

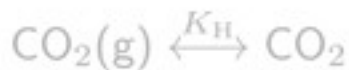
Mathematics for Science and Industry

Undergraduate thesis topics

$$\frac{1}{Eh} \nabla^4 \varphi = \left(\frac{\partial^2}{\partial x^2} \frac{\partial^2}{\partial y^2} - 2 \frac{\partial^2}{\partial x \partial y} \frac{\partial^2}{\partial x \partial y} + \frac{\partial^2}{\partial y^2} \frac{\partial^2}{\partial x^2} \right) + \left(\frac{\partial^2}{\partial x^2} \frac{\partial^2}{\partial y^2} - \left(\frac{\partial^2}{\partial x \partial y} \right)^2 \right) + \frac{1}{Eh} \left(\frac{\partial^2 S_{xx}^{e0}}{\partial y^2} - 2 \frac{\partial^2 S_{xy}^{e0}}{\partial x \partial y} + \frac{\partial^2 S_{yy}^{e0}}{\partial x^2} \right),$$

$$\frac{1}{\nu^2} \nabla^4 w = P_{\text{ext}} + \left(\frac{\partial^2 w_0}{\partial x^2} \frac{\partial^2 \varphi}{\partial y^2} - 2 \frac{\partial^2 w_0}{\partial x \partial y} \frac{\partial^2 \varphi}{\partial x \partial y} + \frac{\partial^2 w_0}{\partial y^2} \frac{\partial^2 \varphi}{\partial x^2} \right) + \left(\frac{\partial^2 w}{\partial x^2} \frac{\partial^2 \varphi}{\partial y^2} - 2 \frac{\partial^2 w}{\partial x \partial y} \frac{\partial^2 \varphi}{\partial x \partial y} + \frac{\partial^2 w}{\partial y^2} \frac{\partial^2 \varphi}{\partial x^2} \right) - \frac{1}{\nu^2} \left(\frac{\partial^2}{\partial x^2} (M_{xx}^{e0} + \nu M_{yy}^{e0}) + 2(1-\nu) \frac{\partial^2 M_{xy}^{e0}}{\partial x \partial y} + \frac{\partial^2}{\partial y^2} (M_{yy}^{e0} + \nu M_{xx}^{e0}) \right) - \rho g h,$$

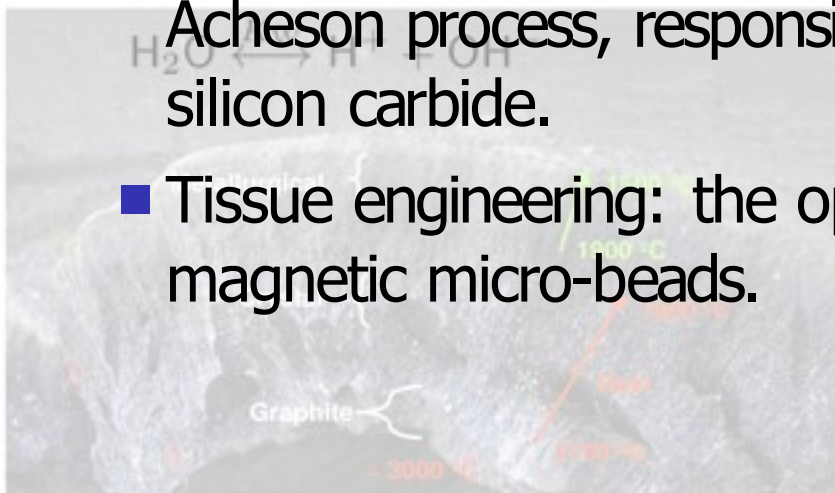
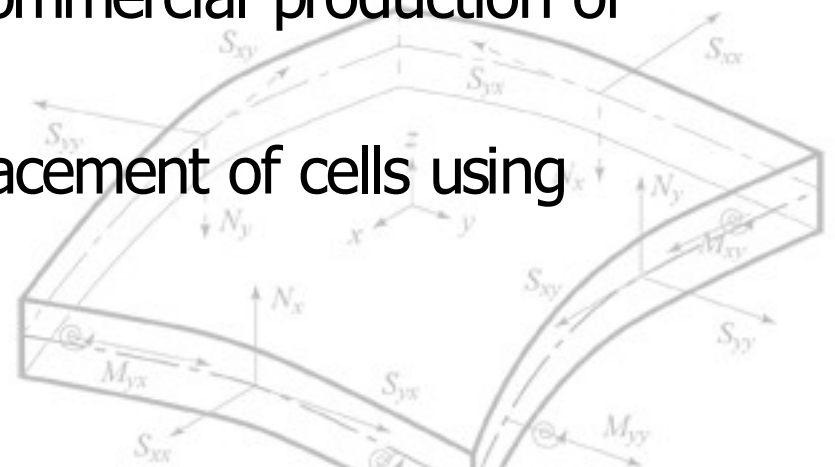
C. Sean Bohun (possible topics: 1 of 2)

