Imaginary vector potential and its physical applications

Naomichi Hatano

Aoyama Gakuin University, Tokyo, Japan

Abstract

I introduce a non-Hermitian generalization of quantum mechanics based on an imaginary vector potential. The one-particle version of the Hamiltonian is given by

$$\mathcal{H} = \frac{1}{2m}\left(\vec{p} + \vec{A}\right)^2 + V(\vec{x}), \tag{1}$$

where the vector potential $\vec{A}$ can be a complex field. The imaginary part of $\vec{A}$ makes the Hamiltonian non-Hermite.

I show that the generalization is useful in studying various physical (Hermite) models. For example, when either $V(\vec{x})$ or the real part of $\vec{A}$ is a random potential, the model (**??**) is a generalization of the one-particle Anderson model of localization [1,2]. We can calculate the localization length of the *Hermitian* Anderson model by tuning the imaginary part of the vector potential. In another application, where $V(\vec{x})$ is a scattering potential for a particle, a centripetal imaginary vector potential enables us to calculate the life-time of resonance states [3].

References

[1] N. Hatano and D.R. Nelson, Phys. Rev. Lett. **77**, 570 (1996); Phys. Rev. B**56**, 8651 (1997); Phys. Rev. B**58**, 8384 (1998).
[2] A. Zee, Physica A **254**, 300 (1998); N. Hatano Physica A **254**, 317 (1998).
[3] N. Hatano, K. Katō and T. Myo, in preparation.