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Geometrical description of nonreciprocity in coupled two-mode systems JOSE AUMENTADO, LEONARDO RANZANI, National Institute of Standards and Technology, Boulder, CO — Traditional microwave and optical devices that break reciprocal symmetry are based on the Faraday effect in anisotropic materials such as ferrites. These devices contain permanent magnets and are therefore not compatible with superconducting quantum circuits. Various nonreciprocal devices that do not employ dc magnetic fields to break reciprocal systems have been discussed in the literature, but it is not obvious if and how these different systems might be connected conceptually. In this talk we explore the concept of nonreciprocity in coupled two-mode systems using a geometric mapping to the Poincaré sphere. In this picture the evolution of the system is described by a rotation sequence of the state vector, where the axis of rotation is determined by the matrix of the coupled-mode system and a different order for the rotations corresponds to a different direction of propagation of the signal. The requirements for reciprocity are then expressed in terms of geometric properties of the rotation axis of the system. We provide a few examples (the microwave circulator, parametric up/down converter, and traveling wave frequency converter) to demonstrate how this general geometric picture can provide insight into specific physical systems.

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