

The background of the slide is a high-magnification fluorescence microscopy image showing numerous chains of small, bright, spherical droplets. These droplets are arranged in a complex, self-organized pattern, with many chains exhibiting a central void or a specific internal structure. The droplets appear to be interconnected, forming a network of interconnected paths. The overall appearance is that of a dynamic, self-organizing system of active particles.

Self-organized dynamics of freely-jointed active droplet chains

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Why are we interested in active assemblies (molecules, superstructures)?

□ Active molecules:



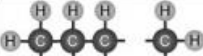


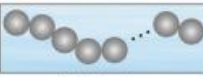



{Theories for nonequilibrium systems will be challenged- dynamical density functional theory (*J. Chem. Phys.* **2016**, *144*,024115) or mode coupling theory (*Phys. Rev. E* **2016**, *93*,012603). These theoretical approaches need to be generalized or completely newly founded if activity comes into play}.

□ Active polymers - Activity driven non-equilibrium fluctuations and conformation changes in polymeric or filamentous structures:

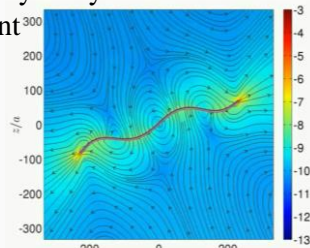
{New physics arises if the background medium is changed towards a complex fluid which can be viscoelastic (*Phys. Rev. Lett.* **2016**, *116*,138301), or if the background itself is another kind of soft matter}.

Broadly: Activity driven folding- inspired by the protein folding

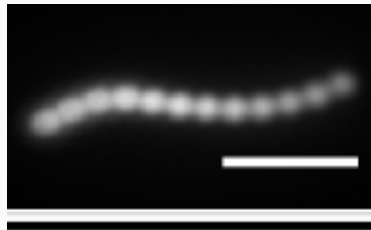
<https://www.dc.fi.udc.es/ai/~santos/proteins/proteins.html>

| | homonuclear | heteronuclear | polymeric |
|----------------------------|--|--|---|
| molecules |  O ₂ O ₃ oxygen ozone |  H ₂ O water |  C _n H _{2n+2} polymer |
| colloidal molecules |  dumbbell colloidal ozone |  colloidal water |  colloidal polymer |
| active colloidal molecules |  propeller spinner |  with active components with passive components |  active colloidal polymer |

Brownian microhydrodynamics
of active filament



Soft Matter **2015**, *11*,9073

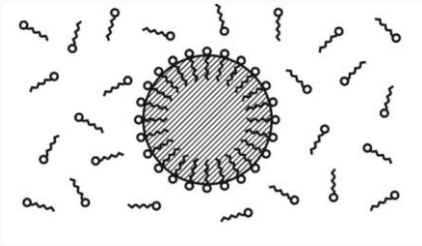


ACS Nano **2017**, *11*(10)

EPL **2018**, *121*,58001

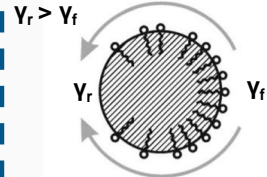
Oil droplet microswimmer – A building-block for active self-assembly

Oil-in-water system

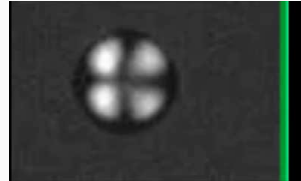


Conc. < CMC

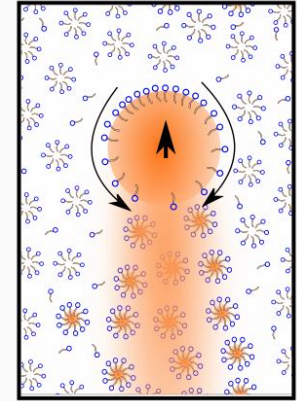
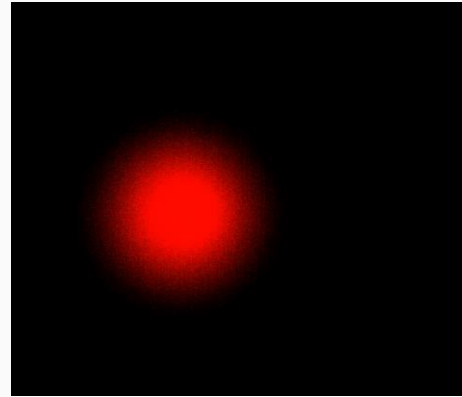
Marangoni flows



