



2013, XIII, 102 p. 71 illus. in color.

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Ryuji Okazaki

# Hidden Order and Exotic Superconductivity in the Heavy-Fermion Compound URu<sub>2</sub>Si<sub>2</sub>

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In this thesis, the author investigates hidden-order phase transition at  $T_0 = 17.5$  K in the heavy-fermion URu<sub>2</sub>Si<sub>2</sub>. The four-fold rotational symmetry breaking in the hidden order phase, which imposes a strong constraint on the theoretical model, is observed through the magnetic torque measurement. The translationally invariant phase with broken rotational symmetry is interpreted as meaning that the hidden-order phase is an electronic "nematic" phase. The observation of such nematicity in URu<sub>2</sub>Si<sub>2</sub> indicates a ubiquitous nature among the strongly correlated electron systems. The author also studies the superconducting state of URu<sub>2</sub>Si<sub>2</sub> below  $T_c = 1.4$  K, which coexists with the hidden-order phase. A peculiar vortex penetration in the superconducting state is found, which may be related to the rotational symmetry breaking in the hidden-order phase. The author also identifies a vortex lattice melting transition.

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