SIXTH FRAMEWORK PROGRAMME

Project contract no. 043363

MANMADE
Diagnosing vulnerability, emergent phenomena and volatility in man-made networks

SPECIFIC TARGETED PROJECT

NEST PATHFINDER
Sub-Priority Tackling Complexity in Science

M36: Deliverable 1.6 Workshop targeting careers in science for women, incorporating key themes of MANMADE Project (to be organized with local school authorities in East London neighbouring QMUL).

Revision [1]

Submission date: December, 2009

Start date of project: 1st of January 2007 Duration: 36 months

Lead author for this Report: D.K. Arrowsmith (QMUL).

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

PURPOSE OF THIS REPORT

This report provides a project update to the project Science Advisors, as of the report date. This report summarises:

1. the deliverable
2. the team leaders for the deliverable an outline of the activities
3. a report by the conference organiser.

The deliverable was a meeting was held at Queen Mary University of London (QMUL) on November 6th to promote within the London area the importance of women taking up careers in science. Its title was

"Women into Science, Technology, Engineering and Maths (STEM) Careers Conference".

The emphasis was on the practicality and necessity of Science in everyday life.

Dr Delilah al Khudhairy, of the EU Joint Research Centre (JRC), Ispra, Italy was the principal speaker. She leads the Institute for the Protection and Security of the Citizen at the JRC. Delilah has a background in structural and civil engineering. She was supported by two researchers in applicable mathematics.

Dr Rosemary Harris of the School of Mathematical Sciences, QMUL, and is a lecturer in applied mathematics.

Dr Karman Poljansek, also of the JRC. There were 4 workshops during the meeting which concentrated on network resilience and traffic flow problems.

The event was structured and overseen by Dr Laura Thomas of the Corporate Affairs Department at QMUL.
There were over 80 female students attending the meeting from the East End of London. A further 150 students expressed interest, but were unable to attend due to room availability for workshops during the university term time.

The presentations were:
Dr Delilah Khudhairy - **Reflections on a career in Science and Engineering**

Dr Rosemary Harris **– From Applied Maths to Transport Modelling**

Dr Karmen Poljansek **– Science for Society**

Women into Science, Engineering, Technology and Mathematics Conference sponsored by Manmade

Friday 6th November, 2009

Event Report by the organisor
Dr Laura Thomas

The aims of this conference were to highlight the career options available by studying science and to encourage and motivate these young women to consider a career in science.

Fourteen schools from the London area attended, their names and locations can be found in the Appendix. A sample programme can be found below:

9.30 am – 10.00 am	Registration	
10.00 am – 11.00 am	Plenary: Delilah Al Khudhairy BSc (Eng), PhD Head, Institute for Protection and Security of the Citizen at the European Union Joint Research Center, Ispra, Italy	
11.00 am – 11.45 am	GROUP A From Applied Maths to Transport Modelling Dr Rosemary Harris Queen Mary, University of London Science for Society:	GROUP B Karmen Poljansek Joint Research, Center, Ispra, Italy
12.00 – 12.45 pm	Lunch in the Octagon (provided)	
1.00 pm – 1.45 pm	GROUP A Science for Society: Karmen Poljansek Joint Research, Center, Ispra, Italy	GROUP B From Applied Maths to Transport Modelling Dr Rosemary Harris Queen Mary, University of London
2.00 pm – 2.45 pm	Q&A Panel Session	

Our three session leaders are affiliated to the Manmade project and those on the panel were our current undergraduates or postgraduates. At Queen Mary we are fortunate to have a postgraduate society for Women in Science and Engineering. Two members of this took part in the panel session. The areas represented on the panel included:

- Electronic Engineering
- Chemistry
- Physics
- Mathematics
- Medical Engineering
- Biochemistry

The entire group were together for the first and last sessions. On either side of lunch they were split into two and attended separate sessions. Lunch was provided for the students and their teachers.

When advertised, this conference drew a large response from schools showing that this type of activity is something that is provided a desirable service for them. In total we had eighty-one student attendees plus accompanying

teachers. This was the maximum capacity of the rooms available to us on that day. A further one hundred and twenty students were on our waiting list.

Evaluation forms were completed by 70 students and teachers and a summary can be found below:

Did you find this event useful?	Very useful: 31% Useful: 59% Not useful: 10%

Those who commented that it was not useful said that they wanted more degree information or that they were expecting more information on medicine and dentistry. We could perhaps have spent more time on entry requirements, but the comment regarding medicine and dentistry shows that the schools themselves did not understand that these topics were not part of the conference. If this is run next year then we will make that more explicit in our publicity materials.

Comments on the returned evaluations that student's would have liked more interation, but

The Q&A session was the most popular, many commented that they would have liked for it to go on longer. Neverheless, there were over 25 questions asked.
Some particularly positive comments were:
"Thank you for this opportunity, it's helpful!"
Useful talking to a panel. Was motivating.
"Motivating."
"Has helped me decide about my future."
"The advice and questions from the uni students was really useful and also reassuring and motivating."
"Very good Q&A session"

Appendix

List of schools who attended:

Caterham School	Caterham, Surrey	CR3 6YA
Leyton VITH Form	London	E10 6EQ
Bacons College	Rotherithe, London	SE16 6AT
Burntwood School	London	SW17 0AQ
Christ the King Sixth Form College	Lewisham, London	SE13 5GE
St Martin's School	Brentwood, Essex	
Oaks Park High School	Dagenham	IG2 7PQ
St Albans Girls' School	St Albans, Hertfordshire	AL3 6DB
Aylesbury High School	Aylesbury	HP21 7SX
Freman College	Buntingford	SG9 9BT
Sydney Russell School	Dagenham	RM9 5QT
The Coopers Company and Coborn School	Upminster, Essex	RM14 3HS
Shooters Hill	London	SE18 4LD
Kingsmead School	Wirral	CH47 0LL

Reflections on a career in Science and Engineering
An Invited Talk
by
Dr Delilah al-Khudhairy

"Women into Science, Technology, Engineering and Maths (STEM) Careers Conference"
sponsored within the framework of an EC funded project MANMADE and organised by Queen Mary , London University, School of Mathematical Sciences
6th November 2009

I have split my presentation into two parts:
1) in the first part I briefly describe my education, my experiences working in a male dominated professional environment, as well as feedback from my colleagues and my main observations which I have drawn from my experience which could be useful for women embarking in a scientific career or already working in a scientific / technical environment.
2) in the second part I will briefly talk about the scientific work we carry out in our department in support of some EU policies

I was brought up in a multi-cultural environment in which education was extremely important, and I was continuously encouraged to work hard and do my best in whatever I did.