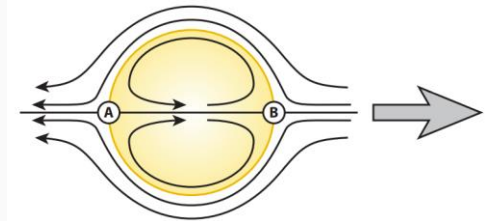
Conc. \gg CMC



PNAS 2018 115 (21) 5403



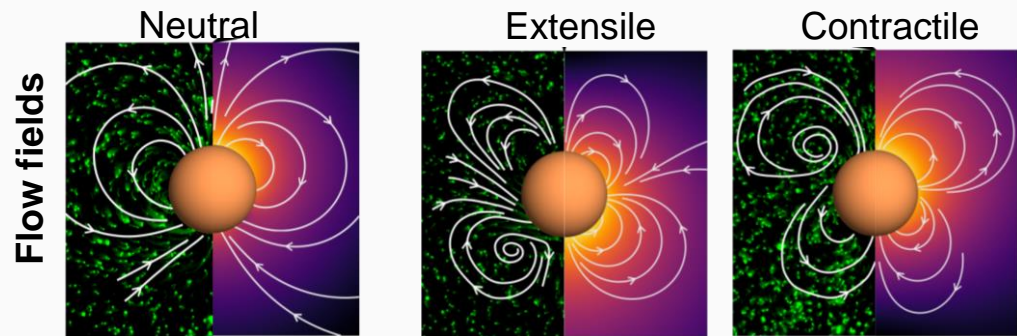
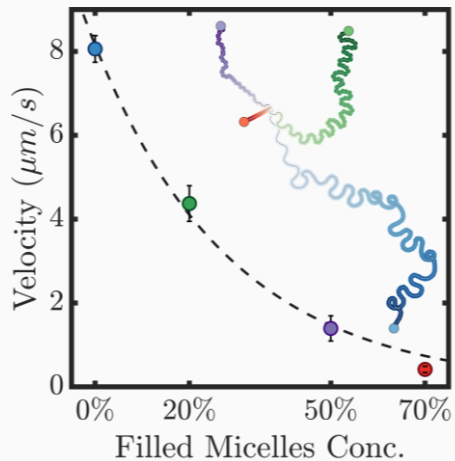
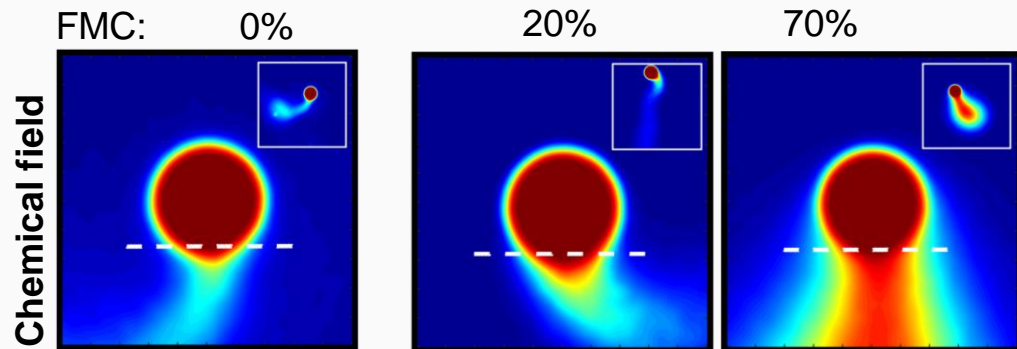
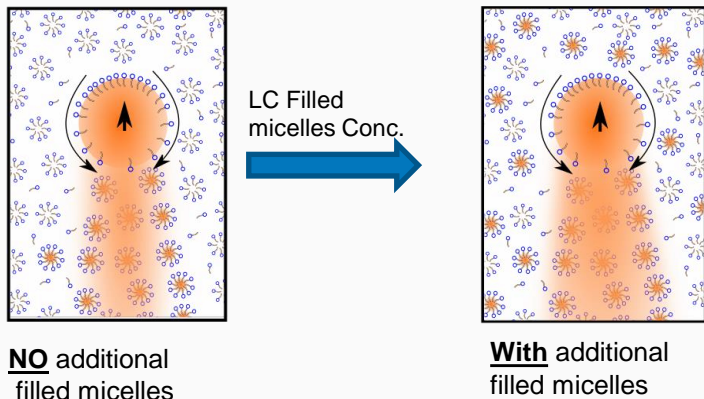
SDS, 25%



