

INVESTIGATING SOFT MATTER WITH OPTICAL METHODS

Irena Drevenšek-Olenik

Research group “Light and Matter”

*J. Stefan Institute, Department of Complex Matter, Ljubljana
and University of Ljubljana, Faculty of Mathematics and Physics*



University of Ljubljana
Faculty of *Mathematics and Physics*

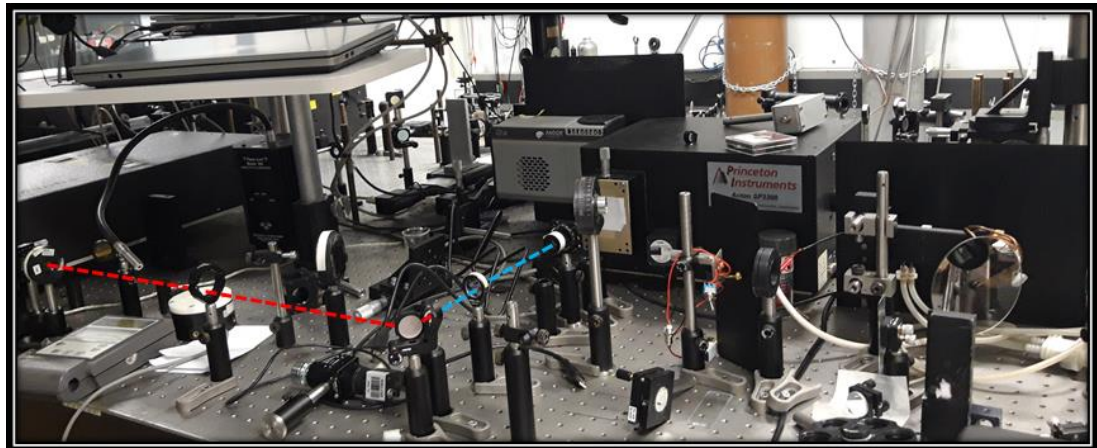


Martin ČOPIČ
Marko ZGONIK

Boris MAJARON
Alenka MERTELJ
Mojca VILFAN
Lea SPINDLER
Natan OSTERMAN

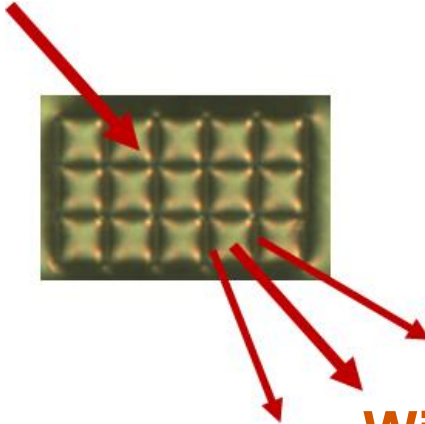
Andrej PETELIN
Nerea SEBASTIAN UGARTECHE
Luka CMOK

Matjaž LIČEN
Patricija HRIBAR BOŠTJANČIČ
Žiga GREGORIN

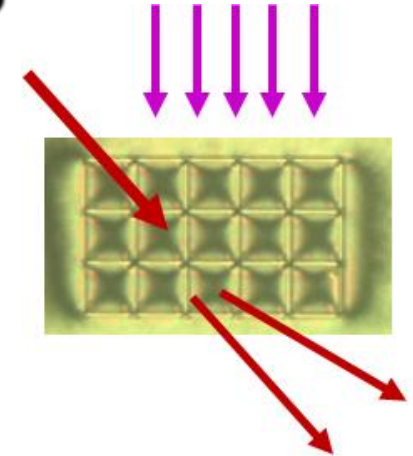


WHAT DO WE DO ?

Investigate
matter with light



Influence and
manipulate
matter with light



What kind of matter?

- Magnetic soft matter
- Liquid crystalline materials
- Polymers and elastomers
- Colloidal systems
- (Bio)molecular solutions
- Biological materials

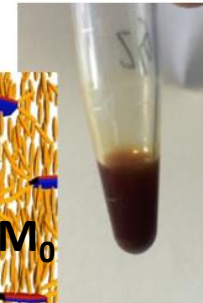
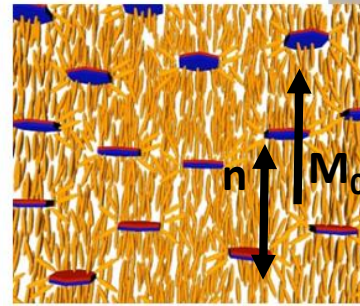
With what kind of methods?

