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XY-like frustrated magnetic phase transitions in α -RuCl₃

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It is known that a honeycomb-lattice antiferromagnet with the nearest-neighbor exchange interaction undergoes a conventional magnetic ordering even for the spin-1/2 case. However, when a certain amount of second-neighbor exchange interaction or anisotropic exchange interaction exists, the honeycomb-lattice quantum magnet exhibits an unusual ground state. In the last decade, spin-1/2 quantum magnets on honeycomb lattices have been attracting considerable attention from the viewpoints of the frustrated $J_1 - J_2$ model and the Kitaev-Heisenberg model, both of which can exhibit the spin liquid state in some parameter range.

α -RuCl₃ is a layered compound, in which magnetic Ru³⁺ ions with the $4d^5$ electronic state form a honeycomb lattice. We have investigated the magnetic properties of α -RuCl₃ via magnetization and specific heat measurements using single crystals. It was observed that α -RuCl₃ undergoes a structural phase transition at $T_t \simeq 150$ K accompanied by fairly large hysteresis. The magnetizations and magnetic susceptibilities are strongly anisotropic, which mainly arise from the anisotropic g -factors. These g -factors and the obtained entropy indicate that the effective spin of Ru³⁺ is one-half, which results from the low-spin state. Specific heat data show that magnetic ordering occurs in four steps at zero magnetic field. The magnetic phase diagram is obtained. The successive magnetic phase transitions can be ascribed to the competition among exchange interactions. We discuss the strongly anisotropic g -factors and deduce that the exchange interaction is strongly XY-like. Main results of this talk was published in Phys. Rev. B **91**, 094422 (2015).