

# Rheology of elongated grains and suspensions of fibers

(TÉT-Balaton researcher exchange program 2016-2017)

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Budapest*

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Adeline Favier

*Ecole Supérieure de Physique et Chimie  
Industrielles (ESPCI)  
CNRS  
Paris*

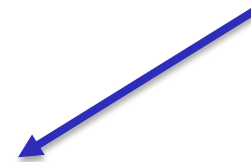
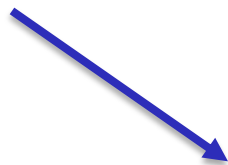
## Two laboratories with complementary expertise

Budapest

*experiments with **elongated particles**,  
discrete element **simulations** of granular flows*

Paris

*studies on the **rheology** of suspensions and  
granular materials*



**Rheology of elongated particles using numerical simulations**

# Flow of elongated objects at various length scales

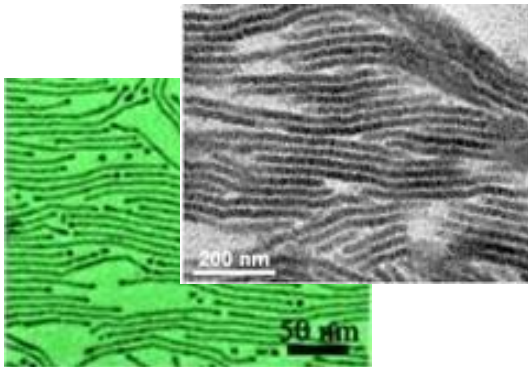
granular materials



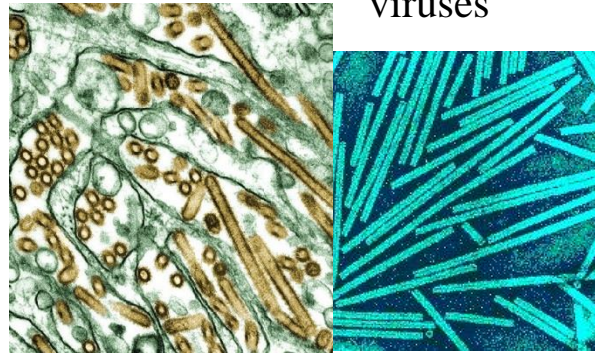
bacteria



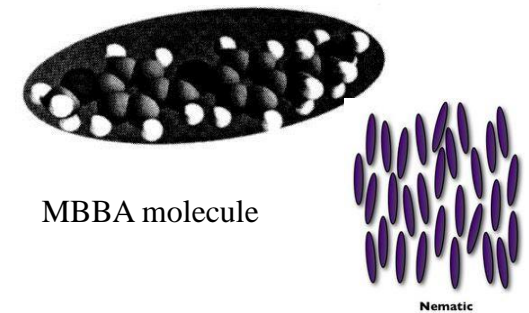
nanorods, nanowires



viruses



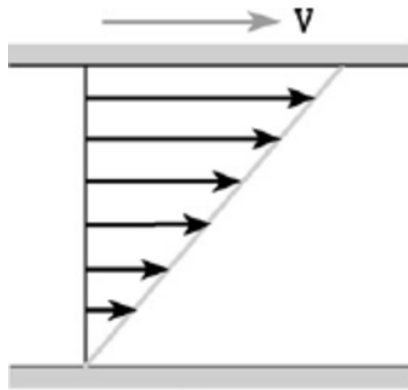
nematic liquid crystals



MBBA molecule

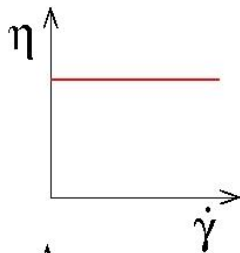
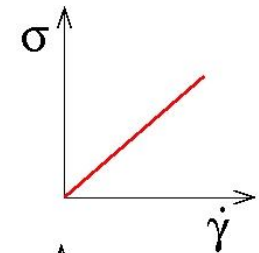
Nematic

# Rheology

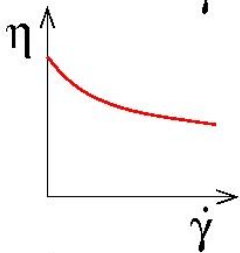
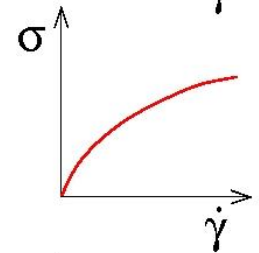


