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Spin diffusion in ultracold spin-orbit coupled ^{40}K gas T. YU, M. W. WU, Univ of Sci Tech of China — We investigate the steady-state spin diffusion for ultracold spin-orbit coupled ^{40}K gas by the kinetic spin Bloch equation approach. It is found that the behaviors of the steady-state spin diffusion are determined by three characteristic lengths in the system: the mean free path, the Zeeman oscillation length and the spin-orbit coupling oscillation length. It is further revealed that by tuning the scattering strength, the system can be divided into *five* regimes, in which the behaviors of the spacial evolution of the steady-state spin polarization shows different dependencies on the scattering strength, Zeeman field and spin-orbit coupling strength. These rich behaviors of the spin diffusions in different regimes are hard to be understood in the framework of the simple drift-diffusion model or the direct inhomogeneous broadening picture in the literature. However, almost all these rich behaviors can be well understood by means of our *modified* drift-diffusion model and/or *modified* inhomogeneous broadening picture. Specifically, several anomalous features of the spin diffusion are revealed, which are in contrast to those obtained from *both* the simple drift-diffusion model and the direct inhomogeneous broadening picture.

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