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Sommario/riassunto	This thesis presents major advances toward the realization of quantum control in complex molecules for applications in precision metrology. Polyatomic molecules engineered to be sensitive to new fundamental particles and forces are a powerful platform to search for physics

beyond the Standard Model. A major limitation to this application, as well as any other relying on the complete quantum control of complex polyatomic molecules, is that fully understanding them remains a research frontier. This thesis represents several major steps toward the goal of quantum control in complex molecules, including tailored laser-driven chemistry to enhance their production, high-resolution spectroscopy to understand their structure, including the critical role of symmetry, and successful implementation of coherent quantum control. This thesis lays the foundation for fundamental studies in nuclear physics, particle physics, and physical chemistry using engineered, quantum-controlled molecules.