Shear rate:  $\dot{\gamma}$

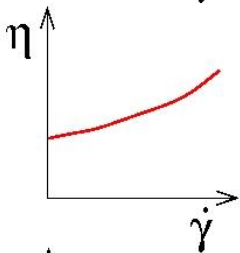
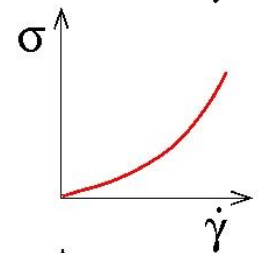
Viscosity:  $\eta$



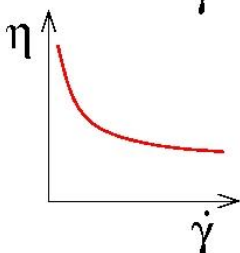
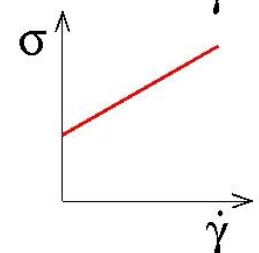
Newtonian: water, oil



Shear thinning:  
polymer solutions, paints



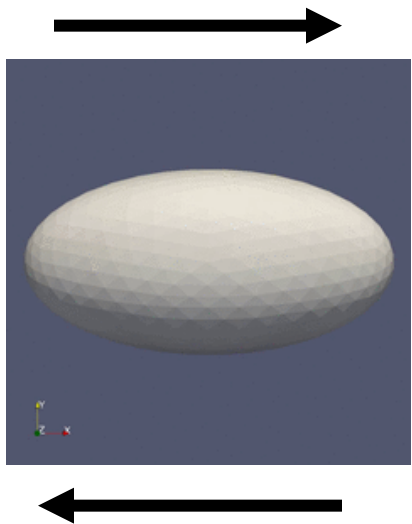
Shear thickening:  
resins, dense suspensions