I had a carefree childhood. I was encouraged not to be afraid from trying out anything new, not to be scared of failure or mistakes, and to speak out and express my opinion.

By the time I was 15 years old I had already lived in three different countries, exposing me to an explosion of interesting multi-cultural and varied experiences.

By the time I was 16 years old, I was already studying alone in London. So, I learned Responsibility at an early stage in my life.

I am reflecting on these points because I believe ones' childhood and environment have an influence in shaping our choices when it come to further education, decisions we take in our work and life, and the way we relate and work with people.

The most valuable life lessons that I have learned from my education and professional career is to:

- be yourself (and not try to be like everybody else in order to fit in or to be accepted),
- do your best, be passionate and enjoy what you do,
- not to be scared of trying new things and taking on new challenges,
- show compassion for others

Since my under-graduate and my doctorate degrees I have been used to studying and working in a male dominated engineering environment. Obviously studying in a male dominated university environment was fun. But what I didn't appreciate at the time, was that studying in such an environment was excellent preparation for working in a male dominated environment.

I graduated with a first class honours' degree in Materials Science Engineering from Queen Mary College, London University. In recognition of this, I was awarded an industrial scholarship by British Gas to carry out a doctoral degree at Queen Mary College in the department of material science on the efficiency of coal gasification processes. A topic which is important in today's climate change and energy agenda. My

mixed experimental and numerical background and experience acquired during my doctoral studies lead to an offer for a fellowship at the US MIT.

After I finished my PhD degree, I worked in British Gas in their mathematics and modeling department, where I contributed to team work on developing and validating numerical models for British Gas operational reservoir engineers. A couple of years later, after passing an EC competition, I was offered a job at the European Commission's scientific and reference centre, the Joint Research Centre, otherwise widely known as the JRC. There are still too few female engineers and scientists working at the EC, and so it is worthwhile to keep a look out for future EC competitions once you graduate if you are interested in a well paid and satisfying career in EU institutions and the opportunity to work outside the UK.

I have had a rather varied career at the JRC. It didn't start off smoothly. My career, in the first half, went through numerous, sometime non-transparent changes, beyond my control. However, there were +ve aspects to these several changes which provided me with the opportunity to gain experience in additional scientific areas and new fields. My SOLID engineering background helped me to adapt to these changes easily and to also grow professionally as a result of them.

During my career in British industry and the European Commission, I have not felt, or been made to feel, that in being a woman working in a scientific/technical field that I am different in a professional context from my male colleagues. My choice in education had already determined that I will most likely be involved in a predominantly male environment. Personally, I have never felt disadvantaged being a woman working in a male-dominated scientific/technical environment.

Today, I manage a Unit of around 90 persons, which is fairly large by European Commission standards. It is the largest unit of my institute, and circa 25% of its members are women. This is a good percentage given that the Unit's underlying main expertise lies in information and web technologies, engineering and statistics, some of which do not particularly attract, in terms of 1st education compared to other fields, many women.

The contributions I would like to highlight have been:
1) to successfully introduce changes in the Unit: through merging sectors and creating new ones in order to further develop S/T areas and to bring them in line with required EU policy support
2) to create a working environment which is open and cooperative, and which enables the Unit's staff to advance in their work and their responsibilities, to grow professionally, and which also allows them to try out new developments without fear of failure.

In view of my presentation today, I asked some of my colleagues their views on having a female manager of a scientific department, which you should view not a reflection of me only but you should extrapolate to female managers in general of scientific depts.

Here are some of their remarks:
1) in terms of S/T competence, they do not think of me as being female or male – only view my S/T capacity and experience and its application at the management level
2) Specific attributes (and they are not sure if these are particularly because I am female or down to me personally). They have worked with male managers, and moreover for most of them it's the first time they have had a female manager, **and this is what they think is different about having a female manager:**

a) although I always eventually get my decisions through, including tough ones, I leave room for debate and I carry through my decisions, including the tough ones in a humane way

b) do not impose my views immediately, but 1st allow colleagues room for discussion and for providing their opinions

c) relate to colleagues in a compassionate manner and look after the Unit as a family

d) bring energy and dynamism which they associate with new ideas and challenges, new technologies – all embraced with energy, dedication and enthusiasm

e) working directly with people at all levels in the Unit, and getting technically involved in a manner which has been more than what they have expected from a manager and their experience of their previous managers.

On the basis of my experience acquired during my career, I have a series of observations concerning women in science and the working environment

- I DO BELIEVE Women feel that they do have to work harder, to prove they are at least as good as their male counterparts (this applied to both under graduate /post graduate studies and later on in one's career) – But hard work is not enough. Female scientists should do more to make their voices heard and their achievements visible. This means going to more conferences and workshops and accepting to give talks and lectures. Women should learn to communicate their ideas more effectively, and to enhance their access to RELEVANT networks through which they can facilitate the visibility of their work and achievements. The more people you know, the more people know you, your work, and your achievements.

- Maternity leave can be a set back in a woman's professional career - If it did not, then why do we have professional women either not having children, or delaying having children until they are more established in their career, or when they do have children, they are trying to rush back to work as soon as it's convenient! We still need to move towards establishing a work culture that does not perceive women as being less committed to their work and career when they decide to have children and look after their family. And we need a work culture that allows women to have a family without being discriminated.
- It is difficult to balance a professional career with family life – we still work in an environment where long hours usually mean that you are an achiever and more productive than those who work standard, reasonable, hours. Working part-time or flexi-time, taking time off to look after a sick child or parent leaving before 7pm, not going on travel abroad for family reasons are all preconceptions that we are less committed to our careers. So if we wish to encourage women to be successful and to progress onto roles with more responsibility, then it's essential that women do not perceive that environment to be one in which they have to make sacrifices at the expense of their family responsibilities.