Hydrodynamic field

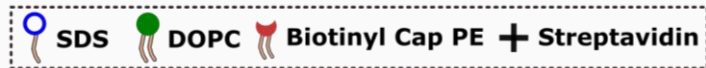
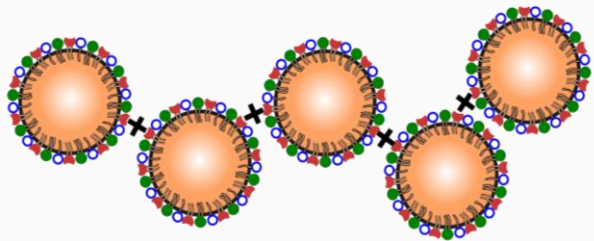
Self-sustained conc.
gradient between filled
and empty micelles

Tuning the slip velocity modulates the droplet flow fields

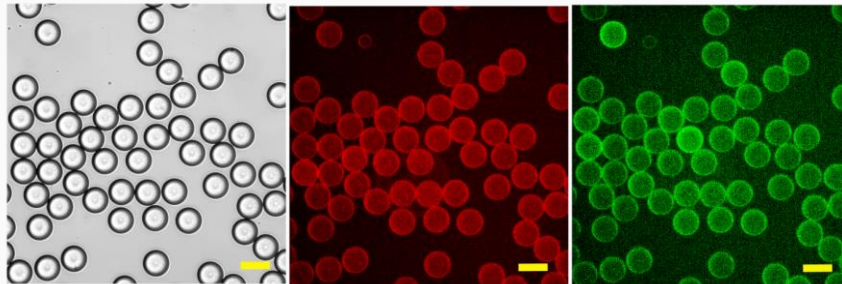


Formation of freely-jointed chains of droplet swimmer

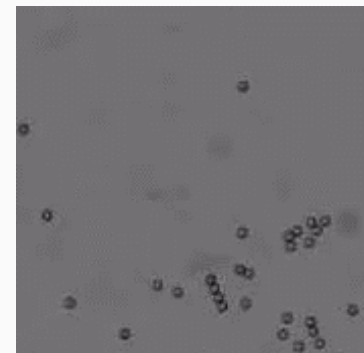
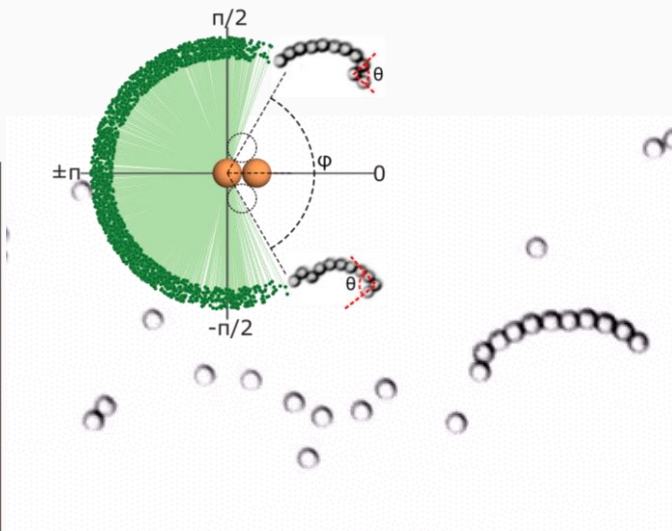
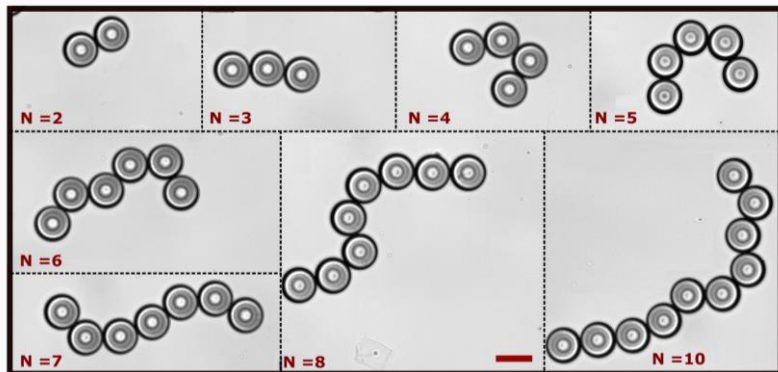
Scheme for making assemblies



