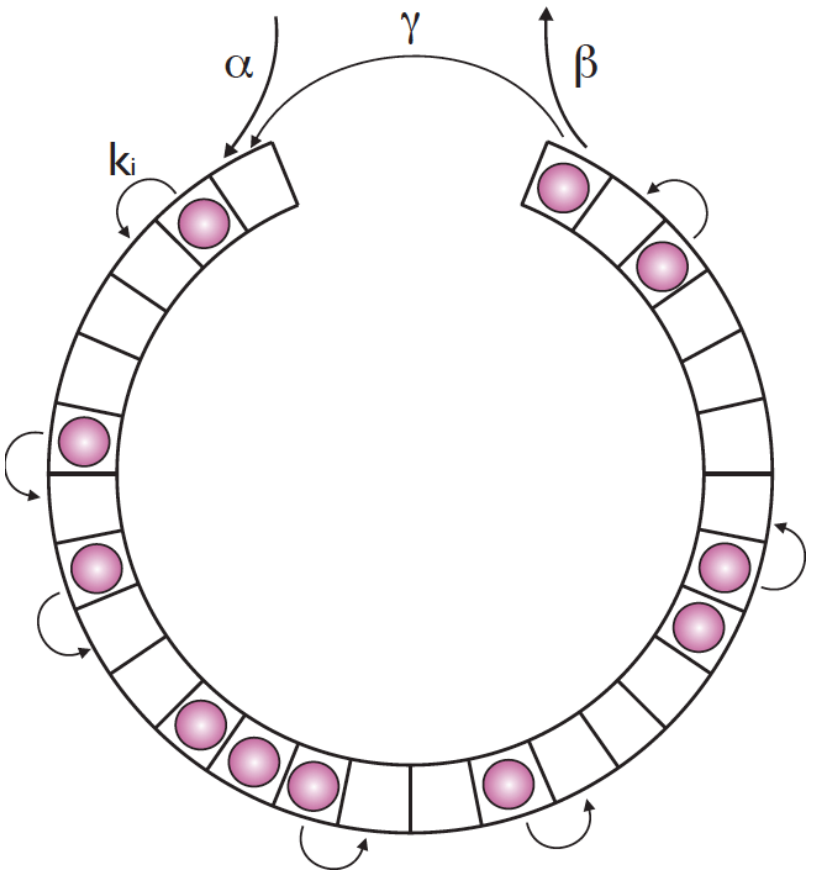
SUPA PALS THEME

Highlights of Interdisciplinary Science in the last twelve months

Reduce, reuse, recycle: modeling of ribosome recycling in *S. cerevisiae*

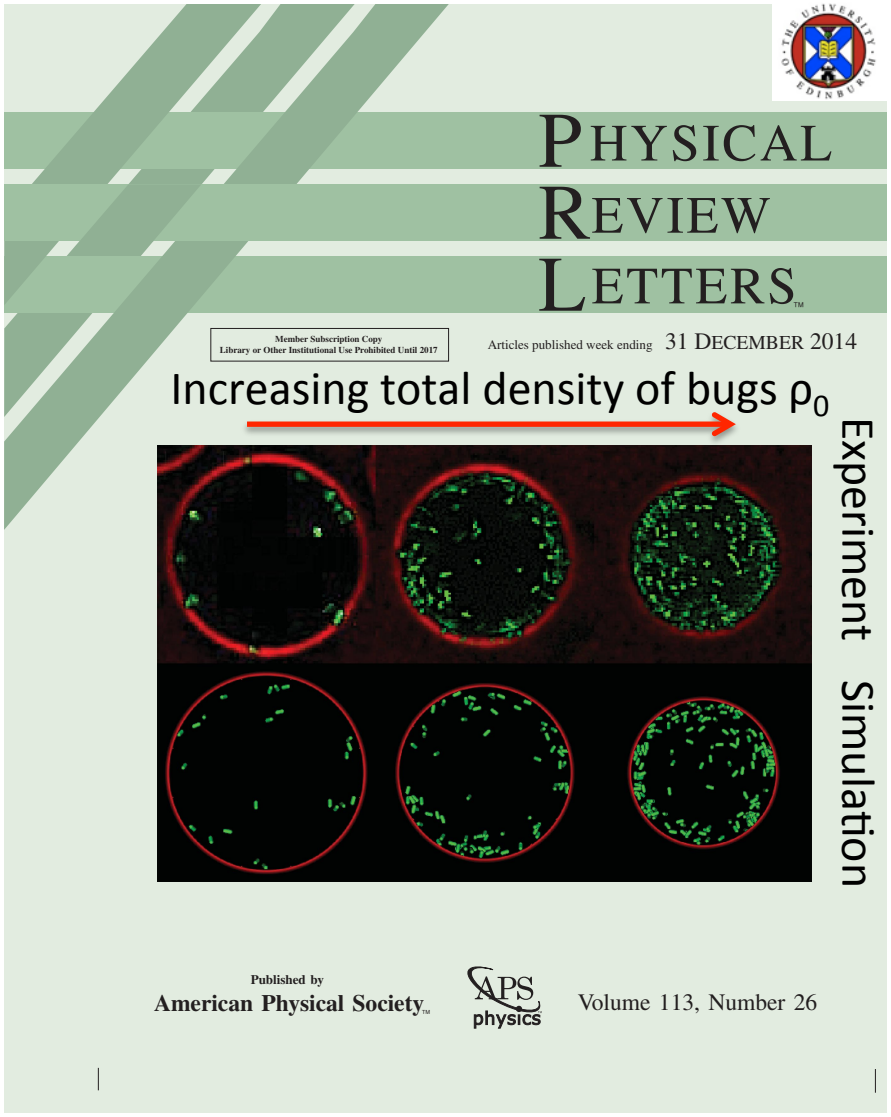


We model the biological process of translation of an mRNA into a protein based on the Totally Asymmetric Simple Exclusion Process (TASEP), paradigmatic in non-equilibrium statistical physics. Ribosomes are represented by particles which hop stochastically through a lattice, which represents the mRNA.

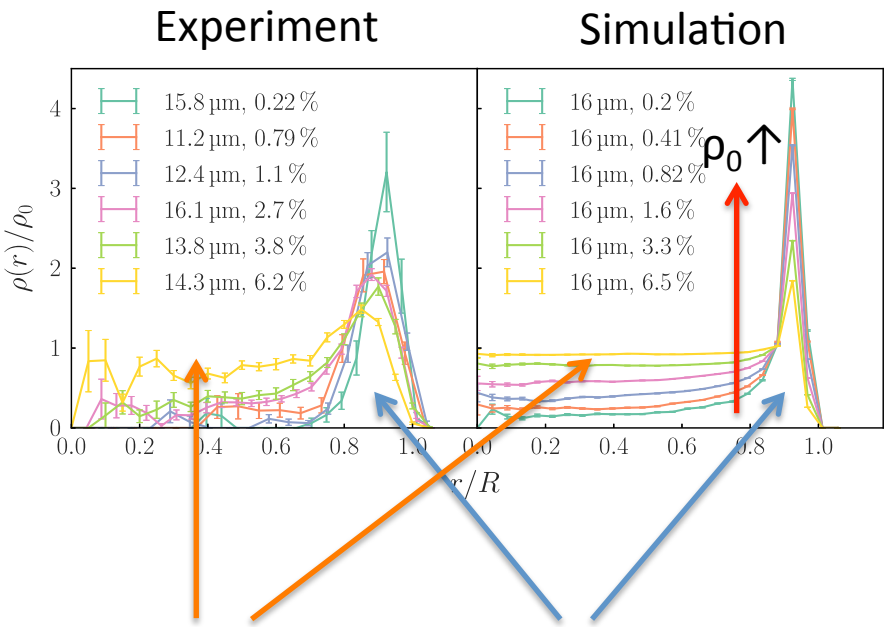
In this work we have described the process of ribosome recycling, namely ribosomes can re-start a new round of translation once they reach the end of the mRNA. We have shown that this effect has fundamental and non-intuitive consequences for the process of protein production, namely increasing the availability of ribosomes can lead to a decrease in the protein production rate.

E. Marshall, I. Stansfield, M. C. Romano
J. R. Soc. Interface: 2014 11 20140589; DOI: 10.1098/rsif.2014.0589. Published 9 July 2014

How do motile bacteria fill up an emulsion drop?