- Lack of female role models – although my mentors have been men, the gender of our mentors is not important if the mentors have the career of their staff in mind. Mentoring is a good solution and today many organisations have mentoring schemes to help their staff develop leadership skills – this implies identifying persons, male or female, with leadership skills, who female scientists can closely examine in order to learn, gain confidence and even advance themselves in their career. And educational institutions should also think of developing something similar to encourage women at a young age already to embark on a scientific career and also to help them develop the necessary skills that will allow them to succeed in their further education and professional life.

- Men take care of each other in the professional environment – women do not as often as they should; they are more likely to cut each other down. We need to learn from our male colleagues and make an effort to support each other more.

- Women do have different management styles from men – but that doesn't mean either style is right or wrong – we are just different – For example, women managers tend to use transformational techniques which includes building up collaborative and open communication between them and their employees. Men tend to manage by following a more hierarchical approach with their employees; whereby they reward good performance and penalise bad performance.

According to the Economist and the FT, today women have never had it so good. Women, and not Asia per se, are considered to be the biggest drivers of global economic growth. Since the 1970s, two of out every three new job has gone to women. In many parts of both the developed and emerging worlds, the female workforce is growing at an increasing fast rate. Moreover, many are increasingly advancing to reach that glass ceiling and are even daring to break through it, and staying there. Where that has happened, it is acknowledged that it's having positive results, in terms of financial, creativity, efficiency, on the concerned companies and environments. The most successful companies in the list of Fortune 500 companies are those who have mixed gender boardrooms.

So, we should not see the educational (under graduate or post graduate) or later on the professional environment in the scientific or technical fields as male dominated, but instead we should encourage the benefits the diversity, a mixed female/male team brings at all levels in the organisation.

If we want to benefit more from female resources and to benefit from their talent, then we need to continue towards improving the professional environment to allow women to link their career with their family life i.e. have a career and raise children. In other words, to move away from a situation whereby they feel that they are obliged to turn down professional responsibilities in order to avoid scarifying family life and obligations.

Now I thought it would be useful to pass on to you my observations so that you can make use of them to your advantage if you wish, and also to make you think how you could eventually contribute yourselves to bringing about needed changes I mentioned in the professional environment, <u>because together you can</u>.

From Applied Maths to Transport Modelling

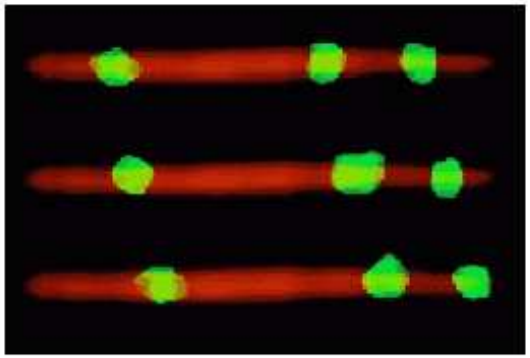
(via non-equilibrium statistical mechanics)

Rosemary Harris

Queen Mary
University of London

Women into STEM Conference, November 6th 2009

Transport processes



Outline

- Framework
  - Stochastic Markovian dynamics
- Toy example – Asymmetric Simple Exclusion Process (ASEP)
  - Definition of model
  - Fundamental diagram for periodic boundary conditions
  - Phase diagram for open boundary conditions
- Applications to traffic
  - Cars
  - Ants
  - Molecular motors
- Summary and perspectives

Stochastic Markovian dynamics

- Interacting **particles**
- Discrete space, **configurations** labelled by $\sigma(t)$
  ("where the particles are at a given time")

- **Dynamics** ("how the particles move")
  - Memoryless – *Markov*
  - Inherently random – *Stochastic*
  - Continuous time
- Transition rates (probabilities per unit time) $k_{\sigma',\sigma}$
- Probability distribution $P(\sigma,t)$ changes in time according to Master Equation:

$$\frac{d}{dt}P(\sigma,t) = \sum_{\sigma'\neq\sigma}\left[k_{\sigma,\sigma'}P(\sigma',t) - k_{\sigma',\sigma}P(\sigma,t)\right]$$

- Aside: Can also be written in matrix formulation

$$\frac{d}{dt}\mathbf{P}(t) = -\mathbf{H}\,\mathbf{P}(t)$$

Equilibrium versus non-equilibrium

- Master equation again

$$\frac{d}{dt}P(\sigma,t) = \sum_{\sigma' \neq \sigma} \left[k_{\sigma,\sigma'} P(\sigma',t) - k_{\sigma',\sigma} P(\sigma,t) \right]$$

- Conservation of probability

$$\sum_{\sigma} P(\sigma,t) = 1$$

- Long-time/stationary distribution

$$\frac{d}{dt}P^*(\sigma,t) = 0$$

- *Equilibrium*, detailed balance

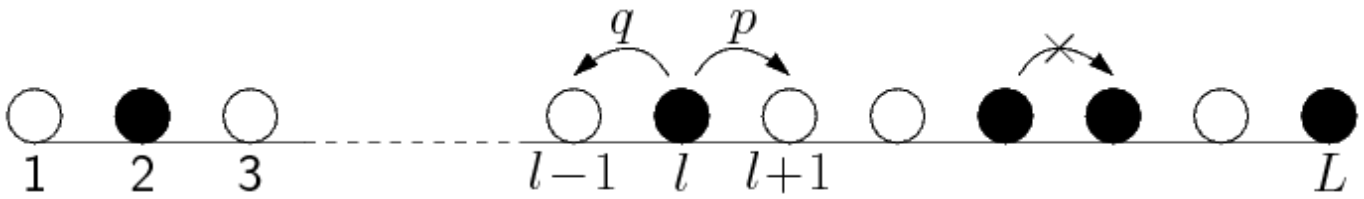
$$k_{\sigma,\sigma'} P^*(\sigma') = k_{\sigma',\sigma} P^*(\sigma)$$

- *Non-equilibrium*
  - Broken detailed balance
  - Stationary state has non-zero currents
- (So far) non-equilibrium statistical mechanics not well understood...