- Polarization optical (video)microscopy (POM)
- Dynamic light scattering (DLS) and differential dynamic microscopy (DDM)
- Measurements of electrooptic, magneto optic, elastooptic, opto-optic and similar responses
- Optical diffraction measurements
- Various spectroscopy methods (*fluorescence spectroscopy, diffuse reflectance spectroscopy, UV-VIS spectroscopy, Raman spectroscopy*)
- Manipulation with optical and magnetic tweezers
- Spectroscopic ellipsometry and Brewster angle microscopy
- Nonlinear optical methods (*SHG microscopy and spectroscopy, IR-VIS SFG spectroscopy, DFWM*)
- Photothermal radiometry
- Various non-optical methods (SEM, AFM, dielectric spectroscopy, etc.)

MAGNETIC SOFT MATTER

- **Ferromagnetic liquid crystals**

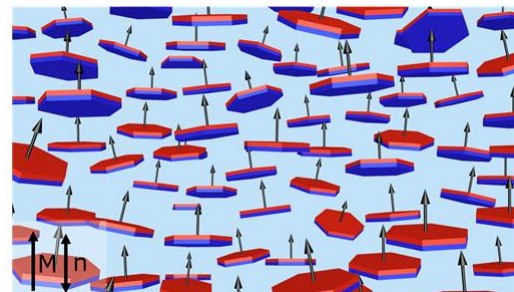
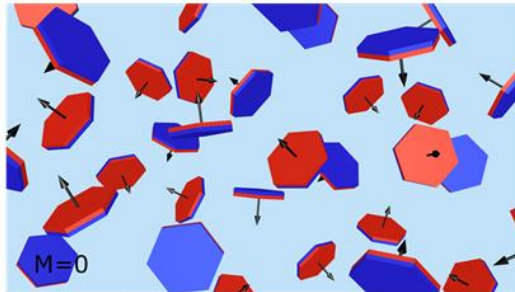
(J. Brence et al., *Soft Matter*, **15**, 8758 (2019))



Manipulation with
mT B-fields

- **Magnetic colloidal systems**

(P. Boštjančič et al., *J. Phys. Chem. C*, **37**, 23272 (2019))

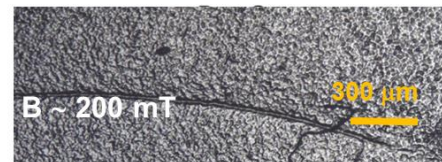
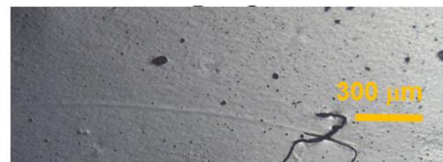
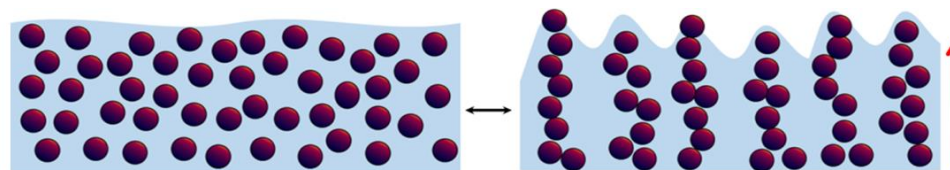


BHF nanoplatelets

Ferromagnetic
ferrofluid

- **Magneto-active elastomers**

(G. Glavan et al., *Polymers*, **11**, 594 (2019))

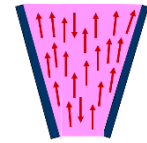
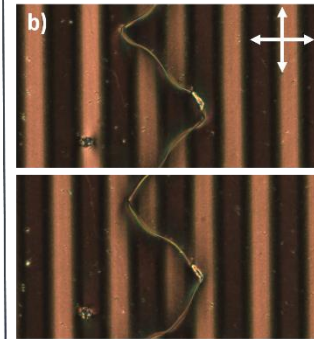
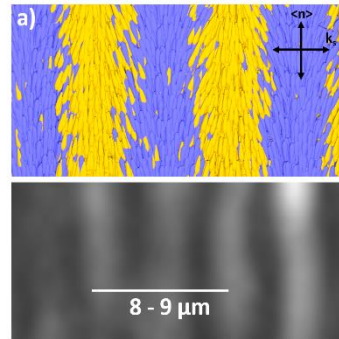


Magnetically
tunable surface
roughness

LIQUID CRYSTALS (LCs) and related

- **New liquid crystalline phases** (ferroelectric nematic phase, splay nematic phase)

