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Nota di contenuto	Introduction -- Superconducting Gap in CeCoIn5 -- Pairing Mechanism in CeCoIn5 -- Real and Momentum Space Probes in CeCoIn5: Defect States in Differential Conductance and Neutron Scattering Spin Resonance -- Transport in Nanoscale Kondo Lattices -- Charge and Spin Currents in Nanoscale Topological Insulators -- Conclusions -- Appendix: Keldysh Formalism for Transport.
Sommario/riassunto	This thesis reports a major breakthrough in discovering the superconducting mechanism in CeCoIn5, the “hydrogen atom” among

heavy fermion compounds. By developing a novel theoretical formalism, the study described herein succeeded in extracting the crucial missing element of superconducting pairing interaction from scanning tunneling spectroscopy experiments. This breakthrough provides a theoretical explanation for a series of puzzling experimental observations, demonstrating that strong magnetic interactions provide the quantum glue for unconventional superconductivity. Additional insight into the complex properties of strongly correlated and topological materials was provided by investigating their non-equilibrium charge and spin transport properties. The findings demonstrate that the interplay of magnetism and disorder with strong correlations or topology leads to complex and novel behavior that can be exploited to create the next generation of spin electronics and quantum computing devices.