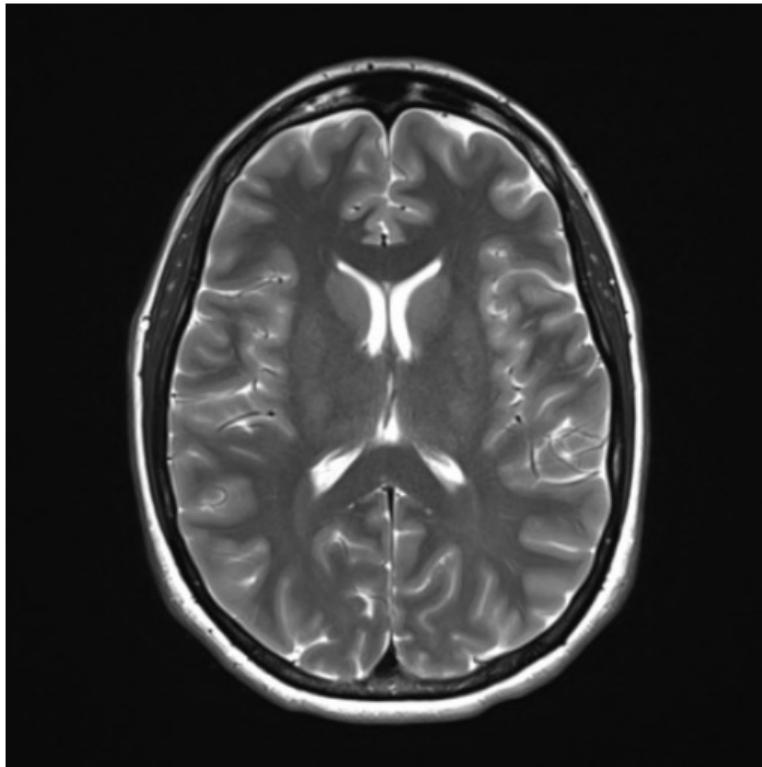
MRI Physics:  
 $T_1$  and  $T_2$   
Weighted  
Imaging

Freesurfer  
Analysis

Freesurfer  
Tutorial

MRI Physics:  
DWI

DWI Tutorial



## $T_2$ -weighted scan

- Water is bright
- A mix of water/tissue is less bright (grey matter)
- Fatty tissue is dark (white matter)

# $T_1$ and $T_2$ Overview

Functional  
MRI: Part 2 of  
2

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Housekeeping

Freesurfer and  
DTI Overview

Learning  
Objectives

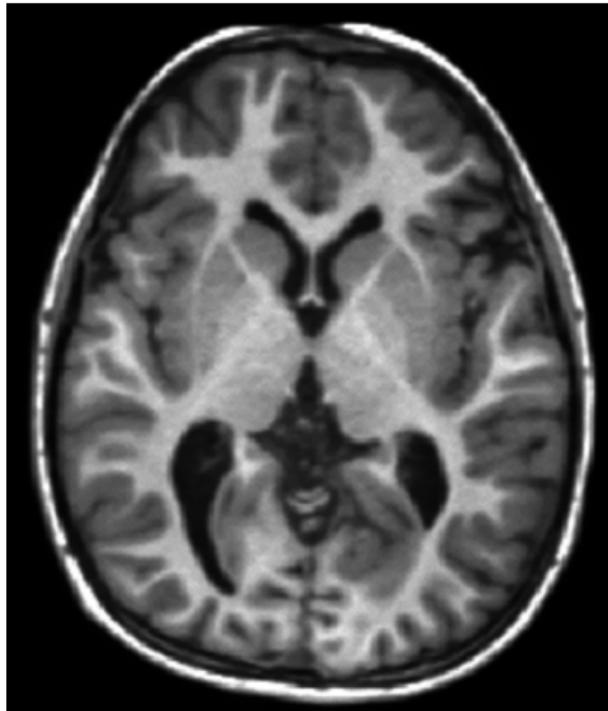
MRI Physics:  
 $T_1$  and  $T_2$   
Weighted  
Imaging

Freesurfer  
Analysis

Freesurfer  
Tutorial

MRI Physics:  
DWI

DWI Tutorial



## $T_1$ -weighted scan

- Fatty tissue is bright (white matter)
- A mix of water/tissue is less bright (grey matter)
- Water is dark

