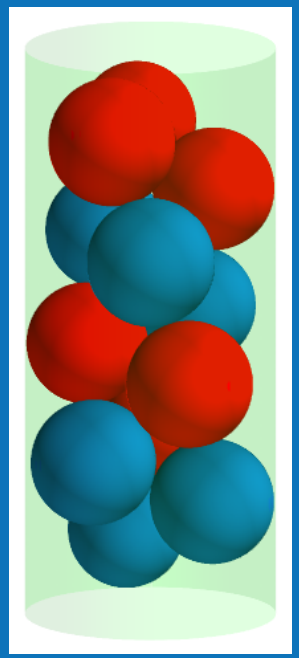
Coláiste na Tríonóide, Baile Átha Cliath
Trinity College Dublin
Ollscoil Átha Cliath | The University of Dublin

Columnar structures: Packing spheres into cylinders



March 30, 2019 | Jens Winkelmann

Co-authors: A. Mughal, D. Weaire and S. Hutzler

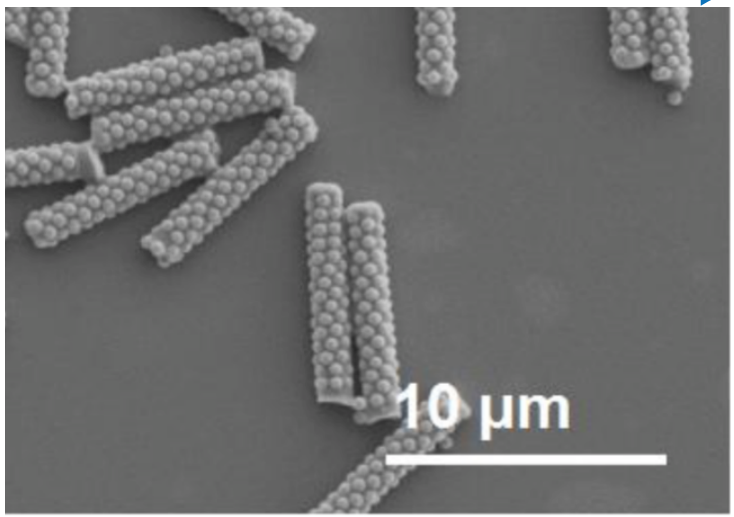
"Packing and stacking
we lay waste our days!"

Ordered columnar structure: Appearance from cm to nm!

cm → μm → nm

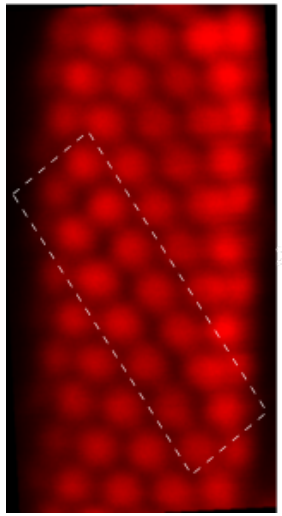
Bushy Park, Dublin

Foam



Micro-rods

Wu *et al.*; J Am Chem Soc 139, 5095–5101 (2017)



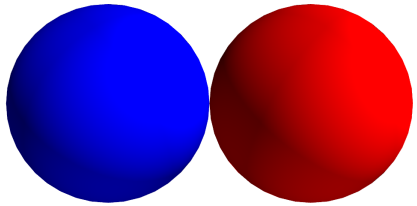
Optical metamaterial

Tanjeem *et al.*(**Harvard**); Bull Am Phys Soc (2018)

Who ordered this?

Simulation: Packing *soft* spheres into cylinders

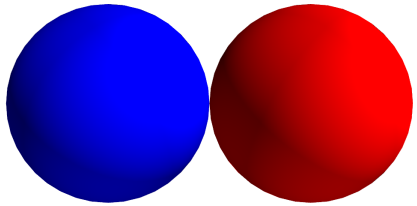
No overlap!



Hard spheres

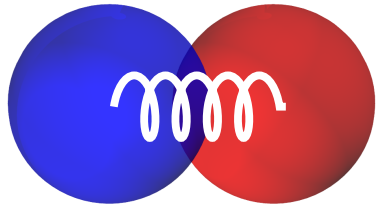
Simulation: Packing *soft* spheres into cylinders

No overlap!



