



筑波大学

University of Tsukuba

Condensed Matter Seminar

物性論セミナー

2026年9月29日 (火), Sep 29 (Tue), 2026, 15:00-16:00

自然系学系棟B棟1階: 118号室 (Institutes of Natural Sciences Bldg. B 118)

[\[Map\]](#)

Topological waves in geo- and astro-physical fluids from a bulk-edge correspondence perspective

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Continuous media, such as fluids, may host various trapped waves of topological origin, e.g. similar to the unidirectional chiral edge states of a Chern insulator. In the absence of a boundary, such trapped waves may still exist at "interfaces" if the fluid develops specific gradients of physical quantities. In that case, their topological origin is well-defined despite the absence of an underlying lattice. Geophysical and astrophysical fluids, namely atmospheres, oceans and stars, are such continuous media that naturally develop gradients of different kinds, such as density and rotation rate, which leads to various trapped topological waves.

In this talk, I will introduce basic linear models that describe wave propagation in such fluids and show how topology can help interpreting or predicting new wave behaviors. From the perspective of a condensed matter physicist, I will discuss in particular the topological description of unidirectional Equatorial waves that are responsible for the El Nino phenomenon, and of Lamb waves whose recent prediction in the Sun might allow for the first probe of the Sun's core rotation rate.

References:

[1] A core-sensitive mixed-mode of the Sun predicted by wave topology and hydrodynamical simulation

Arthur Le Saux, Armand Leclerc, Guillaume Laibe, Pierre Delplace, Antoine Venaille

ApJL 987 L12 (2025) <<https://iopscience.iop.org/article/10.3847/2041-8213/ade396>>

[2] Mode-Shell correspondence, a unifying phase space theory in topological physics -- part II: Higher-dimensional spectral invariants

Lucien Jezequel and Pierre Delplace

SciPost Phys. 18, 193 (2025) <<https://scipost.org/SciPostPhys.18.6.193>>

[3] The Exceptional Ring of buoyancy instability in stars

Armand Leclerc, Lucien Jezequel, Nicolas Perez, Asmita Bhandare, Guillaume Laibe and Pierre Delplace

Phys. Rev. Research 6, L012055 (2024) <<https://journals.aps.org/prresearch/abstract/10.1103/PhysRevResearch.6.L012055>>

[4] Unidirectional modes induced by nontraditional Coriolis force in stratified fluids

Nicolas Perez, Pierre Delplace and Antoine Venaille

Phys. Rev. Lett. 128, 184501 (2022) <<https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.128.184501>>

[5] Topological transition in stratified fluids

Manolis Perrot, Pierre Delplace and Antoine Venaille

Nature Physics, 15, 781 (2019) <<https://www.nature.com/articles/s41567-019-0561-1#article-info>>

[6] Topological origin of equatorial waves

Pierre Delplace, J. B. Martson and Antoine Venaille

Science 358, 1075 (2017) <<http://science.sciencemag.org/content/358/6366/1075>>

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