464th Wilhelm and Else Heraeus Seminar

Self Organization in Cell Assemblies and Tissues

Physics Center Bad Honnef, August 29 - September 3, 2010

Scientific Organizers

Claus Fütterer & Josef A. Käs
Soft Matter Physics Division, University of Leipzig

Registration

Pre-registration at the conference secretariat is required since the number of participants is limited. Please send your registration to pwmsec@rz.uni-leipzig.de.
Deadline is **July 16, 2010**.

There is no registration fee. This meeting is funded by the Wilhelm and Else Heraeus Foundation, which covers local costs for all participants. A small number of travel grants for students (in general from East European countries) are available on request, please call.

Application for Posters

Please send your applications to pwmsec@rz.uni-leipzig.de. Deadline for abstract submission is **July 16, 2010**.

The dynamics of tissues and morphogenesis is currently progressing rapidly and there is a stron exchange and discussion. The meeting's intention is to bring biologists, biophysicists and physicians to enjoyable and inspiring atmosphere in a charming old manor in Bad Honnef close to the Rhine river t their research, to enjoy inspiring discussions and posters about the deep secrets of the organizatio cellular systems. The talks will address a interdisciplinary scientific community. The number of pa limited to avoid the hectic conference atmosphere. Plenty of time will be given for discussion and excha

Conference Flyer

Topics included:

- Self organization of cells
- Reaction diffusion models
- Cellular signaling
- Cell migration in tissues
- Embryogenesis
- Cell and tissue mechanics
- Emergent phenomena
- Evolution of tissues

Invited Speakers & Abstracts:

Markus Affolter *(University of Basel)*, Françoise Brochard-Wyart *(Institut Curie)*, Damian Brunner *(EMBL Heidelberg)*, Kristian Franze *(University of Cambridge)*, Erwin Frey *(LMU Munich)*, Raymond E. Goldstein *(University of Cambridge)*, Ramin Golestanian *(University of Sheffield)*, Thomas W. Holstein *(University of Heidelberg)*, Paul Janmey *(University of Pennsylvania)*, Frank Jülicher *(MPI Dresden)*, Robert B. Laughlin *(Stanford University)*, Paul Layer *(TU Darmstadt)*, Hans Meinhardt *(MPI Tübingen)*, Albrecht Ott *(Saarland University)*, Jacques Prost *(ESPCI Paris)*, Andrea Robitzki *(BBZ Leipzig)*, Eva-Maria Schötz *(Princeton University)*, Malcolm Steinberg *(Princeton University)*, Thomas Surrey*(EMBL Heidelberg)*, Roland Wedlich-