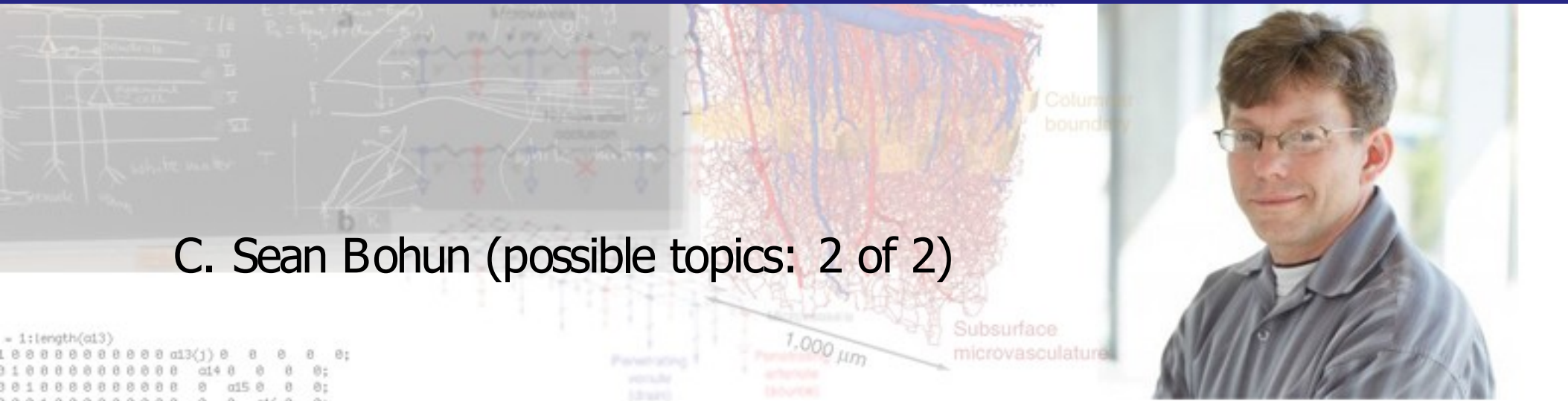


■ Predicting and prescribing distortion of thin glass sheets.

■ Investigate complex chemical processes. Examples include: the carbonate system, responsible for ocean acidification; the Acheson process, responsible for commercial production of silicon carbide.

■ Tissue engineering: the optimal placement of cells using magnetic micro-beads.



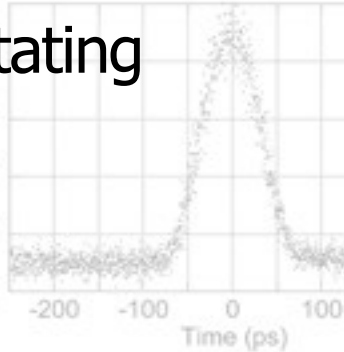


C. Sean Bohun (possible topics: 2 of 2)

- Modelling processes that characterize unknown samples to increase their current capabilities. Examples include: rotating disk apparatus, high resolution melt analysis and cyclic voltammetry.

- Develop mathematical tools to help design high power tuneable lasers.

- Model biological processes. Examples include: brain vascular systems and bone remodelling.



```
- = 1:length(a13)
1 0 0 0 0 0 0 0 0 0 a13(j) 0 0 0 0 0;
2 1 0 0 0 0 0 0 0 0 a14 0 0 0 0;
3 0 1 0 0 0 0 0 0 0 0 a15 0 0 0;
4 0 0 1 0 0 0 0 0 0 0 0 a16 0 0;
5 0 0 0 1 0 0 0 0 0 0 0 0 a17 0;
6 0 0 0 0 1 0 0 0 0 0 0 0 0;
7 1 0 0 0 0 1 0 0 0 0 0 0 0;
8 0 1 0 0 0 0 1 0 0 0 0 0 0;
9 0 0 1 0 0 0 0 1 0 0 0 0 0;
10 0 0 0 1 0 0 0 0 1 0 0 0 0;
11 1 0 0 0 0 1 0 0 0 0 0 0 0;
12 0 1 0 0 0 0 1 0 0 0 0 0 0;
13 0 0 1 0 0 0 0 1 0 0 0 0 0;
14 0 0 0 1 0 0 0 0 1 0 0 0 0;
15 1 0 0 0 0 1 0 0 0 0 0 0 0;
16 0 1 0 0 0 0 1 0 0 0 0 0 0;
17 0 0 1 0 0 0 0 1 0 0 0 0 0;
18 0 0 0 1 0 0 0 0 1 0 0 0 0;
19 1 0 0 0 0 1 0 0 0 0 0 0 0;
```

```
current = inv(C)*V; % CV
1(j) = V(1) - 1*current(1);
2(j) = V(2) - 1*current(2);
3(j) = V(3) - 1*current(3);
4(j) = V(4) - 1*current(4);
```