Bingham plastic: toothpaste, mayonnaise

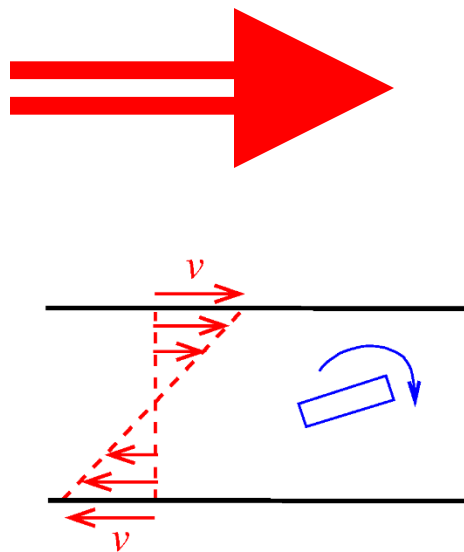


# Single ellipsoid in a liquid under shear

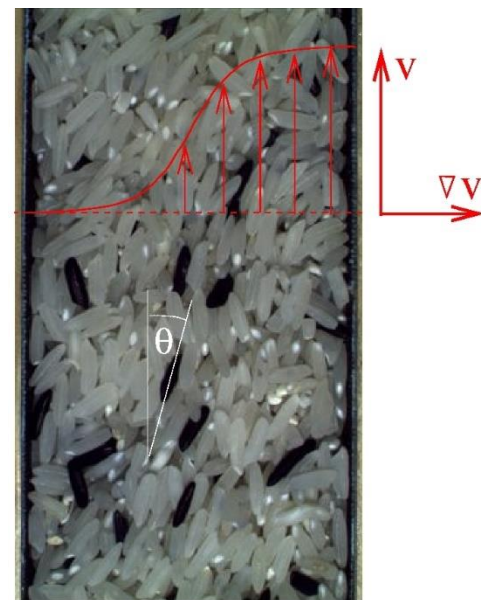


*Jeffery,*  
1922

*D. Das*

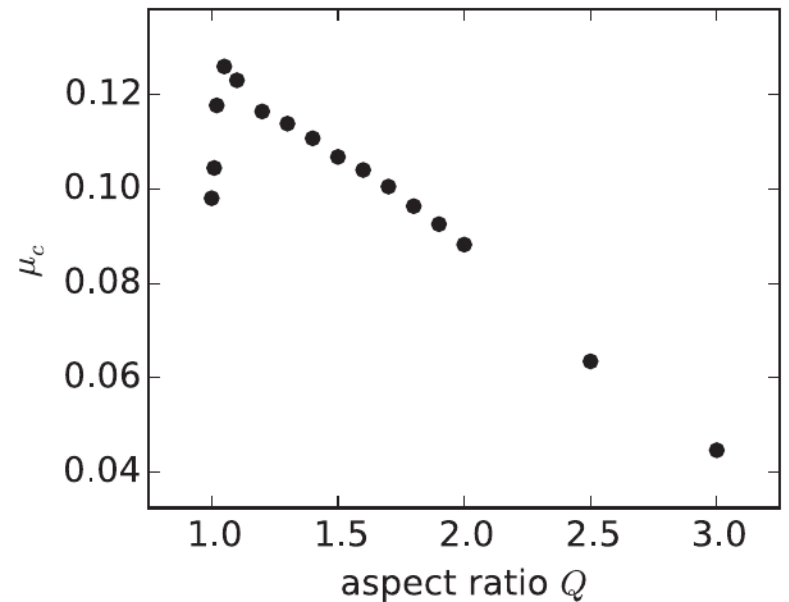
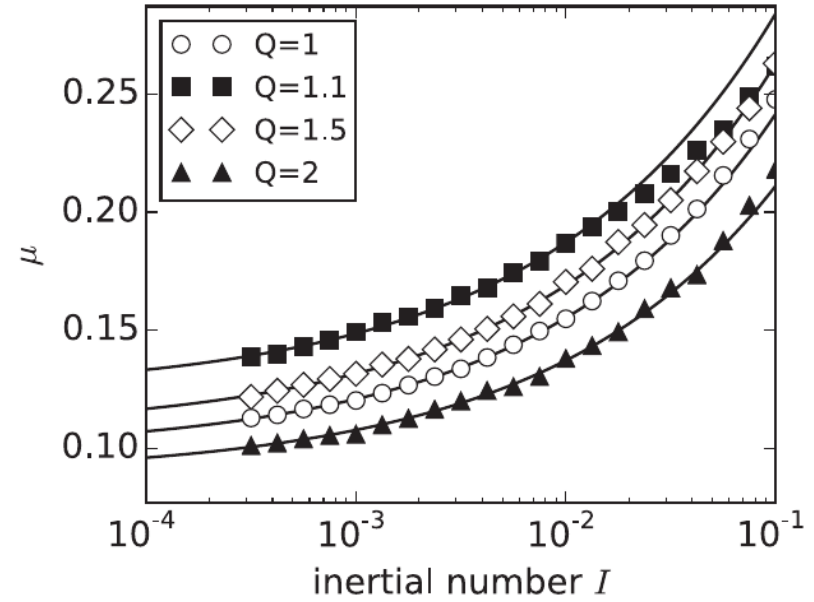
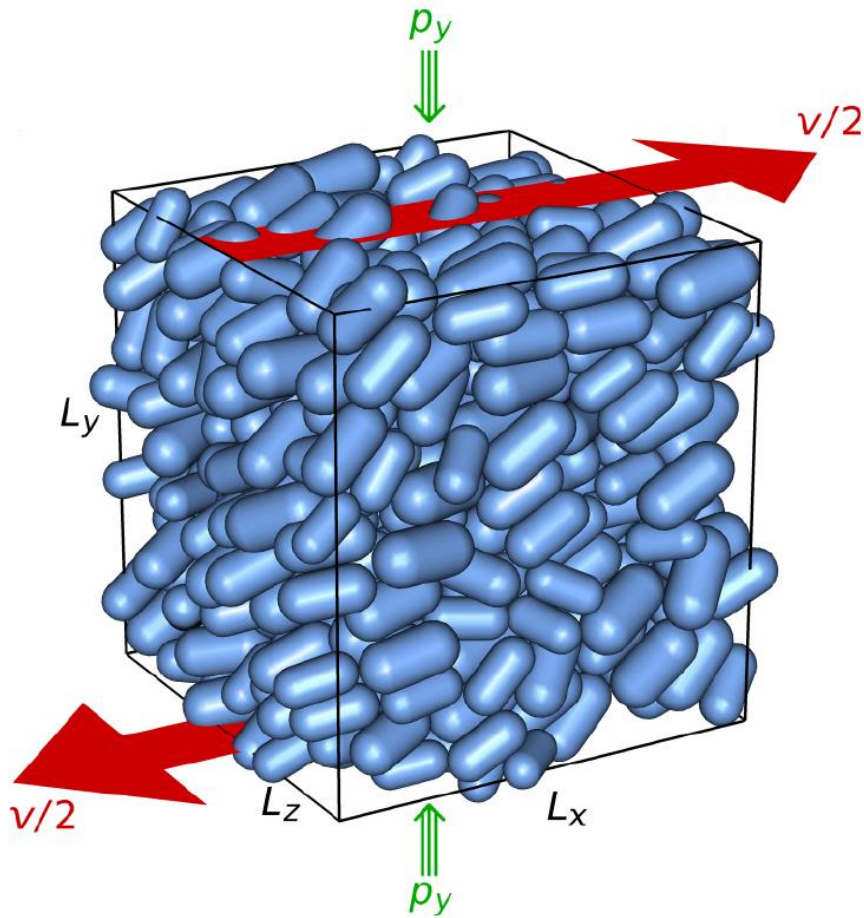


