Supervisor Project Idea

Supervisor

Insert a brief CV and/or external link, the total number of publications, the ORCID link, 5 of the most significant/recent publications, and a list of funded projects and awards. max 300 words

Current position:
Associate Professor of Physics
Head of the "Optics of Soft Matter" research group (https://simau.univpm.it/optics-of-soft-matter/)

Main research topics
- Nonlinear optical properties of liquid crystals
- Optical trapping and manipulation in liquid crystalline environment
- Ferroelectric nematic liquid crystals
- Wetting and electrowetting of complex fluids
- Liquid crystal- based biosensors

Author of more than 100 publications in refereed journals and of 3 book chapters. https://orcid.org/0000-0002-3231-1845

Invited talks at Conferences and seminars:
- Author of more than 30 invited talks and keynote lectures, of 10 invited seminars and of more than 30 other talks at conferences.
- Teacher at 3 International Schools.

Participation to projects
- National Project INFM *Structure, dynamics and memory effects in confined liquid crystals*;
- National Project INFM (2002-2003) *Light-Induced Molecular Adsorption and Orientation at Solid-Liquid Crystal Interfaces*;
- European Thematic Network *Photosensitive organic materials for optical processing* –LC Photonet;
- National Project INFM – ASI (Italian Spatial Agency) *Real time Holography in liquid crystals for aberrations compensation in large aperture space telescopes*;
- European COST Action MP0604 *Optical micro-manipulation by nonlinear nano-photonics*;
- European COST Action MP1205 *Advances in Optofluidics: Integration of Optical Control and Photonics with Microfluidics.*
- *Characterization and control of the polar coupling to electric fields in the novel ferroelectric nematic liquid crystal phase* - grant W911NF2410252 (2024 – 2027)

5 most significant/recent publications
. A new twist in ferroelectric liquids, Science, **2024**, 384, 1067
. Fluid jets and polar domains, on the relationship between electromechanical instability and topology in ferroelectric nematic liquid crystal droplets, Soft Matter, **2024**, 20, 4878
. Fluid superscreening and polarization following in confined ferroelectric nematics, Nature Physics, **2023**, 19(11), 1658.
. Walking Ferroelectric Liquid Droplets with Light, Advanced Materials, **2023**, 35(22), 2212067
. Explosive electrostatic instability of ferroelectric liquid droplets on ferroelectric solid surfaces, PNAS, **2022**, 119(32), e2207858119

Research Group Description

Provide the name the reference department and a brief description of the research group, including external links, and available instrumentations and infrastructures. max 300 words

The Optics of Soft Matter group (https://simau.univpm.it/optics-of-soft-matter/) is part of the Department of Science and Engineering of Materials, Environment and Urban Planning. It is currently composed of Liana Lucchetti (leader), Raouf Barboza (researcher), Stefano Marni (former PhD student) and Lorenzo Fiorentini (graduate student). The research topics are mainly related to optics and nonlinear optics of liquid crystalline materials.
The group was among the first to combine liquid crystals with lithium niobate ferroelectric crystals both in conventional cells and in optofluidic configuration and is a worldwide recognized pioneer in the characterization of the new ferroelectric nematic liquid crystal phase.

Facilities

Oscilloscope: TEKTRONIX, TBS2074, 4 CHAN 70MHz, 1GSPS oscilloscope
Arbitrary Waveform Gen: Agilent 33511B, 1CHAN 10MHz, 1mVpp-10Vpp
Digital multimeter: Agilent 34401A, 6.5 digits resolution
DAQ systems
NI cDAQ-9185 (NI CompactDAQ) ethernet chassis with 4 slots
NI-9215 4-Channel Voltage Input Module (±10 V, 100 kS/s/ch, 16-Bit, Simultaneous Input)
SPS-606 (ISO-TECH BENCH POWER SUPPLY DIGITAL 500W) 1 CHAN 0-60V 0-6A
EL302T (TTI -Thurlby Thandar Instruments Power Supplies DC 125W) bench power supply,3 chan 2 x 30V/2A + 5V/1A

Zeiss Axioscope up-right microscope
Olympus CKX41 inverted microscope
CalCTec hot stage for microscopy

Coherent Innova 90C
MellesGriot HeNe Lasers (3X) 05-LPH-151 (15mW) @632nm, (1X) 05-LHP-321 (5mW) @632nm
Coherent Genesis MX532-500 Optically pumped semiconductor laser system @532nm, 500mW
TOPTICA DL 100 semiconductor laser @405nm, 13mW

Newport URS1000CC (2) high precision rotation stage &Newport ESP300 universal motion controller.
PI M-605 100 PI high precision linear stage & PI Mercury C-863 DC Motor Controller

Spectrometer Ocean Optics S2000
Halogen fiber-coupled sources (2X), HL-2000-HP-FHSA, HL-2000-FHSA
Camera Canon EOS 750D
CMOS camera Basler acA2500-60uc (2X)

26-1K Mercury exposure system for UV curing
Transonic 310 ultrasonic bath
RX3 Vortex Mixer (Velp Scientifica)
Arex Heating Magnetic Stirrer (Velp Scientifica)
Heidolph Vibramax 100, shaker
Spin coater PiKem

Title and goals

Provide the title of the topic and a short summary of the project idea. max 200 words

Characterization and control of the polar coupling to electric fields in the novel ferroelectric nematic liquid crystal phase

The novel ferroelectric nematic phase (NF) exhibits a peculiar combination of fluidity and polar coupling to electric fields. The proposal focusses on a crucial consequence of such a combination: the readiness by which NF can displace polarization charges at the interfaces by small collective rotations of the mean molecular axis. This extreme electric responsivity leads to the cancellation of the electric fields inside the material, a condition reminiscent of the electric properties of conductors, but made more complex by the possible formation of bulk polarization charges due to divergences of the polarization field. This effect is at the core of our first observations on the response of NF to electric fields that revealed a variety of unprecedented behaviors, such as the explosion of sessile droplets, the guiding of electric field along winding paths and the formation of soliton-like field-responsive defect structures. The project idea deals with a set of experiments in which NF is in contact with electro- and photo-active surfaces and placed in electric fields within complex confined geometries. The final goal is to understand and govern the coupling of fluid polarity and electric fields, and to exploit it to control fluid motion and polarization patterns.

Contact details (*including email address of the supervisor*)

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