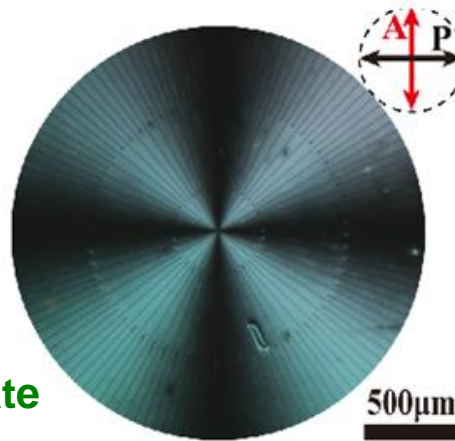
(N. Sebastián et al., *Phys. Rev. Lett.* **124**, 037801 (2020))



EO switching in polar splay nematic phase

- **Composite systems based on LCs and polymers**

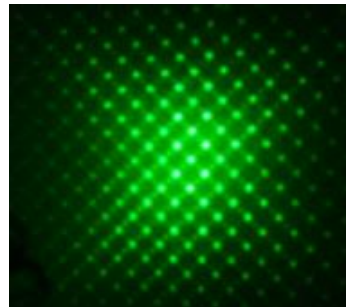
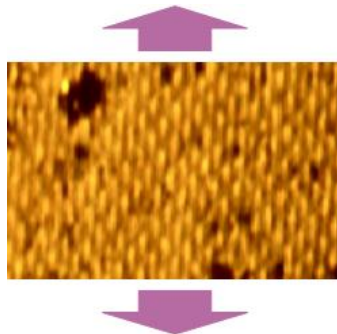
(M. Fleisch et al., *Liq. Cryst.*, **46**, 2075 (2019))



LC q-plate

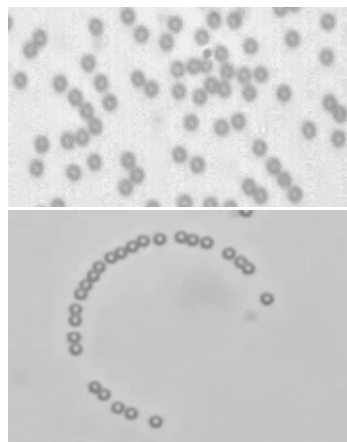
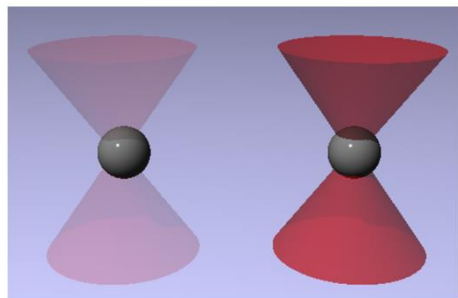
Electrically and magnetically switchable diffractive optical elements (DOEs)

- **Liquid crystalline elastomers** (D. Bošnjaković et al., *Appl. Sci.*, **46**, 1330 (2018))



Mechanically stretchable optical grating structures

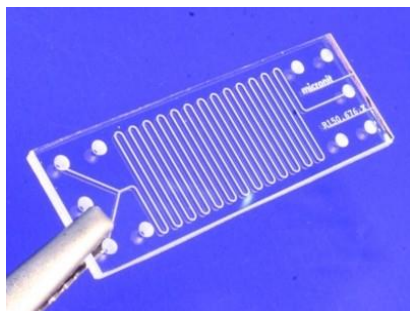
COLLOIDAL SYSTEMS



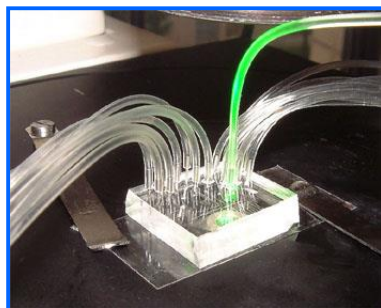
- Manipulation of particles and LCs with optical and/or magnetic tweezers

(T. Emeršič et al., *Sci. Adv.*, **5**, eaav4283 (2019))

