RAPPORT PEDR

PERIOD: 2017 - 2021

TERESA LOPEZ-LEON

1. CURRICULUM VITAE

Nationality: Spanish
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Current position CNRS researcher (CR) at the UMR 7083 Gulliver

Education and earlier positions

2018 Sorbonne Université, France		HDR
2013-2016 ESPCI Paris, France		CR
2010-2012 Université de Montpellier II, France		Post-Doc
2007-2009 Harvard University/GaTech, USA		Post-doc
2006 University of Granada, Spain	Physics	Ph. D
2003 University of Granada, Spain	Physics	Ma. Sc.
2001 University of Granada, Spain	Physics	B. Sc.

Awards

CNRS Bronze Medal (2019)

Selected previous grants and fellowships

ANR Jeune Chercheur (JCJC) (2013)
Marie Curie Fellowhip (2009)
MEC-Fullbright Fellowship (2007)

Current grants and networks

PHC STAR (France-Corea) (2022-2024) "Polymeric micro-actuators: 3D structural control through liquid crystal patterning"

ANRT-Cifre with the company CETIAT (2019-2022) "Développement d'un système de mesure de nano-débits de liquides" (Partner)
CNRS-UChicago Joint Call (2019-2022). "Coupling active and passive liquid crystals"(PI)
COST Action: CA17139. (2018-2022): "European Topology Interdisciplinary Action" (Partner)
H2028-MSCA-COFUND Grant: (2018-2021). "Topological Living Matter" (PI)
CLICTEAM-ANR-18-CE09-0028-02 (2018-2022). "Spherical Cholesteric Liquid Crystal: a Test-bed to study Enzyme Activity Mechanisms on Polysaccharides" (Partner)
NYU-PSL Global Alliance Cooperation Grant (2018-2019). "Bacteria in droplet self-assemblies: towards new assay strategies for microbial ecology" (PI)

h-index = 20, # publications = 35, citations = 1590, most cited = 298 (source web of science)

Mentoring: 2 postdocs, 8 PhD students, 4 visiting PhD students (U. Colorado Boulder, U. Barcelona, U. Santiago) and 11 undergraduate and master students

Professional activities (last 4 years)

- Scientific commitee**, Institut de Physique du CNRS** (from 2017-2019)
- Equality, Diversity and Inclusion Officer at **ESPCI** (from 2019)
- Consultant for the **MISRI** regarding ANR reforms and gender laws (2019, 2020)
- Management committee, **European Network EUTOPIA**: COST Action - CA17139 (from 2018)
- Scientific commitee, **Saint-Gobain/ESPCI Chair** (from 2018)
- Management committee, **Nuit des Sciences et Lettres de l'ENS** (from 2018)
- Representative of the experimentalist researchers at the **UMR7083** (2019)
- Invited Editor, **Frontiers in Physics** (2018-2020)
- Evaluation activities for: funding programs (ANR, INC, NKFIH, etc), thesis dissertations (9), journal reviewing (Science, Science Advances, ACS Central Science, PRX, PRL etc).

Selected invited conferences (last 4 years)

- **PSL Soft Matter Days**, Paris, France (2021). **Keynote lecture**
- **2021 Liquid Crystal Gordon Research Conference**, "From Nature to Transformational Technology through Liquid Crystal Science" (postponed to 2023)
- **28th International Liquid Crystal Conference**. Lisbon, Portugal (postponed to 2022)
- **Workshop at the Lorenz Center**: Hydrodynamics at all length scales. Leiden, Netherlands (2019)
- **TAU-ESPCI Summer School**: Self-organization and self-assembly: from Physics and Chemistry to Biology. Tel Aviv, Israel (2019)
- **CECAM workshop** on "Collective behavior of soft matter under confinement". Mainz, Germany (2018)
- **Journées Surfaces Interfaces**. Strasbourg, France (2018)
- **18th Colloque sur les systèmes anisotropes auto-organisés**. Lyon, France (2017)
- **10th Liquid Matter Conference**. Ljubljana, Slovenia (2017). **Keynote lecture**
- **2017 Liquid Crystal Gordon Research Seminars**. Biddeford (ME) United States (2017). **Keynote lecture**

Collaborations (last 4 years)

