Diffusion Basics
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Highlights
- What is Diffusion MRI
- Basics of how Diffusion MRI is characterized and quantified
- What does Diffusion offer for the student of neuroimaging?

Target Audience
The target audience is the absolute beginner in neuroimaging who wants to understand more about diffusion MRI. The goal of this presentation is to develop a vocabulary about diffusion and diffusion tensor MRI and will lay the foundation for more advanced topics.

What are the challenges we face when understanding Diffusion MRI?
Diffusion Imaging is an MRI technique that offers rich information about the human nervous system in vivo and been applied to understanding maturation and diseases such as stroke or neurodegeneration. Due to the growth and interest in diffusion MRI, a quick literature search for "Diffusion Tensor MRI" results in over 6000 manuscripts on applications, fundamentals of how to do diffusion MRI, the pre-processing and mathematics necessary to derive parametric images reflective of tissue anisotropy, and derivation of fiber pathways. Furthermore, examples of diffusion MRI in the literature often offer abbreviated methods because certain conventions have been adopted. Thus, the goal of this talk is to provide the basics to not only interpret current literature, but also to develop a vocabulary of how a diffusion weighted signal is achieved, how this signal can be quantified and used to derive information about the microstructural integrity of nervous system tissue.

Diffusion MRI 101
The acquisition of diffusion MRI data is grounded in fundamental MRI physics, but requires many steps to generate parametric data that appears in the literature. Additionally, with the growing desire to derive greater biophysical information from tissue in vivo, correct for artifacts, and to transition to higher field strengths the number of steps necessary to perform a diffusion experiment has increased dramatically. This lecture will cover aspects of the following:
- What is diffusion?
- How does diffusion differ in ordered vs. random media?
- How is a diffusion weighted MRI sequence performed?
- Transitioning from diffusion weighting to the diffusion tensor (What is a diffusion tensor?)
- Mathematics of contrasts that can be derived from a DTI experiment
- Tissue properties that give rise to the contrasts estimated from a diffusion tensor
- Basics of diffusion magnitude, directional diffusivity and connectivity
- Brief examples of in vivo applications.

What will we learn?
Listeners will develop a vocabulary for understanding literature that uses diffusion and diffusion tensor imaging to probe tissue characteristics in the nervous system.

In particular, they will be able to:
- Distinguish between diffusion weighted and diffusion tensor imaging
- Understand how the tensor is formed, and what information can be derived from the tensor
- Think about tissue characteristics that are reflected in the parametric maps
- Be able to perform a basic diffusion or diffusion tensor imaging experiment
- Interpret the literature and understand how diffusion is different in disease