EPSRC Centre for Doctoral Training in Cross-Disciplinary Approaches to Non-Equilibrium Systems (CANES)

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Outline

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Non-equilibrium systems

- Typically time-irreversible
- Aging, driven (dissipate energy input)
- Cascades of failure, extreme events

Example non-equilibrium challenges

- Spread of epidemics
- Likelihood of extreme meteorological events
- Optimize nanoparticles for drug and gene delivery
- Control heating in fast electronic devices
- Stability of financial networks
- Predict the fate of cellular states

National and international context

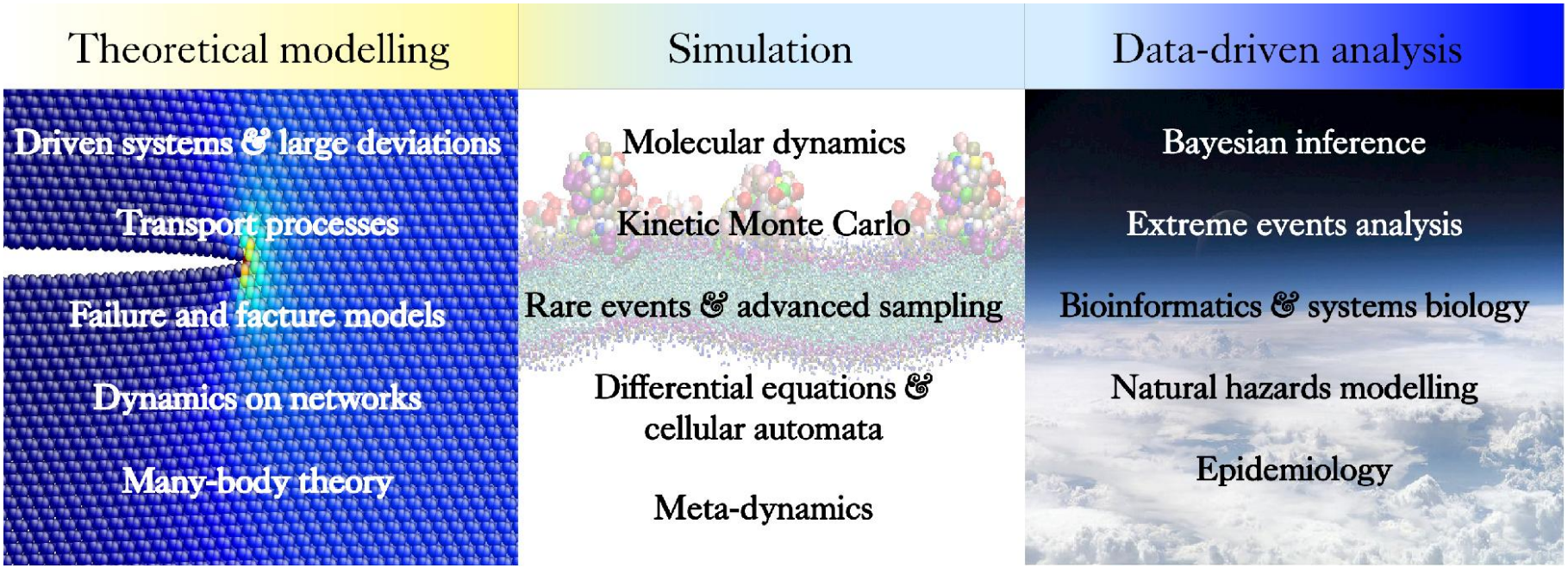
- Emergence and physics far from equilibrium identified by EPSRC as Grand Challenge
- EPSRC NetworkPlus, to develop roadmap
- Similar initiatives in USA: Office of Science (Dept of Energy) grand challenge, Non-Equilibrium Energy Research Centre
- CANES will bring UK to forefront of this research agenda
- CANES is integrated into:
  - Thomas Young Centre (materials theory and simulation)
  - CoSyDy (complex systems dynamics) LMS network
  - European network NETADIS (statistical physics on / for networks)
  - CECAM-UK-JCMaxwell node (advanced computation)

The CANES mission

The mission of CANES is to train future research leaders in the understanding, control and design of systems far from equilibrium, based on rigorous training in theoretical modelling, simulation and data-driven analysis, and a breadth of awareness of common themes across disciplines.

