

# Theoretische Bio-Nano Physik

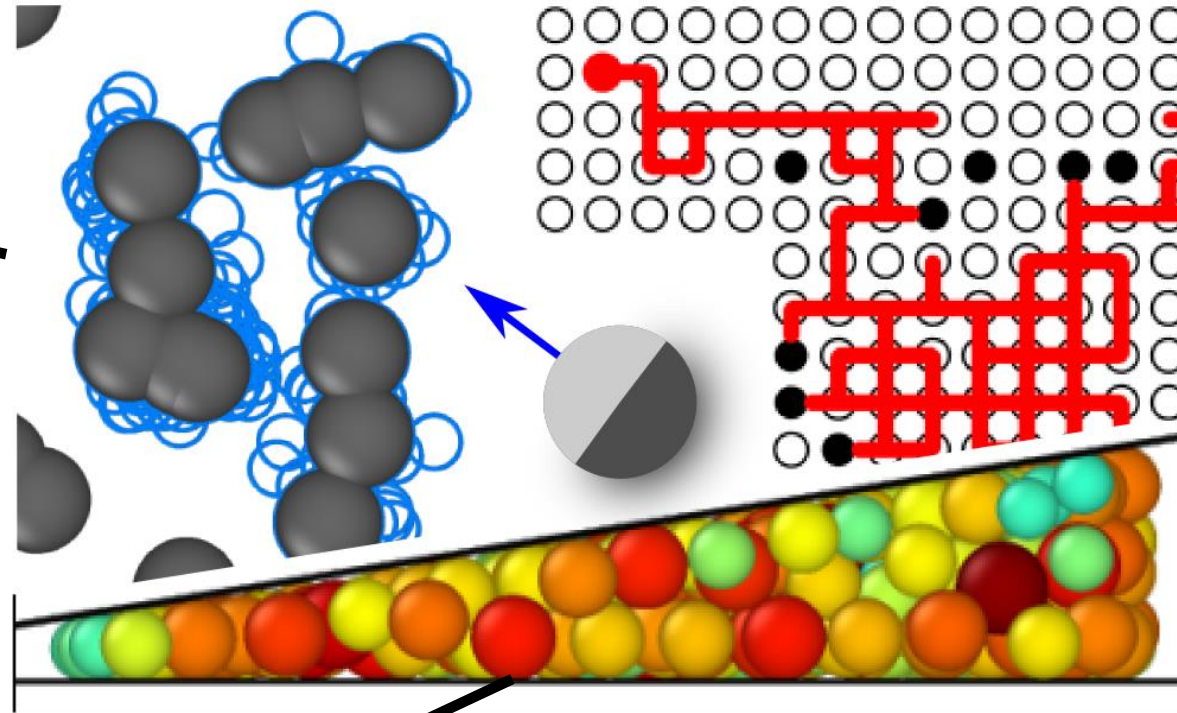
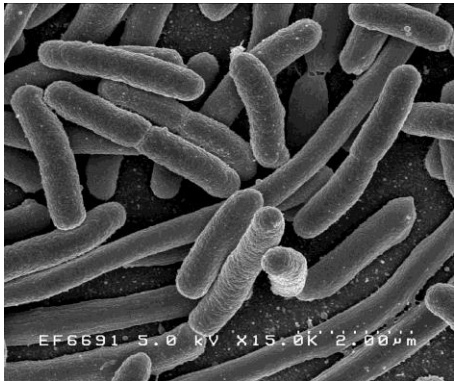
**Prof. Thomas Franosch, Anton Lüders**

16.01.2025

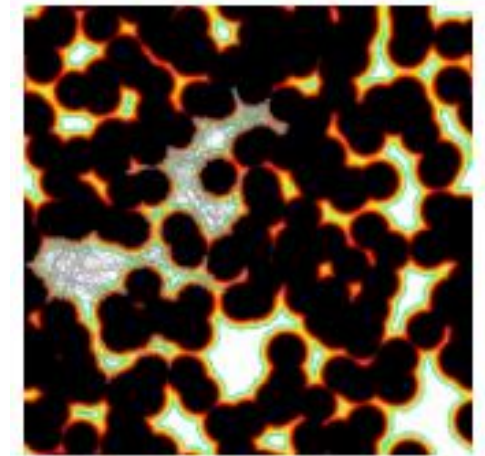
Institut für Theoretische Physik  
Universität Innsbruck

