# Berry curvature computing method

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Here, I implemented a project to compute the Berry curvature for a quantum Hall photonic cyrstal with broken time-reversal symmetry. The calculation is based on *Comsol* and *Matlab*, where fields are extracted from Comsol and processed in Matlab.

To numerically compute Berry curvature, we prefer a formula that works in a discretized Brillouin zone and is gauge-independent. The efficient method developed by [*Fukui et al. (2005)*](https://arxiv.org/abs/cond-mat/0503172v2) satisfies these requirements and is adopted in my computation.

The unit cell of the photonic crystal is a square, where a cylinder made of gyromagnetic material is surrounded by air. Details about setting up the Comsol simulation can be found in [*Want et al. (2020)*](https://link-springer-com.tudelft.idm.oclc.org/article/10.1007/s12200-019-0963-9). In particular, I successfully reproduce Fig. 3 of that paper, see below:

Graphical user interface

Description automatically generated

Some useful materials:

[*Paz et al. (2019)*](https://doi.org/10.1002/qute.201900117) gives a friendly tutorial for computing Berry curvature. In particular, it clarifies how to compute the inner products of fields. [*Bisharat et al. (2021)*](https://arxiv.org/abs/2104.00122) could be useful as well since it provides an open-access code to compute Berry curvature (though maybe not easy-to-use).