# $T_1$ and $T_2$ Overview

Functional  
MRI: Part 2 of  
2

Dr. Alexander  
Mark Weber

Housekeeping

Freesurfer and  
DTI Overview

Learning  
Objectives

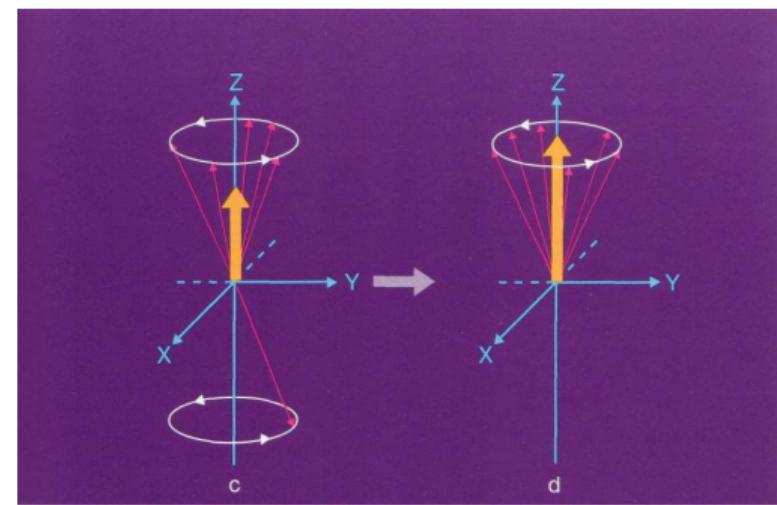
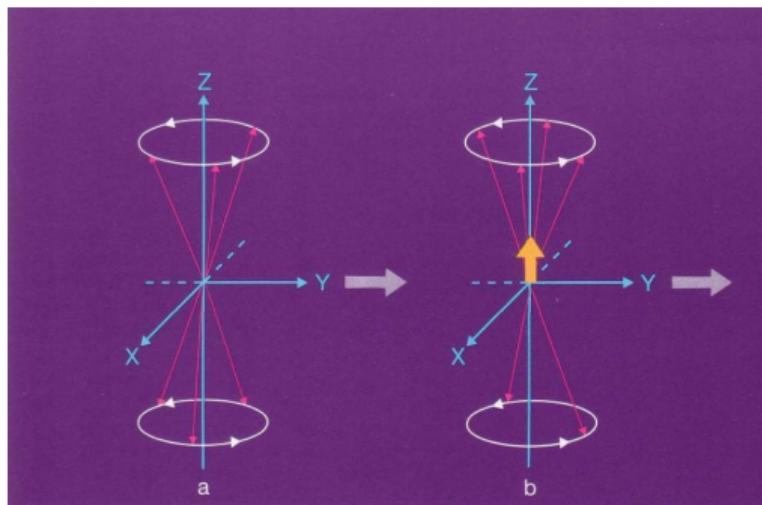
MRI Physics:  
 $T_1$  and  $T_2$   
Weighted  
Imaging