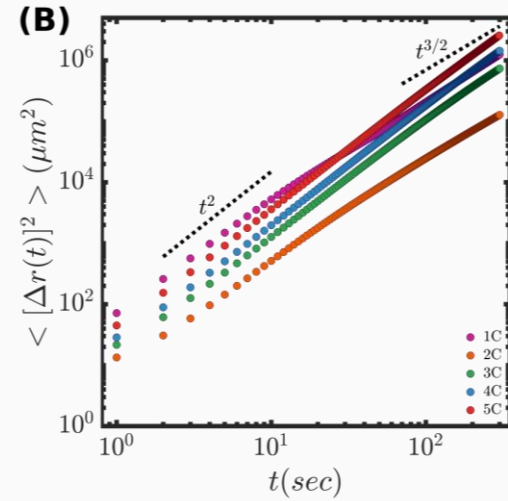
Uniform size droplets, produced using Microfluidics



Linear assemblies (Chains)

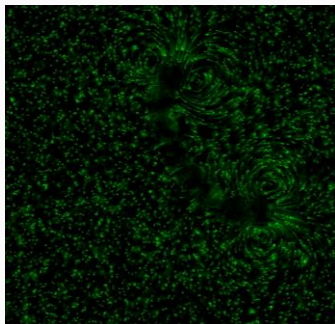


Dynamics of freely-jointed chains of droplet microswimmer

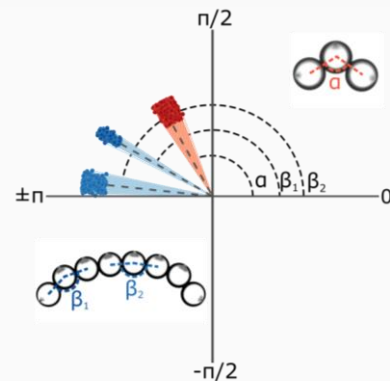
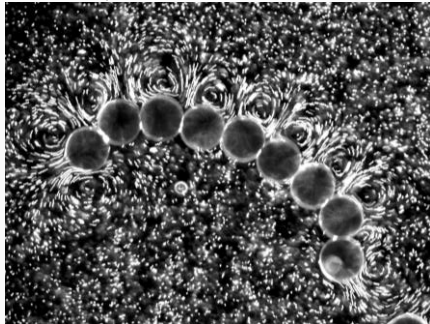


