Steve, our mentor

Eirini Messaritaki
School of Medicine
Cardiff University Brain Research Imaging Centre (CUBRIC)
Cardiff, UK

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Steve's students

- **Kent Blackburn (1990)**

  Senior Resesarch Scientist (MPS)

  LIGO Laboratory, Caltech, Pasadena, California, USA

- **Brian Baker (2002)**

  Principal Systems Engineer

  Ball Aerospace, Boulder, Colorado, USA

- **Dong-Hoon Kim (2005)**

  Researcher

  Institute for the Early Universe, Ewha Women's University, Seoul, Rep of Korea

- **Ian Vega (2009)**

  Associate Professor

  University of the Philippines, Diliman, Philippines

Then …

$$\nabla^2 \psi = -4 \pi \varrho.$$

$$\nabla^2_{(0+1+2)} \bar{h}^{(0+1+2)}_{\mathrm{S}\,ab} + 2R_{(0+1+2)\,a\ \,b}^{\ \ \ \ \ \ \ \ \ \ \ c\ \ d} \bar{h}^{(0+1+2)}_{\mathrm{S}\,cd} = -16\pi T_{ab}$$

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Analytical solutions
Numerical solutions

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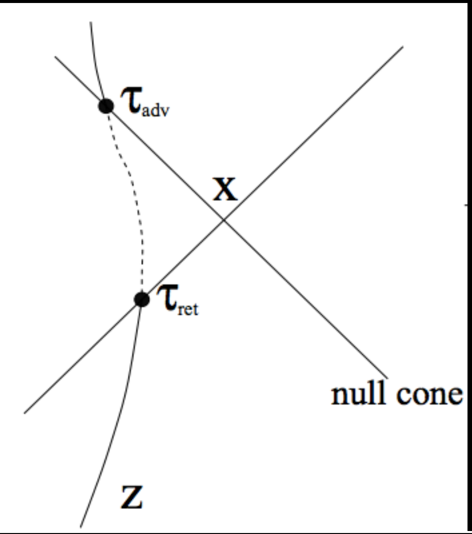
Analytical solutions
Numerical solutions



Then and Now

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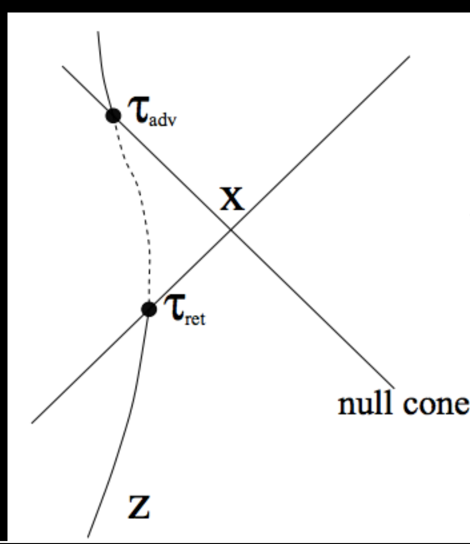

$$\vec{\nabla}\cdot(\rho\vec{v}) = S_{\mathrm{B}}$$

$$\frac{\rho}{\varepsilon}\left[\frac{\partial\vec{v}}{\partial t} + \varepsilon^{-1}(\vec{v}\cdot\vec{\nabla})\vec{v}\right] = -\vec{\nabla}p - \Re_{\mathrm{c}}^{-1}(\vec{x})\vec{v}$$

$$\phi\frac{\partial c}{\partial t} + \nabla\cdot(\mathbf{v}c) = \nabla\cdot(\phi\mathbf{D}_t\cdot\nabla c)$$

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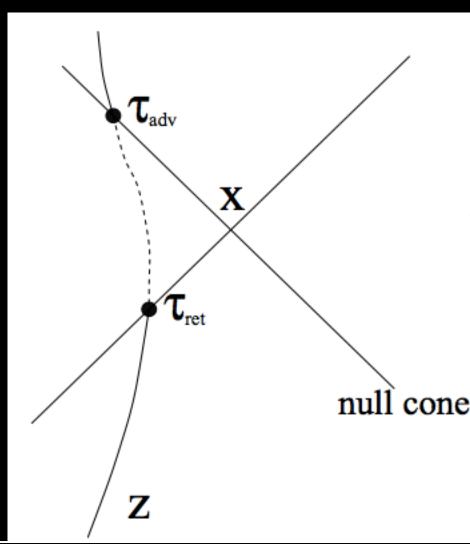