Freesurfer  
Analysis

Freesurfer  
Tutorial

MRI Physics:  
DWI

DWI Tutorial



# $T_1$ and $T_2$ Overview

Functional  
MRI: Part 2 of  
2

Dr. Alexander  
Mark Weber

Housekeeping

Freesurfer and  
DTI Overview

Learning  
Objectives

MRI Physics:  
 $T_1$  and  $T_2$   
Weighted  
Imaging

Freesurfer  
Analysis

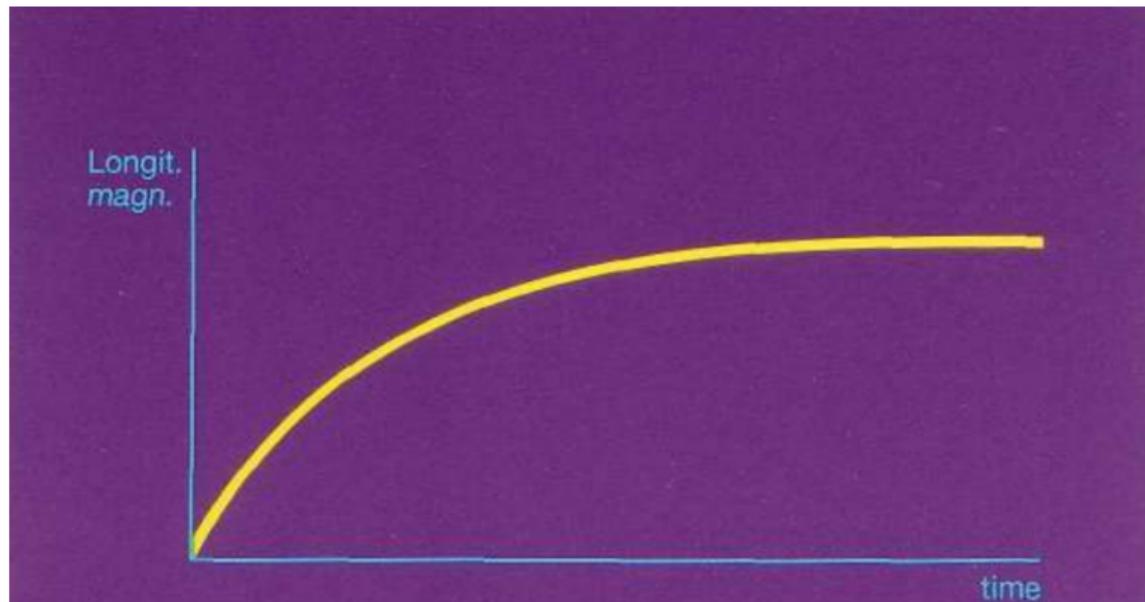
Freesurfer  
Tutorial

MRI Physics:  
DWI

DWI Tutorial

## $T_1$ relaxation

Also known as spin-lattice or longitudinal relaxation: it is a time measure of the rate of recovery caused by spin-lattice interactions



# $T_1$ and $T_2$ Overview

Functional  
MRI: Part 2 of  
2

Dr. Alexander  
Mark Weber

Housekeeping

Freesurfer and  
DTI Overview

Learning  
Objectives

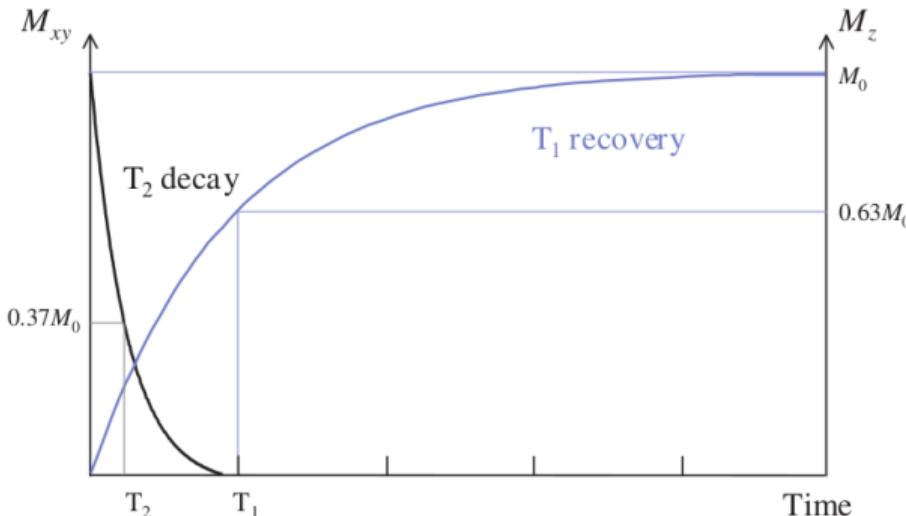
MRI Physics:  
 $T_1$  and  $T_2$   
Weighted  
Imaging

