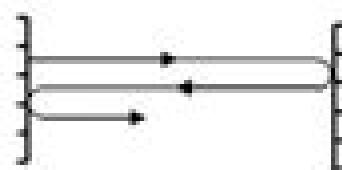
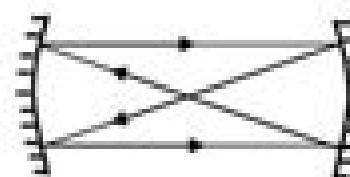


# What is an optical resonator?

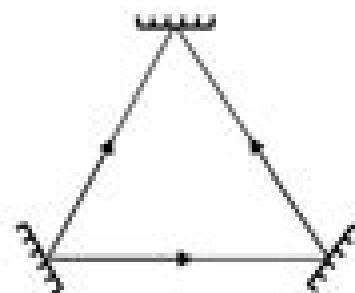
An optical resonator, the optical counterpart of an electronic resonant circuit, confines and stores light at certain resonance frequencies. It may be viewed as an optical transmission system incorporating feedback; light circulates or is repeatedly reflected within the system, without escaping.



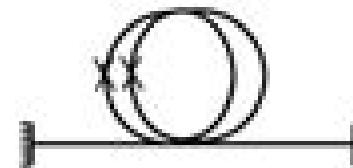
(a)



(b)



(c)



(d)

# Optical Resonators

**S Nieto**



## **Optical Resonators**

**Optical Resonators** Norman Hodgson, Horst Weber, 2013-03-09 Optical Resonators provides a detailed discussion of the properties of optical resonators for lasers from basic theory to recent research. In addition to describing the fundamental theories of resonators such as geometrical optics, diffraction and polarisation, the characteristics of all important resonator schemes and their calculation are presented. Experimental examples, practical problems and a collection of measurement techniques support the comprehensive treatment of the subject. Optical Resonators is the only book currently available that provides a comprehensive overview of the subject. Combined with the structure of the text and the autonomous nature of the chapters, this work will be as suitable for those new to the field as it will be invaluable to specialists conducting research.

**Fiber-Based Optical Resonators** Deepak Pandey, 2024-01-29 After laying the foundation by explaining the fundamental principles of light propagation and optical resonators, this book delves into the realm of implementing resonators through a fiber-based approach. It extensively explores fiber-based resonators, encompassing a comprehensive discussion spanning from their intricacies of design to their pivotal roles in advancing quantum optics experiments. Furthermore, it details the design techniques, meticulously explaining the latest developments within this dynamic field. There are vivid illustrations highlighting the various applications of resonators in experimental optics and cavity quantum electrodynamics. Also, a discourse is presented regarding the future potential of fiber-based resonators in quantum technology. The book serves as a valuable resource for individuals with an interest in optical resonators and their boundless possibilities.

[Laser Resonators and Beam Propagation](#) Norman Hodgson, Horst Weber, 2005-12-19 Optical Resonators provides a detailed discussion of the properties of optical resonators for lasers from basic theory to recent research. In addition to describing the fundamental theories of resonators such as geometrical optics, diffraction and polarisation, the characteristics of all important resonator schemes and their calculation are presented. Experimental examples, practical problems and a collection of measurement techniques support the comprehensive treatment of the subject. Optical Resonators is the only book currently available that provides a comprehensive overview of the subject. Combined with the structure of the text and the autonomous nature of the chapters, this work will be as suitable for those new to the field as it will be invaluable to specialists conducting research. This second edition has been enlarged by new sections on Q switching and resonators with internal phase amplitude control.

**Optical Resonators – Science and Engineering** R. Kossowsky, Miroslav Jelinek, Josef Novák, 1998 This volume contains 33 of the papers presented at the Advanced Research Workshop in July 1997. The workshop was designed to initiate a dialogue among specialists in resonator and cavity design from NATO and CP countries. The papers fall under the headings of physics and theory, phase conjugation optics and optimization of design. Topics include nonorthogonal optical modes and resonators, thermal lensing in Kerr lens, modelocked solid state lasers, beam divergency studies on a long pulse XeCl excimer laser, highly efficient high average power Nd YAG laser with a passive Q switch and creation of channels into Ti sapphire.

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**Optical Microresonators** John Heebner, Rohit Grover, Tarek A. Ibrahim, 2008 Optical Micro Resonators are an exciting new field of research that has gained prominence in the past few years due to the emergence of new fabrication technologies. This book is the first detailed text on the theory, fabrication and applications of optical micro resonators and will be found useful by both graduate students and researchers in the field.

