Anomalous velocity with spin-orbit coupling

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ABSTRACT

Spin-orbit coupling is usually represented in condensed matter physics as a properly chosen symmetry-allowed combination of products of spin operators and the particle momentum components. By the general quantum mechanics rules, this interaction introduces a new spin-dependent component in the particle velocity, the so-called anomalous term. Here we present and discuss the general concept of this anomalous velocity and analyze several examples of its critical effects in the physics of the spin-orbit coupled condensed matter.

1. We consider the collapse of spin-orbit coupled self-attractive Bose-Einstein condensates and show that it can be prohibited if the spin-dependent anomalous velocity is taken into account [1].
2. We analyze short-term spin dynamics in random one-dimensional systems. Here the anomalous velocity produces mixed spin states and, therefore, strongly influences the spin relaxation [2], leading to a new spin relaxation mechanism.
3. We study coherent spin dynamics in cold atomic gases described by the Fermi- or the Bose-statistics, in synthetic gauge fields. For both statistics, this dynamics can be studied in terms of classical trajectories characterized by the anomalous spin-dependent velocity [3].

References

[1] Sh. Mardonov et al. *Collapse of spin-orbit-coupled Bose-Einstein condensates* Phys. Rev. A **91**, 043604 (2015).

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[3] I. V. Tokatly and E. Ya. Sherman *Spin evolution of cold atomic gases in gauge fields* arXiv:1604.08522.