Topological photonics

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In a first part, I will introduce the basics of topological physics, topological insulators and topological photonics. I will then show that the photonic modes of a planar microcavity can be described by a wide variety of effective 2 bands Hamiltonians (both Hermitian and non Hermitian) [1,2,3,4,5] with non trivial geometry and topology. I will show how the quantum geometric tensor (including Berry curvature and quantum metric) can be directly measured in this type of system by state tomography [6,7]. I will show some examples of Hermitian and non-Hermitian topological transition which are realized by tuning some cavity parameters [5,8], and the realized singularities can trigger helical lasing [9]. One of these transitions on which I will focus relates to the annihilation of Exceptional points issued from different Dirac singularities when linear dichroism controlling non-hermiticity degree is increased [5].

In a second part I will focus on the semi-classical motion of wave packets in two band models. It is traditionally described by two opposite limits. The adabiatic limit in a single band where anomalous Hall effect is described by the Berry curvature [10,6]. The other limit involves coherent superposition of states, beating, and Zitterbewegung like motion which can be related to non-Abelian gauge field theory [11]. I will that that both limits and all intermediate cases can be described by a new set of semi-classical equations involving only quantum metric elements [12].

The experimental results I will present in this talk were obtained in the frame of different collaborations with groups in Lecce, Beijing, Xian, and Warsaw.

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