$$G[A] = \frac{A}{\sqrt{W_0}} \sqrt{aEe^E},$$

$$M[A] = A \left[\frac{1}{2} - \frac{V}{2} \cos \left(\mu \pi e^{-T^2} \right) \right],$$

$$D[A] = \frac{\sigma e^{i\pi/4}}{\sqrt{\pi}} \int_{-\infty}^{\infty} A(\tau) e^{-i\sigma^2(\tau-T)^2} d\tau,$$

$$E = \int_{-\infty}^{\infty} |A|^2,$$

$$F[A] = A e^{i|A|^2},$$

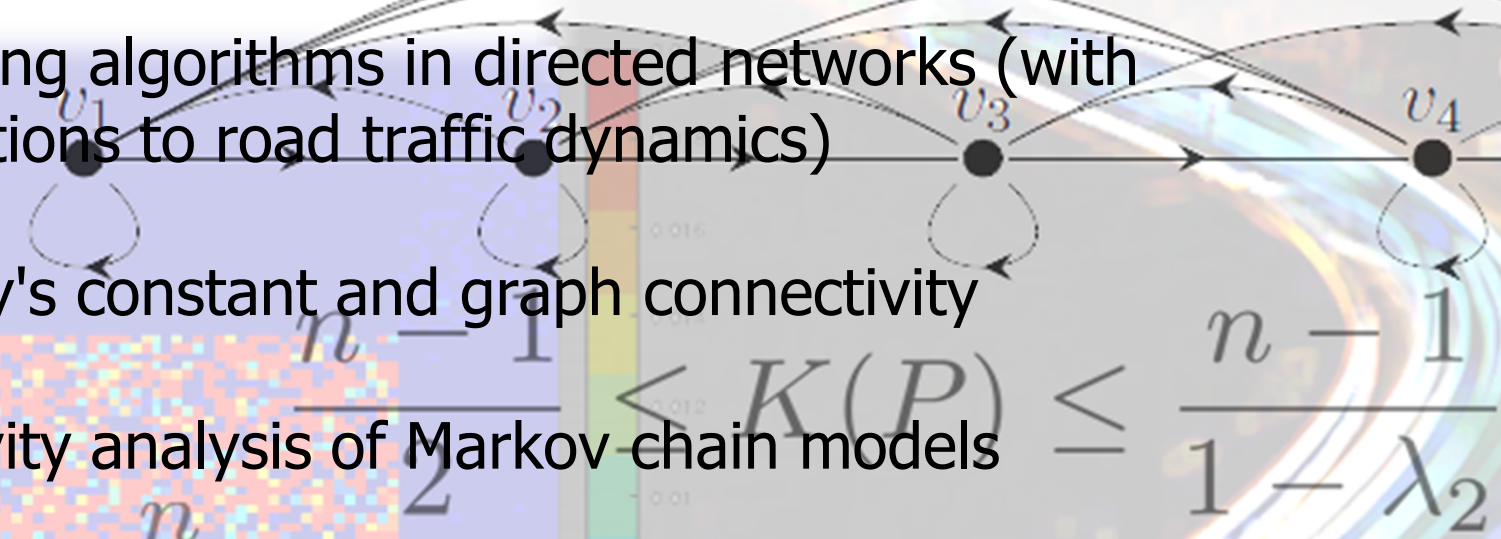
$$L[A] = Ah.$$



$$-1 \leq \lambda_n < \lambda_{n-1} < \dots < \lambda_2 < \lambda_1 = 1$$

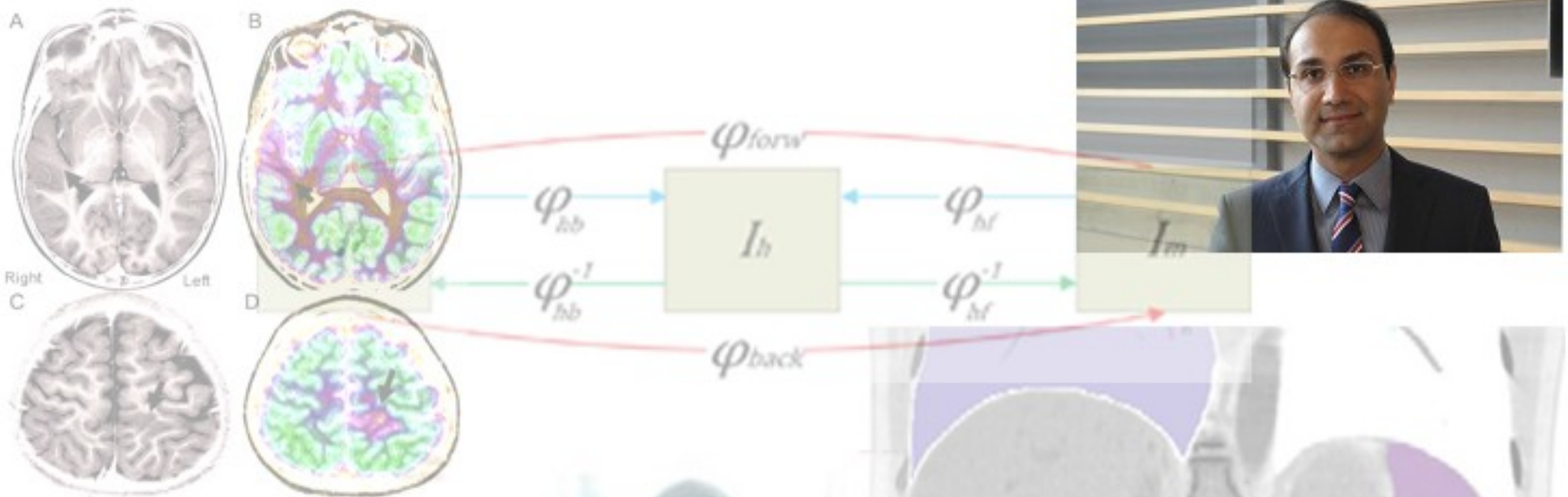
Jane Breen (possible topics) – ON LEAVE JULY /25 TO JULY /26

- Clustering algorithms in directed networks (with applications to road traffic dynamics)
- Kemeny's constant and graph connectivity
- Sensitivity analysis of Markov chain models



$$K(P) \leq \frac{n-1}{1-\lambda_2}$$

$$\bar{E}(h) = \sum_{j=1}^n m(F_j) \max_{x \in F_j} h(x)$$



Mehran Ebrahimi (possible topics)

- Medical image registration
- Medical image segmentation
- Medical image fusion

$$\frac{\partial \mathbf{u}}{\partial t} = \nu \nabla^2 \mathbf{u} - 2\boldsymbol{\Omega} \times \mathbf{u} + (g\mathbf{e}_z)$$