Vladescu et al. *PRL* **113** (2014) 268101



Bulk density rises uniformly

Bugs accumulate at the inner surface

Simple theory predicts surface:bulk ratio

Behaviour mimics a classical 'confined Knudsen gas' inside a 'sticky' container … … but the physics is due to the peculiarities of an interacting system of self-motile particles ('active colloids')

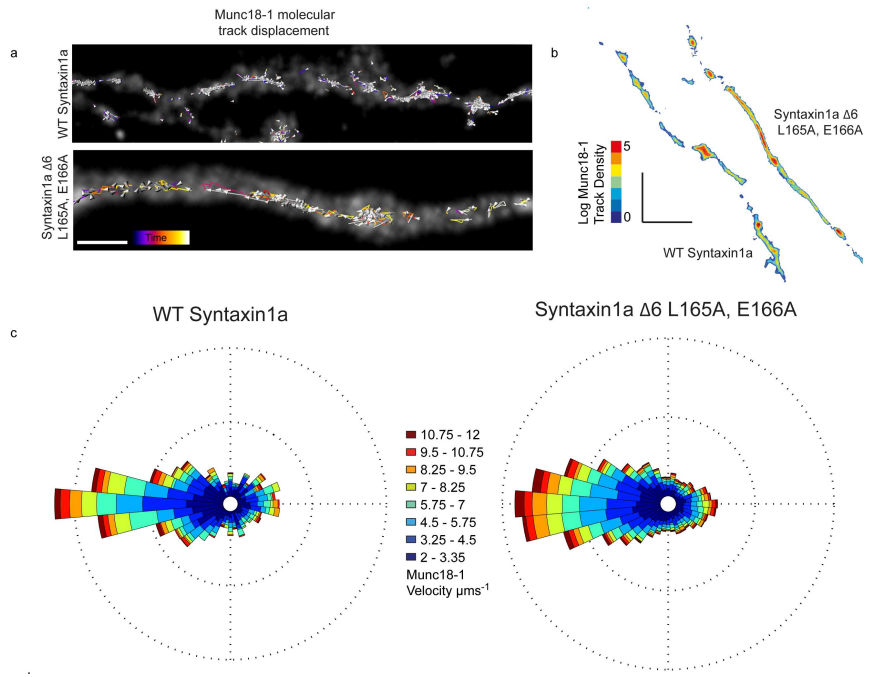
May have relevance for bioremediation, plant infection by pathogens and food safety

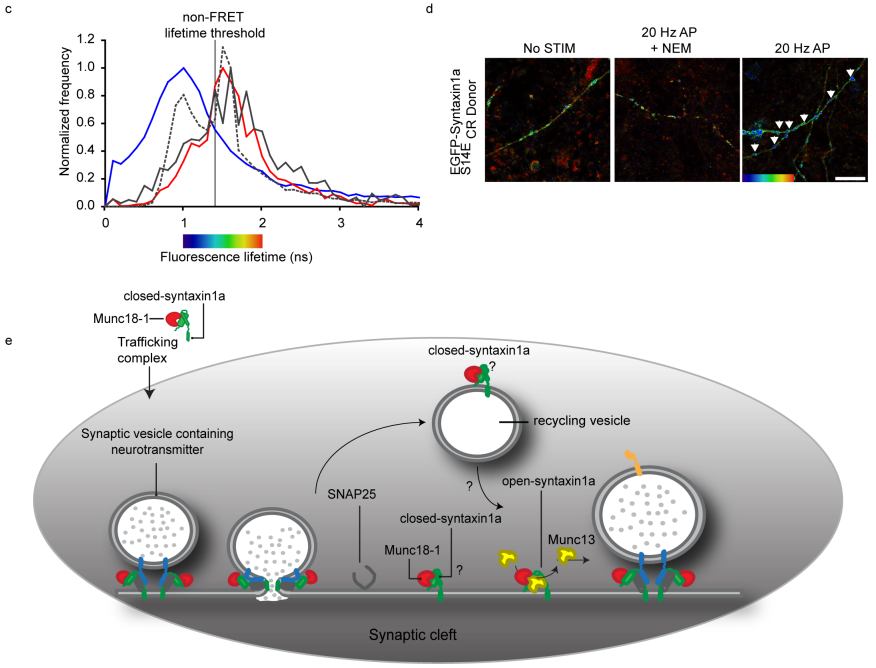
NATURE COMMUNICATIONS | ARTICLE OPEN

Nat Commun. 2014 Dec 17;5:5774.
doi: 10.1038/ncomms6774.

