Agencia Nacional de Investigación y Desarrollo

Ministerio de Ciencia, Tecnología, Conocimiento e Innovación

ACTIVE MATTER
Núcleo Milenio Física de la Materia Activa

Millennium Nucleus

MILLENNIUM NUCLEUS PHYSICS OF ACTIVE MATTER NMFMA

Impact Area: Materials for new technologies
Specialty: Physics of active matter, statistical thermodynamics and microfluidics

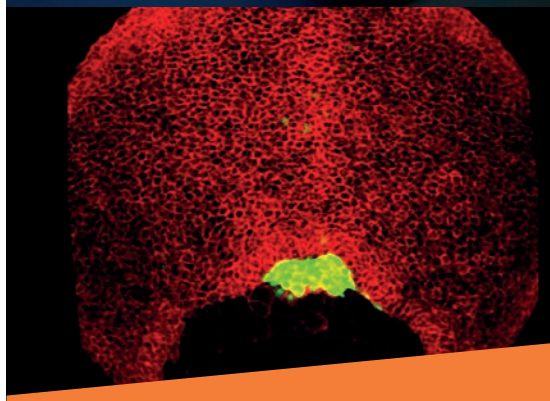
We have seen how flocks of birds, schools of fish and other animal collectives move in a synchronous and organized way, to such an extent that the swarm seems to have a life of its own. The same also happens at a smaller level: suspensions of bacteria, cellular tissues and artificial swimmers show surprising group movements.
These systems are what physicists call active matter, a term coined only in the last decade to describe these structures composed of many biological or artificial elements, where each individual has the ability to extract energy from the environment to generate motion.

What are the properties of active matter? In what states can it occur? How can we predict its behavior? How can we take advantage of its properties? These are just some of the questions that the Millennium Nucleus Physics of Active Matter seeks to answer.

To do so, we brought together a large and diverse team that combines more than a decade of experience in experimental and theoretical physics, numerical analysis and simulations, statistical thermodynamics, and experimental manipulation of biological models.

Housed in the Faculty of Physical and Mathematical Sciences of the University of Chile and in the University of Aysén and Mayor University, this academic center aims ultimately to build a thermodynamic theory for the active matter that can be extended to other systems out of equilibrium and –in the long term– apply these new concepts to systems of biological interest.
Because advancing in the knowledge of active matter will not only be a great contribution to physics but could revolutionize other fields such as biophysics, medicine, and nanotechnology.

Research Topics:
- Active material.
- Bacterial suspensions, cellular tissues, and active colloids.
- Statistical mechanics, non-equilibrium systems.
- Microfluidics, dynamics of droplets confined in microchannels.
- Ecology on a chip.



>> PUBLICATION PRODUCTIVITY:

ISI: **31**
PUBLICATIONS WITH **239 CITATIONS**

*Data updated by Millennium Centers to March 2021

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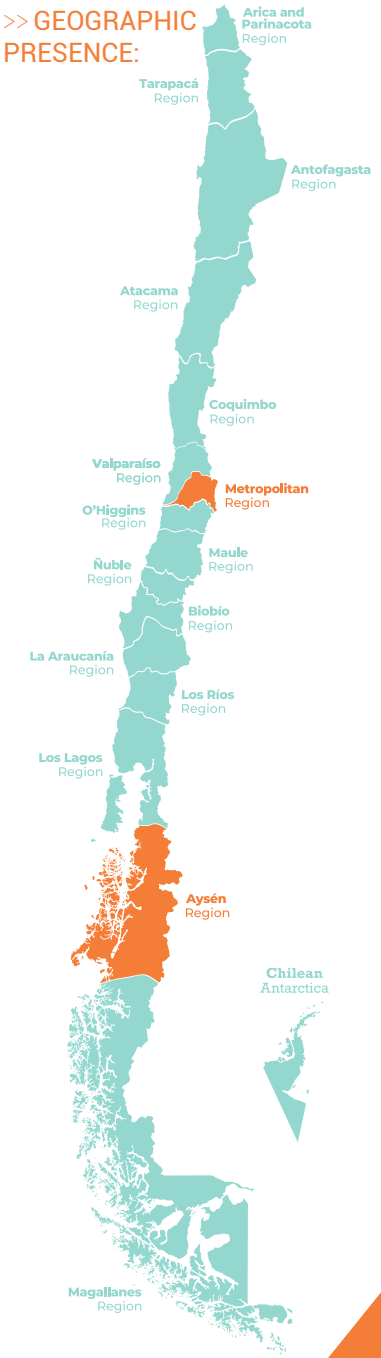
>> GEOGRAPHIC PRESENCE:



>> OUTREACH ACTIVITIES:

- Diálogos científicos ("Scientific dialogues") series: videos and spots where researchers from the Millennium Nucleus interview and talk to scientists from other areas on topics of current interest. The series was premiered in 2018-2019 and completed two seasons, with six chapters, and reached more than 500,000 people through our YouTube channel, social networks, and VTR TV broadcasting.
- Questions and memes contest. Contest based on the series Diálogos científicos. 9 winning questions and 4 winning memes were chosen. The questions were answered by the invited scientists in 12 videos. These were disseminated on YouTube and our social networks.
- Animated spots: 1-minute spots that explain with drawings and very didactically some of the most important research of the Millennium Nucleus. Between 2019 and 2020 five spots were made with more than 6,000 views on YouTube and more than 30 views on Facebook and Twitter.

>> MAIN ACHIEVEMENTS:

- Description of the properties of bacterial systems under confinement conditions, identifying their thermodynamic phases.
- Analysis of the fluxes produced by carpet folders and their possible role in carpet nutrition.
- Construction of experimental microfluidic devices to generate and study the dynamics of confined droplets.
- Collaborative study on bacterial swarm physics with researchers from PUC (Chile) and ESPCI (France).
- Manufacture of two engine motors, made with bacteria confined in microdroplets.
- Design of a mechanism for the controlled fabrication of microrobots made with active colloids.
- Project with the Faculty of Medicine (University of Chile) to describe the migration and coordination of cells during the development of fish embryos.
- Characterization of the stability of epithelial tissues when they are subjected to active cellular stresses.
- Quantum and classical description of thermodynamic systems and, in particular, the description of open systems.
- Complete characterization of bacterial swimming systems and how they respond to chemical signals.

Information updated to March 2021

Host Institutions:
University of Chile
Mayor University
University of Aysén

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Gobierno de Chile

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