# Topological photonics in plasmonic lattices

**Päivi Törmä**[1]

1. Aalto University, 00076 Aalto, Finland

Arrays of plasmonic nanoparticles, so-called plasmonic lattices, when combined with an emitter material (gain medium), provide a versatile platform for studies on light-matter interaction in the nanoscale, including collective coherent phenomena as well as topological photonics. For example, we have experimentally realized a new type of condensate: a BEC of hybrids of surface plasmons and light in a nanoparticle array, with interesting polarization and coherence properties [1-4]. In the lasing regime, we have observed a bound state in continuum (BIC) mode of topological charge one [5]. Recently, we realized a system where by tuning the size of a hexagonal unit cell we can realize lasing that shows transitions between states of topological charges zero, one and two [6]. We found that the transitions are driven by losses, determined by the geometric structure of the modes of different topological charges. We have also studied both theoretically and experimentally the possibility of non-zero Berry curvature and quantum metric in plasmonic lattices [7].

## References

[1] Hakala, T.K., Moilanen, A.J., Väkeväinen, A.I., Guo, R., Martikainen, J.-P., Daskalakis, K.S., Rekola, H.T., Julku, A., Törmä, P. 2018. *Nature Phys.* 14, 739.
[2] Väkeväinen, A.I., Moilanen, A.J., Necada, M., Hakala, T.K., Törmä, P. 2020. *Nature Commun.* 11, 3139.
[3] Taskinen, J.M., Kliuiev, P., Moilanen, A.J., Törmä, P. 2021. *Nano Letters* 21, 5202.
[4] Moilanen, A.J., Daskalakis, K.S., Taskinen, J.M., Törmä, P. 2021. *Phys. Rev. Lett.* 127, 255301.
[5] Heilmann, R., Salerno, G., Cuerda, J., Hakala, T.K., Törmä, P. 2022. *ACS Photonics* 9, 224.
[6] Salerno, G., Heilmann, R., Arjas, K., Aronen, K., Martikainen, J.-P., Törmä, P. 2022. *Phys. Rev. Lett.* 129, 173901.
[7] Cuerda, J., Taskinen, J.M., Källman, N., Herrmann, L., Rosenberg, M., Törmä, P. 2023. in preparation.