UNIVERSITÄT LEIPZIG

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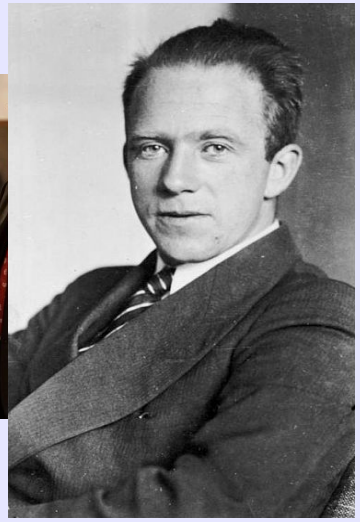
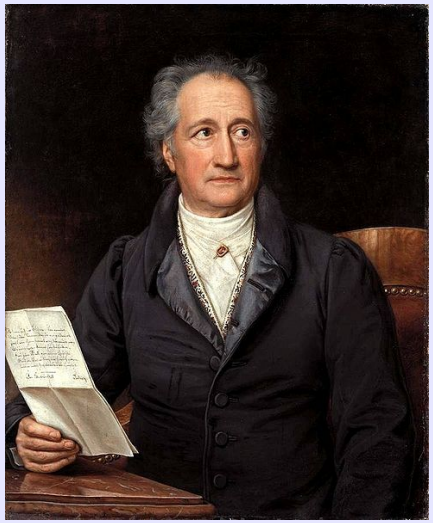
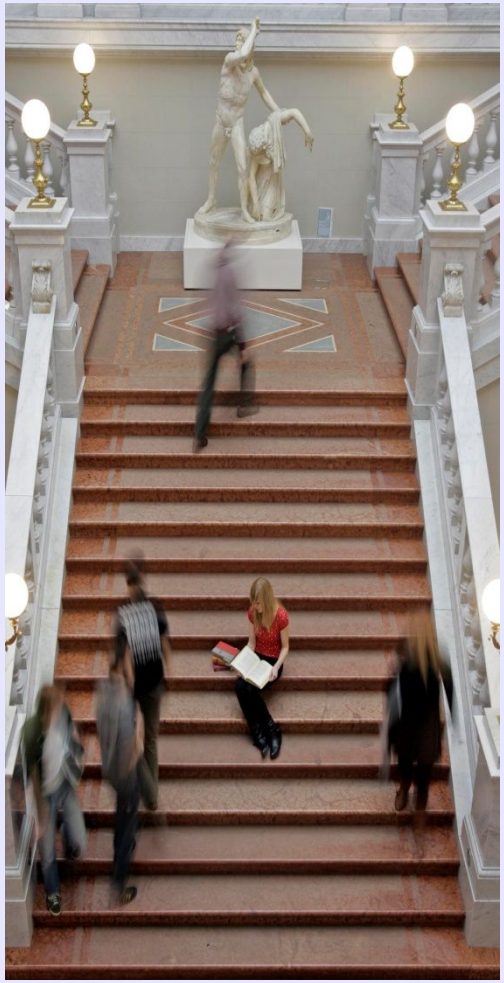
Heisenberg – Ostwald – Hertz – Leibniz –
Müntzer – Lessing – Goethe – Wagner – Nietzsche – Kästner

Hans-Dietrich Genscher, Angela Merkel (Physics)

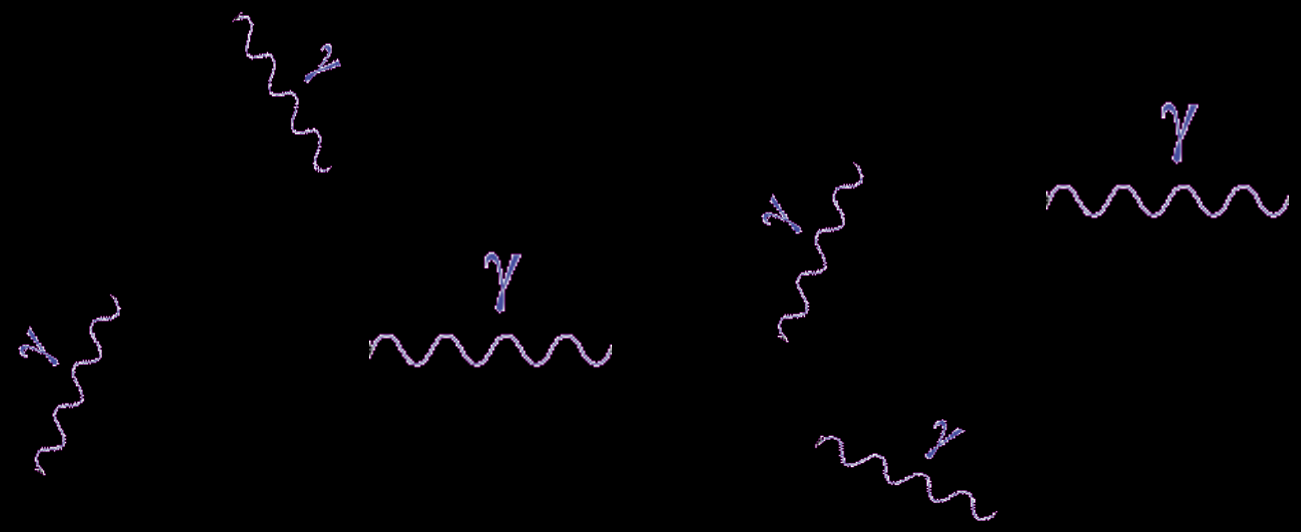






Thanks to Wilhelm and Else Heraeus!

