Spin-axion coupling

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Abstract

© 2015 American Physical Society. We establish a new covariant phenomenological model, which describes an influence of pseudoscalar (axion) field on spins of test massive particles. The model includes general relativistic equations of particle motion and spin evolution in background pseudoscalar (axion), electromagnetic and gravitational fields. It describes both the direct spin-axion coupling of the gradient type and indirect spin-axion interaction mediated by electromagnetic fields. Special attention is paid to the direct spin-axion coupling caused by the gradient of the pseudoscalar (axion) field. We show that it describes a spin precession, when the pseudoscalar (axion) field is inhomogeneous and/or nonstationary. Applications of the model, which correspond to the three types of four-vectors attributed to the gradient of the pseudoscalar (axion) field (timelike, spacelike, and null), are considered in detail. These are the spin precessions induced by relic cosmological axions, axions distributed around spherically symmetric static objects, and axions in a gravitational wave field, respectively. We discuss features of the obtained exact solutions and some general properties of the axionically induced spin rotation.