**Laser Resonators and Beam Propagation** Norman Hodgson, Horst Weber, 2001-03-15 Optical Resonators provides a detailed discussion of the properties of optical resonators for lasers from basic theory to recent research. In addition to describing the fundamental theories of resonators such as geometrical optics, diffraction and polarisation, the characteristics of all important resonator schemes and their calculation are presented. Experimental examples, practical problems and a collection of measurement techniques support the comprehensive treatment of the subject. Optical Resonators is the only book currently available that provides a comprehensive overview of the subject. Combined with the structure of the text and the autonomous nature of the chapters, this work will be as suitable for those new to the field as it will be invaluable to specialists conducting research. This second edition has been enlarged by new sections on Q switching and resonators with internal phase amplitude control.

*Optical Resonators - Science and Engineering*, 1997 This report contains conference proceedings concerning the following topics related to optical resonators:

1. physics and theory
2. phase conjugation
3. optics
4. optimization of design

**Optical Resonators** Society of Photo-optical Instrumentation Engineers, 1990

**Compact Coupled Optical Resonators and Their Applications** Wenqiong Guo, 2016 Optical resonators can slow down light by utilizing the interference between light waves. This makes them a technology of great significance. Thanks to the emergence of silicon photonics on chip, optical resonator devices have seen an unprecedented reduction in footprint and a high level of integration. Coupled resonator optical waveguides (CROW) which consist of a chain of optically coupled cavities are one of the widely studied and most promising structures. They exhibit unique abilities to support broadband slow light and dynamic tunability which have important applications in many branches of photonics. These features however generally require coupling a large number  $N$  of resonators which compromises compactness and thermal stability. In this work we introduce two new classes of optical interferometers that exhibit properties similar to CROWs while occupying a much smaller area ( $1/N$ ) and being consequently more stable against temperature gradient. First we propose the coupled spiral interferometer (CSPIN) which consists of a planar waveguide coiled into a spiral. The distance between the spiral's adjacent arms is small enough that light is continuously coupled between them. This distributed coupling gives CSPINs a distinct set of properties some similar to those of ring resonators and CROWs and others unique. Their actual behavior depends on the number of arms and the intra arm coupling distribution. Besides the main advantage of greater compactness and stability, simulations show that as a result of the waveguides inherent mode index dispersion any intra arm coupling coefficient acts as critical coupling maximum energy storage at selected wavelengths.

Similarly a CSPIN can be designed as a sensor with a sensitivity that is maximum for any value of the intra arm coupling provided the wavelength of the light interrogating the sensor is suitably selected Second we study the nested coupled resonant optical waveguides nested CROW It consists of a set of concentric rings with decreasing radii The rings are located inside each other with very small spacing so light can continuously couple between them A nested CROW behaves like a ring resonator when the intra ring coupling is weak and like a CSPIN and a CROW when the coupling is strong A unique aspect of the nested CROW is that its resonant wavelengths depend on the intra ring coupling When the propagation loss is relatively small any value of strong coupling is the critical coupling for a set of resonant wavelengths Increasing the number of rings creates more resonance peaks By selecting appropriate intra ring couplings a nested CROW can also exhibit broadband transmission window that has flat top and sharp roll off In this thesis work we compared the sensitivity of a CSPIN and a nested CROW to existing resonators including a CROW and a single ring resonator with the same radius and loss coefficient After optimizing each device individually for maximum sensitivity by selecting the optimum intra ring or intra arm coupling and optimum interrogating wavelength we show that coupling resonators together as in a CROW a CSPIN or a nested CROW does not increase the device's sensitivity These resonators all exhibit the same optimal sensitivity as a single ring resonator with the same radius and loss When applied to the particular case of rotation sensing using the Sagnac effect we confirmed through numerical simulations that the sensitivity to rotation is independent of the number of arms in the CSPIN and exactly the same as the sensitivity to rotation of a ring resonator The last part of this thesis describes the fabrication and characterization of the first experimental CSPINs The devices are made with silicon waveguides with sub micron transverse dimensions on a silica substrate with a spiral radius of 150 m and either two or three arms They were found to exhibit the resonance spectra predicted by theory Measurements confirm that the sensitivity of a CSPIN with modal index dispersion is independent of the intra arm coupling This property gives the CSPIN a significant edge over other resonator based sensors which require careful adjustment of the coupling ratio a difficult task with low reproducibility in practice

