Statistical Analysis and Mathematical Modeling of Dynamics in Biological Systems

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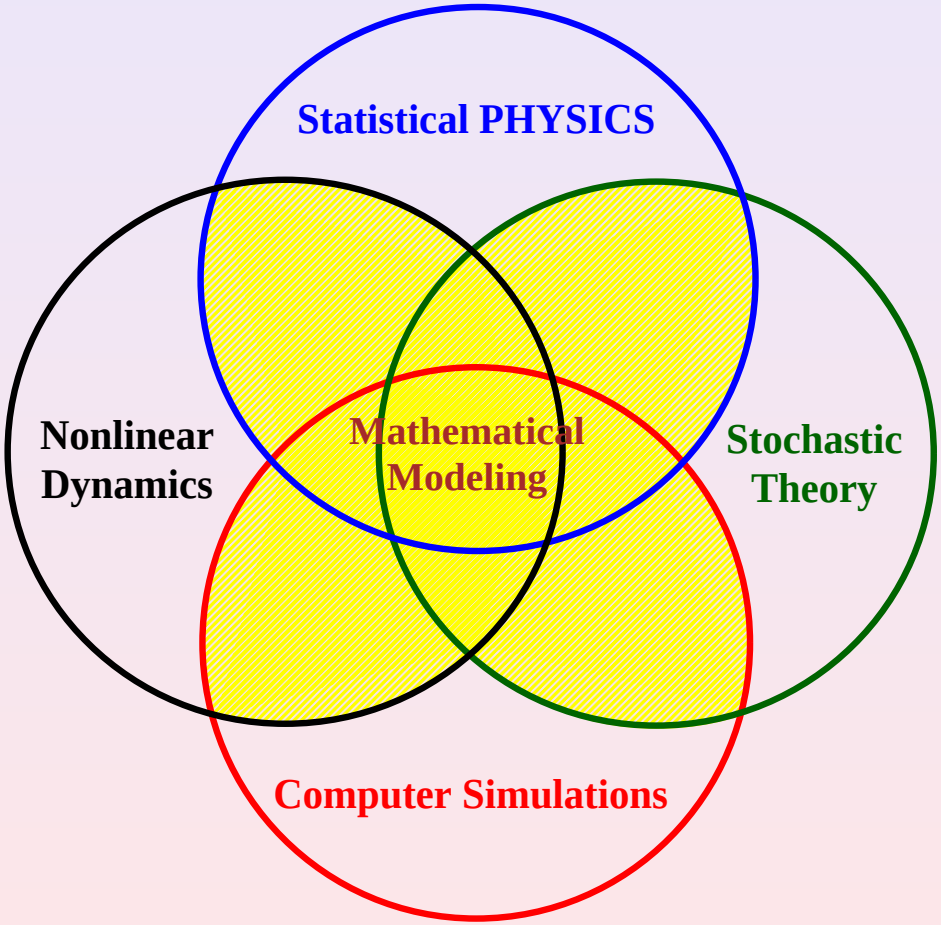
My scientific background

applied mathematics / theoretical physics:



Research interests

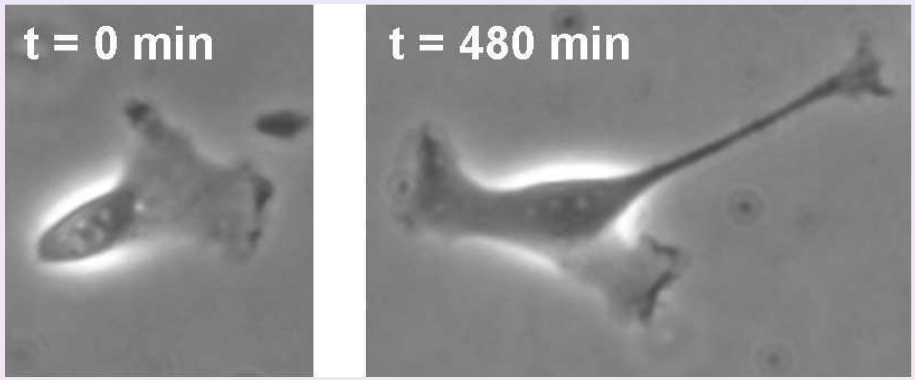
Goal:
understand dynamics of complex systems in 'nonequilibrium' (i.e., when driven by external forces or gradients); applications to nano-systems and **biology**

in this talk two biological examples:

1. **cell migration**
2. **bumblebee foraging**

Project 1: Cell migration

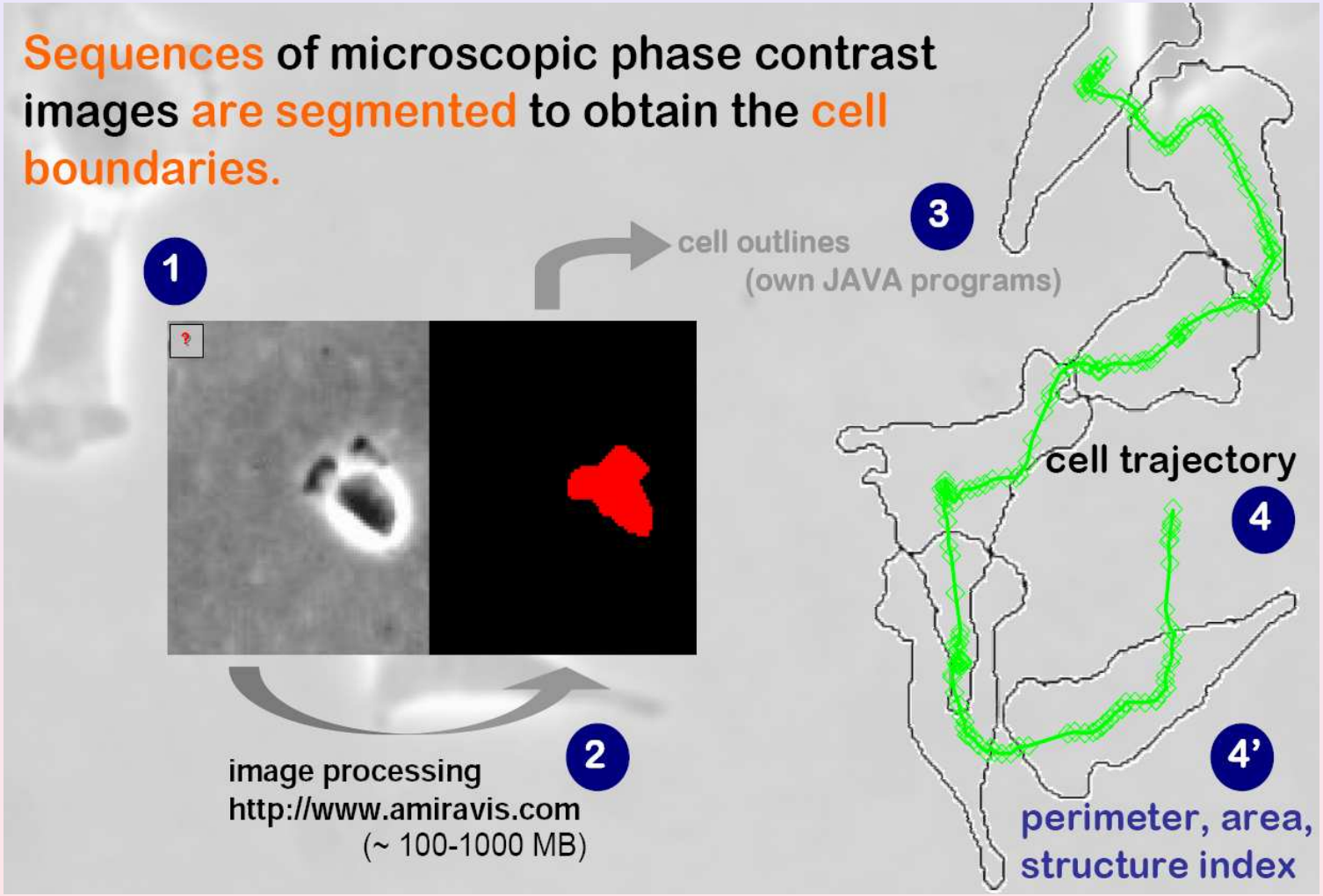
put a single biological cell onto a substrate – the cell *crawls*:



movie: crawling canine kindney cell

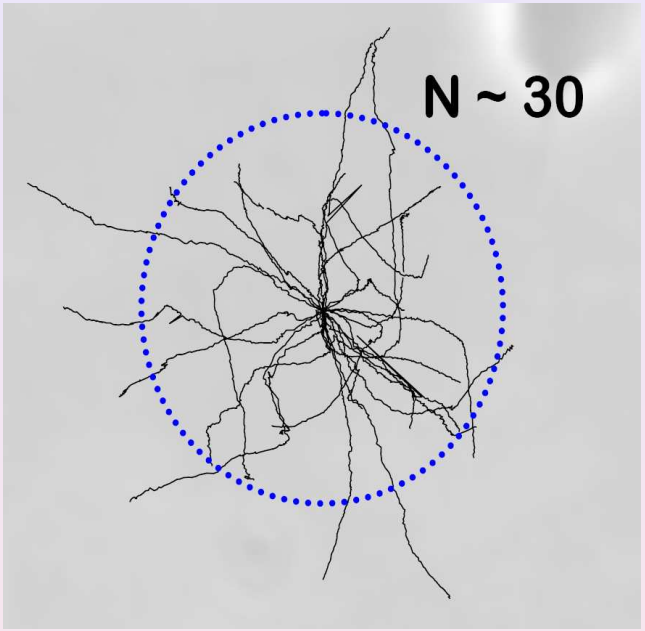
Question: Can we **mathematically characterize** cell migration?
(e.g., for distinguishing between healthy and deficient cells)

From experiment to data analysis



Statistical analysis and mathematical modeling

picture of 30 cell paths, shifted to the origin:



1. statistically analyze these paths for quantifying cell migration
2. construct an integrative mathematical model
3. compare theoretical predictions with experimental data

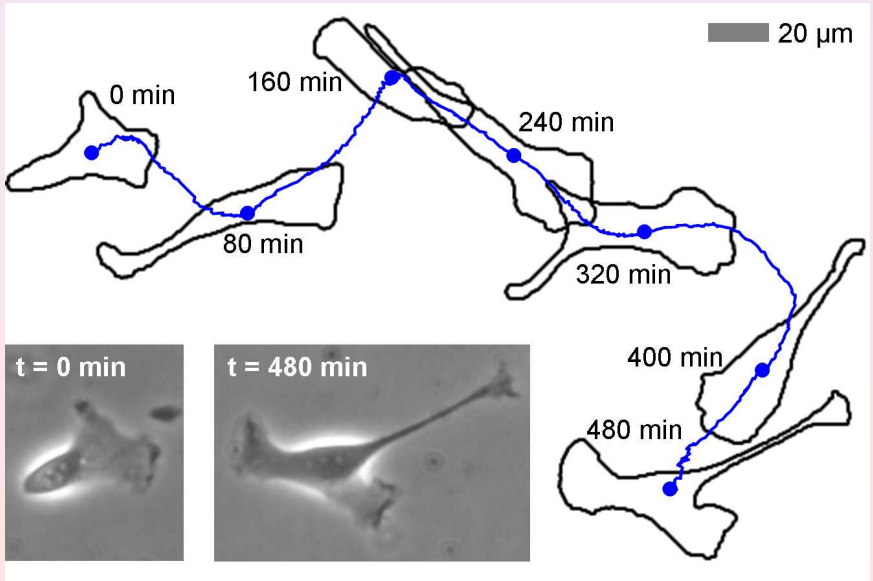
Cell migration project

main result: cells perform highly correlated dynamics

publication:

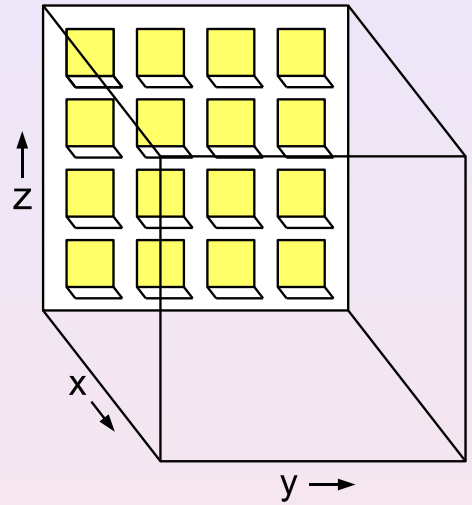
P.Dieterich, R.K., R.Preuss, A.Schwab, Anomalous dynamics of cell migration, PNAS **105**, 459-463 (2008)

- very cross-disciplinary team
- very well-cited article
- project partially funded by EPSRC grant



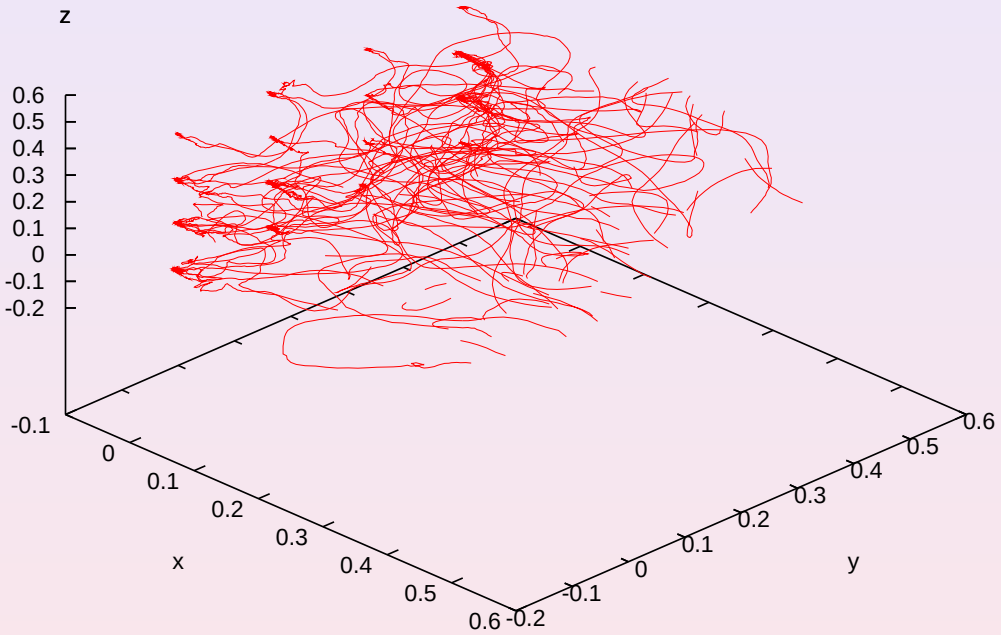
Project 2: Bumblebee foraging

joint project together with Tom Ings and Lars Chittka (SBCS): artificial flowers in a box . . .



. . . partially equipped with artificial spiders

record flights of single bees



Question: any change of the bee flights under predation thread?