Freesurfer  
Analysis

Freesurfer  
Tutorial

MRI Physics:  
DWI

DWI Tutorial



# $T_1$ and $T_2$ Overview

Functional  
MRI: Part 2 of  
2

Dr. Alexander  
Mark Weber

Housekeeping

Freesurfer and  
DTI Overview

Learning  
Objectives

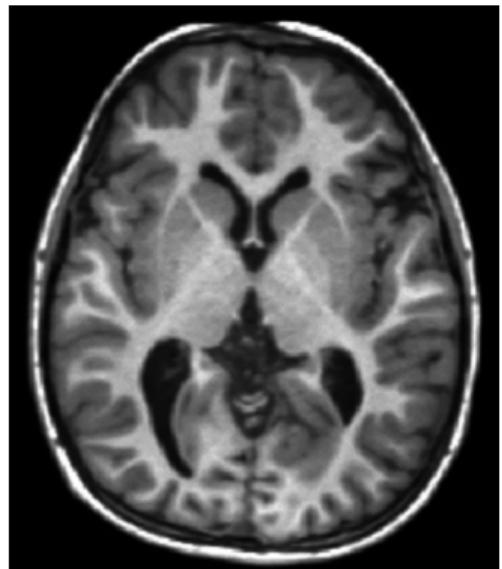
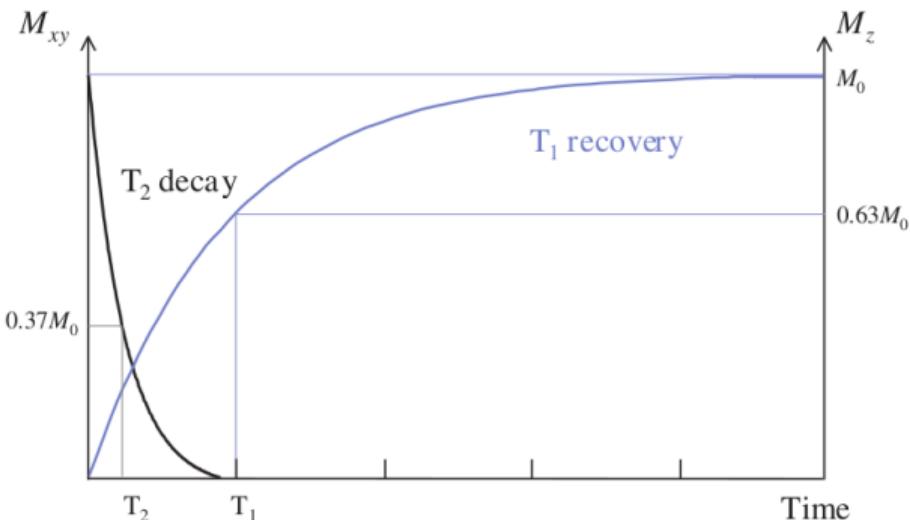
MRI Physics:  
 $T_1$  and  $T_2$   
Weighted  
Imaging

Freesurfer  
Analysis

Freesurfer  
Tutorial

MRI Physics:  
DWI

DWI Tutorial



# Freesurfer

Functional  
MRI: Part 2 of  
2

Dr. Alexander  
Mark Weber

Housekeeping

Freesurfer and  
DTI Overview

Learning  
Objectives

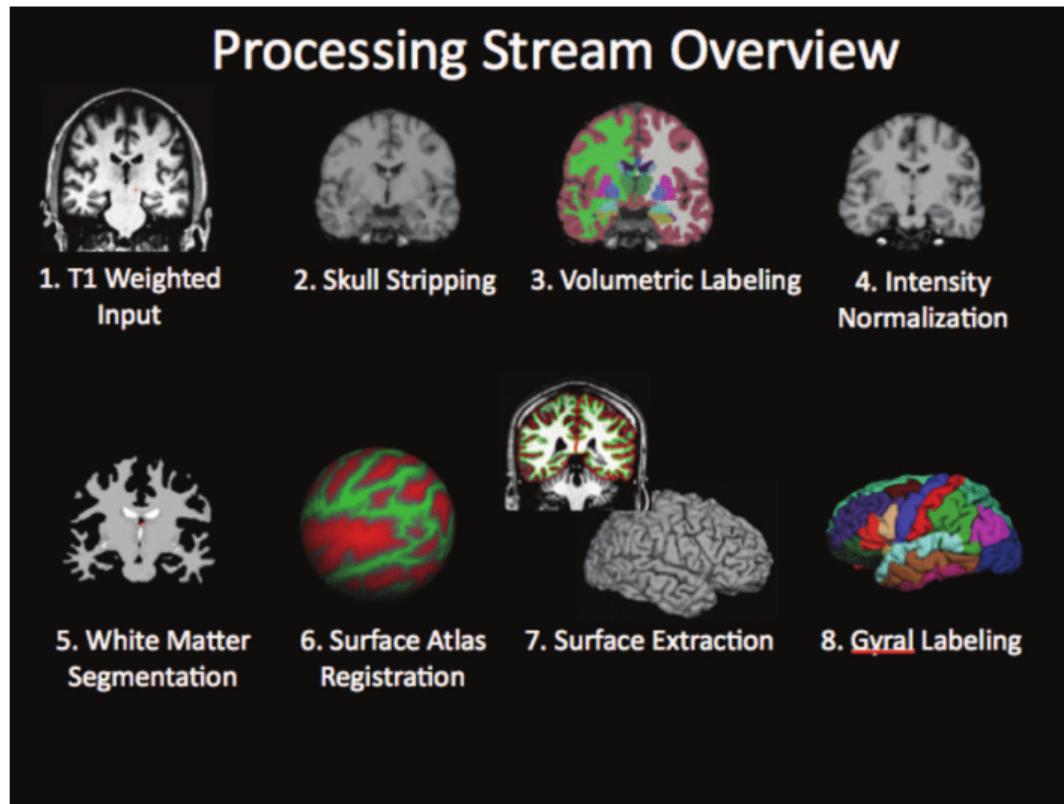
MRI Physics:  
 $T_1$  and  $T_2$   
Weighted  
Imaging