- Kyoto University: External fields on liquid crystal shells (Chaire Joliot from ESPCI)
- University of Chicago: External fields on liquid crystal shells and active nematics (CNRS-UChicago cooperation grant)
- University of Colorado Boulder: Topological solitons (Chaire Paris Science from ESPCI)
- University of Bordeaux: Topological solitons
- University of Seville: Microfluidics
- University of Pennsylvania: Polymeric micro-actuators (Shared post-doc)
- KAIST: Switchable lasers
- University of Barcelona: Active nematics (Visiting PhD student)
- University of Oxford: Active nematics
- ESPCI – PMMH: Bacterial motion in liquid crystal (co-supervision of a PhD student, PSL cooperation grant)
- ESPCI- Gulliver: Measure of nano-flows (co-supervision of a PhD student, ANRT-Ciffre)
- CETIAT (Company): Measure of nano-flows (co-supervision of a PhD student, ANRT-Ciffre)
- INRAE: Cellulose based cholesteric shells (ANR)
- SOLEIL: Cellulose based cholesteric shells (ANR)

Press and highlights

- Invited Article in *"Crystals": Early Career Stars of the Decade* (2021)

- Invited Article in *"Soft Matter": Emerging Investigators Issue* (2021)
- Invited Article in *"Liquid Crystals Reviews": Maurice Kleman Commemorative Issue (2021)*

- *Focus* Article in the journal "Physics" of the *American Physics Society* (2020) (https://physics.aps.org/articles/v13/131)
- Invited Editorial in *"Frontiers in Physics"*: *Topological Soft Matter* 8, 373 (2020)
- CNRS Silver and Bronze Medals in Chemistry, Angewandte Chemie International Edition, 54, 7911(2019)
- Les talents 2019 du CNRS,"L'actualité chimique", Journal of the *French Chemistry Society* (2019)
- Cover of the journal "L'actualité chimique" of the *French Chemistry Society, 424* (2017)
- *Q&A* Article in the journal "Physics" of the *American Physics Society* about my research, "Q&A: A world of experiments inside a liquid crystal" (2017) (https://physics.aps.org/articles/v9/152)

2. SCIENTIFIC RESEARCH

TOPOLOGICAL SOFT MATTER

The past decade has seen striking experimental and theoretical advancements in the field of material science, where the concepts of topology and activity have emerged as cornerstones. On the topology front, liquid crystals have provided a platform to create and stabilize new topological states. On the field of active matter, theoretical developments have provided new tools for understanding the behavior of these out of equilibrium systems, where simple mechanisms at the level of the elementary constituents lead to complex collective behaviors. Active nematics are a fundamentally novel class of materials where topology and activity naturally merge, and whose fascinating properties are yet to be uncovered. In the last four of years, I have been working, with my students and collaborators, on these research areas. Below I described my contributions to four main domains:

I) Liquid crystal shells: a playground to study topological defects

Liquid crystal shells have emerged as a new platform where stabilizing and studying topological defects. My works, pioneering in this field, have motivated a substantial number of recent research studies. In these last four years, we have provided new mechanisms to produce, manipulate and probe topological defects in liquid crystal shells.

In collaboration with the team of R. Kamien (Upenn), we have studied topological transformations in cholesteric shells. By abruptly changing the topological constraints on the shell **Ref [2]**, we have been able to study the interconversion between director defects and pitch defects, a phenomenon usually restricted by the complexity of the cholesteric phase **Ref [10]**. In collaboration with the team of J. Yamamoto (Kyoto University) and the team of J. de Pablo (Chicago University), we have studied the structural transformations undergone by nematic shells under external fields, using both experiments and numerical simulations **Ref [3]**. We have been able to achieve control on the trajectories and dynamics of the defects by tuning the intensity and orientation of the field. These experiments allowed us to observe a hybrid splay-bend Helfrich wall for the first time.

These studies have provided us with a toolbox to control the nucleation and dynamics of topological defects in liquid crystal shells. In collaboration with I. Smalyukh (University of Colorado Boulder) and E. Brasselet (University of Bordeaux), we have taken advantage of such toolbox to trigger the formation of topological solitons, non-singular but topologically nontrivial structures in fields, which have fundamental significance across various areas of physics, from particle physics to condensed matter. We have reported the formation of linear and axisymmetric objects, which we have identified as cholesteric fingers and skyrmions (or elementary torons), respectively, and studied their nucleation, growth and interactions **Ref [4]**.

