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Turno General

Área Temática: Ciencias físicas
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Título: Shaping Life: From Active Mechanics in Elastic Materials to Biological Morphogenesis and Beyond

Resumen de la Memoria:

RESUMEN DE LA TRAYECTORIA. Throughout my scientific career, I've focused on understanding the complex interplay between mechanics and biology in active matter systems [PRL 118 - 15, 2017]. My work has ranged from exploring the formation of structures in living tissues to investigating the dynamics of active colloids [Physical Review Research. 2 - 1, 2021, Soft Matter. 19: 2297-2310, 2023]. Central to my approach is the use of advanced simulations, particularly in studying the out-of-equilibrium behaviors of viscoelastic materials and their morphological diversity under different conditions. I've contributed significantly to the field by developing novel simulation frameworks and leading several studies as the principal investigator [PNAS 118 - 10, 2021, arXiv:2307.05749 (2023), arXiv preprint arXiv:2308.12754 (2023)]. My research has provided profound insights into biological shape formation, mechanochemical processes, and pattern formation in elastic shells, contributing to our understanding of both natural and artificial systems. Additionally, my work on biofilm formation and dense active matter has revealed key aspects of biological systems' behavior and responses, further enriching the field of biophysics [Soft Matter. 13 - 17, 2017, Soft Matter. 16 - 3344, 2020, PNAS 116 - 27, 2020, ACS nano. 15 - 9, 2021].
My career path demonstrates a strong commitment to internationalization and mobility. My journey through diverse cultural and academic landscapes has been marked by collaborations with eminent scientists and institutions, showcasing my adaptability and dedication to contributing to the global scientific community. This international experience, coupled with my achievements and collaborations, positions me uniquely for opportunities where a global perspective and network are paramount.

LÍNEA DE INVESTIGACIÓN. Active matter systems, which include entities like flocks of birds and molecular motors, are pivotal in understanding the statistical physics of non-equilibrium systems. These units consume energy from their surroundings and convert it into mechanical work, leading to complex behaviors. Recent research has focused on how curvature and geometry influence these active systems. Our knowledge is limited on how active motion is affected by curvature, a key aspect in biological processes. For example, cellular behavior in embryonic development shows how curvature affects the formation of three-dimensional structures. My line of research aims to unravel these effects through theoretical and numerical simulations on GPUs, exploring the collective behavior of active matter in curved environments. The study will distinguish universal features from those dependent on specific models, enhancing our understanding of active matter physics and its biological applications, especially in developmental biology where curvature plays a significant role.

This research could significantly enhance our understanding of the effects of curvature on active motion, contributing to the broader knowledge of active matter physics. Beyond physics, it has potential implications in fields where curvature is a prevalent aspect of living systems, particularly in developmental biology. In these systems, the intrinsic curvature of active systems plays a crucial role, making this research particularly relevant for understanding complex biological processes.

Resumen del Currículum Vitae:

My research merges active matter, elasticity and mechanics in biology with a robust foundation in theoretical physics. With a background deeply rooted in statistical mechanics and non-equilibrium physics, I have cultivated a fascination with biological tissues. These complex systems intertwine the challenges of physics with the intricacies of living organisms' organization.
During my postdoctoral research, I applied high-performance computing and non-equilibrium physics to explore active matter in biological tissues. This led to expanded skills in experimental microbiology, imaging techniques, and new theoretical physics frameworks, resulting in innovative experimental collaborations.
My diverse skill set is demonstrated through recent publications, establishing me as a leader capable of guiding interdisciplinary biophysics teams. I have a proven track record as an independent leader, with many first-author publications, international collaborations, and research student mentorship.
My adaptability and scientific curiosity are evident in my willingness to embrace new challenges and my international mobility across various disciplines. Despite shifts in scientific focus, I have consistently developed robust and ambitious research plans, anchored by my deep expertise and knowledge. These plans adhere to the highest standards and have gained recognition from both local and international scientific communities, as evidenced by my numerous invited talks.
I have published papers in journals like PNAS, PRLs, and ACS Nano, with additional papers under review and in preparation. I have presented at 17 international conferences and worked at five universities across Argentina, France, the UK, the US, and Poland. Notably, I spent seven years as a postdoctoral researcher at institutions like CONICET, LiPhy-Universite Grenoble Alpes, University of Dundee, and Northwestern University. Since 2021, I have been an independent researcher, first at the University of Warsaw and currently leading a research group in Madrid.
Since 2023, I've been leading a research group at Complutense University of Madrid, focusing on soft matter and computational physics in biology, backed by a 400,000 grant. From 2021 to 2023, I initiated my independent career at the University of Warsaw, teaching courses like Active Matter and Neural Networks, and conducting research. At Northwestern University (2019-2021), I collaborated with Prof. Monica Olvera de la Cruz on impactful research. My career (2014-2019) involved diverse research across the UK, France, and Argentina. I've published 24 papers with 450 citations, received prestigious awards for my PhD thesis, and am globally recognized, evidenced by my presentations and teaching in physics and related fields. I possess expertise in programming languages and technical skills, holding professional certifications in computing and AI/ML applications.