  ...insight from "toy" models, e.g., **asymmetric simple exclusion process**

Asymmetric Simple Exclusion Process

- Model defined in continuous time:

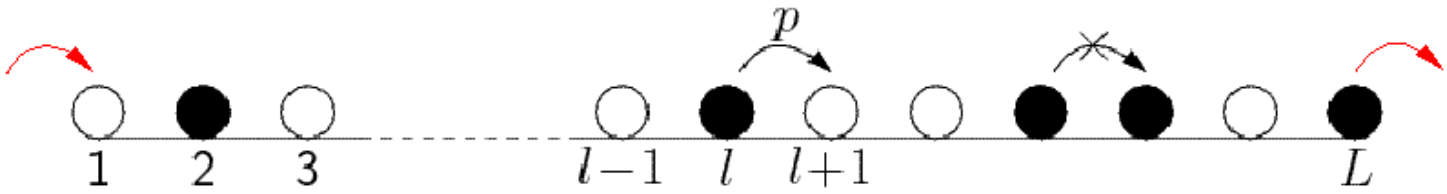


- Site occupancies

$$n_l = \begin{cases} 1 & \text{(particle)} \\ 0 & \text{(hole)} \end{cases}$$

- Results look roughly the same for all $p \neq q$
- Let's make life easier and look at the Totally Asymmetric case (TASEP) with $q = 0$
- What happens at the boundaries...?

Periodic boundary conditions



- Total number of particles is constant
- Let's look at *average* quantities, denoted by angular brackets, e.g., $\langle X \rangle$
- Average density (same on all sites)

$$\varrho = \langle n_l \rangle$$

- *How does current depend on density?*
- Average current

$$j = p \times \langle n_l(1 - n_{l+1}) \rangle$$

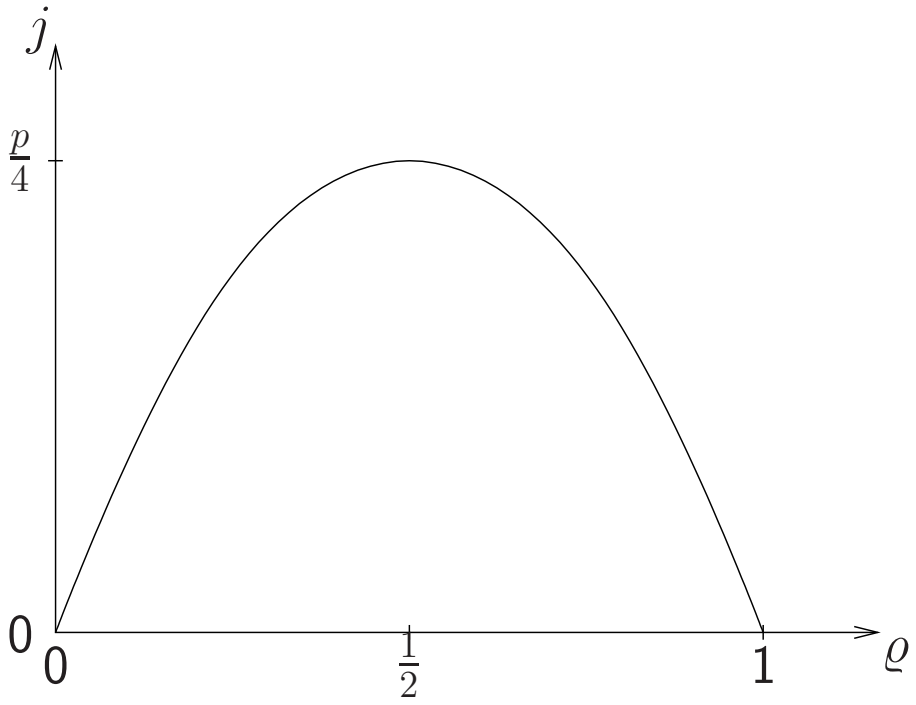
- Assume no correlations, i.e., n_l and n_{l+1} independent

$$\begin{aligned} j &= p \times \langle n_l \rangle \times (1 - \langle n_{l+1} \rangle) \\ &= p\varrho(1 - \varrho) \end{aligned}$$