A molecular toggle after exocytosis sequesters the presynaptic syntaxin1a molecules involved in prior vesicle fusion

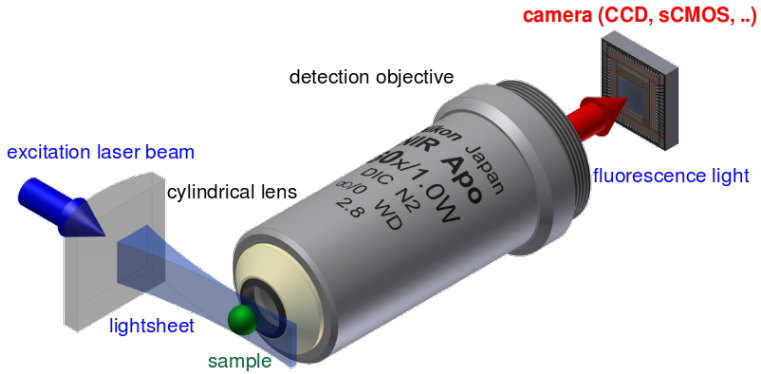
Deirdre M. Kavanagh, Annya M. Smyth, Kirsty J. Martin, Alison Dun, Euan R. Brown, Sarah Gordon, Karen J. Smillie, Luke H. Chamberlain, Rhodri S. Wilson, Lei Yang, Weiping Lu, Michael A. Cousin, Colin Rickman & Rory R. Duncan





- Inter-disciplinary (biophysics, mathematics, neurobiology and electrophysiology
- Inter-mural and international (HWU, UoE, Strathclyde, Glasgow and OmniVision, USA
- First integrated study in living synapses during electrical depolarization of single molecule tracking, dynamics, interactions and positions on the nanoscale
- Funded by the Wellcome Trust, MRC and EPSRC

Advanced light beam shaping for light sheet microscopy



Light-sheet microscopy using an Airy beam

Tom Vettenburg[1], Heather I C Dalgarno[1], Jonathan Nylk[1,2], Clara Coll-Lladó[3], David E K Ferrier[3], Tomáš Čižmár[4], Frank J Gunn-Moore[2] & Kishan Dholakia[1]

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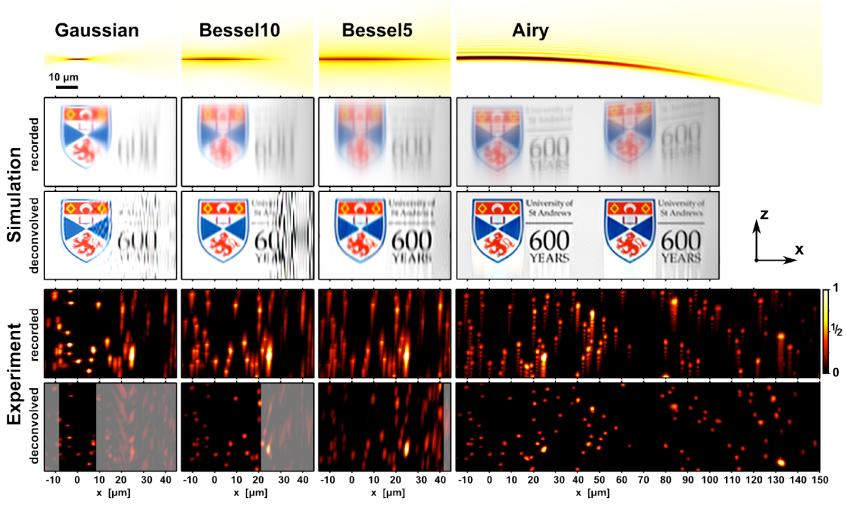
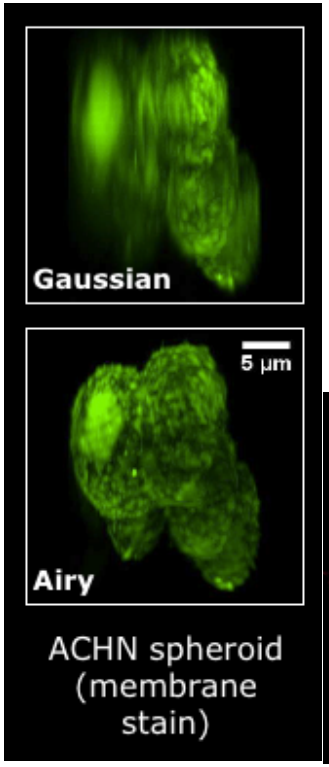
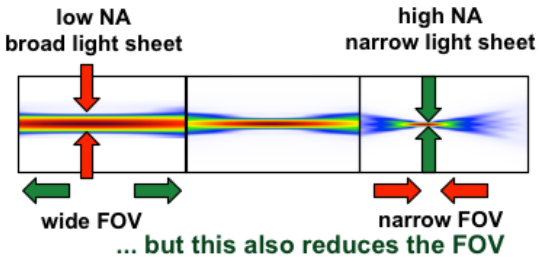
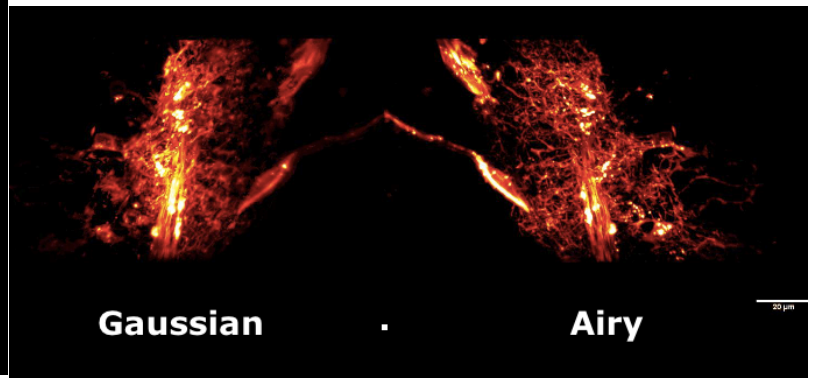