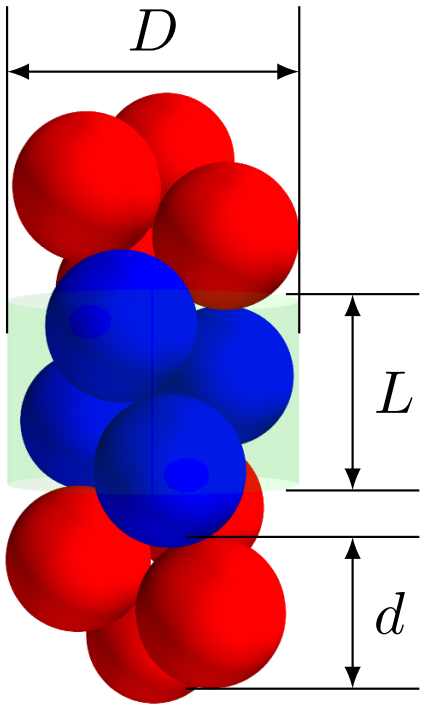
Hard spheres

$U(\delta_{ij}) \propto$ overlap δ_{ij}^2



Soft spheres

Simulation: Packing *soft* spheres into cylinders



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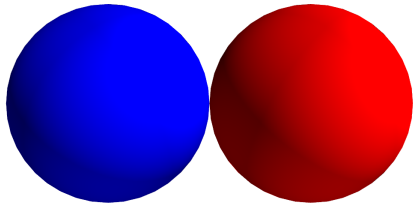

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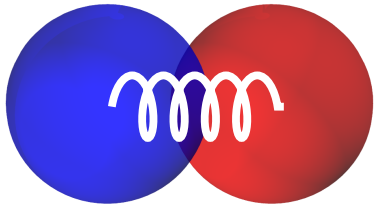


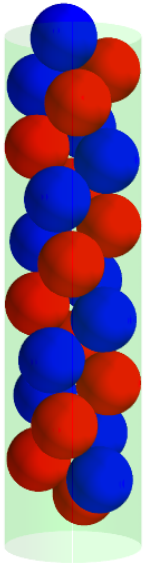
Soft spheres

- Generate structure at const pressure p

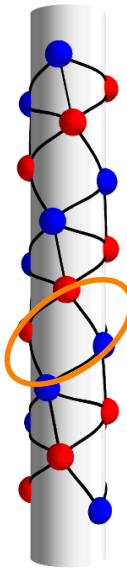
$$\text{Enthalpy } H = \underbrace{U(\delta_{ij})}_{\text{internal energy}} + \underbrace{pV}_{\text{pressure x volume term}}$$

Enthalpy minimisation

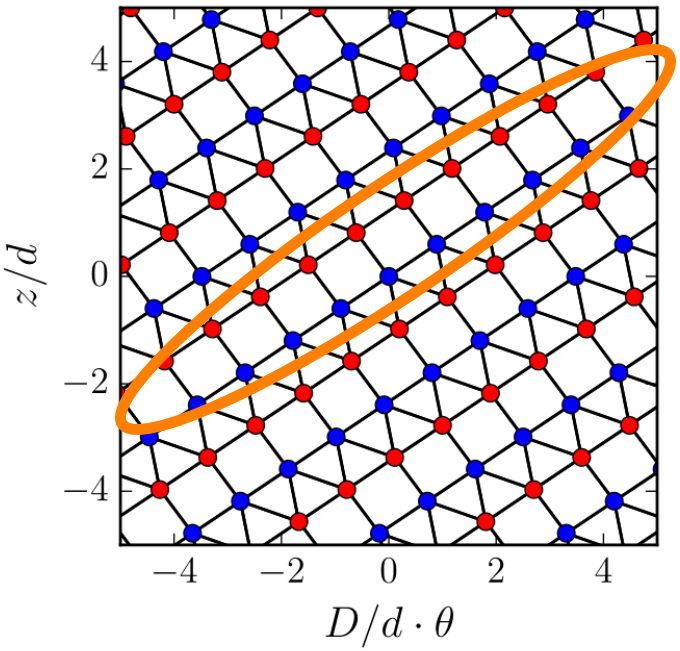
What is a *line-slip* structure?