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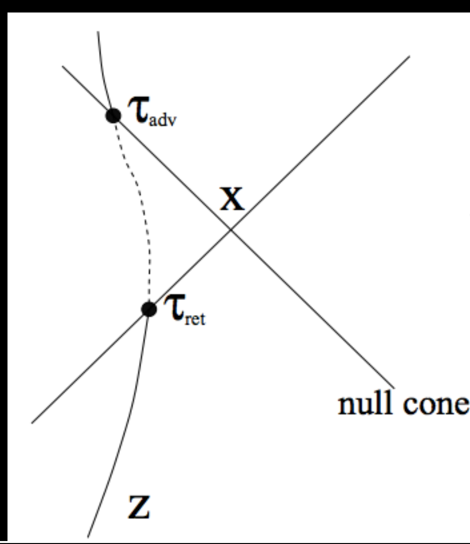

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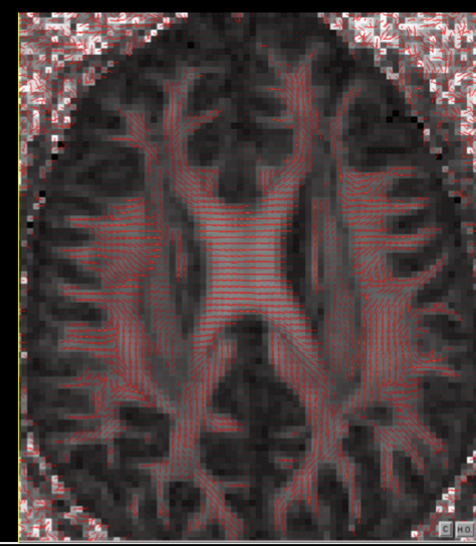
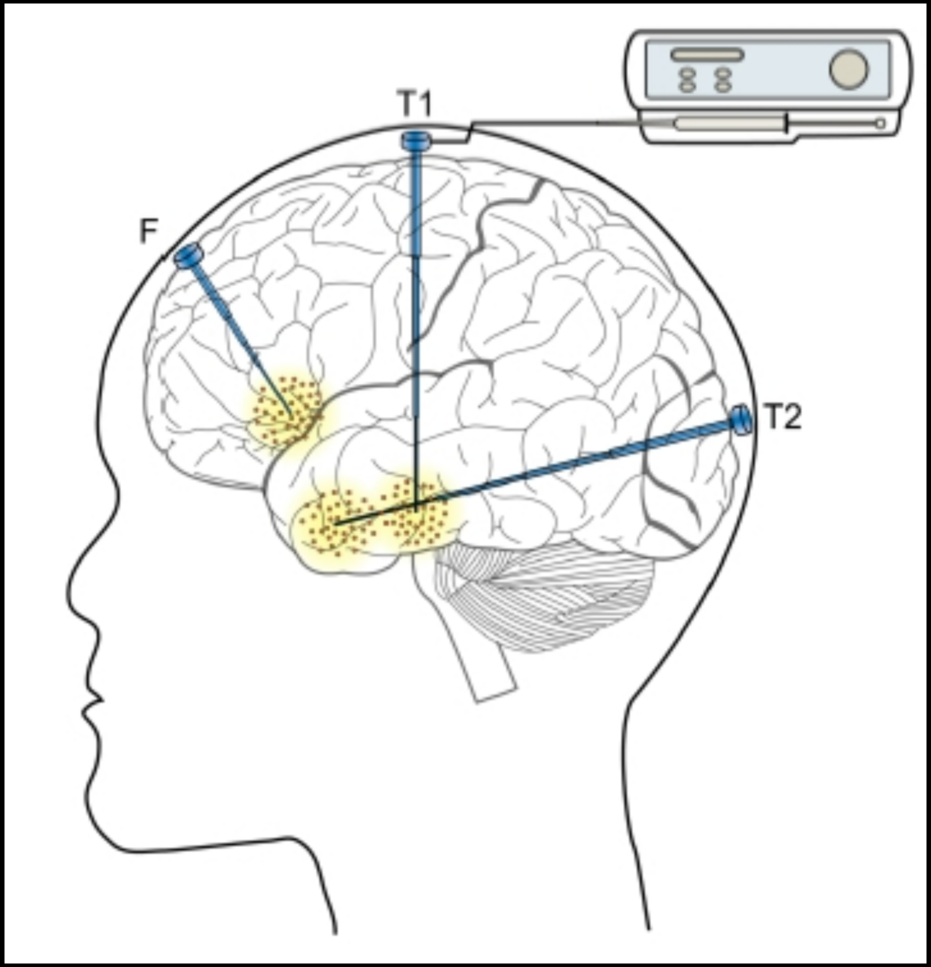