# Granular shear flow



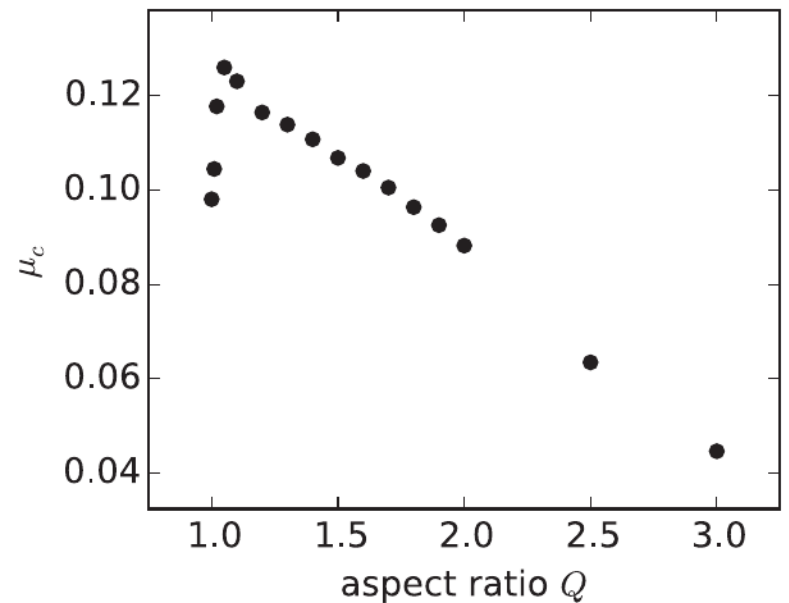
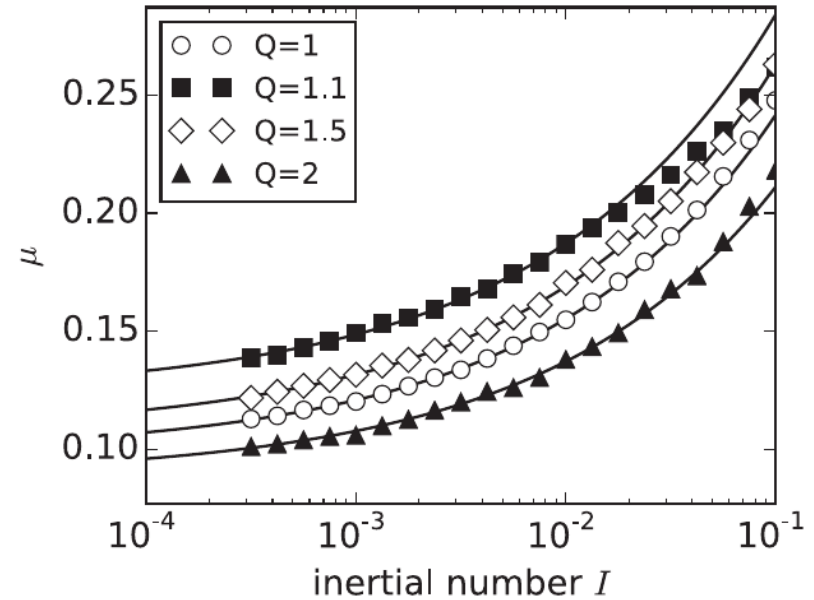
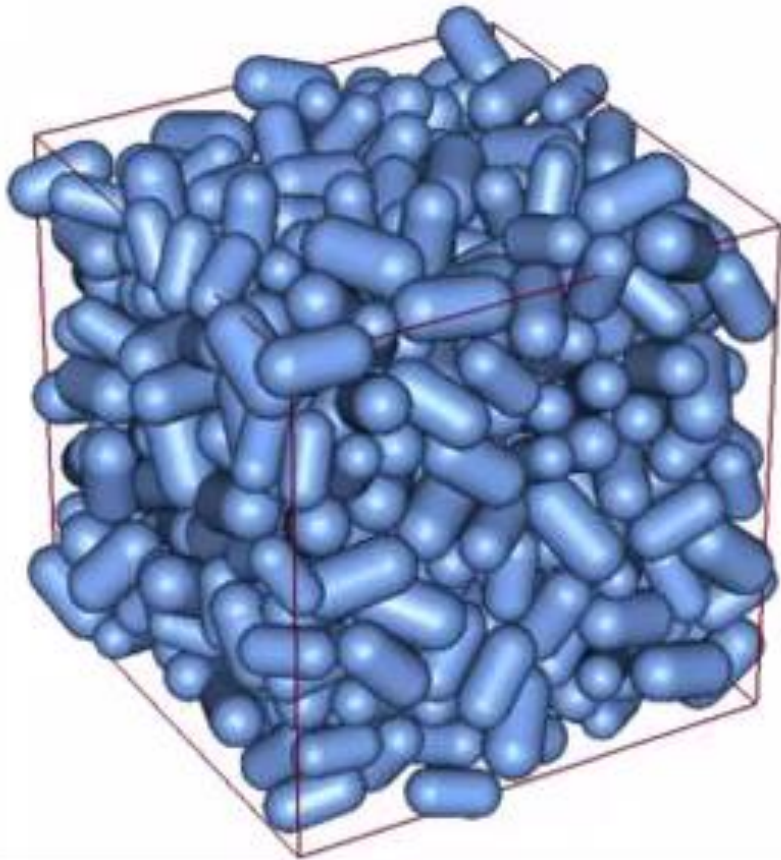
Börsönyi et al. [PRL 2012](#), [PRE 2012](#), [Soft Matter 2013](#)