line-slip packing



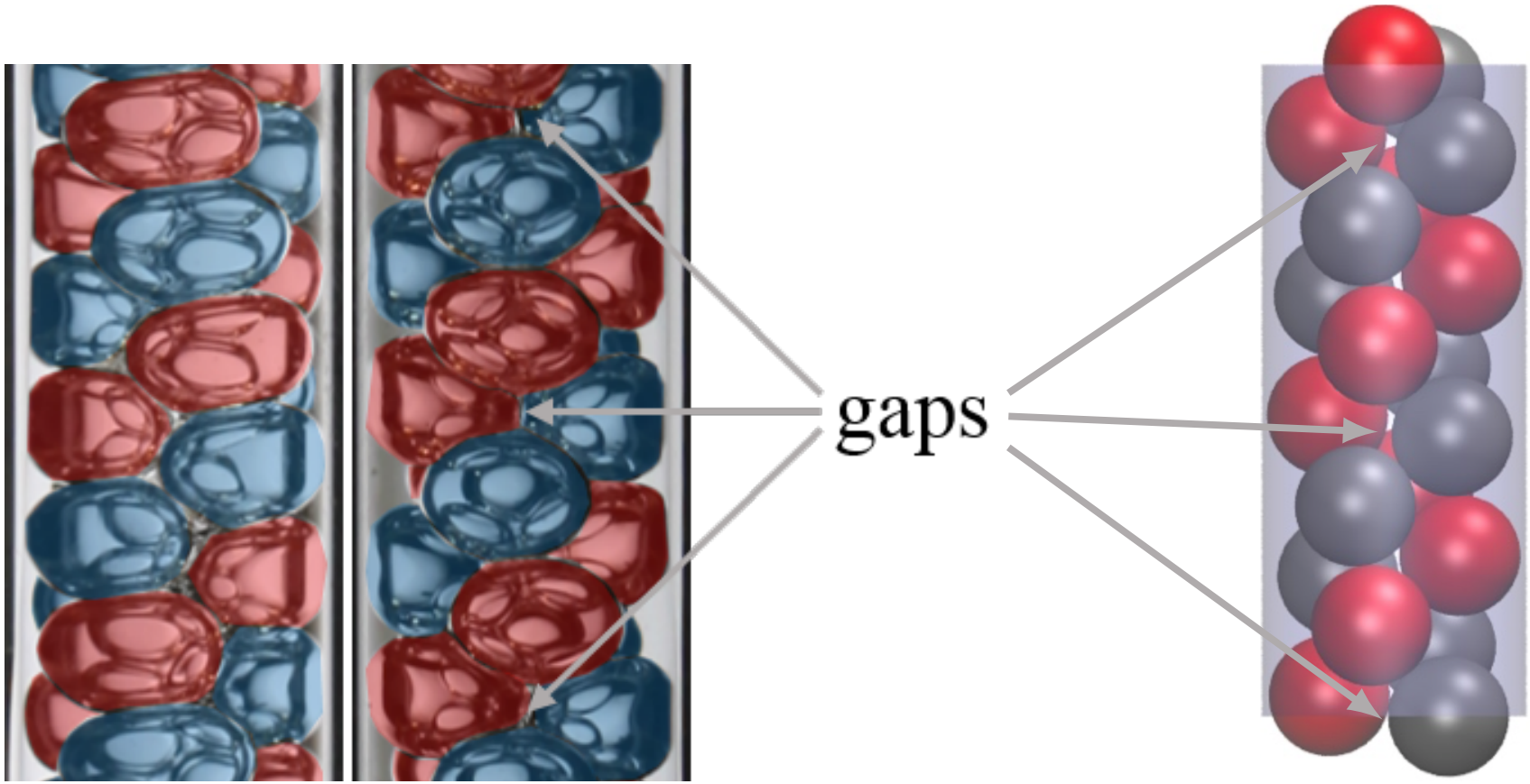
Contact network



Rolled-out network

- Line slip is adjustable with pressure/compression
- For microrods: Stiffness/conductivity are adjustable by compression

Experimental *line slip* in a foam



[0]Winkelmann et al; *Simulation and observation of line-slip structures in columnar structures of soft spheres*; Phys Rev E 97, 059902 (2017)

https://www.maths.tcd.ie/~jwinkelm

- Twitter handle: @WinmanJ
- Google scholar
- Researchgate