Dynamics of freely-jointed chains with and without LC filled micelles

FMC, 0%



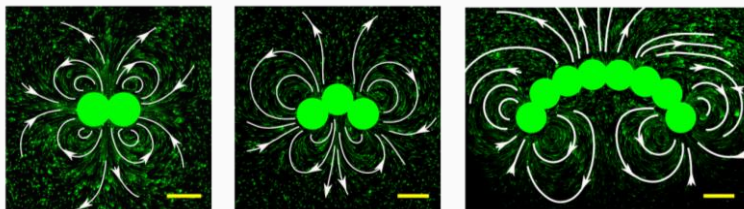
FMC, 70%



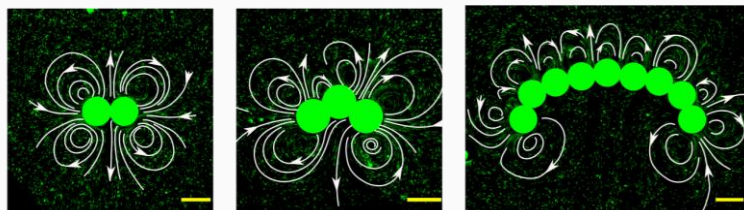
FMC

Flow fields

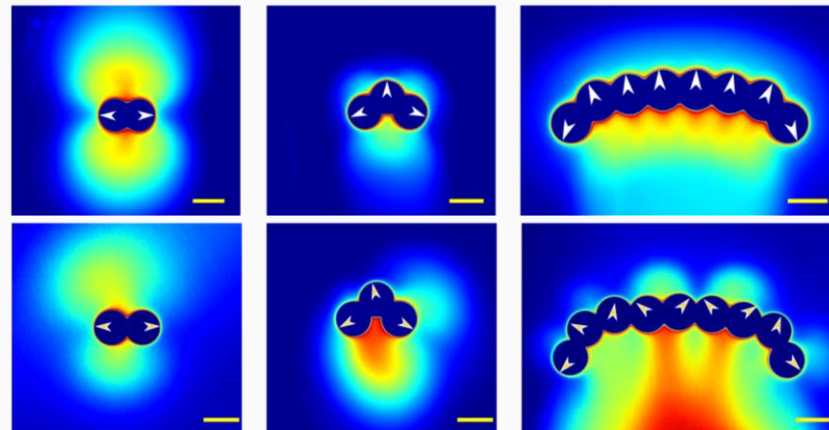
0%



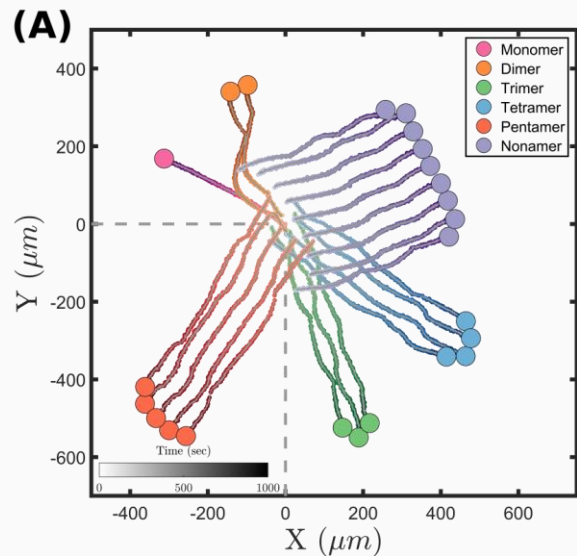
70%



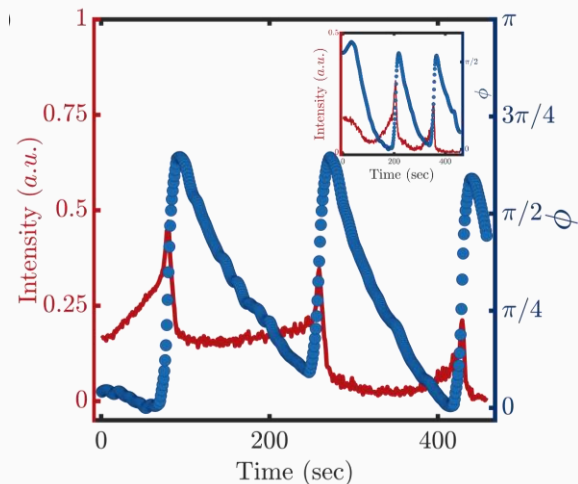
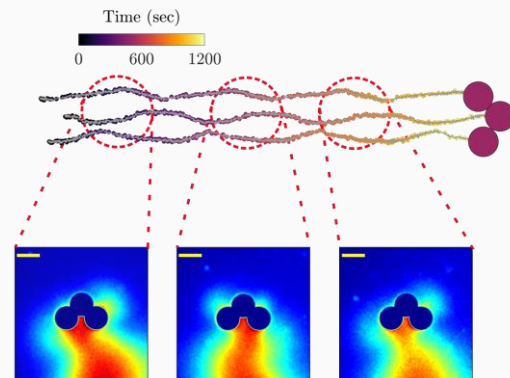
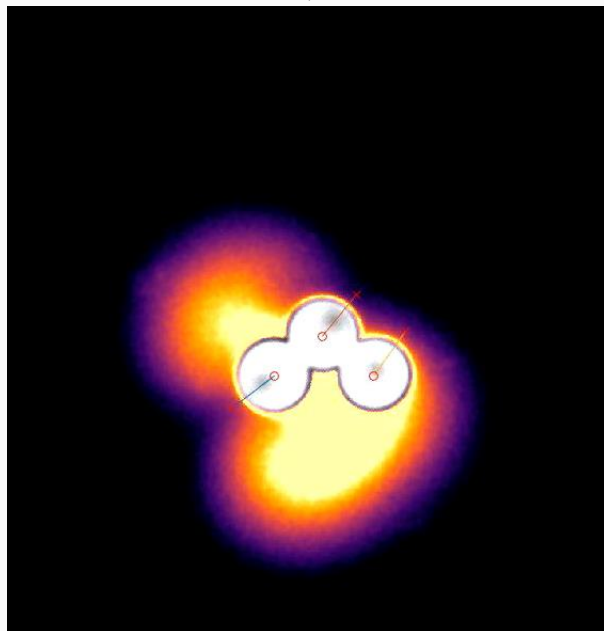
Chemical field



