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Mechanism of circular dichroism under magnetic-light- atom interaction

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In the research of the interaction between light and atoms, optical ellipticity is a key parameter to characterize the pump and absorption process [1,2]. It was generally believed that ellipticity only originated from the the interaction between magnetic fields and polarized alkali metal atomic ensembles in previous researches [3,4,5]. In this research, a new mechanism of circular dichroism caused by the interaction between the probe light and the polarized atom ensemble in the SERF regime is revealed by establishing a quantum mechanical model based on the density matrix, combining with Maxwell equations. The experiment results indicates that the interaction between magnetic field, alkali metal atomic ensemble and probe light is a new source of ellipticity. We prove that ellipticity is an inherent property of atomic ensemble, and is independent of external excitation conditions. This research verifies the coupling mechanism of the resonance light and the atomic ensemble in SERF magnetometer and provides a new theoretical framework for ultra-high sensitivity atomic magnetometer and multi physical field coupling measurement.

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