Outline

Cohesive training in three strands



- Strands cut across disciplines
- Existing tools need to be applied to new areas
- Applications provide "driving questions" for new tools

Innovative 1+3-year programme

- Taught 1st year, cohort integration via group research projects
- Annual retreat
- Cross-disciplinary PhD projects
- Open questions sandpits
- Master classes, journal clubs, seminars
- Transferable skills, Creativity-at-home course
- Contributions to outreach, social media channels
- Careers sessions & fora
- Internships in year 3
- Biennial CONES conference

Outline

Participating departments and universities

Departments at King's College London

- Mathematics, Physics, Informatics, Chemistry
- Geography
- Randall Division of Cell & Molecular Biophysics
  Institute of Pharmaceutical Science

Partners

- Computational Chemical Physics, Theoretical Physics (Imperial College)
- Condensed Matter and Materials Physics (UCL)
- London Centre for Nanotechnology
- Mathematical Sciences (Queen Mary London)

Industrial and international academic partners

Industry

- National Physical Laboratory
- Microsoft Research Cambridge
- The Francis Crick Institute (under construction)
- Fios Genomics
- Financial Network Analysis
- DZB (co-operative bank network)
- Unilever
- AWE
- Office of Naval Research Global

Academic

- Universität Potsdam, TU Berlin, Jülich, UPMC Paris, Montpellier 2, UC Irvine, Wuhan University, ...

Outline

First semester modules

15 credits each, semester = term

- Dynamical modelling of non-equilibrium systems
- Simulation methods for non-equilibrium systems
- Statistical learning and data-driven analysis
- Rare events and large deviations in non-equilibrium systems*
- Modelling quantum systems*

*Choose one for examination, but need to audit other one – for cohort coherence and flexibility

- Mathematical foundation course (as needed)
- Timetable includes flexible slots for additional seminars or tutorials

Second semester modules

15 credits each

- Advanced topics in non-equilibrium systems
- Topics covered to include (choose 3 for examination):
  - Fluctuation theorems
  - Green's functions
  - Non-equilibrium networks
  - Advanced simulation methods
  - Non-stationary time series
- One optional module – discuss with senior CDT tutor

Research methods modules

Second semester & summer, 30 credits each

- Three modules, one for each strand of CANES
- Introductory lectures, then group-based research projects
- Output: project reports and presentations
- Deadline early Sept, earlier for one module

Mark ranges

For most modules (level 7):

- 40-49%: condoned fail / D
- 50-59%: pass / C
- 60-69%: merit / B
- 70-100%: distinction / A

For level 6 modules (possible as options):

- Credit for marks $\geq 33\%$
- But count as condoned fail even if mark $\geq 50\%$

Credits, MSc award conditions

- Need to take 180 credits
- Can take up to 210 credits,
  but may be better to audit extra modules instead
- Can have at most 30 credits from condoned fails
- Research methods modules are core and must be passed
- Final award pass, merit or distinction,
  based primarily on mark average

Outline

Work towards research project in year 1

- PhD project proposals presented in semester 1
- Discussion with potential supervisors
- Project selection & allocation in early 2015
- Work out detailed project outline by end of summer

Progression to years 2–4

- Normally requires passing MSc with merit
- Also approval of project outline
- Formal registration is then for MPhil in year 2
- Transfer to PhD 9-15 months later,
  based on transfer report and viva
- Regular (6-monthly) progress monitoring

Outline

Transferable skills training

- Co-ordinated by KCL Graduate School
- National framework: Researcher Development Programme

Topics include:

- Time management
- Being an effective researcher
- Presentation skills
- Good science writing
- Databases and e-resources
- Stress management
- Getting the most out of conferences, . . .

Training needs analysis

- Reviewed annually
- To identify what training you need,
  what courses would be most beneficial
- Can include additional science background,
  including LTCC (London Taught Course Centre) courses
- Also language courses (English Language Centre)

Outline

People you can and should talk to

- Peter Sollich (CANES Director)
  General feedback, input, suggestions
- Alessia Annibale (2015 cohort tutor)
  Module choices, training needs in year 1
  Date for initial meetings to be confirmed
- Valeria De Marco (CANES Centre Manager)
  Almost everything else
- Your module lecturers and tutors – after lectures, in office hours

Other resources

- CANES website www.kcl.ac.uk/canes/
- KEATS e-learning platform
- Google calendars for events and timetables
- Student mailing list, facebook, twitter
- General KCL student support:
  The Compass, Careers Service, ...

We are excited about CANES

. . . and hopefully so are you!