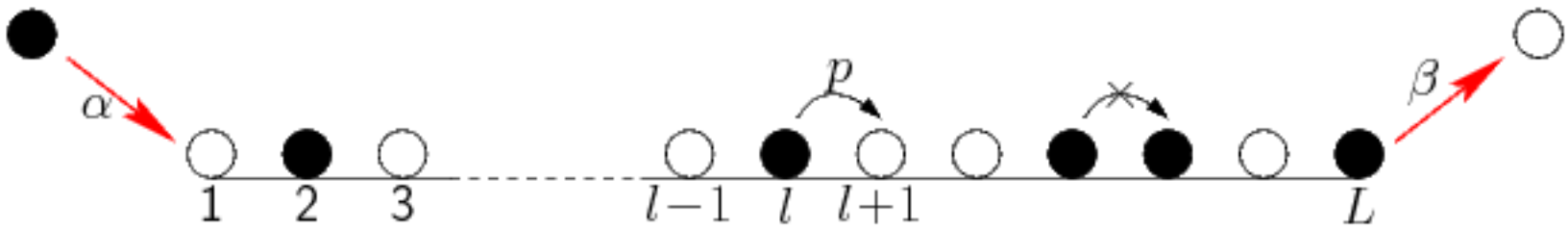
Fundamental diagram

- *How does current depend on density?*

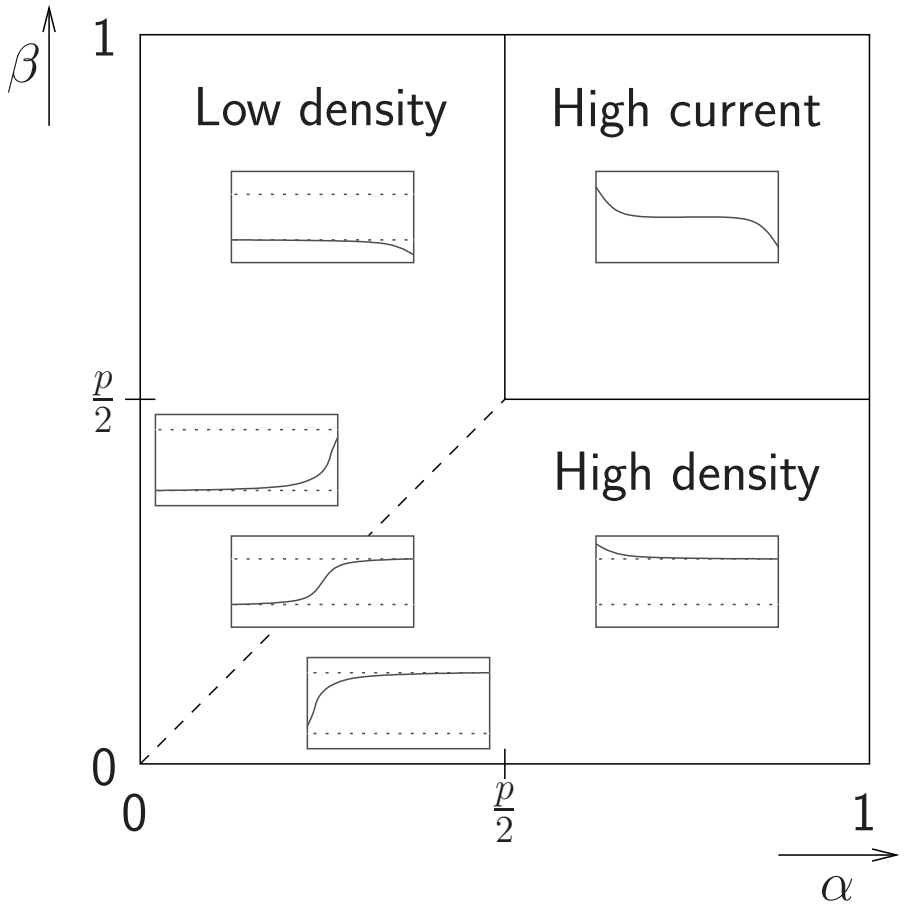
$$j = p\varrho(1-\varrho)$$



Open boundary conditions



- Model has *phase transitions*



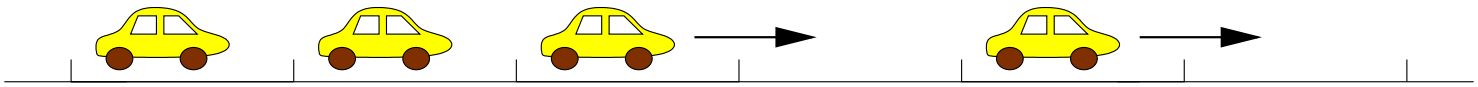
Modelling of transport

- Models are a simplification of reality

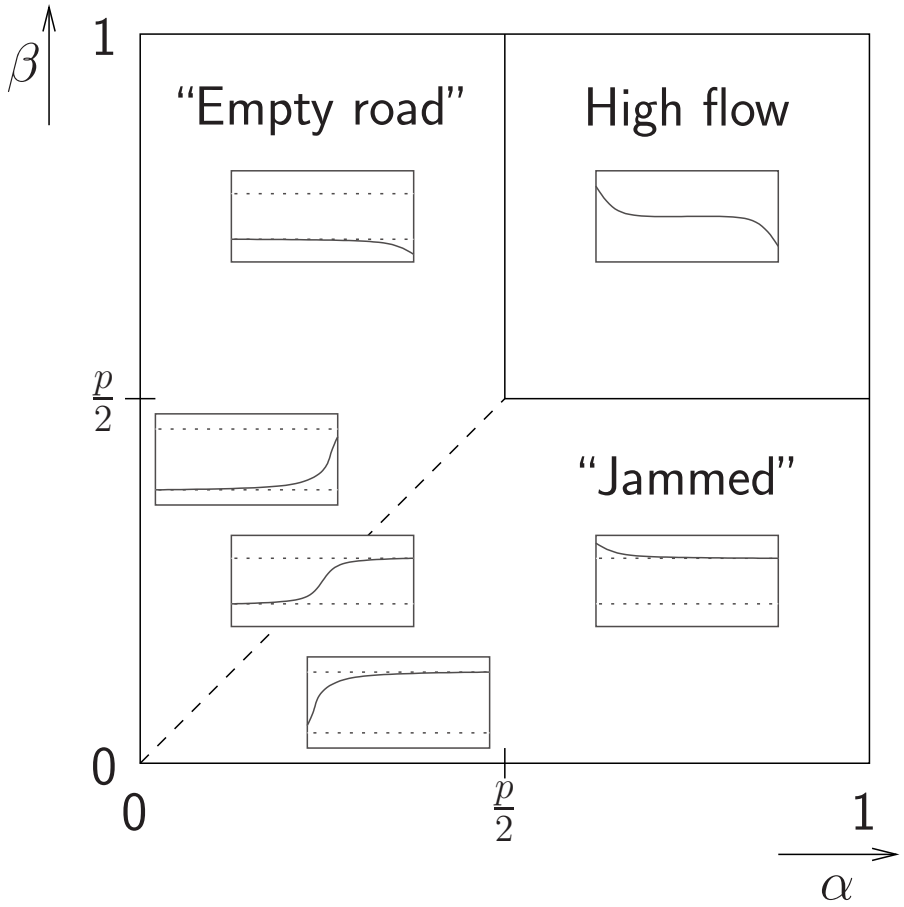
- Onion picture, build up layers:
  - Simplest possible toy model
  - Progressively add more details
  - Use computer!

- ASEP used as starting point for various transport processes...

Vehicular traffic

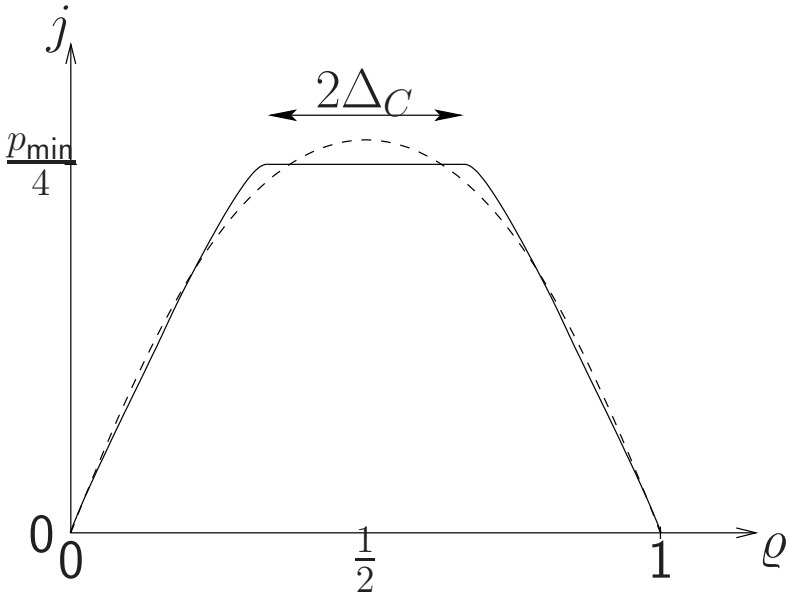


- ASEP is toy model for single-lane traffic
- Phase diagram already shows some features of real traffic



