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3.5.1 Heterodyne Measurements of Frequency3.5.2 Self-heterodyning; 3.5.3 Aliasing; 3.6 Frequency Stabilization with a Noisy Signal; 3.6.1 Degradation of the Frequency Stability Due to Aliasing; 4 Macroscopic Frequency References; 4.1 Piezoelectric Crystal Frequency References; 4.1.1 Basic Properties of Piezoelectric Materials; 4.1.2 Mechanical Resonances; 4.1.3 Equivalent Circuit; 4.1.4 Stability and Accuracy of Quartz Oscillators; 4.2 Microwave Cavity Resonators; 4.2.1 Electromagnetic Wave Equations; 4.2.2 Electromagnetic Fields in Cylindrical Wave Guides; 4.2.3 Cylindrical Cavity Resonators
4.2.4 Losses due to Finite Conductivity4.2.5 Dielectric Resonators; 4.3 Optical Resonators; 4.3.1 Reflection and Transmission at the Fabry-Perot Interferometer; 4.3.2 Radial Modes; 4.3.3 Microsphere Resonators; 4.4 Stability of Resonators; 5 Atomic and Molecular Frequency References; 5.1 Energy Levels of Atoms; 5.1.1 Single-electron Atoms; 5.1.2 Multi-electron Systems; 5.2 Energy States of Molecules; 5.2.1 Ro-vibronic Structure; 5.2.2 Optical Transitions in Molecular Iodine; 5.2.3 Optical Transitions in Acetylene; 5.2.4 Other Molecular Absorbers
5.3 Interaction of Simple Quantum Systems with Electromagnetic Radiation5.3.1 The Two-level System; 5.3.2 Optical Bloch Equations; 5.3.3 Three-level Systems; 5.4 Line Shifts and Line Broadening; 5.4.1 Interaction Time Broadening; 5.4.2 Doppler Effect and Recoil Effect; 5.4.3 Saturation Broadening; 5.4.4 Collisional Shift and Collisional Broadening; 5.4.5 Influence of External Fields; 5.4.6 Line Shifts and Uncertainty of a Frequency Standard; 6 Preparation and Interrogation of Atoms and Molecules; 6.1 Storage of Atoms and Molecules in a Cell; 6.2 Collimated Atomic and Molecular Beams
6.3 Cooling

Sommario/riassunto

Of all measurement units, frequency is the one that may be determined with the highest degree of accuracy. It equally allows precise measurements of other physical and technical quantities, whenever they can be measured in terms of frequency.This volume covers the central methods and techniques relevant for frequency standards developed in physics, electronics, quantum electronics, and statistics. After a review of the basic principles, the book looks at the realisation of commonly used components. It then continues with the description and characterisation of important frequency standards

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