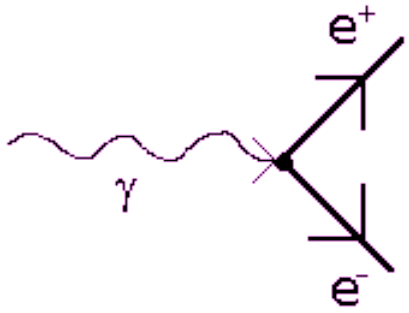
Early universe

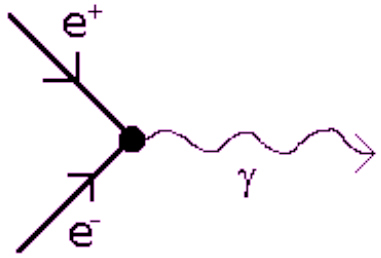


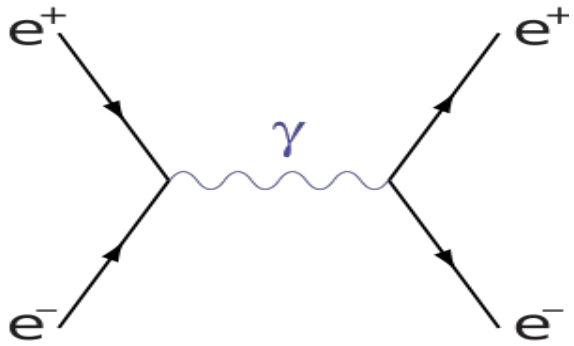
Radiation (Photons, ...)

Baryogenesis

Photons decayed *reversibly* to massive particles and anti-particles



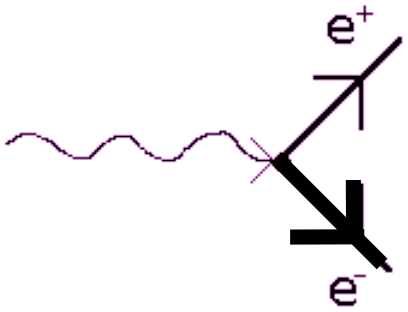




Our world is a left over due to ***symmetry breaking***

Most of matter and antimatter anihilated again

But a bit was left over...



to become our world...

Emergence

$$\frac{\vec{p}_i^{\,2}}{2m_i} + V(\vec{x}_i) = 0$$

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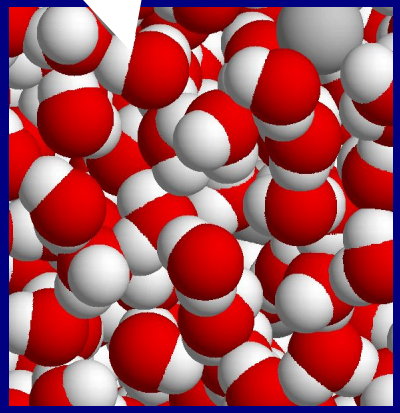
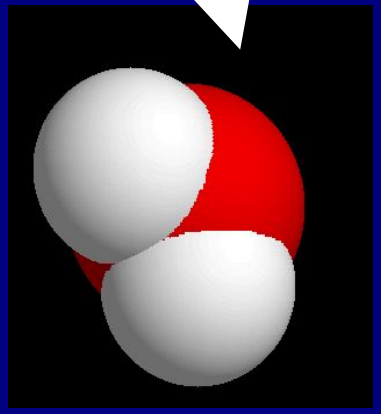
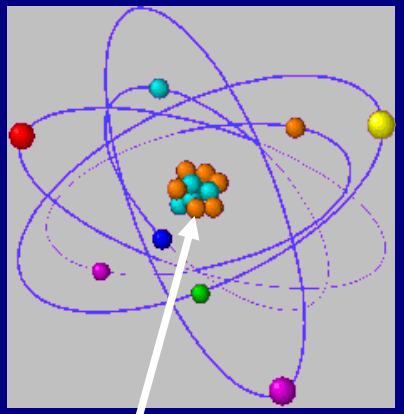