Adding details

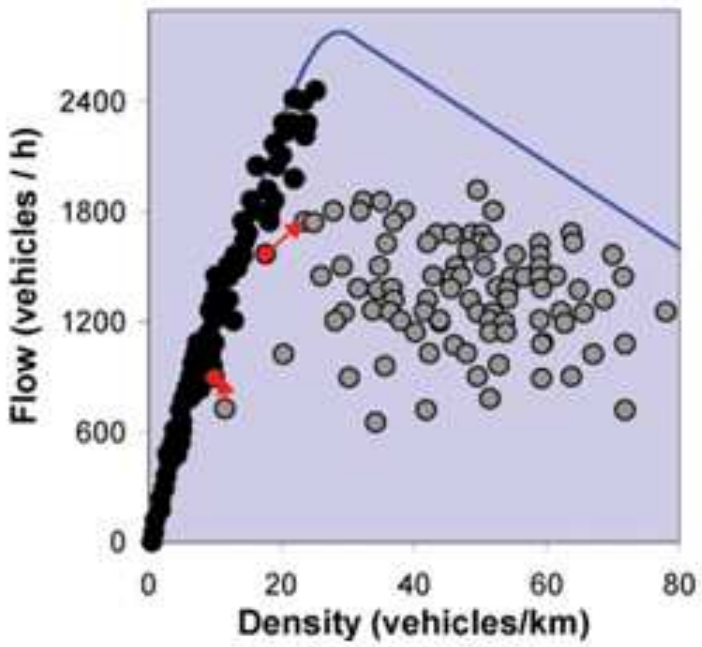
- Variation in road-surface, add disorder



- Different speeds, rules for acceleration/deceleration (e.g., Nagel-Schreckenberg)
- For computational simplicity often work in discrete time – *cellular automata*
- Different geometries
  - More lanes
  - Road networks