Delivery of medicine to the brain

Delivery of medicine to the brain



Fluid Dynamics Equations

- Mass balance

$$\vec{\nabla} \cdot (\rho \vec{v}) = S_{\mathrm{B}}$$

- Momentum balance

$$\frac{\rho}{\varepsilon}\left[\frac{\partial \vec{v}}{\partial t} + \varepsilon^{-1}(\vec{v} \cdot \vec{\nabla})\vec{v}\right] = -\vec{\nabla} p - \mathfrak{K}_{\mathrm{e}}^{-1}(\vec{x})\vec{v}$$

- Fluid transport

$$\varepsilon \frac{\partial C}{\partial t} + \vec{v} \cdot \vec{\nabla} C = \vec{\nabla} \cdot [\mathfrak{D}_{\mathrm{e}}(\vec{x})\vec{\nabla} C] + R(C, \vec{x}) + S(C, \vec{x})$$

Fluid Dynamics Equations

- Mass balance

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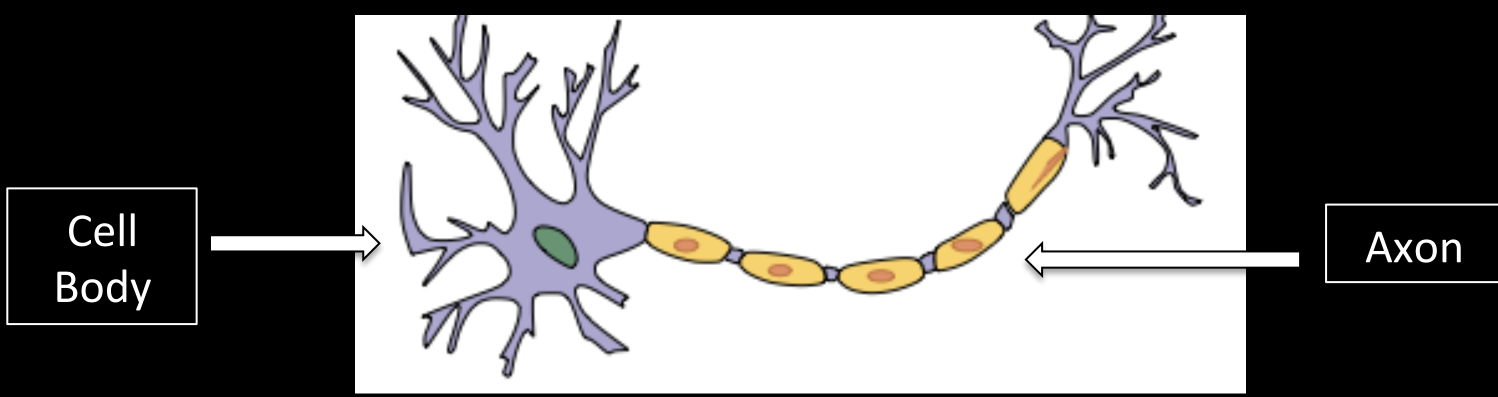
Diffusion in the brain

Diffusion in the brain

GRAY MATTER:
NEURON BODIES

WHITE MATTER:
HIGHLY ALIGNED NEURONAL AXONS

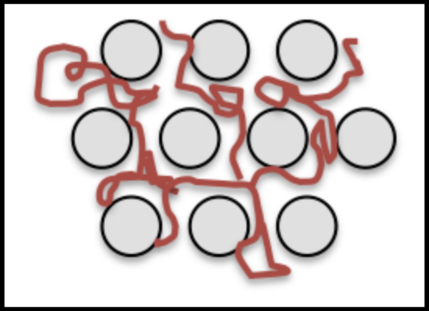


Diffusion in the brain

GRAY MATTER:

NEURON BODIES

ISOTROPIC DIFFUSION



WHITE MATTER:

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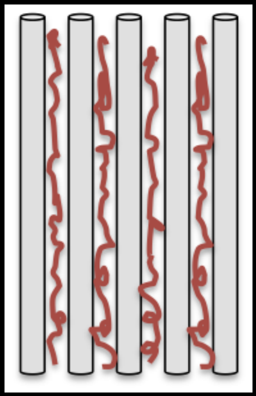
ANISOTROPIC DIFFUSION



Magnetic Resonance Imaging scanner

Thank you!