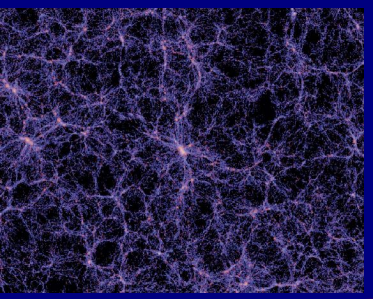


$$\rho(\partial_t \vec{u} + \vec{u}\cdot\vec{\nabla}\vec{u}) = \eta\nabla^2\vec{u} - \vec{\nabla}\vec{p}$$

$$\mathcal{L}_{\mathrm{QCD}}(q,A) = \bar{q}(i\gamma^\mu D_\mu - m)q - \frac{1}{4}F^a_{\mu\nu}F^{\mu\nu}_a$$

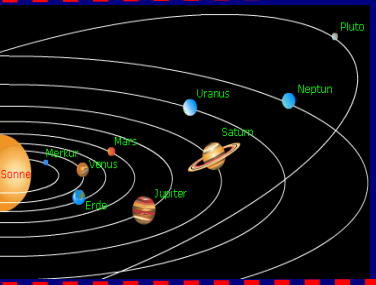
Knowing the equations = understanding the phenomenon?

Levels of emergence



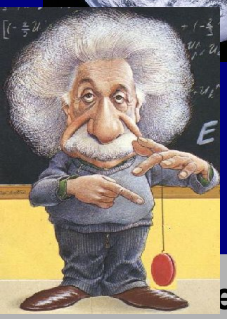
Structure of universe

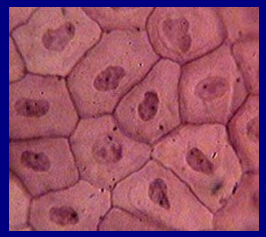
Galaxies



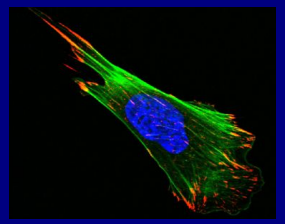
Planet-systems

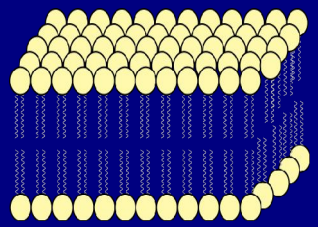
Ecosystems, planets

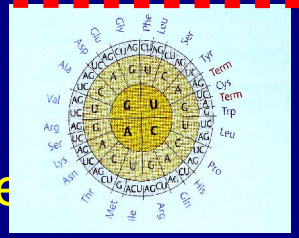


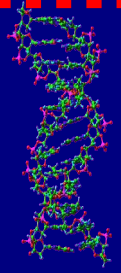


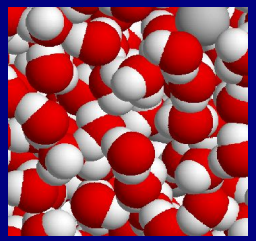
Tissues, organisms, cells

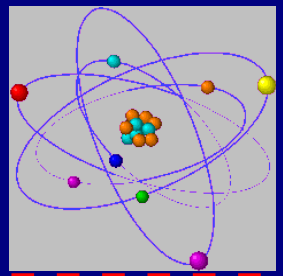






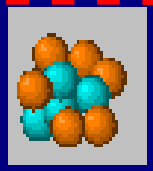






Molecules and condensed matter

Atoms



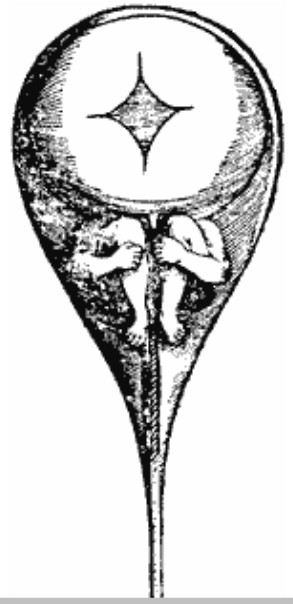
$$\mathcal{L}_{\mathrm{QCD}}(q,A) = \bar{q}\,(i\gamma^{\mu}D_{\mu} - m)\,q - \frac{1}{4}F^{a}_{\mu\nu}F^{\mu\nu}_{a}$$

$$= \bar{q}(i\gamma^{\mu}\partial_{\mu} - m)q + g\bar{q}\gamma^{\mu}T_{a}qA^{a}_{\mu} - \frac{1}{4}F^{a}_{\mu\nu}F^{\mu\nu}_{a}$$