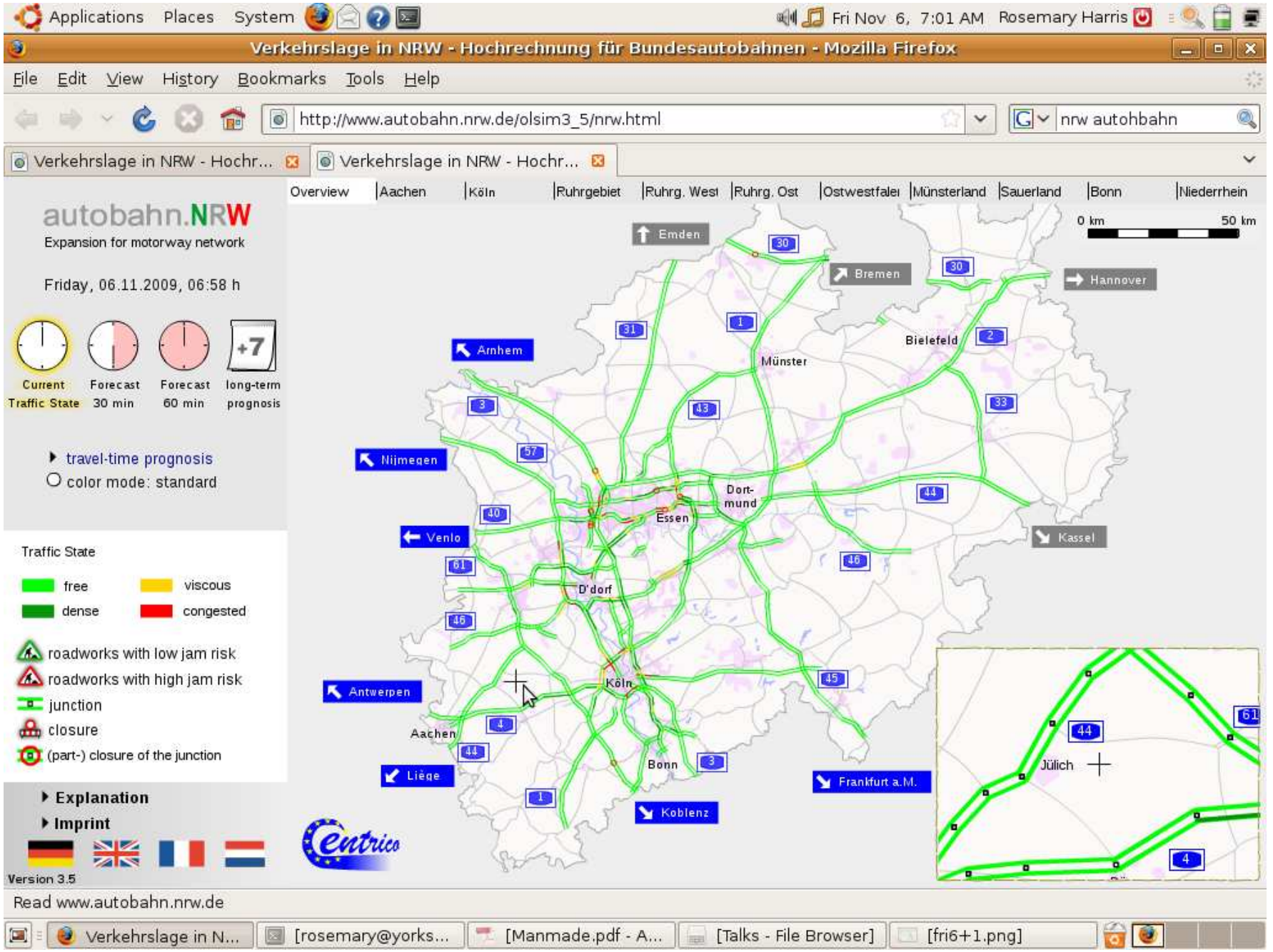
Experiments on real traffic

- Not usually periodic boundary conditions...
- Fundamental diagram



- Note "metastable states"
- Can construct simple models with similar effects

Real life: measurement

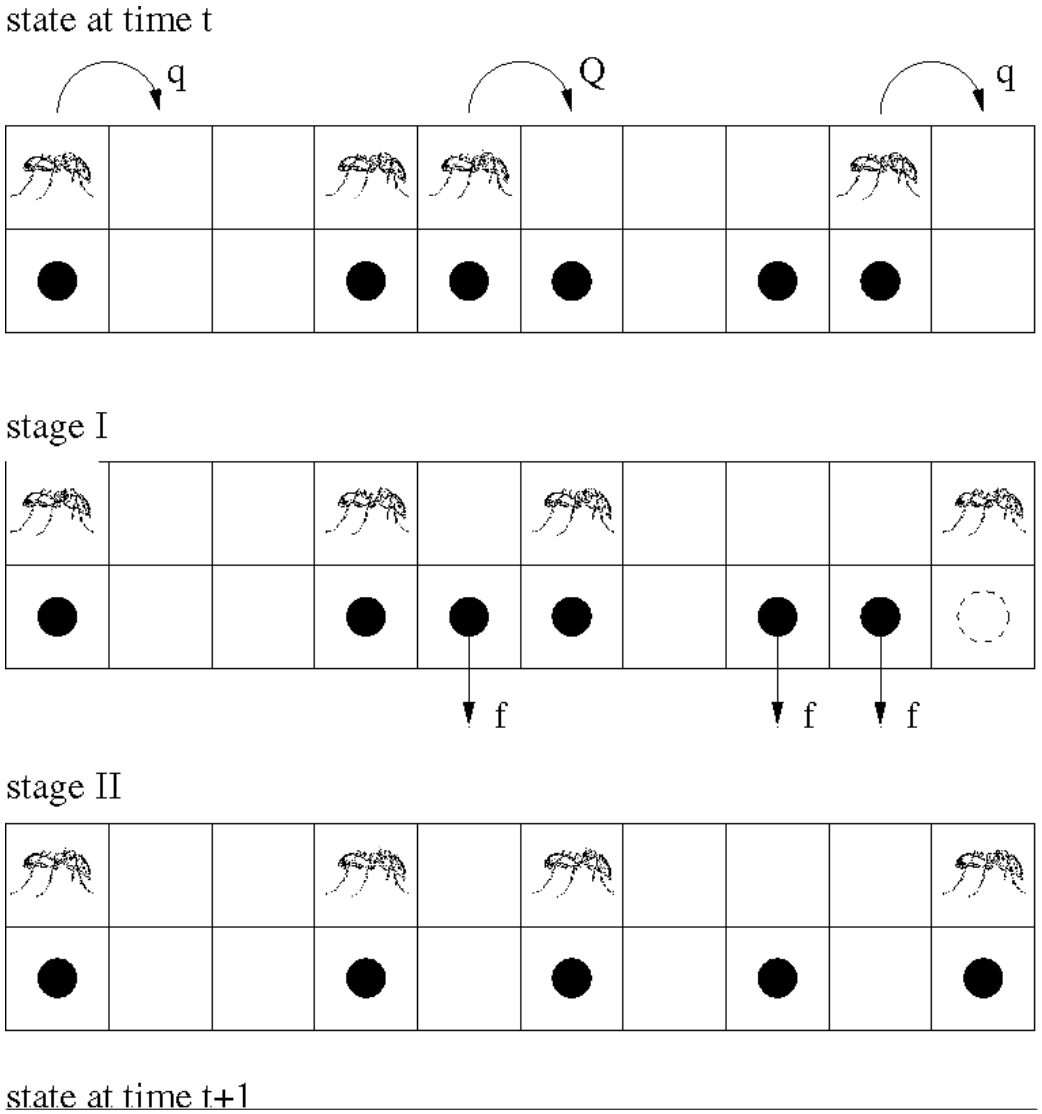


Real life: prediction

Real life: validation

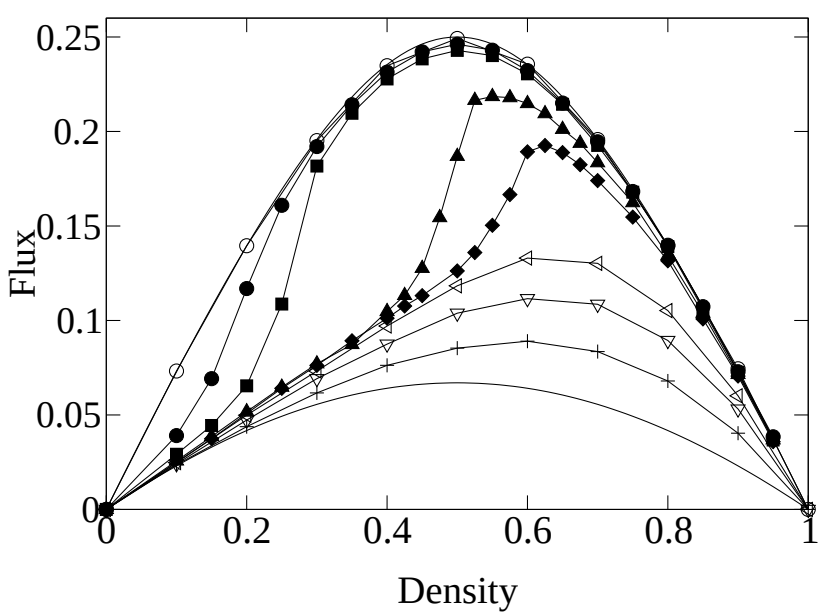
Ant-trail model

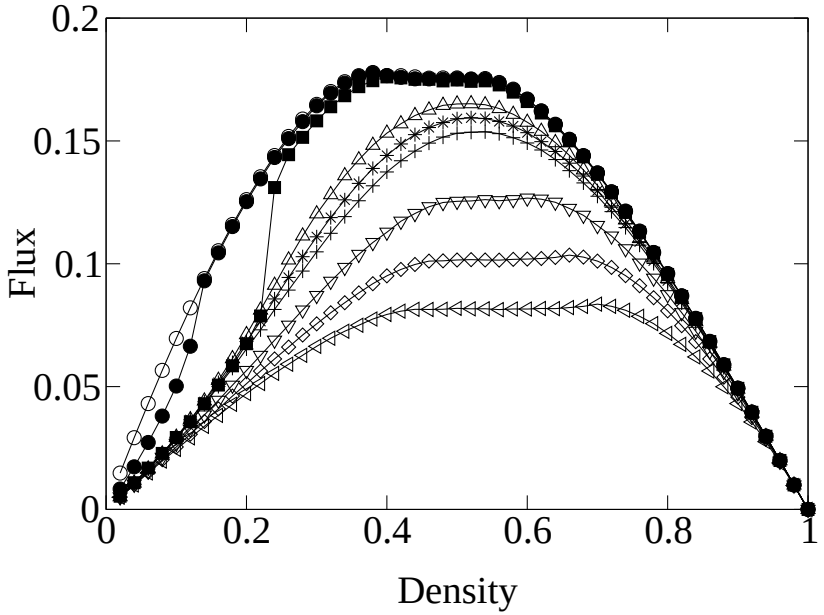
- Modify model to include chemical signals (pheromones)



Ant fundamental diagrams

- Uni-directional versus bi-directional movement



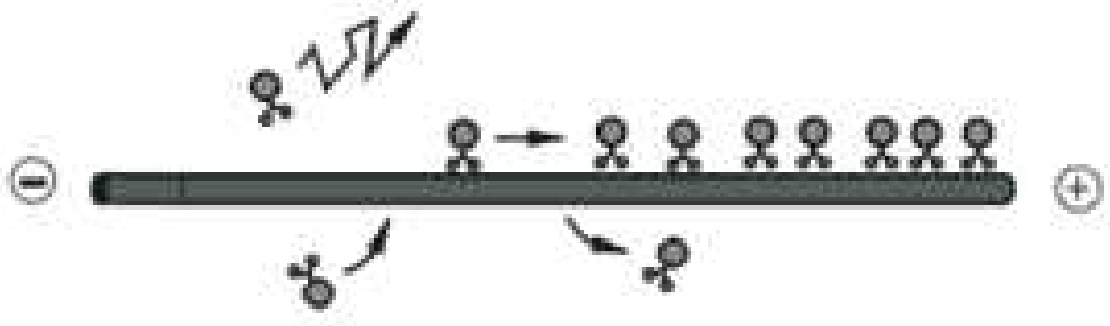


[Schadschneider *et al.* '03]

- Model predicts formation of "platoons"...

Intracellular transport

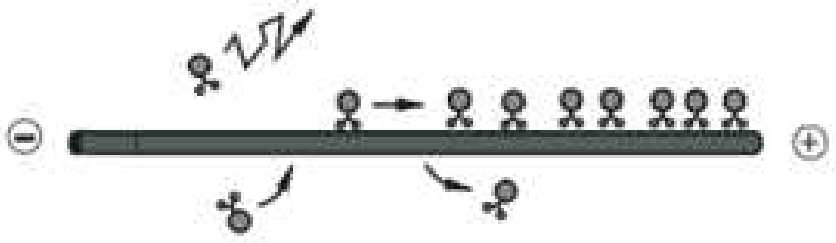
- Kinesin on axonal microtubule...



[from Klumpp & Lipowsky]

- Key features:
  - Preferred direction
  - Discrete steps
  - Exclusion
  - Attachment and detachment
- At coarse-grained level can model by stochastic exclusion process...

Breakdown of intracellular transport



- Higher than usual concentration of tau protein in Alzheimer's patients
- Experiments on tau, e.g., [Trinczek *et al.*]:
  - Doesn't affect speed of motors on microtubules.
  - *But* reduces their absorption probability
- Theoretical calculations for simple model, simulation for more complicated model [Grzeschik, Harris & Santen '08]:
- System robust to low concentration of tau but at higher densities
  - Mean current strongly reduced