Airy beam gives up to 10x field of view

Compact version realised (Published Autumn 2014)

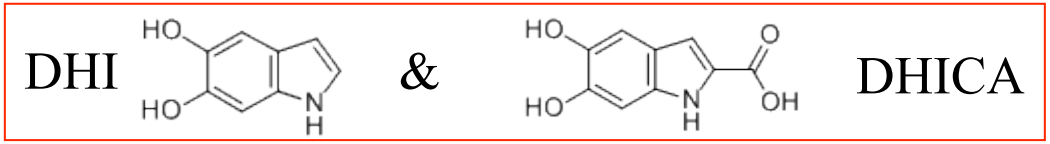
collaborations incl. Edinburgh (Lyons, Wheeler, Nolan) and Oxford (Emptage)

Melanin structure

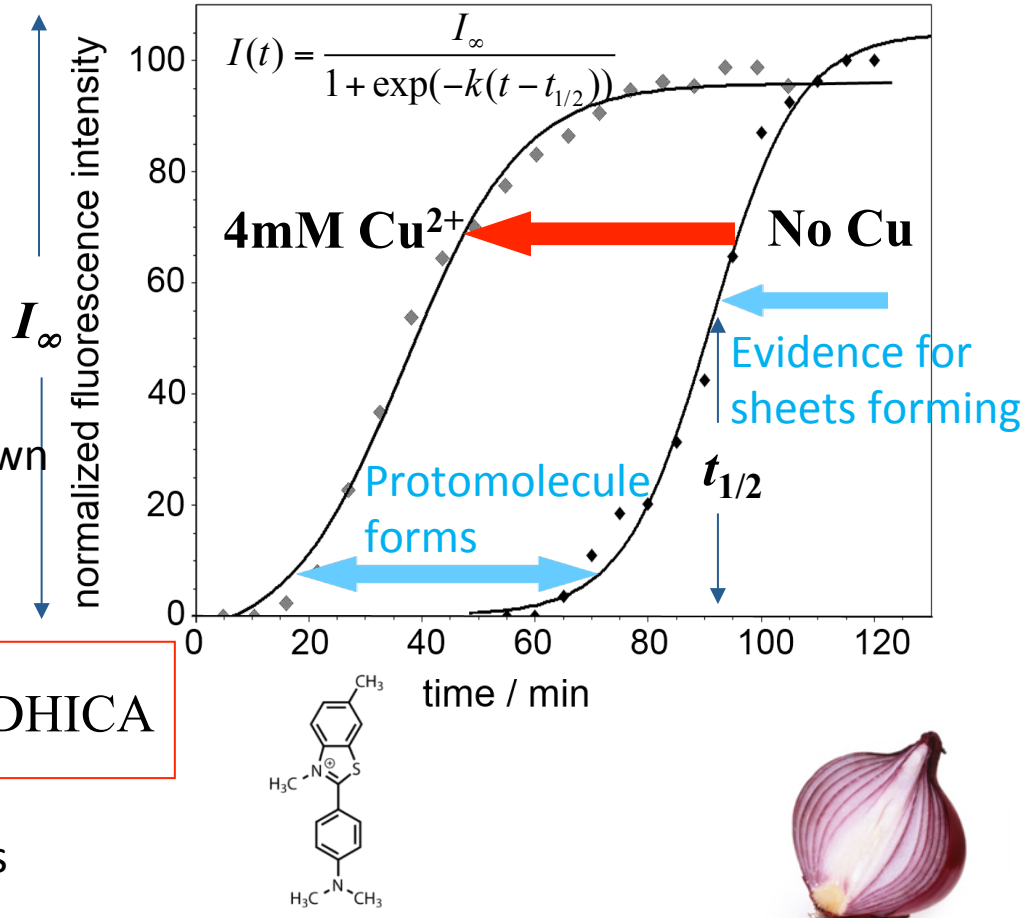
Metal ion influence on eumelanin fluorescence and structure
J-U Sutter and D J S Birch. Methods Appl. Fluoresc. 2, 024005, 2014.