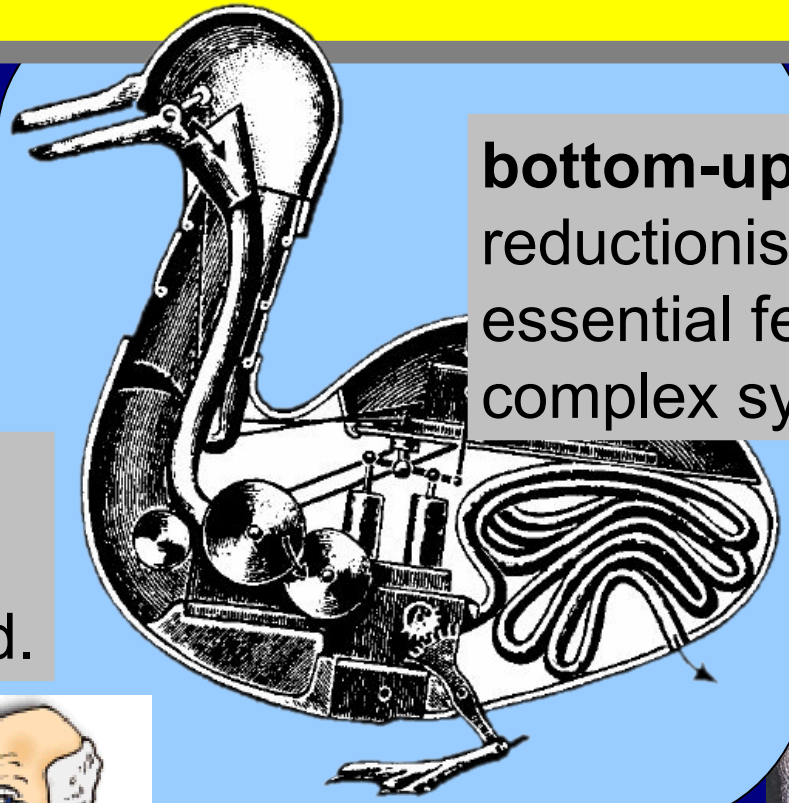
$$F = \frac{d}{dt}mv$$

Quantum gravitation

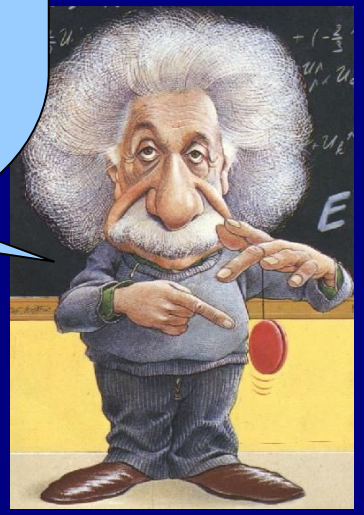
Top-down = bottom-up?



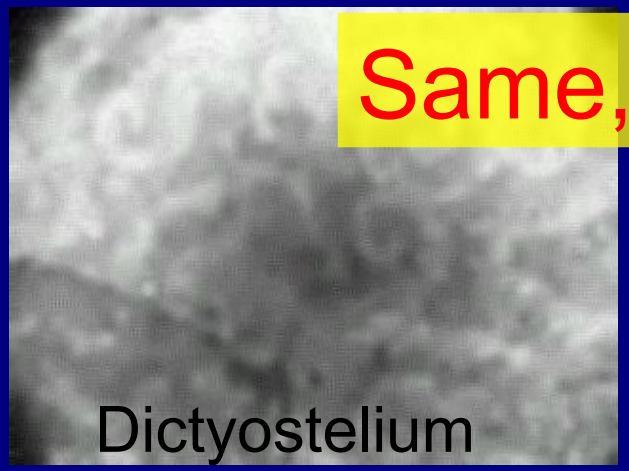
top-down: self-organizing matter is more powerful we ever might have imagined.