  - Fluctuations increased...

Current fluctuations

- Often (relatively) easy to calculate mean current
- But finite-time observations can yield average current larger or smaller than real mean
- Characterizing these fluctuations is important in applications
- Also of theoretical importance
  - Current large deviations analogous to free energy in equilibrium

$$p(j,t) \sim e^{-\hat{e}(j)t}$$

  - Exhibit particular symmetry (fluctuation theorem)
  - Insight into structure of non-equilibrium statistical mechanics

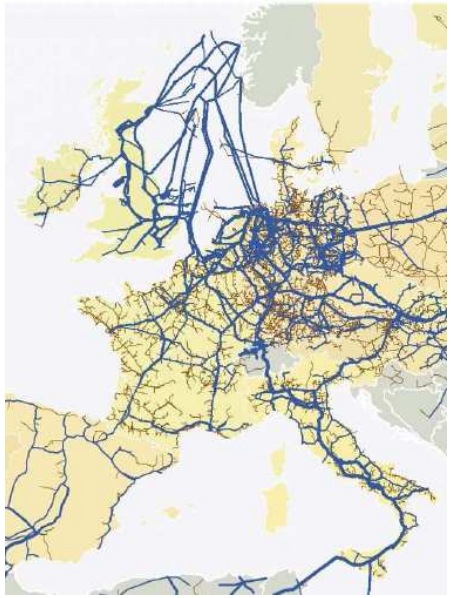
Summary

From Applied Maths...

- Probability
- Differential equations
- Matrices

...to Transport Modelling

- Can model important real-life situations
  - Transport failure in Alzheimer's disease
  - Pedestrian dynamics at the Hajj
  - Gas network



via non-equilibrium statistical mechanics

- Non-equilibrium physics typically very different to equilibrium physics
- ASEP is a simple test model allowing exact calculations

Acknowledgments / References

- Thanks to Andreas Schadschneider (Cologne University) for supplying the videos

- Some interesting websites:
  - `http://www.thp.uni-koeln.de/ant-traffic/`
  - `http://www.thp.uni-koeln.de/~as/Mypage/Pedestrians/pedest_2.html`
  - `http://www.traffic-simulation.de/`
  - `http://www.autobahn.nrw.de/` [traffic state in NRW]
  - `http://www.soms.ethz.ch/` [simulations/videos, articles on Hajj]
  - `http://www.maths.qmul.ac.uk/~harris/`