**Fiber-Based Optical Resonators** Deepak Pandey, 2024-01-29 After laying the foundation by explaining the fundamental principles of light propagation and optical resonators this book delves into the realm of implementing resonators through a fiber based approach It extensively explores fiber based resonators encompassing a comprehensive discussion spanning from their intricacies of design to their pivotal roles in advancing quantum optics experiments Furthermore it details the design techniques meticulously explaining the latest developments within this dynamic field There are vivid illustrations highlighting the various applications of resonators in experimental optics and cavity quantum electrodynamics Also a discourse is presented regarding the future potential of fiber based resonators in quantum technology The book serves as a valuable resource for individuals with an interest in optical resonators and their boundless possibilities

**The Physics and Technology of Laser Resonators** Dennis Hall, 1990-01-01 Comprehensive yet concise The Physics and Technology of Laser

Resonators presents both the fundamentals and latest developments in laser resonator technology including specific case studies. The book covers various types of resonators including unstable ring laser and multifold laser. It also discusses numerical resonator calculations and laser beam analysis. This reference will be of value and interest both to newcomers to the field and to professional engineers wishing to update their knowledge. **Novel Optical Resonators** John Nelson, 2011

Optical resonators two mirrors facing each other separated by a distance are a very well studied technology. However even such a well understood technology can sometimes present surprises. The first part of this thesis investigates the surprising properties of some canonical optical resonators. The basic properties of resonators are introduced. The imaging properties of stable and unstable resonators are examined. The second part of this thesis examines the potential use of grating coupled cavities in gravitational wave detectors and describes an experiment carried out on a 10 m prototype of such a cavity.

**Electromagnetics and Optics** E. E. Kriezis, D. P. Chrissoulidis, A. G. Papagiannakis, 1992 The book addresses the natural link between electromagnetics and optics. The electromagnetic origin of optical phenomena is sought through a dual approach to optics which is based on the wave equation and ray theory. A review of the underlying principles as well as mechanisms of wave ray interactions with matter are presented first. An examination of guided propagation of light through various dielectric waveguides follows. Aspects of resonant light propagation such as Gaussian beams, resonators and lasers are treated next. The basic theory of light processing by optical elements is presented in the fourth part which covers Fourier optics, the scalar theory of diffraction and holography. The book further refers to miscellaneous topics such as optical radiation, remote sensing and nonlinear phenomena. *Practical Applications of Microresonators in Optics and Photonics* Andrey B. Matsko, 2018-09-03 Assembling an international team of experts this book reports on the progress in the rapidly growing field of monolithic micro and nanoresonators. The book opens with a chapter on photonic crystal based resonators, nanocavities. It goes on to describe resonators in which the closed trajectories of light are supported by any variety of total internal reflection in curved and polygonal transparent dielectric structures. The book also covers distributed feedback microresonators for slow light controllable dispersion and enhanced nonlinearity. A portion of coverage is dedicated to the unique properties of resonators which are extremely efficient tools when conducting multiple applications.

**Unstable Optical Resonators** Stanford University. Microwave Laboratory, 1974 *The Theory of Optical Resonators* L. Ronchi, 1979

*Selected Papers on Laser Resonators*, 1975 *Passive Optical Resonators for Next-Generation Attosecond Metrology* Ioachim Pupeza, 2022-02-01 This book introduces readers to the development of a new generation of high pulse repetition frequency instruments for multi dimensional attosecond resolution photoelectron spectroscopy attosecond PES. It investigates the power scaling of femtosecond enhancement cavities for efficient intracavity high harmonics generation HHG. Further it derives and verifies advanced resonator designs that feature large illuminated spots on all mirrors which mitigate both intensity and thermally induced enhancement limitations. The dynamics of a high finesse passive resonator in the

presence of a highly nonlinear optical process such as HHG are quantitatively investigated both theoretically and experimentally. These investigations are instrumental in achieving the holistic optimization of the XUV source reported on here which for the first time reached intracavity HHG conversion efficiencies comparable to those achieved in single pass setups with a similar gas target. Coupling out the XUV beam from the enhancement cavity by purely geometric means employing both the fundamental and higher order transverse Gaussian modes is studied. This offers the advantages of robustness, low distortion to the participating pulses and photon energy scalability. Last but not least the author provides a range of proof of principle attosecond angle resolved PES experiments. The book gives an outlook on the possible future development of cavity enhanced HHG and an extensive discussion on the generation of isolated XUV attosecond pulses via intracavity wavefront rotation. Selected Papers on Laser Resonators, 1975. **Gaussian Beams and Optical Resonators** Anatolii Nikolaevich Oraevskii, 1996. Gaussian Beams Optical Resonators. Proceedings Of The Lebedev Physics Institute A N Oraevsky

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