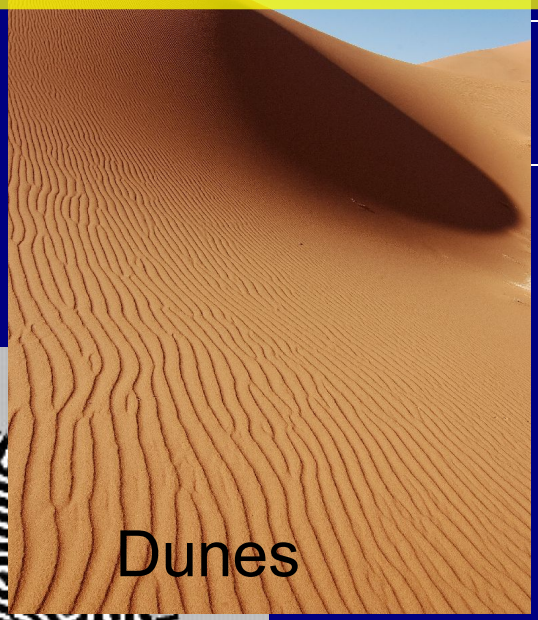
bottom-up: reductionists miss essential features of complex systems.



Same, same but different...



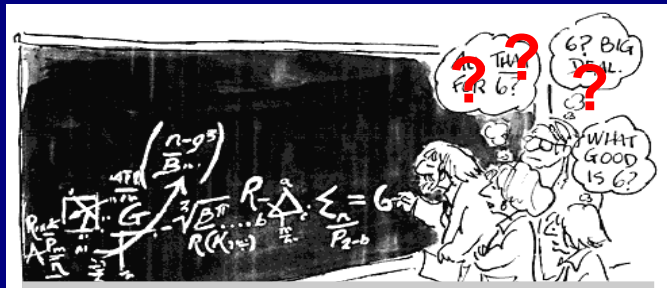
Dictyostelium



Dunes

Convection,Hydrodynamics

Chemistry
BZ-Reaction



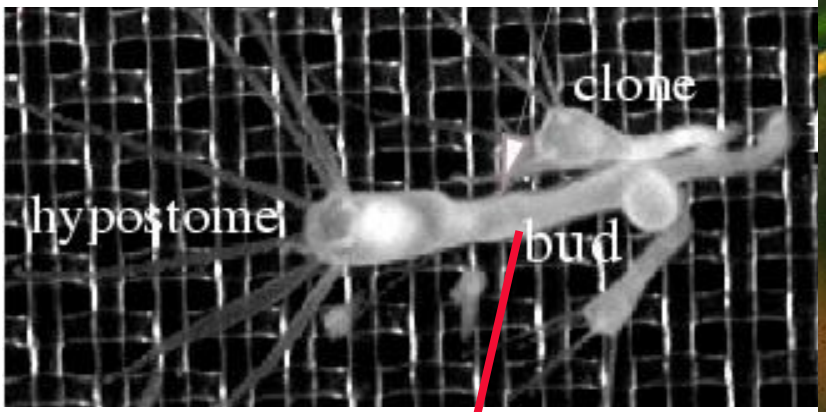
Universal Organization principles???