- A new, IOP high impact journal for fluorescence
- Founding Editors-in-Chief David Birch, Otto Wolfbeis, Yves Mely

- Melanin is our UV skin protector
- It is a soft solid
- It is also implicated in melanoma – the most virulent form of skin cancer
- However, melanin's structure is unknown
- It is synthesized by oxidising indoles-



- Copper ions enhance melanin synthesis



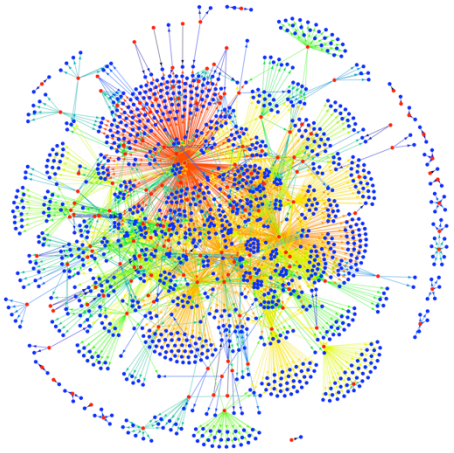
Conclusion: Fluorescence growth curves of a sheet probe (ThT) suggest melanir forms protomolecules arranged in a layered nanoparticle (maybe like onion!)

Buffered Qualitative Stability explains the robustness and evolvability of transcriptional networks

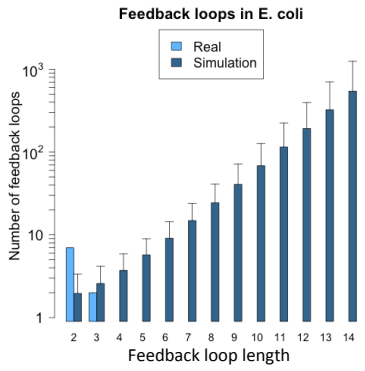
L. Albergante, J Julian Blow, Timothy J Newman

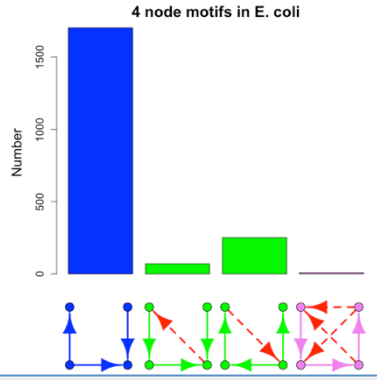
Albergante *et al.* eLife 2014;3:e02863. DOI: 10.7554/eLife.02863

Gene Regulatory Networks (GRNs) give a system level view of transcriptional interactions: they are the *operating system* of the cell

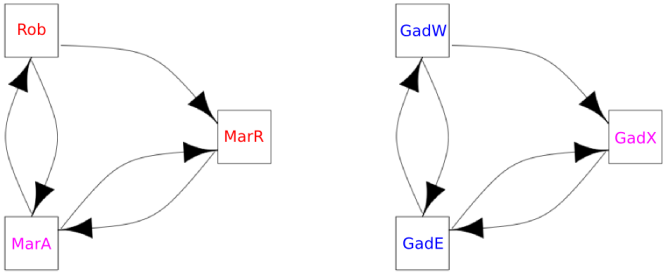


We developed the theory of **Buffered Qualitative Stability (BQS)** which predicts the features of *evolutionarily robust* GRNs. All the predictions of BQS were verified using biologically derived GRNs from 5 organisms.





Foci of diminished robustness were found in *E. coli* and *M. tuberculosis* associated with antibiotic resistance genes suggesting new mechanisms that promote drug resistance.



Non-cancer human cells verify all the predictions of BQS, while leukemia cells do not, suggesting a global loss of robustness in cancer.