Freesurfer  
Analysis

Freesurfer  
Tutorial

MRI Physics:  
DWI

DWI Tutorial



# Sockeye

Functional  
MRI: Part 2 of  
2

Dr. Alexander  
Mark Weber

Housekeeping

Freesurfer and  
DTI Overview

Learning  
Objectives

MRI Physics:  
 $T_1$  and  $T_2$   
Weighted  
Imaging

Freesurfer  
Analysis

**Freesurfer  
Tutorial**

MRI Physics:  
DWI

DWI Tutorial

# Diffusion Weighted Imaging

Functional  
MRI: Part 2 of  
2

Dr. Alexander  
Mark Weber

Housekeeping

Freesurfer and  
DTI Overview

Learning  
Objectives

MRI Physics:  
 $T_1$  and  $T_2$   
Weighted  
Imaging

Freesurfer  
Analysis

Freesurfer  
Tutorial

MRI Physics:  
DWI

DWI Tutorial

## Diffusion Weighted Imaging

- diffusion-weighted imaging is an MRI technique based on the tissue **water diffusion rate**
- It allows for very sensitive probing of water movements within the architecture of the tissues

# Diffusion Weighted Imaging

Functional  
MRI: Part 2 of  
2

Dr. Alexander  
Mark Weber

Housekeeping

Freesurfer and  
DTI Overview

Learning  
Objectives

MRI Physics:  
 $T_1$  and  $T_2$   
Weighted  
Imaging

Freesurfer  
Analysis

Freesurfer  
Tutorial

MRI Physics:  
DWI

DWI Tutorial

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## Brownian Motion

random motion of particles suspended in a medium

# Diffusion Weighted Imaging

Functional  
MRI: Part 2 of  
2

Dr. Alexander  
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Housekeeping

Freesurfer and  
DTI Overview

Learning  
Objectives

MRI Physics:  
 $T_1$  and  $T_2$   
Weighted  
Imaging

Freesurfer  
Analysis

Freesurfer  
Tutorial

MRI Physics:  
DWI

DWI Tutorial

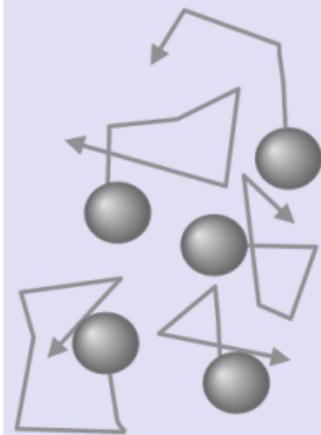
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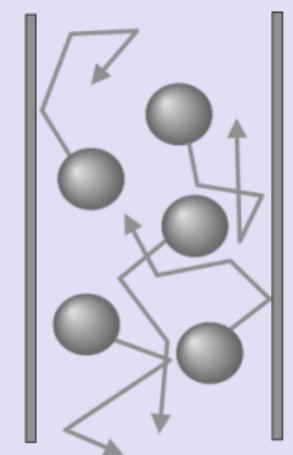
## Brownian Motion

random motion of particles suspended in a medium

Isotropic diffusion



Restricted diffusion



McRobbie et al. MRI: From Picture to Proton, 2nd Ed

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Functional  
MRI: Part 2 of  
2

