# Diffusion Imaging: From Physics to Physiology

## ESMRMB Educational Program

14-16 October 2010
Worcester College, Oxford, UK

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## Thursday, 14 October 2010
## Diffusion Imaging Techniques

**09:00-10:00**
**Introduction to diffusion imaging**
***Derek K Jones, Cardiff***
- Diffusion in tissue: a qualitative description
- ADC, b-value and the diffusion tensor
- Basic experiment types: trace, multiple directions, multiple diffusion times
- Examples of key applications

**10:00-11:00**
**Basic acquisition techniques**
***Karla L Miller, Oxford***
- Diffusion-encoding gradients
- Single-shot, multi-shot & navigated sequences
- Parallel imaging
- Eddy-current compensation

***Coffee/Tea (30 minutes)***

**11:30-12:30**
**Data in practice: Artifacts, confounds and pitfalls**
***Derek K Jones, Cardiff***
- Artifacts: ghosting, distortion, chemical shift, eddy currents, cardiac pulsation
- Optimizing diffusion measurements: b-value, directions, resolution, SNR
- Pitfalls in analysis: pre-processing, parameter estimation
- Pitfalls in interpretation: what can be inferred from diffusion data?

***Lunch (1 hour)***

**13:30-14:30**
**Advanced acquisition techniques**
***Klaus Scheffler, Basel***
- Stimulated echoes, SSFP and hyperechoes
- Double wave vector encoding
- Influence of diffusion on sequences not intended for diffusion imaging

***Coffee/Tea (30 minutes)***

**15:00-16:30**

**Exercises: Data acquisition**
***Day 1 Lecturers***

**16:30-17:30**
**Plenary: Diffusion and microstructure: What are we measuring?**
***Christian Beaulieu, Alberta***

- White matter microstructure: key players in diffusion
- Sources of diffusion anisotropy
- Restricted and hindered diffusion: the tissue perspective

***Welcome Dinner***

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## Friday, 15 October 2010
## Diffusion Modeling and Analysis

**09:00-10:00**
**Models of tissue orientation**
***Saad Jbabdi, Oxford***

- The tensor model and its limitations
- Higher order and multiple tensors
- "Model-free" methods

**10:00-11:00**
**Fibre tractography**
***Geoffrey Parker, Manchester***

- Deterministic tractography
- Uncertainty and probabilistic tractography
- Multi-fibre methods
- Validation

***Coffee/Tea (30 minutes)***

**11:30-12:30**
**Exercises: Orientation and tractography**
***Day 2 Lecturers***

***Lunch (1 hour)***

**13:30-14:30**
**Models of tissue microstructure**
***Valerij Kiselev, Freiburg***

- The diffusion propagator, diffusion time and q
- Non-Gaussian diffusion and cumulants
- Models of restricted and hindered diffusion
- Lessons from Monte Carlo simulations

**14:30-15:30**
**Extracting microstructural parameters**
***Daniel Alexander, University College London***

- Microstructure models in practice
- Experimental requirements
- Sequence optimization

*Coffee/Tea (30 minutes)*

**16:00-17:00**
**Exercises: Diffusion and microstructure**
***Day 2 Lecturers***

**17:00-18:00**
**Plenary: What unique insights can diffusion MRI offer?**
***Denis Le Bihan, Orsay***

- Water transport: what can it tell us about the brain?
- The role of water in neuronal architecture and function
- Perspectives and future possibilities for diffusion MRI

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## Saturday, 16 October 2010
## Diffusion Imaging in the Neurosciences

**09:00-10:00**
**Voxel-wise analysis of diffusion data**
***Stephen M Smith, Oxford***

- Voxel-wise regression analysis and registration confounds
- Local estimation of diffusion-derived parameters
- Interpretation, confounds and future directions

**10:00-10:30**
**Diffusion imaging in basic neuroscience**
***Timothy EJ Behrens, Oxford and University College London***

**10:30-11:00**
**Diffusion imaging in anatomical investigations**
***Marco Catani, Institute of Psychiatry***

*Coffee/Tea (30 minutes)*

**11:30-12:00**
**Diffusion imaging of development, learning and recovery**
***Heidi Johansen-Berg, Oxford***

**12:00-12:30**
**Diffusion imaging in clinical neuroscience**
***Chris Clark, University College London***

**12:30-13:00**
**Panel discussion: The present and future role of diffusion in neuroscience**
***Day 3 Lecturers***

*Adjourn*