Effects of dipole-dipole interaction in atomic vapors probed by two-dimensional coherent spectroscopy*

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Neutral atoms without permanent dipole moments can interact due to transition-induced dipole moments. Dipole-dipole interactions (DDIs) can lead to an energy shift of the atomic energy level and a change in the dephasing rate. The DDIs are usually detected by measuring the energy shift which might be difficult for weak DDIs, while the dephasing rate change has been largely overlooked. Optical two-dimensional coherent spectroscopy (2DCS) is extremely sensitive to DDIs and able to reveal the dephasing rate change due to DDIs. We implemented photon-echo, 1Q-2Q and double-quantum optical 2DCS to probe the effect of DDIs in the rubidium atomic vapor. From these spectra, we retrieved the decay rate change due to DDIs for the hyperfine levels of ^{87}Rb or ^{85}Rb's D2 lines. The results show that the change in dephasing rate is the primary effect, compared to the energy shift, of DDIs in dilute atomic vapors. This technique allows us to detect weak DDIs and measure the effects in both energy shift and dephasing rate due to DDIs.

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