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Housekeeping

Freesurfer and  
DTI Overview

Learning  
Objectives

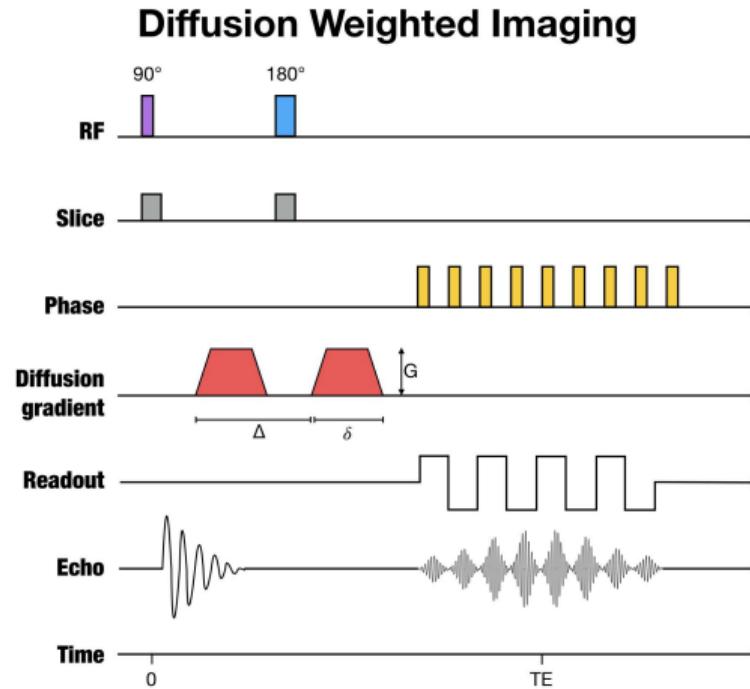
MRI Physics:  
 $T_1$  and  $T_2$   
Weighted  
Imaging

Freesurfer  
Analysis

Freesurfer  
Tutorial

MRI Physics:  
DWI

DWI Tutorial



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Functional  
MRI: Part 2 of  
2

Dr. Alexander  
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Housekeeping

Freesurfer and  
DTI Overview

Learning  
Objectives

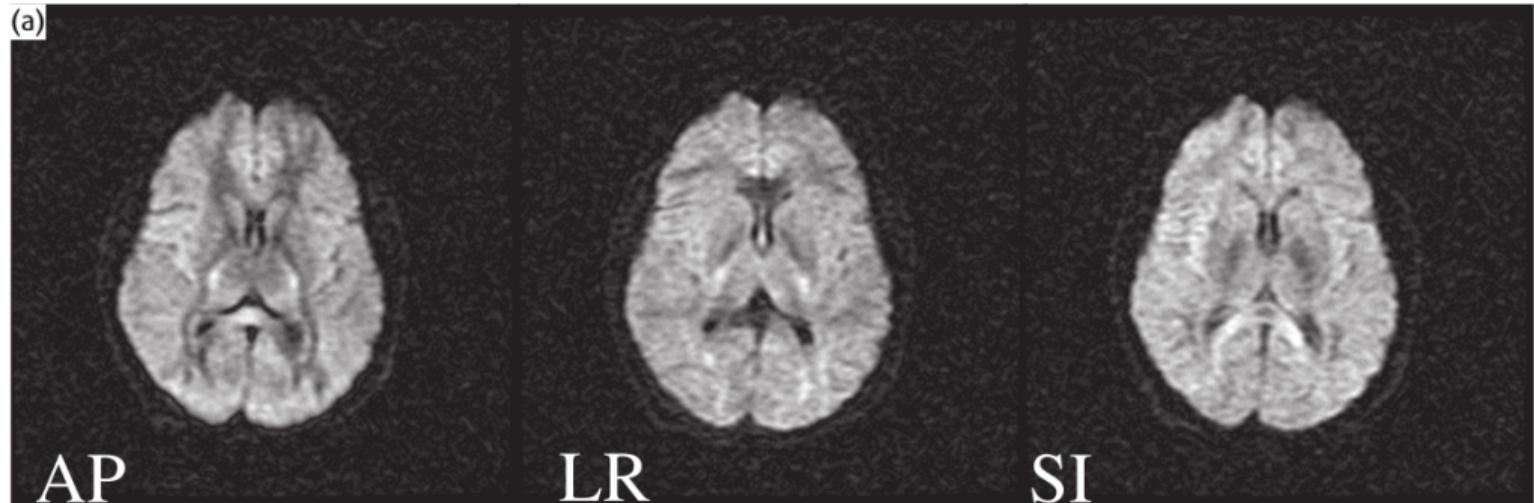
MRI Physics:  
 $T_1$  and  $T_2$   
Weighted  
Imaging

Freesurfer  
Analysis

Freesurfer  
Tutorial

MRI Physics:  
DWI

DWI Tutorial



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Functional  
MRI: Part 2 of  
2