Oscillatory dynamics of the chain dictated by self-generated chemical field



FMC, 70%

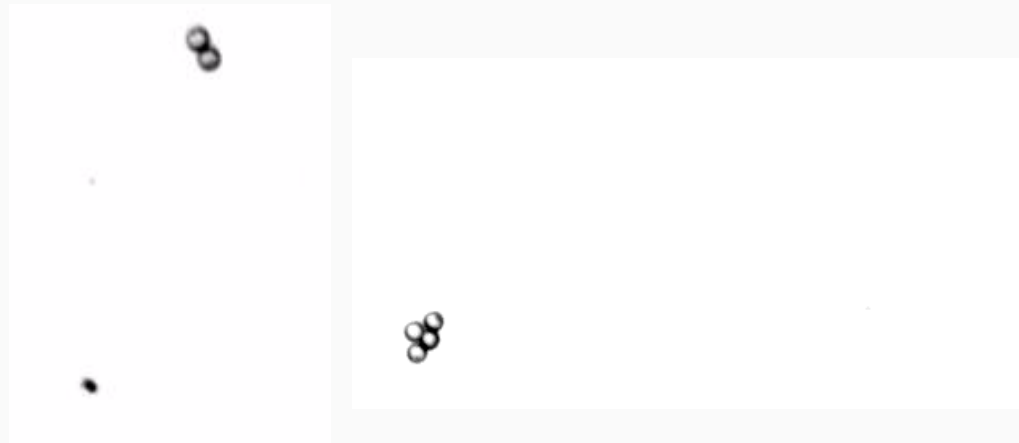
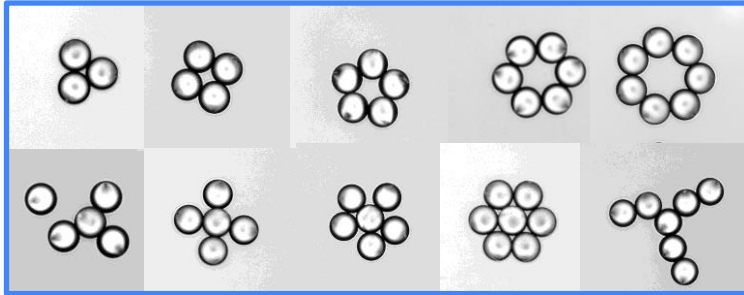


In Summary:

- ❑ We form freely-jointed chains of active droplets which can propel- normal to their body axis and along their body axis.
- ❑ Tuning of the slip velocity (monomer and linear assemblies) by controlling the self-sustained concentration gradient.
- ❑ Hydrodynamic and chemical fields shape each other.
- ❑ Oscillatory dynamics of the active droplet chains

Teaser and Other prospects of this work

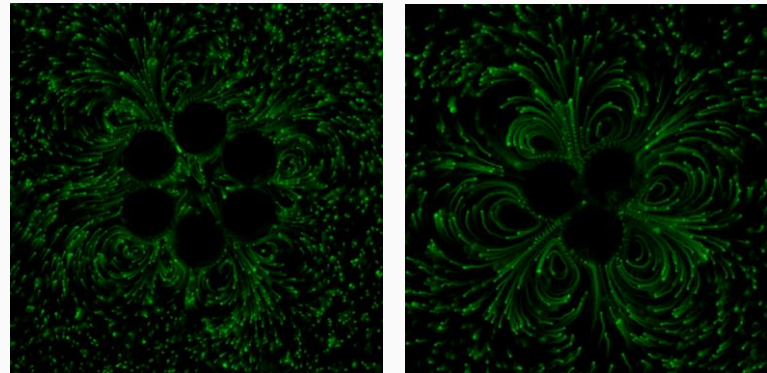
Closed and branched assemblies assemblies



Dynamics



Flow field



Questions

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Thank You..