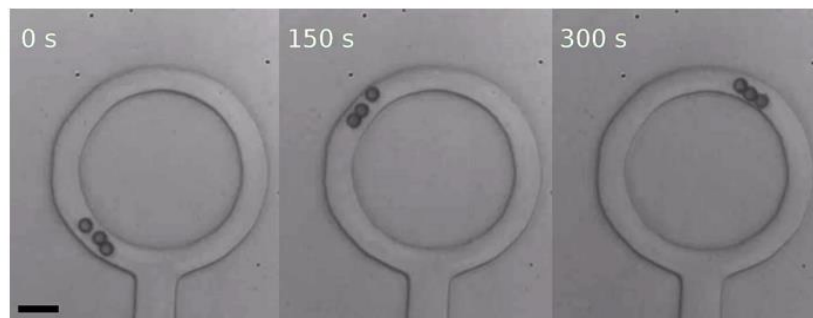
- Fabrication of microfluidic assemblies and manipulation of particles and LCs in microfluidic channels



Laser Lithography

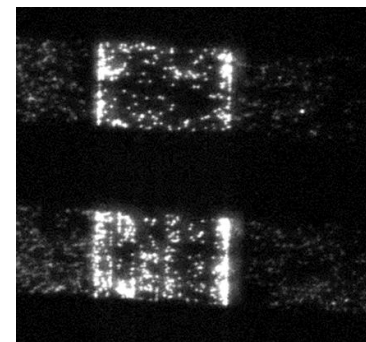
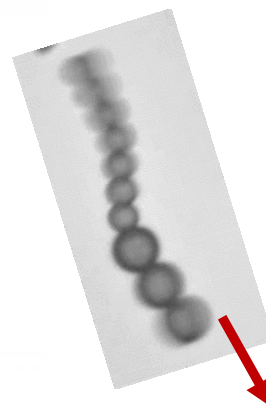
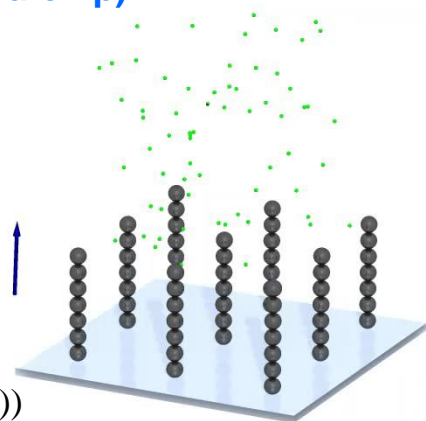


(lab-on-a chip)

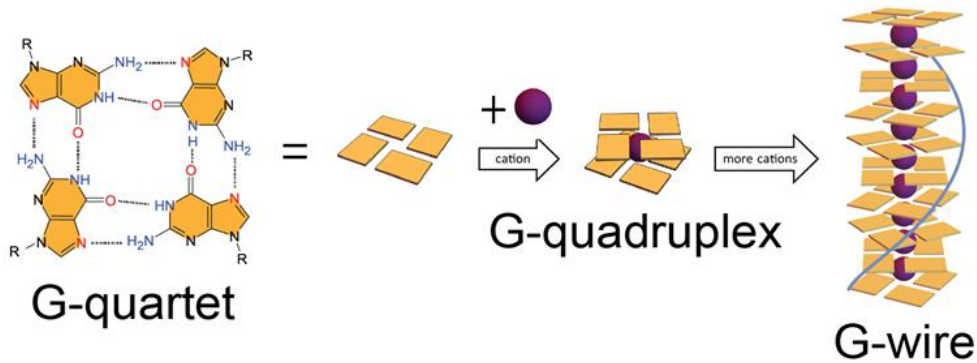


- Locomotion at low Reynolds numbers, biomimetic systems, microrheology, thermophoresis, etc.

(M. Vilfan et al., *Soft Matter*, **14**, 3415 (2018))



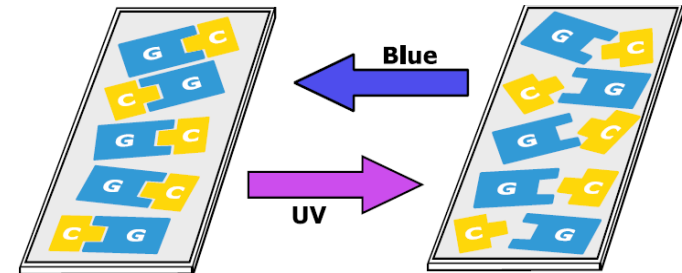
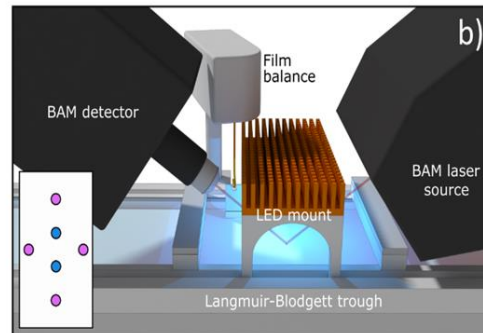
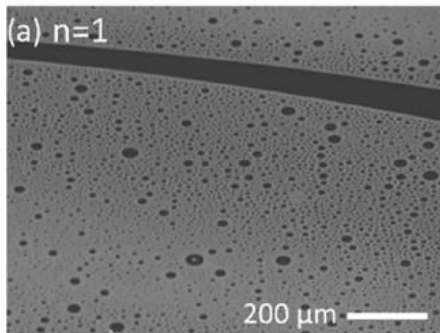
BIOMOLECULAR MATERIALS