Statistical analysis and mathematical modeling

- statistical data analysis - **main result:**

  no change in velocity *distributions* but in velocity *correlations* under predation thread

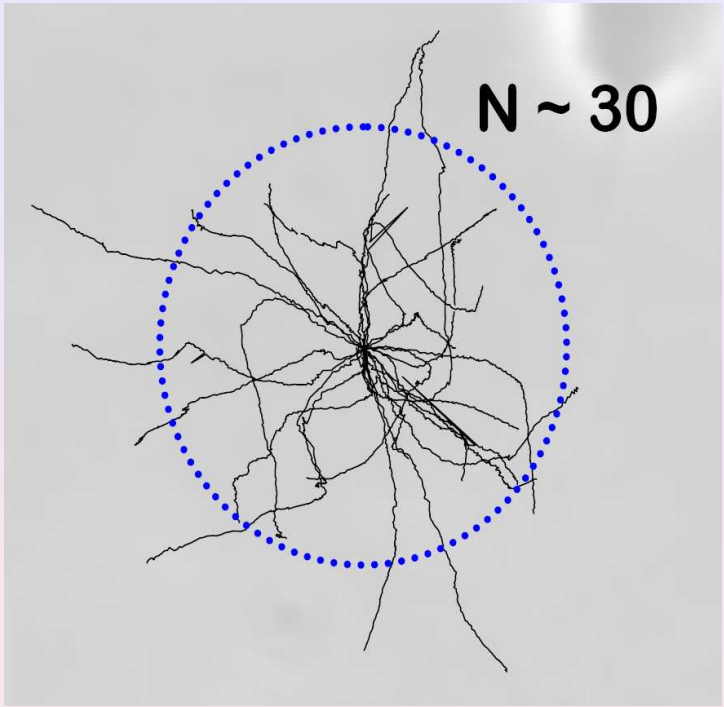
  reproduced by a simple mathematical model

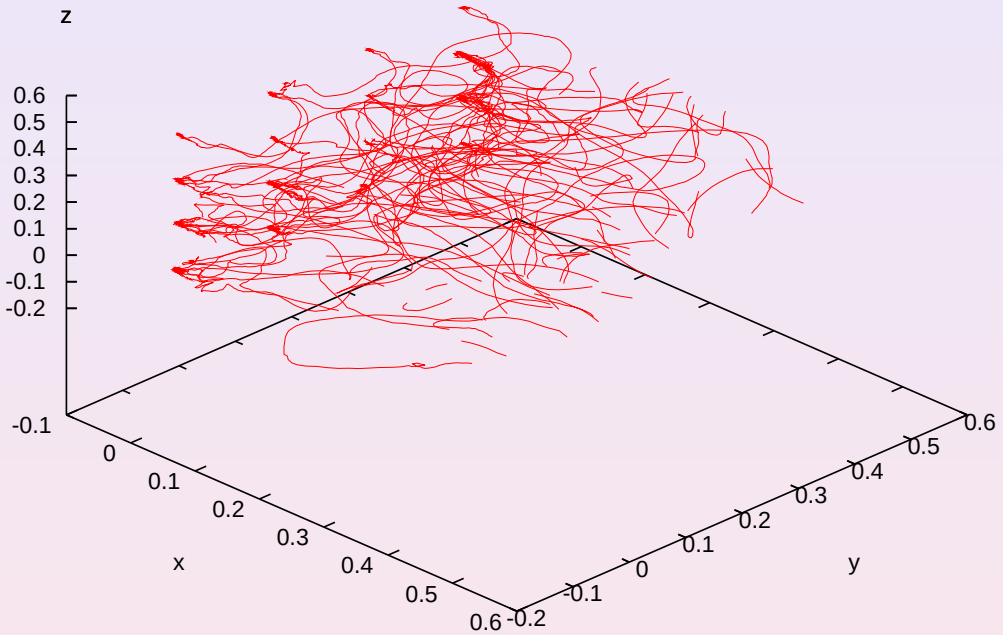
- **publication:**
  F.Lenz, T.Ings, A.V.Chechkin, L.Chittka, R.K.,
  Spatio-temporal dynamics of bumblebees foraging under predation risk, Phys. Rev. Lett. **108**, 098103 (2012)

  editor's choice and highlighted by the American Phys. Soc.

- funded by the *Bridging the Gaps* initiative and a PhD studentship from QMUL

Outlook





If you have a *'spaghetti soup'* representing a biological process and need some statistical analysis with mathematical modeling:

Let me know...

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