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High Harmonic Generation of quantum light via topologically nontrivial crystals

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High harmonic generation (HHG) is a physical effect which happens when a strong driving laser acts on atomic, molecular, or solid systems. As a result, a system emits at frequencies of integer multiples of the driving laser frequency [1]. It was also shown that including correlations between atoms can generate entangled and squeezed light or entangled photon pairs [2]. These can be an important resource in quantum technology and quantum metrology. Also, such radiation may have pulse durations about attosecond timescales. In 2023 the achievements in this area were awarded the Nobel in physics [3]. However, there is no particular theory that can describe the generation of quantum light from the topologically nontrivial systems as crystalline. It is important because the nontrivial geometric properties of the system can provide more efficient way of HHG. In this work we develop a formalism that describes the influence of topological properties of systems on HHG taking into account arbitrary crystalline structure as an example. As a result, the 1D and 2D crystals were considered as examples. Moreover, we pay extreme attention to self-correlation effects, namely dipole-dipole correlations that are always presented in solid systems and estimate their effect on outgoing generation. For example, as it can be seen, in the topological phase of the 1D Su–Schrieffer–Heeger model (SSH) these effects are stronger than in the trivial phase resulting in stronger squeezing. The main reason for that is the difference of geometric tensor for trivial and topological phases on winding number.

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