Symmetry

Symmetry has to be broken to increase structural complexity

Hydra vulgaris: stunning regeneration through symmetry breaking

Most cells can redifferentiate to build a new organism with 20000 cells



New Hydra

Dispersed cells

Cell aggregate

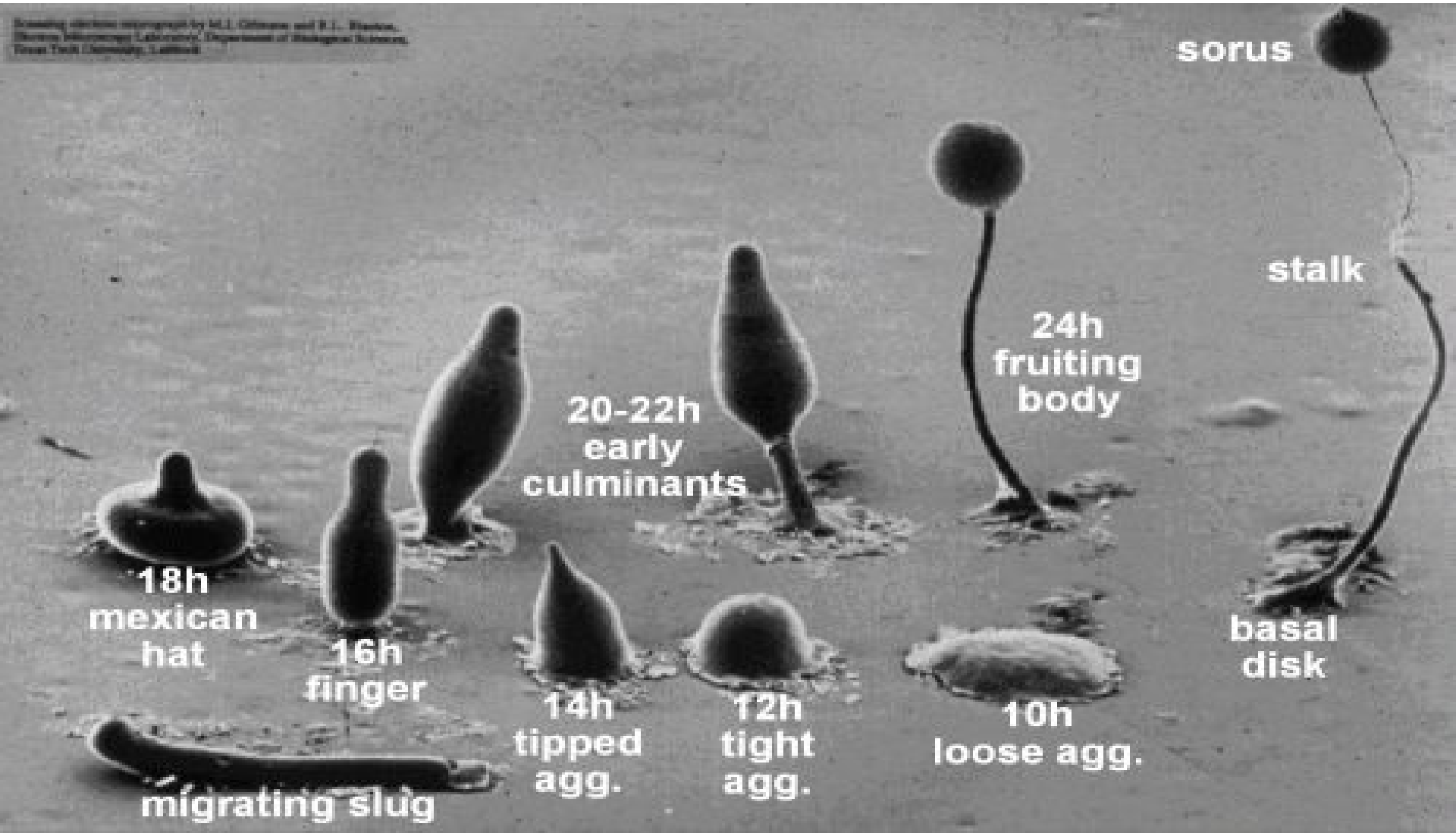
Symmetry Breaking with OSCILLATIONS

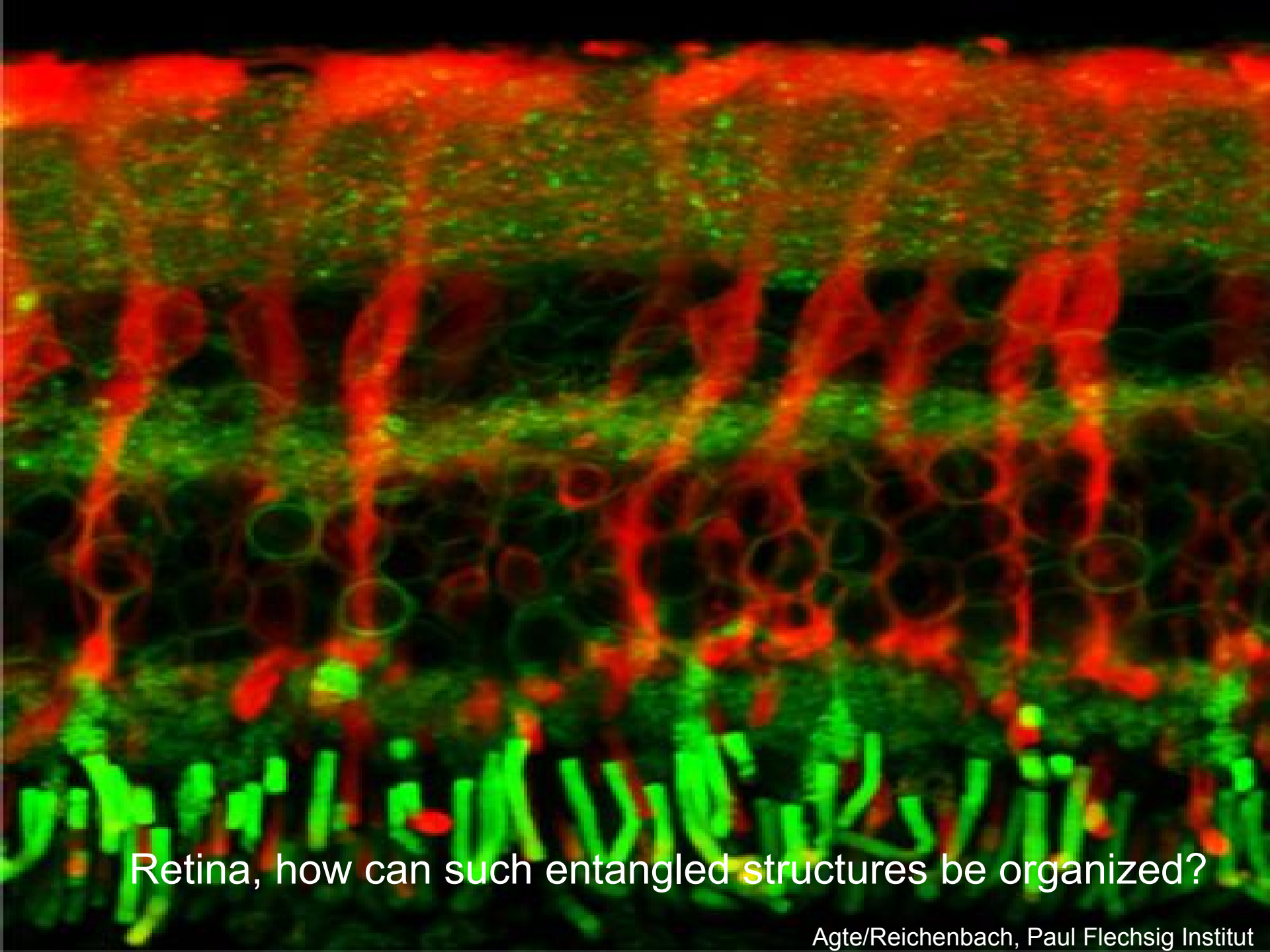
“Androgenesis“

Terminator

Biological materials can do it!!!

Dictyostelium discoideum





Agte/Reichenbach, Paul Flechsig Institut

Questions

What is due to self-organization, what is controlled in tissues?

Tissue formation: long range order through long or short range interaction? What is important, forces, gradients or signaling?

Which internal elements from cell are essential for tissues?
To what extend can tissues be described as emergent entities similar to flowing water disregarding molecular properties of H_2O?

What is the role of fluctuations and oscillations?
Are they needed to exploit “phase space” similar to brownian motion for molecular transport?