# Some results of the project



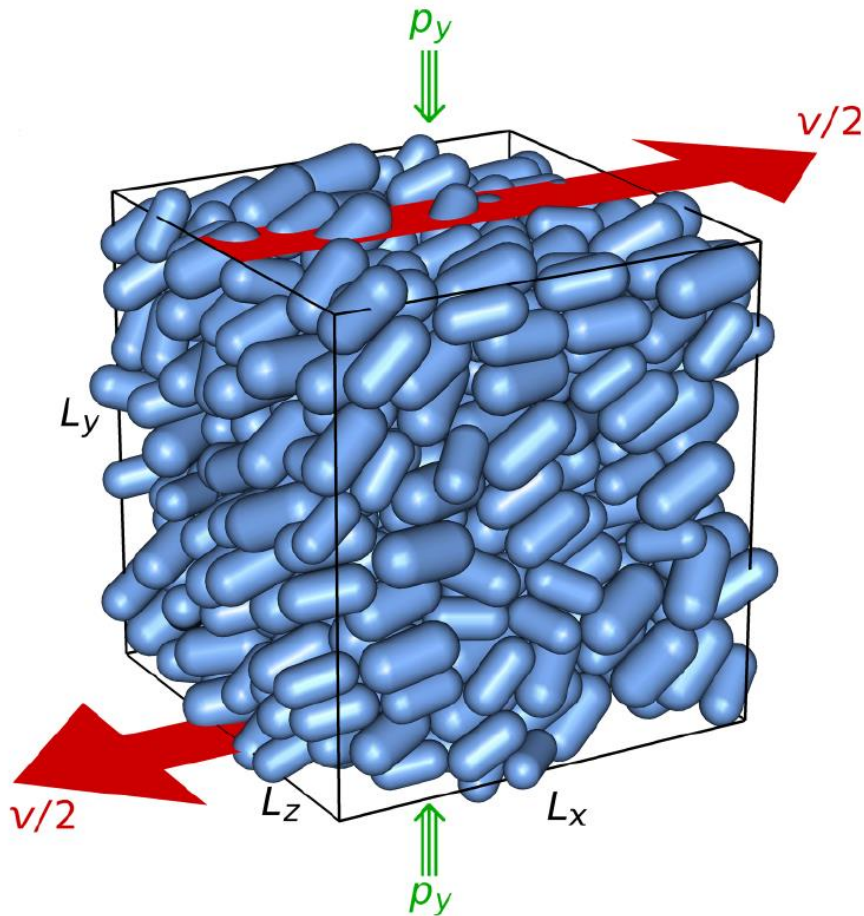
- ▶ 2 publications:
  - ▶ Nagy, Claudin, Börzsönyi, Somfai, Phys. Rev. E (2017)
  - ▶ Somfai, Nagy, Claudin, et. al., EPJ Web Conf. (2017)
- ▶ 2 conference presentations:
  - ▶ Statistical Physics Day, Budapest April 2017.
  - ▶ DPG Spring Meeting, Berlin March 2018.