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Housekeeping

Freesurfer and  
DTI Overview

Learning  
Objectives

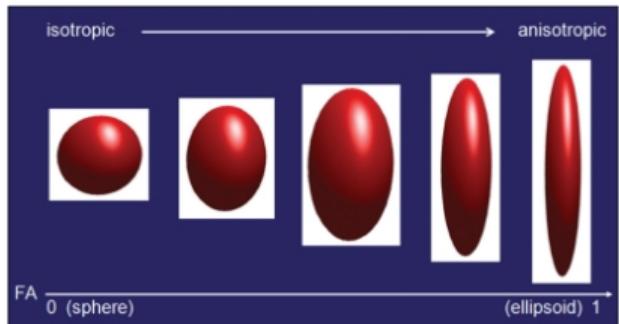
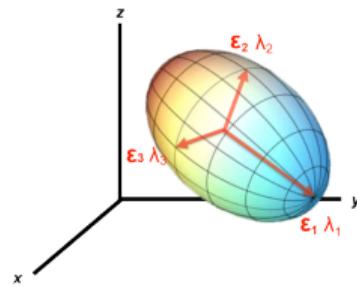
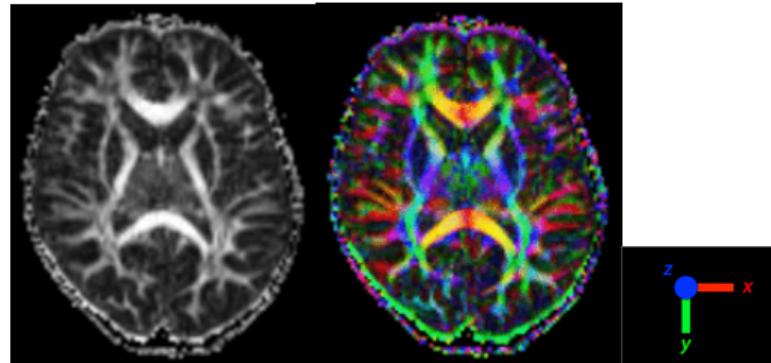
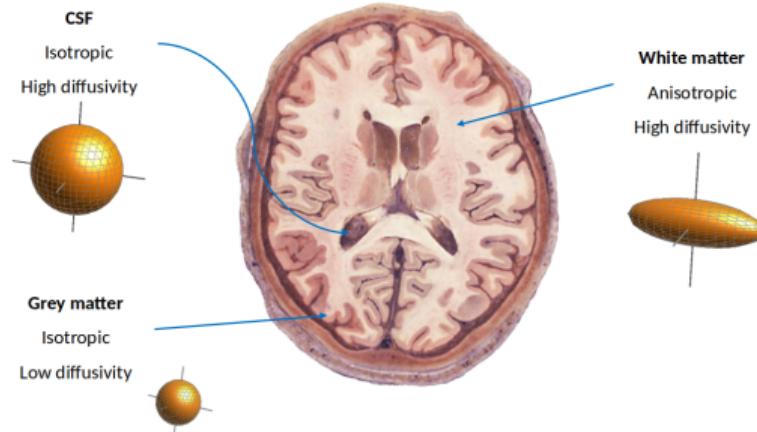
MRI Physics:  
 $T_1$  and  $T_2$   
Weighted  
Imaging

Freesurfer  
Analysis

Freesurfer  
Tutorial

MRI Physics:  
DWI

DWI Tutorial



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Functional  
MRI: Part 2 of  
2

Dr. Alexander  
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Housekeeping

