We describe an unusual phenomenon that we have noticed for alkali-metal vapor that is optically pumped with D1, circularly polarized laser light. For certain optical frequencies, sufficiently weak light causes the vapor to become more opaque, while more intense light of the same frequency causes the vapor to become more transparent. This is in marked contrast to all previous observations that we know of, where pumping with circularly polarized D1 light increases the transparency of the vapor.

In summary, we have experimentally demonstrated the unusual signal reversal phenomena of the magnetic resonances of ground-state alkali-metal atoms pumped by D1 circularly polarized laser light. Under this circumstance, the hyperfine splitting has to be at least partially optically resolved, and the optical frequency of the pumping light should be tuned to reach near the lower hyperfine multiplets. The phenomena cannot be explained by the conventional two- or three-level modelings, or even a multi-level modeling with a universal damping rate. A valid theoretical explanation involves a density-matrix modeling with two important spin-relaxation mechanisms, spin-rotation interaction and spin-exchange interaction. The reversal phenomena are more pronounced especially when the rapid spin-exchange interaction. The reversal phenomena are more pronounced especially when the rapid spin-exchange interaction.

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