



筑波大学

University of Tsukuba

Condensed Matter Seminar

物性論セミナー

2025年11月6日 (木), Nov 6 (Thu), 2025, 16:00-17:30

自然系学系棟D棟3階: 301号室 (Institutes of Natural Sciences Bldg. D 301)

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* オンラインも併用いたします。ご希望の方はご連絡ください。

Nonlinear topological photonics

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Topology manifests in a wide range of physical systems, from single-particle phenomena to strongly correlated, topologically ordered states hosting anyons. Yet, the intermediate regime of classical or mean-field nonlinear systems has been comparatively less explored. In this talk, we discuss nonlinear topological effects in photonic platforms that occupy this regime. We demonstrate how incorporating optical nonlinearity gives rise to distinct bosonic phenomena with no direct electronic analogs—such as topological frequency combs and harmonic generation. In particular, we show that topological design enables nested combs, efficient phase matching, and operation without post-fabrication tuning. These results open pathways toward classical and quantum optical devices with intrinsic robustness, advancing next-generation optoelectronic, optical computing, and quantum technologies.

- [1] S. Mittal, G. Moille, K. Srinivasan, Y. Chembo and M. Hafezi “Topological frequency combs and nested temporal solitons”, *Nature Physics* 17, 1169 (2021).
- [2] C. Flower*, M. Jalali Mehrabad*, L. Xu*, G. Moille, D. G Suarez-Forero, O. Orsel, G. Bahl, Y. Chembo, K. Srinivasan, S. Mittal, M. Hafezi, “Observation of topological frequency combs” *Science*, 384, 1356 (2024).
- [3] L. Xu*, M. Jalali Mehrabad*, C. Flower*, G. Moille, A. Restelli, D. Suarez-Forero, Y. Chembo, Sunil Mittal, K. Srinivasan, and M. Hafezi “On-chip multi-timescale spatiotemporal optical synchronization” *Science Advances*, 11(37):eadw7696 (2025).
- [4] M. Jalali Mehrabad*, L. Xu*, G. Moille, C. Flower, S. Sarkar, A. Padhye, S. Ou, Daniel G Suarez-Forero, M. Ghafarizadeh, Y. Chembo, K. Srinivasan, M. Hafezi “Multi-timescale frequency-phase matching for high-yield nonlinear photonics” *arXiv:2506.15016* (2025).

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