

1. Record Nr.	UNINA9910300557003321
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Titolo	High Precision Optical Spectroscopy and Quantum State Selected Photodissociation of Ultracold 88Sr2 Molecules in an Optical Lattice // by Mickey McDonald
Pubbl/distr/stampa	Cham : , : Springer International Publishing : , : Imprint : Springer, , 2018
ISBN	3-319-68735-2
Edizione	[1st ed. 2018.]
Descrizione fisica	1 online resource (XVII, 183 p. 60 illus., 57 illus. in color.)
Collana	Springer Theses, Recognizing Outstanding Ph.D. Research, , 2190-5053
Disciplina	543.5
Soggetti	Quantum optics Low temperature physics Low temperatures Physical measurements Measurement Atomic structure Molecular structure Spectroscopy Microscopy Quantum Optics Low Temperature Physics Measurement Science and Instrumentation Atomic/Molecular Structure and Spectra Spectroscopy and Microscopy
Lingua di pubblicazione	Inglese
Formato	Materiale a stampa
Livello bibliografico	Monografia
Nota di bibliografia	Includes bibliographical references at the end of each chapters.
Nota di contenuto	Chapter1. Introduction -- Chapter2. Structure of 88Sr and 88Sr2 -- Chapter3. Measurements of binding energies -- Chapter4. Measurements of Zeeman shifts -- Chapter5. Magnetic control of transition strengths -- Chapter6. Subgradient spectroscopy -- Chapter7. Carrier thermometry in optical lattices -- Chapter8. Photodissociation and ultracold chemistry.

## Sommario/riassunto

This thesis unites the fields of optical atomic clocks and ultracold molecular science, laying the foundation for optical molecular measurements of unprecedented precision. Building upon optical manipulation techniques developed by the atomic clock community, this work delves into attaining surgical control of molecular quantum states. The thesis develops two experimental observables that one can measure with optical-lattice-trapped ultracold molecules: extremely narrow optical spectra, and angular distributions of photofragments that are ejected when the diatomic molecules are dissociated by laser light pulses. The former allows molecular spectroscopy approaching the level of atomic clocks, leading into molecular metrology and tests of fundamental physics. The latter opens the field of ultracold chemistry through observation of quantum effects such as matter-wave interference of photofragments and tunneling through reaction barriers. The thesis also describes a discovery of a new method of thermometry that can be used near absolute zero temperatures for particles lacking cycling transitions, solving a long-standing experimental problem in atomic and molecular physics.

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