



筑波大学

*University of Tsukuba*

# Condensed Matter Seminar

## 物性論セミナー

Supported by Variety and universality of bulk-edge correspondence in topological phases:  
From solid state physics to transdisciplinary concepts  
Grant-in-Aid for Scientific Research (S) Project No.17H06138

2020年2月27日 (木), Feb.27 (Thur.) 2020

14:00-15:00

自然系学系棟B棟1階: 118号室 [\[地図\]](#)

## Topological waves from condensed matter to the atmosphere

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Uni-directional boundary modes are the hallmark of Chern insulators. Such topological states have been engineered in various platforms, from condensed matter to artificial crystals e.g. in photonics, acoustics or cold atoms physics. Remarkably, such chiral modes also exist in continuous media encountered in nature.

This is the case of oceanic and atmospheric equatorial waves that only propagate their energy eastward (figure 1a). This remarkable property, that triggers the El Niño southern oscillations and impacts the climate over the globe, has a topological interpretation analogous to those of Chern insulators [1]. Similar topological arguments also allow the prediction of new kinds of waves in strongly stratified fluids (figure 1b) that might be observed e.g. in stars [2]. In the presence of a solid boundary, Kelvin already pointed out the existence of one-way directional waves propagating along the coasts of lakes. In strong contrast with crystals, the existence of these chiral modes in continuous media depends on the boundary conditions: they are not topologically protected as one would naively expect from the analogy with the celebrated bulk-boundary correspondence in condensed matter. However, a generalization to this cornerstone concept of topological physics can be formulated, leading to the prediction of "ghost modes" that coexist with the bulk states [3].

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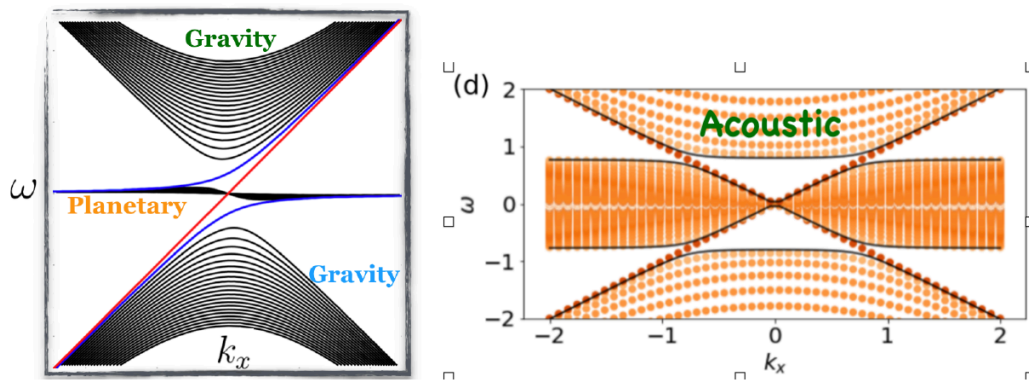


Figure 1: (left) Frequency spectra of equatorial waves. The Kelvin wave (red) and the Yanai wave (blue) propagate eastward. (right) Emergence of topological acoustic waves in the spectral gap of stratified compressible fluids.

- [1] Topological origin of equatorial waves  
**P. Delplace**, B. Marston and A. Venaille, *Science* **358**, 1075 (2017)
- [2] Topological transition in stratified fluids  
M. Perrot, **P. Delplace** and A. Venaille, *Nature Physics* volume 15, pages781?784 (2019)
- [3] Anomalous bulk-edge correspondence in continuous media  
C. Tauber, **P. Delplace** and A. Venaille, arXiv:1902.10050 (2019)

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