II) Topology and geometry: new tools to create functional microparticles

One of the current challenges in colloidal and material science is to bring a method to produce anisotropic colloidal particles with a symmetry that can be controlled at will. These anisotropic building-blocks are expected to self-assemble in pre-defined structural arrangements and derive new materials with revolutionary technological applications, such as photonic crystals or meta-materials. Despite the important progress, we are still far from having a robust method to produce the colloidal superlattices that future applications will require.

Liquid crystals offer new opportunities to engineer micro-particles with tailored structures and functionalities. We have been working on a new approach where we take advantage of the topological defects that appear in liquid crystal shells to create colloids with a valency **Ref [9]**. We have also explored another strategy that consist in using liquid crystal droplets as a scaffold to synthesize stimuli-responsive polymeric particles. We have uncovered a universe of possibilities in terms of particle shape and actuation capabilities, which we are currently exploring. For instance, in collaboration with the team of R. Kamien (Upenn), we have shown that the polymerisation of bipolar nematic droplets can lead to the formation of twisted spindle shaped particles **Ref [6]**. Finally, in collaboration with the team of D. K. Yoon (KAIST, Korea), we have developed a method to fabricate highly stable switchable emulsions, which are able to behave as switchable micro-lasers **Ref [8]**.

III) Bio-inspired active matter: taming flows through confinement

Active matter refers to systems composed of self-driven units, such as tissues, bacterial suspensions, or mixtures of biofilaments and motor proteins, that organize their textures and flows autonomously by consuming either stored or ambient free energy. This distinctive hallmark sometimes conceals another significant, and often unappreciated, feature of active systems: their capability to adapt to the environments where they reside. In collaboration with the team of F. Sagués (University of Barcelona) and the team of J. Yeomans (Oxford University), we have shown that geometrical confinement enables control of active flows, replacing the bulk chaotic flow state often termed active turbulence, by more regular flow configurations. In particular, we have studied the effect of lateral confining in a microtubule-based active nematic. While lateral confining in 2D squared channels leads to the formation of organized flows **Ref [7]**, the existence of boundaries at the ends of the channel forbids net mass transport in the system. Interestingly, we have shown that confining an active nematic to a network of connected annular microfluidic channels enables controlled directional flows and autonomous transport **Ref [5]**. Our results have relevance to possible future applications of active materials in microfluidics and self-assembly, and in assessing the relevance of the concepts of active mater in the description of biological systems.

IV) A model to study enzymatic activity in plant cell walls

The bioconversion of biomass is considered as one of the most promising renewable feedstocks available for human exploitation. However, its fully exploitation remains challenging mainly due to the incomplete degradation of biomass into monomeric sugars due to enzymatic action. We have a poor understanding of how enzymes act in the cell wall deconstruction, particularly when the degradation is performed at high-solid loading. To get a better understanding of those mechanisms, controlled studies on model systems are necessary. In collaboration with the team of I. Capron (INRAE) and F. Jamme (Synchrotron Soleil), we have developed a platform capable to mimic the plant cell wall. It consists of a spherical shell made of cellulose nanocrystals coated by xyloglucan. The results obtained using DUV -synchrotron radiation (to be published) show that the enzyme glucanase GH7 interacts differently with the structured and unstructured parts of the shell, shading new light on the mechanisms controlling biomass degradation.

