Extraordinary properties of light and the quantum spin Hall effect of light

Objective

To study the extraordinary properties of light, including the quantum spin Hall effect of light

Summary of Research Activities

- By analyzing fundamental spin properties of Maxwell waves, we show that free-space light exhibits an intrinsic quantum spin Hall effect—surface modes with strong spin-momentum locking. These modes are evanescent waves that form, for example, surface plasmon-polaritons at vacuum-metal interfaces. Our findings illuminate the unusual transverse spin in evanescent waves and explain recent experiments that have demonstrated the transverse spin-direction locking in the excitation of surface optical modes. This deepens our understanding of Maxwell's theory, reveals analogies with topological insulators for electrons, and offers applications for robust spin-directional optical interfaces.
- We have also performed a systematic study of transverse spin and momentum in two-wave interference.
- Our results provide new insights into: (1) Transverse and longitudinal angular momenta of light; and (2) Spin-orbit interactions of light.

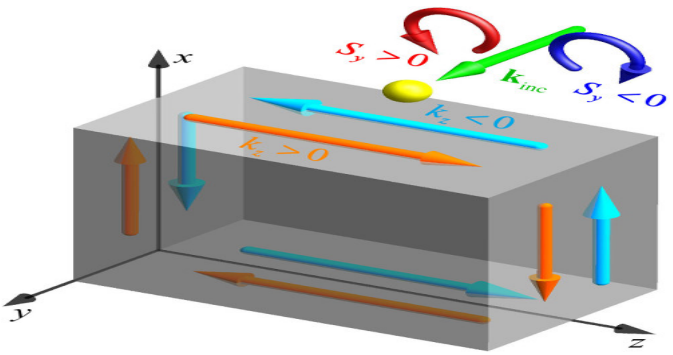

Fig. 1: Schematic of experiments demonstrating the quantum spin Hall effect of light

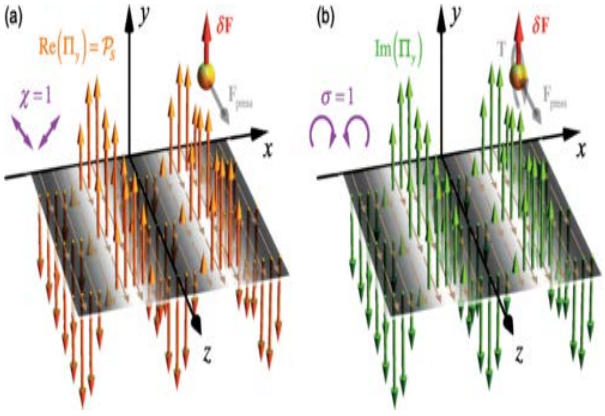

Fig.2 Transverse polarization-dependent momenta in the two-wave interference field.

Publications

K.Y. Bliokh, D. Smirnova, F. Nori, *Quantum spin Hall effect of light*, Science 348, 1448-1451 (2015). Highlighted in a Perspectives [Science 348, 1432 (2015)].

A.Y. Bekshaev, K.Y. Bliokh, F. Nori, *Transverse spin and momentum in two-wave interference*, Phys. Rev. X 5, 011039 (2015).

J. Dressel, K.Y. Bliokh, F. Nori, *Space-time algebra as a powerful tool for electromagnetism*, Physics Reports, Vol. 589, Pages 1–71 (2015).

K.Y. Bliokh and F. Nori, *Transverse and longitudinal angular momenta of light*, Physics Reports, Volume 592, 26, Pages 1–38 (2015).

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