Multidimensional Generalization of Transfer Matrices, Transmission Reciprocity, and Unidirectional Invisibility

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We outline an alternative to the S-matrix formulation of scattering theory in arbitrary dimensions that relies on a multidimensional generalization of the notion of transfer matrix and makes use of certain pseudo-Hermitian and pseudo-normal Hamiltonian operators. This enables us to provide an exact treatment of delta function potentials in two and three dimensions, establish a genuinely multidimensional generalization of the Lorentz reciprocity principle, and extend the concept of unidirectional invisibility to two and three dimensions. We show that the multidimensional reciprocity principle does not prohibit nonreciprocal transmission, thus lifting a major obstruction to devise optical and acoustic diodes using linear material. We give a general method of constructing unidirectionally invisible potentials in two and three dimensions that can support nonreciprocal transmission. As a concrete physical application of our findings, we construct an active optical wire with a rectangular cross-section that is invisible from the right but displays nontrivial reflection and transmission from the left.

References: Phys. Rev. A 93, 042707 (2016) & Preprint arXiv:1605.01225, to appear in Proc. R. Soc. A.