3. PUBLICATIONS

1. J. Hardouin, J. Laurent, T. Lopez-Leon, J. Ignes-Mullol, F. Sagues "Active boundary layers" **PRX** (under minor corrections) (2021)
2. K. He, Y. Zhou, H. Ramezani-Dakhel, J. de Pablo, A. Fernandez-Nieves, T. Lopez-Leon, “From nematic shells to nematic droplets: energetics and defect transitions” **Soft Matter** (accepted) (2021)
3. F. Serra, U. Tkalec, T. Lopez-Leon "Editorial: Topological Soft Matter” **Frontiers in Physics** 8, 373 (2020) **Invited article**
4. G. Durey, Y. Ishii, T. Lopez-Leon "Temperature-Driven Anchoring Transitions at Liquid Crystal/Water Interfaces" **Langmuir** 36, 9368 (2020)
5. Y. Ishii, Y. Zhou, K. He, Y. Takanishi, J. Yamamoto, J. de Pablo, T. Lopez-Leon "Structural transformations in tetravalent nematic shells induced by a magnetic field" **Soft Matter**, 16, 8169 (2020)
6. G. Durey, H.R.O. Sohn, P. J. Ackerman, E. Brasselet, I. I. Smalyukh, T. Lopez-Leon, "Topological solitons, cholesteric fingers and singular defect lines in Janus liquid crystal shells", **Soft Matter** 16, 2669 (2020) **Journal cover.**
7. J. Hardouin, J. Laurent, T. Lopez-Leon, J. Ignes-Mullol, F. Sagues "Active microfluidic transport in two-dimensional handlebodies" **Soft Matter** 16, 9230 (2020)
8. H. Ansell, D. S. Kim, R. Kamien, E. Katifori, T. Lopez-Leon "Threading the Spindle: A Geometric Study of Chiral Liquid Crystal Polymer Microparticles" **Physical Review Letters**, 123, 157801 (2019).
9. J. Hardoüin, R. Hughes, A. Doostmohammadi, J. Laurent, T. Lopez-Leon, J. M. Yeomans, J. Ignés-Mullol, F. Sagués “Reconfigurable Flows and Defect Landscape of Confined Active Nematics" **Communications Physics**, 2, 121 (2019).
10. D. S. Kim, W. Lee, T. Lopez-Leon, D. K. Yoon "Self-Regulated Smectic Emulsion with Switchable Lasing Application" **Small**, 15, 1903818 (2019).
11. K. He, F. Campo-Cortés, M. Goral, T. Lopez-Leon, J. M. Gordillo "Micron-sized double emulsions and nematic shells generated via tip streaming" Physical **Review Fluids**, 4, 12 (2019).
12. L. Tran, M. O. Lavrentovich, G. Durey, A. Darmon, M. F. Haase, N. Li, D. Lee, K. J. Stebe, R. D. Kamien and T. Lopez-Leon "Change in stripes for cholesteric shells via anchoring in moderation" **Physical Review X**, 7, 041029 (2017).
13. A. Darmon, O. Dauchot, T. Lopez-Leon and M. Benzaquen "Elastic interactions between topological defects in chiral nematic shells" **Physical Review E**, 94, 062701 (2016)
14. A. Darmon, M. Benzaquen, S. Čopar, O. Dauchot and T. Lopez-Leon "Topological defects in cholesteric liquid crystal shells" **Soft Matter**, 12, 9280 (2016). **Journal cover.**
15. A. Darmon, M. Benzaquen, D. Seĉ, S. Čopar, O. Dauchot and T. Lopez-Leon "Waltzing route toward double-helix formation in cholesteric shells" **Proceedings of the National Academy of Science of the United States of America**, 113, 9469 (2016)
16. V. Koning, T. Lopez-Leon, A. Darmon, A . Fernandez-Nieves, V. Vitelli "Spherical nematic shells with a threefold valence" **Physical Review E**, 94, 012703 (2016)
17. T. Lopez-Leon, J. L. Ortega-Vinuesa, D. Bastos-Gonzalez, and A. Elaïssari “Thermally sensitive reversible microgels formed by poly(N-Isopropylacrylamide) charged chains: A Hofmeister effect study” **Journal of Colloid and Interface Science** 426, 300 (2014)
18. M. Amine, D. Seč, T. Lopez-Leon, M. Nobili, M. Ravnik, S. Žumer, and C. Blanc “Microparticles confined in a nematic liquid crystal shell” **Soft Matter** 29, 6911 (2013)
19. V. Koning, T. Lopez-Leon, A. Fernandez-Nieves, and V. Vitelli “Bivalent defect configurations in inhomogeneous nematic shells” **Soft Matter** 9, 4993 (2013)
20. T. Lopez-Leon, M. A. Bates, and A. Fernández-Nieves “Defect coalescence in spherical nematic shells” **Physical Review E** 86, 030702(R) (2012). **Selected for PRE Kaleidoscope**.
21. D.Seč, T. Lopez-Leon, M. Nobili, C. Blanc ,A. Fernández-Nieves, M. Ravnik, and S. Žumer “Defect trajectories in nematicshells: Role of elastic anisotropy and thickness heterogeneity” **Physical Review E** 86, 020705(R) (2012).
22. T. Lopez-Leon, A. Fernandez-Nieves, M. Nobili, C. Blanc, “Smectic shells” **Journal of Physics-Condensed Matter** 24, 284122 (2012).
23. T. Lopez-Leon, J.L. Ortega-Vinuesa, and D. Bastos-González, “Ion-Specific Aggregation of Hydrophobic Particles” **ChemPhysChem** 13, 2382 (2012).