- **Formation and aggregation of non-canonical DNA structures in solution (*G*-quadruplexes)**

(D. Pavc et al., *Nucleic Acids Res.*, in press (2020))

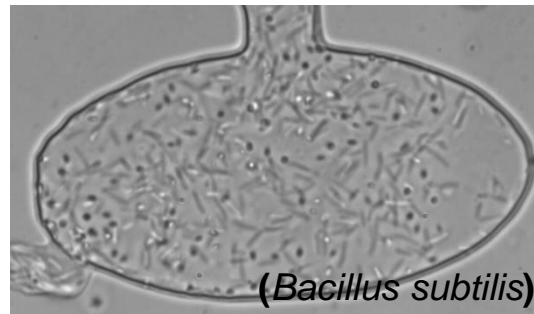
- **Manipulation of thin films of lipophilic DNA nucleosides (*Langmuir-Blodgett* films)**



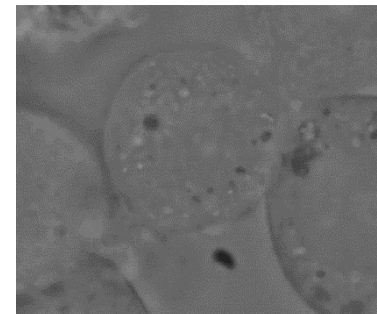
Optical control of base-pairing

(M. Ličen et al., *Langmuir*, **35**, 6550 (2019))

- **Diffusion processes in biofilms and microrheology of bacterial suspensions**

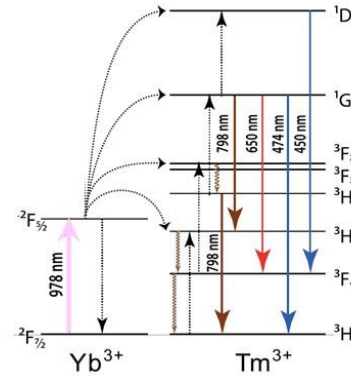
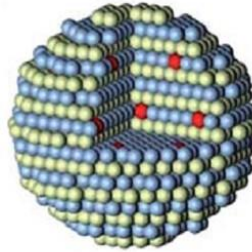


(*Bacillus subtilis*)



BIOMEDICAL OPTICS

- **Nanoparticles for diagnostic bioimaging and therapeutic applications**

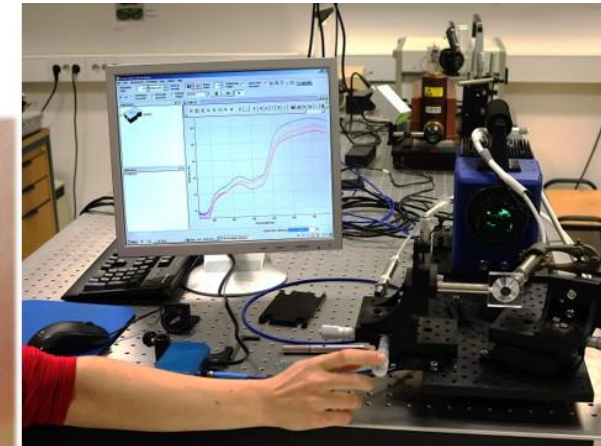


Upconversion fluorescence
($\text{Yb}^{3+}, \text{Tm}^{3+}:\text{NaYF}_4$)

(J. Burns et al., *J. Biomed. Opt.*, **23**, 121616 (2018))

- **Noninvasive characterization of human tissue *in vivo***

Human skin



(N. Verdel et al.,
Biomed. Opt. Express, **10**, 944 (2019))

- **Development and investigations of various laser treatments**
(cooperation with Fotona company)



(N. Verdel et al., *Appl. Opt.*, **57**, D117 (2018))

ACKNOWLEDGEMENTS



**Research group
“Light and Matter”**

<http://www-f7.ijs.si/>

Thank you for your attention



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