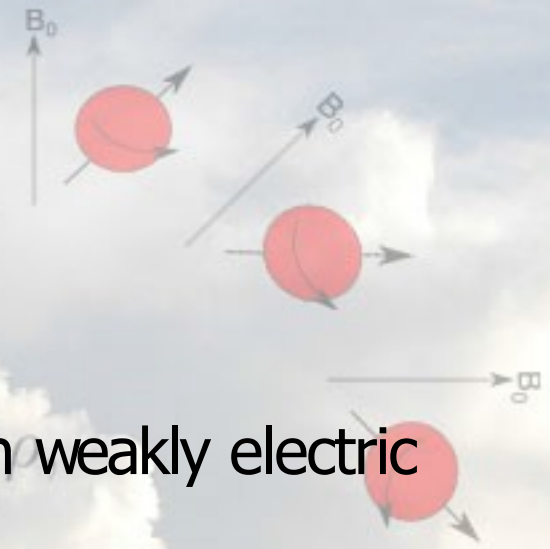
$$\frac{\partial T}{\partial t} = \kappa \nabla^2 T - (\mathbf{u} \cdot \nabla) T,$$

$$\nabla \cdot \mathbf{u} = 0$$



Greg Lewis (possible topics)

- Transitions in atmospheric flow patterns
- Mathematical models for electro-location in weakly electric fish
- Mathematical aspects of MRI



$$\nabla \cdot \mathbf{B} = 0,$$
$$\nabla \times \mathbf{E} = -i\omega \mathbf{B},$$
$$\nabla \times \mathbf{B} = \mu ((\sigma + i\omega\epsilon) \mathbf{E} + \mathbf{j}_s)$$



Lennaert van Veen (possible topics)

- Phase transition in interface formation. Will include elements of: theory of interface formation, stochastic partial differential equations, numerical methods, data analysis.
- Bi-stability and critical noise. Includes: "flickering" noise in dynamical systems, the telegraph process, simple simulations.
- Stability analysis of shear flows. Will include elements of: Navier-Stokes flow, energy methods, Squire's theorem, Orr-Sommefeld equations.