Freesurfer and  
DTI Overview

Learning  
Objectives

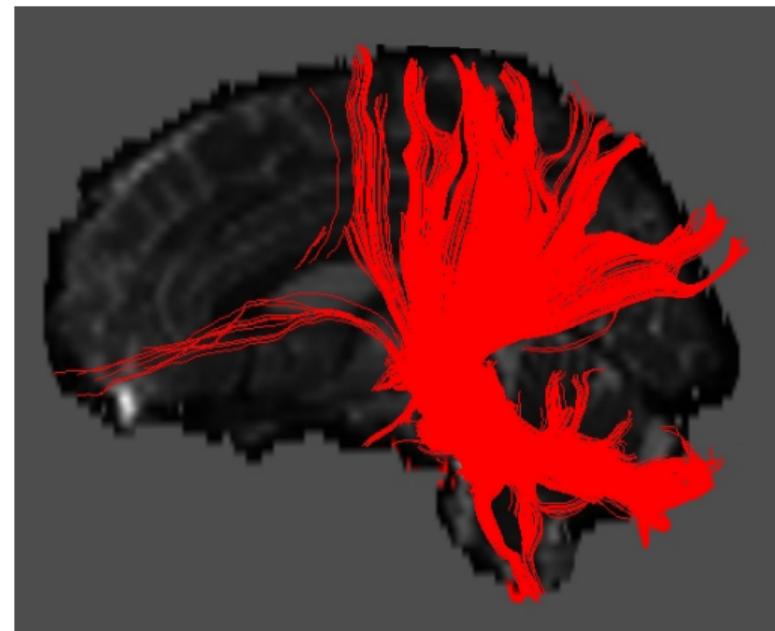
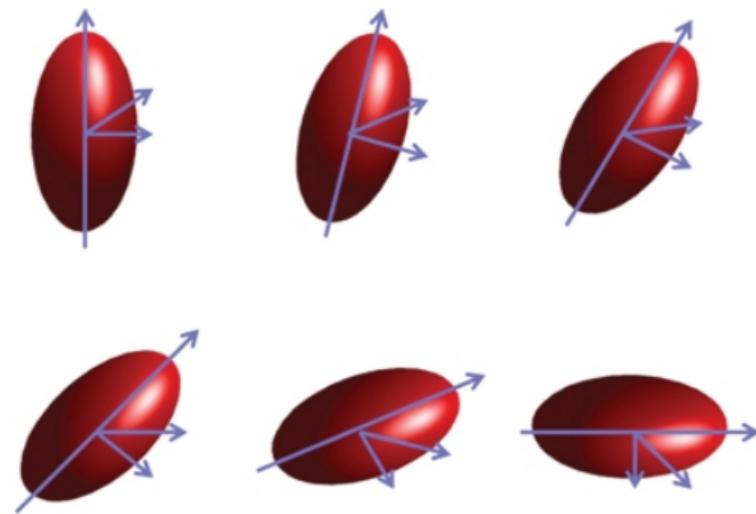
MRI Physics:  
 $T_1$  and  $T_2$   
Weighted  
Imaging

Freesurfer  
Analysis

Freesurfer  
Tutorial

MRI Physics:  
DWI

DWI Tutorial



# DWI Preprocessing

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Freesurfer and DTI Overview

Learning Objectives

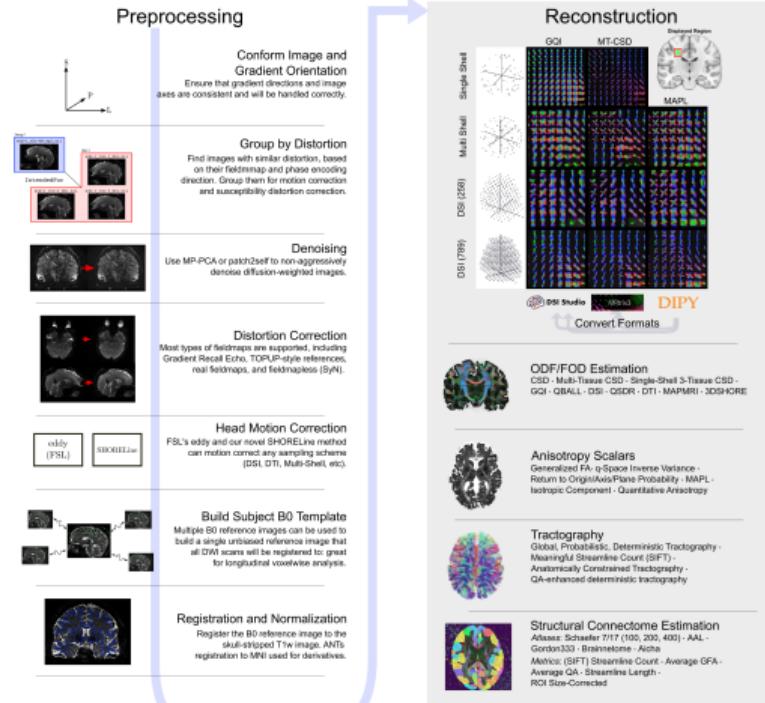
MRI Physics:  
 $T_1$  and  $T_2$   
Weighted Imaging

Freesurfer Analysis

Freesurfer Tutorial

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- Brain extraction
- Head motion correction
- Eddy current correction
- Susceptibility distortion
- Coregistration to T1w images
- Spatial normalization
- Data quality checks

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Functional  
MRI: Part 2 of  
2

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Housekeeping

Freesurfer and  
DTI Overview

Learning  
Objectives

MRI Physics:  
 $T_1$  and  $T_2$   
Weighted  
Imaging

Freesurfer  
Analysis

Freesurfer  
Tutorial

MRI Physics:  
DWI

DWI Tutorial