24. T. Lopez-Leon, A. Fernandez-Nieves, M. Nobili, C. Blanc, "Nematic-smectic transition in spherical shells" **Physical Review Letters** 106, 247802 (2011). **Highlighted in the Soft Matter World Newsletter of January 2012.**
25. T. Lopez-Leon, V. Koning, K. B. S. Devaiah, V. Vitelli, A. Fernández-Nieves, "Frustrated Nematic Order in Spherical Geometries" **Nature Physics** 7, 391-394 (2011).
26. T. Lopez-Leon and A. Fernández-Nieves, "Drops and shells of liquid crystals" **Colloid and Polymer Science** 289, 345-359 (2011). **Invited review article.**
27. T. Lopez-Leon, J.M. López-López, G. Odriozola, D. Bastos-González, and J.L. Ortega-Vinuesa, "Ion-induced reversibility in the aggregation of hydrophobic colloids" **Soft Matter** 6, 1114-1116 (2010).
28. T. Lopez-Leon, D. Bastos-González, J.L. Ortega-Vinuesa, and Abdelhamid Elaïssari "Salt Effects in the cononsolvency of poly(N-isopropylacrylamide) microgels" **ChemPhysChem** 11, 188-194 (2010).
29. T. Lopez-Leon, A. Fernández-Nieves, "Topological transformations in bipolar shells of nematic liquid crystals" **Physical review E** 79, 021707 (2009). **Selected for PRE Kaleidoscope**.
30. T. Lopez-Leon, J.L. Ortega-Vinuesa, D. Bastos-González, "Hofmeister Effects in Colloidal Systems: Influence of the Surface Nature" **Journal of Physical Chemistry C** 112, 16060, (2008).
31. T. Lopez-Leon, A. Fernández-Nieves, "Macroscopically Probing the Entropic Influence of Ions: Deswelling Neutral Microgels with Salt" **Physical review E** 75,011801(2007).
32. T. Lopez-Leon, A. Elaïssari, J.L. Ortega-Vinuesa and D. Bastos-González, "Hofmeister Effects on PNIPAM Microgel Particles: Macroscopic Evidence of Ion Adsorption and Changes in Water Structure" **ChemPhysChem** 8, 148-156, (2007).
33. T. Lopez-Leon, Juan L. Ortega-Vinuesa, Delfi Bastos-González and Abdelhamid Elaïssari, "Cationic and Anionic Poly(N-isopropylacrylamide) Based Submicron Gel Particles: Electrokinetic Properties and Colloidal Stability" **Journal of Physical Chemistry b**, 110, 4629-4636 (2006).
34. T. Lopez-Leon, P.M. Gea-Jódar, D. Bastos-González, and J.L. Ortega-Vinuesa, "Hoffmeister Effects in the Restabilization of IgG-latex Particles: Testing Ruckenstein's Theory" **Langmuir**, 21, 87-93 (2005).
35. T. Lopez-Leon, E.L.S. Carvalho, B. Seijo, J. L. Ortega-Vinuesa, and D. Bastos-González, "Physicochemical Characterization of Chitosan Nanoparticles: Electrokinetic and Stability Behavior" **Journal of Colloid and Interface Science**, 283, 344-351 (2005).
36. T. Lopez-Leon, A. B. Jódar-Reyes, J. L. Ortega-Vinuesa, D. Bastos-González, "Hofmeister Effects on the Colloidal Stability of an IgG-Coated Polystyrene Latex" **Journal of Colloid and Interface Science**, 284, 139-148 (2004).
37. T. Lopez-Leon, A. B. Jódar-Reyes, D. Bastos-González, J. L. Ortega-Vinuesa, "Hofmeister Effects In The Stability And Electrophoretic Mobility Of Polystyrene Latex Particles" **Journal of Physical Chemistry B** 107, 5696 - 5708 (2003).
38. T. Lopez-Leon, M. J. Alonso, B. Seijo, J. L. Ortega-Vinuesa and D. Bastos-González. "Caracterización de Partículas de Quitosano Destinadas al Transporte y Liberación de Fármacos", Coloides e Interfases, Ed. Universidad de Vigo, 2003 (ISBN 84-8158-242-5) pag.153 – 158. **Book chapter**