# Statistical and soft matter physics

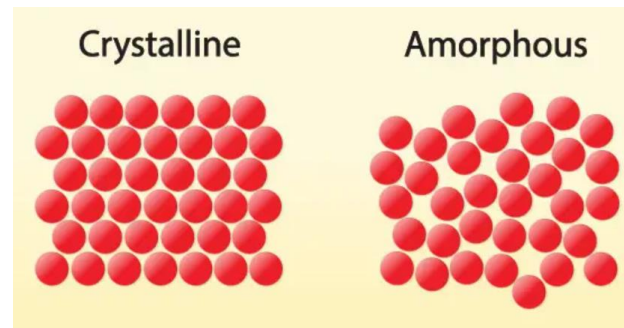
Active matter



Complex transport

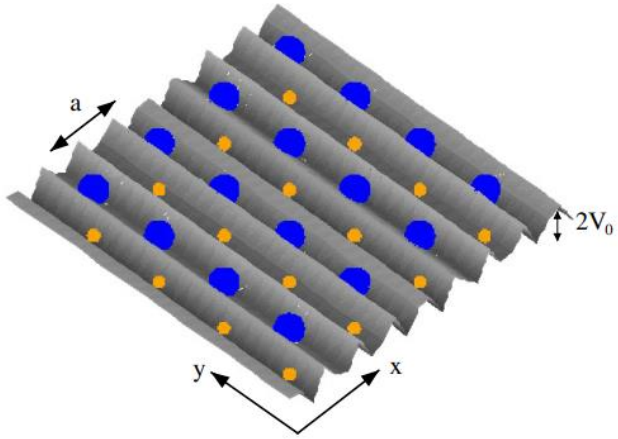


Glassy systems

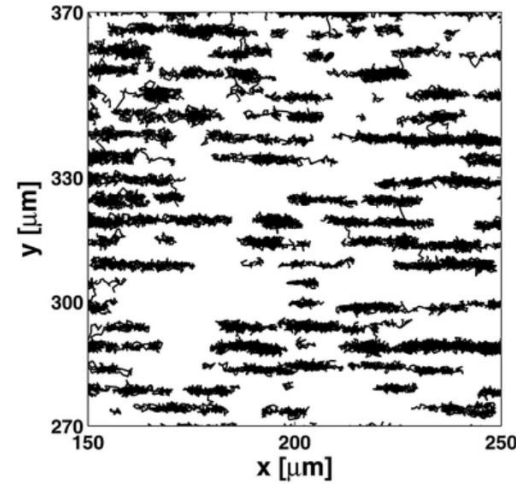


<https://futuretimeline.net/blog/2021/04/9-first-3d-atomic-imaging-amorphous-solid.htm>

