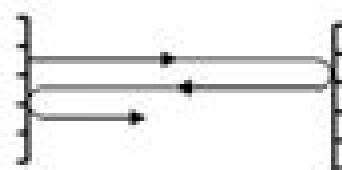
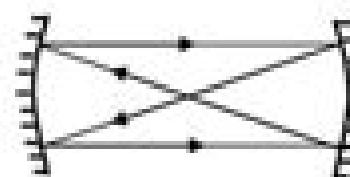


# What is an optical resonator?

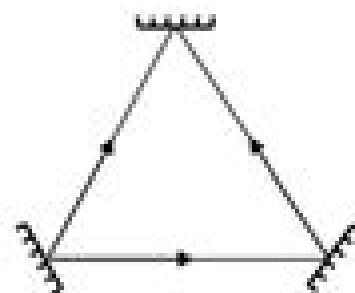
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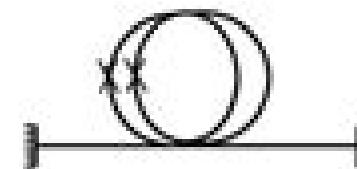
(a)



(b)



(c)



(d)

# Optical Resonators

**Anatolii Nikolaevich Oraevskii**

## **Optical Resonators:**

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**Optical Microresonators** John Heebner, Rohit Grover, Tarek Ibrahim, 2007-12-19 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.

*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.

*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 waveguiding layers

Annotation copyrighted by Book News Inc Portland OR **Gaussian Beams and Optical Resonators** Anatolii Nikolaevich Oraevskii, 1996 Gaussian Beams Optical Resonators Proceedings Of The Lebedev Physics Institute A N Oraevsky *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 **Optical Resonators** Society of Photo-optical Instrumentation Engineers, 1990

**Nonlinear Optical Cavity Dynamics** Philippe Grelu, 2015-12-23 By recirculating light in a nonlinear propagation medium the nonlinear optical cavity allows for countless options of light transformation and manipulation In passive media optical bistability and frequency conversion are central figures In active media laser light can be generated with versatile underlying dynamics Emphasizing on ultrafast dynamics the vital arena for the information technology the soliton is a common conceptual keyword thriving into its modern developments with the closely related denominations of dissipative solitons and cavity solitons Recent technological breakthroughs in optical cavities from micro resonators to ultra long fiber cavities have entitled the exploration of nonlinear optical dynamics over unprecedented spatial and temporal orders of magnitude By gathering key contributions by renowned experts this book aims at bridging the gap between recent research topics with a view to foster cross fertilization between research areas and stimulating creative optical engineering design

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Indiana University in Bloomington on August 8 11 2007 The Meeting focused on experimental tests of these fundamental symmetries and on important theoretical issues including scenarios for possible relativity violations Experimental subjects covered include astrophysical observations clock comparison measurements cosmological birefringence electromagnetic resonant cavities gravitational tests matter interferometry muon behavior neutrino oscillations oscillations and decays of neutral mesons particle antiparticle comparisons post Newtonian gravity space based missions spectroscopy of hydrogen and antihydrogen and spin polarized matter Theoretical topics covered include physical effects at the level of the Standard Model General Relativity and beyond the possible origins and mechanisms for Lorentz and CPT violations and associated issues in field theory particle physics gravity and string theory Contributors consist of the leading experts in this very active research field

**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

**Transverse Patterns in Nonlinear Optical Resonators** Kestutis Staliunas,V.J. Sánchez-Morcillo,2003-07-03 The growth of regularity from disorder the evolution from the simple towards the complex and the spontaneous formation of spatio temporal patterns in general are questions which intrigue everybody This has been one of the basic philosophical topics from ancient to modern times Is nature able to create something fundamentally new by itself If yes how does this creation occurs Or does nature only reproduce something which was already encoded in it from the very beginning This remained a topic exclusively for philosophers until very recently and it was only a few decades ago that physicists started to convert this seemingly purely philosophical subject into a scientific discipline a scientific discipline like other scientific disciplines where one relies on formulas and equations on numerical simulations and on laboratory experiments This book is

not about general questions related to pattern formation and self organization in nature It is about spontaneous patterns in just one part of nature in nonlinear optical systems and more precisely in nonlinear optical resonators Nonlinear optical systems represent a small part of nature but a very representative part one can observe here nearly all the known symmetries of patterns one can generate nearly all known types of localized structures and one can realize nearly all known spatial instabilities and spatial bifurcations *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  $\mu$ 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.

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