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# Continuation of the collaboration



Dániel Nagy

MSc Student

(2016-2017)



Co-tutelle

PhD Student

(2017 – 2021)

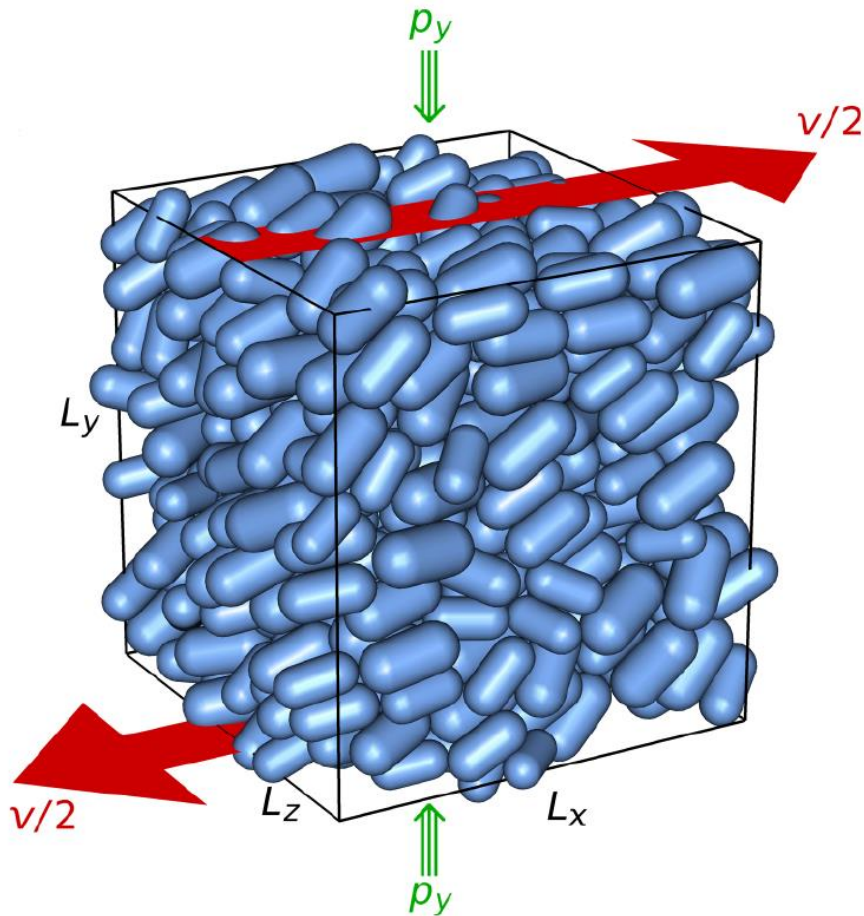
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MSc Student



PhD Student

(2016-2017)

(2017 – 2021)

## New proposals:

MTA-PICS –bilateral (submitted)

EU H2020 Marie Curie ITN  
(to be submitted)

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# Viscosity of nanorod suspensions as a function of shear rate

rheology measurements: Anton Paar MCR 502 rheometer