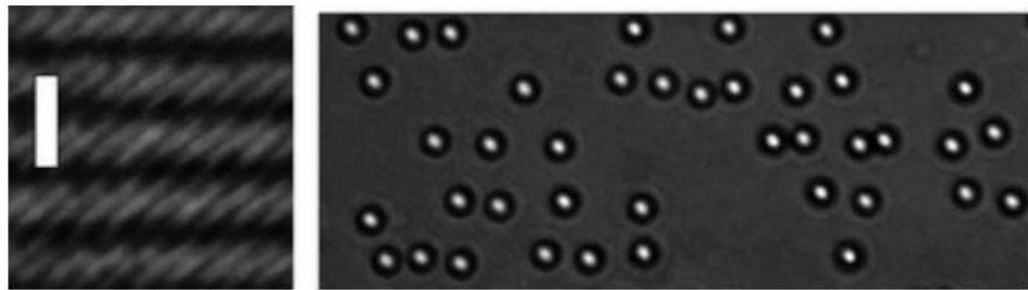
# Brownian motion in periodic systems



K. Franzrahe et al., *J. Condens. Matter Phys.* 40, 404218 (2008)



C. Dalle-Ferrier et al., *Soft Matter* 7, 2064 (2011)



C. Dalle-Ferrier et al., *Soft Matter* 7, 2064 (2011)

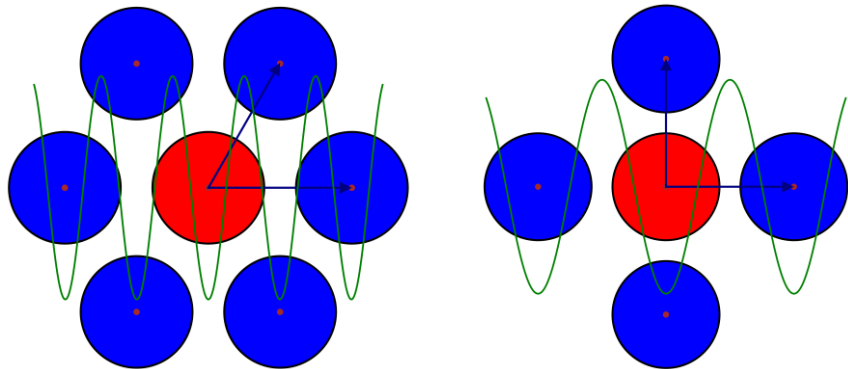
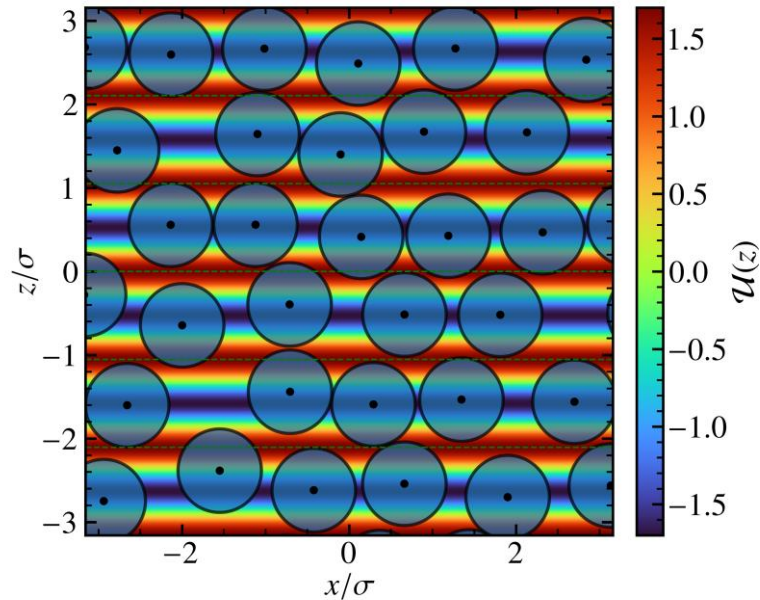
## Goal

**Single colloid dynamics in periodic potentials:** Obtaining and analyzing the probability density for displacements of fluctuating nano- and micro-particles in periodic potentials

## Learning objectives

- Getting familiar with **colloidal systems** (which can be found everywhere in our daily lives)
- Depending on the interest of the student: Learn how to apply **numerical tools, simulations, or analytic strategies** to study colloids in external potentials
- Calculating the **probability density** for a sinus potential with the chosen method

# 2D glass under external periodic modulation



## Goal

### Many-body structure formation in periodic potentials:

Exploring the mechanism by which external fields influence the glass formation using Monte Carlo simulations of hard discs

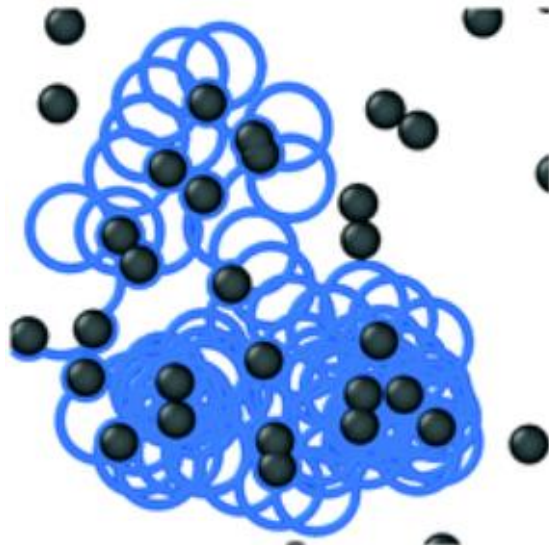
## Learning objectives

- Understanding the fundamentals of the **glass state**
- Learning how to perform **Monte Carlo simulations** of many-body systems (which have a wide range of applications in countless other fields)
- Analyze how the modulation wavelength of an external potential affects the formation and order of **particle cages** that superpose the natural arrangement of hard discs

# Hexbugs in crowded environments



<https://en.wikipedia.org/wiki/Hexbug>



*O. Chepizhko et al., Soft Matter 15, 452 (2019)*

## Goal

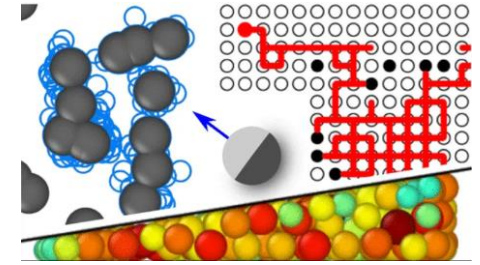
### Rod-shaped circle swimmers in random environments:

Studying the influence of random obstacles on the dynamics of „hexbug-like“ active particles

## Learning objectives

- Getting familiar with simple models for **active matter**
- Learning how to implement and perform **Brownian dynamics simulations** to obtain trajectories of active particles in many-body systems
- Characterize and interpret the motion of rod-shaped active **circle swimmers** through randomly placed obstacles

# Thank you for your attention!



BioNano-Physics



**Potential Master theses are also available in various topics**

- Glass transition
- Active particles
- Complex transport

**If you are interested,  
please just approach us!**

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