

# SOLITON-BASED MICRORING RESONATORS: GENERATION AND APPLICATION IN OPTICAL COMMUNICATION



IRAJ S. AMIRI

# Soliton Based Microring Resonators Application Communication

**Auro Michele Perego, Andrew Ellis**



## **Soliton Based Microring Resonators Application Communication:**

**Soliton-based Microring Resonators** Iraj S. Amiri, 2015-11-27 This book presents the recent developments in generation and application of optical communication pulses which have the properties of soliton Simulation of Optical Soliton Control in Micro- and Nanoring Resonator Systems Suzairi Daud, Sevia Mahdaliza Idrus, Jalil Ali, 2015-03-17 This book introduces optical soliton control in micro and nanoring resonator systems It describes how the ring resonator systems can be optimized as optical tweezers for photodetection by controlling the input power ring radii and coupling coefficients of the systems Numerous arrangements and configurations of micro and nanoring resonator systems are explained The analytical formulation and optical transfer function for each model and the interaction of the optical signals in the systems are discussed This book shows that the models designed are able to control the dynamical behaviour of generated signals

Optical Soliton Communication Using Ultra-Short Pulses Iraj Sadegh Amiri, Harith Ahmad, 2015-05-07 This brief analyzes the characteristics of a microring resonator MRR to perform communication using ultra short soliton pulses The raising of nonlinear refractive indices coupling coefficients and radius of the single microring resonator leads to decrease in input power and round trips wherein the bifurcation occurs As a result bifurcation or chaos behaviors are seen at lower input power of 44 W where the nonlinear refractive index is  $n_2 = 3.2 \times 10^{-20} \text{ m}^2/\text{W}$  Using a decimal convertor system these ultra short signals can be converted into quantum information Results show that multi solitons with FWHM and FSR of 10 pm and 600 pm can be generated respectively The multi optical soliton with FWHM and FSR of 325 pm and 880 nm can be incorporated with a time division multiple access TDMA system wherein the transportation of quantum information is performed **Ring**

**Resonator Systems to Perform Optical Communication Enhancement Using Soliton** Iraj Sadegh Amiri, Abdolkarim Afroozeh, 2014-08-27 The title explain new technique of secured and high capacity optical communication signals generation by using the micro and nano ring resonators The pulses are known as soliton pulses which are more secured due to having the properties of chaotic and dark soliton signals with ultra short bandwidth They have high capacity due to the fact that ring resonators are able to generate pulses in the form of solitons in multiples and train form These pulses generated by ring resonators are suitable in optical communication due to use the compact and integrated rings system easy to control flexibility less loss application in long distance communication and many other advantages Using these pulses overcome the problems such as losses during the propagation long distances error detection using many repeaters or amplifiers undetectable received signals pulse broadening overlapping and so on This book show how to generate soliton pulses using ring resonators in the micro and nano range which can be used in optical communication to improve the transmission technique and quality of received signals in networks such as WiFi and wireless communication Soliton Coding for Secured Optical Communication Link Iraj Sadegh Amiri, Sayed Ehsan Alavi, Sevia Mahdaliza Idrus, 2014-07-24 Nonlinear behavior of light such as chaos can be observed during propagation of a laser beam inside the microring resonator MRR

systems This Brief highlights the design of a system of MRRs to generate a series of logic codes An optical soliton is used to generate an entangled photon The ultra short soliton pulses provide the required communication signals to generate a pair of polarization entangled photons required for quantum keys In the frequency domain MRRs can be used to generate optical millimetre wave solitons with a broadband frequency of 0 100 GHz The soliton signals are multiplexed and modulated with the logic codes to transmit the data via a network system The soliton carriers play critical roles to transmit the data via an optical communication link and provide many applications in secured optical communications Therefore transmission of data information can be performed via a communication network using soliton pulse carriers A system known as optical

multiplexer can be used to increase the channel capacity and security of the signals **Nanoscale Nonlinear PANDA Ring**

**Resonator** Preecha Yupapin, Chat Teeka, J. Ali, 2012-05-02 Microring nanoring resonator is an interesting device that has been widely studied and investigated by researchers from a variety of specializations This book begins with the basic background of linear and nonlinear ring resonators A novel design of nano device known as a PANDA ring resonator is proposed The use of the device in the form of a PA *Optical Frequency Combs* Auro Michele Perego, Andrew

Ellis, 2024-11-27 *Optical Frequency Combs Trends in Sources and Applications* offers an overview of the recent advances on the physics sources and applications of optical frequency comb technology one of the most exciting and fast developing research fields in photonics The book aims at showcasing recent advances through contributions by key players in a multifaceted research ecosystem and at the same time at providing a valuable service to the community by offering an as much comprehensive as possible review which at the same time highlights challenges to be solved and promising future directions The main topics covered include i an overview of different platforms for optical frequency combs generation as fibre lasers quantum cascade lasers integrated microresonators and waveguides fibre resonators electro optic modulators and nonlinear fibres multicore fibres ii a selection of applications in different technologies including sensing spectroscopy precision metrology and optical clocks microscopy radio frequency generation distance ranging and optical communications iii a diverse range of physical methods for frequency comb generation such as modulation laser mode locking techniques dissipative solitons and parametric gain in nonlinear resonators nonlinear spectral broadening and supercontinuum formation in waveguides This book will be a valuable resource for academics researchers and postgraduate students working and interested in the field optical frequency combs and more broadly in photonic technologies too Key Features Edited by authorities in the field with chapter contributions from subject area leading experts in academia and industry Up to date with the latest technological developments applications and fundamental research from the field Describes comb properties depending on source and generation platform and comb specifications matching to application needs **Microring**

**Resonators** A. Afroozeh, I. S. Amiri, A. Zeinalinezhad, Y. Farhang, 2015-12-03 This study starts with design considerations the functional behaviour and key characteristics of the microring resonator and add drop ring resonators allowing the

performance of higher order filters For nonlinear materials the basic equations to describe the formation and propagation of different types of optical solitons are well known The resonance condition is satisfied when the circumference of the microring resonators or generally the round trip length is equal to an integer multiple of the optical wavelength inside the medium The chaotic behaviour of the multi output signals generated from these devices can be filtered using appropriate parameters Optical chaos is observed in many non linear optical systems One of the most common examples is a microring resonator Chaotic behaviour has been considered as a nonlinear property in physics electronics and communication Soliton is a self reinforcing solitary wave a wave packet or pulse that maintains its shape while it travels at constant speed Among all the types of solitons optical vector solitons draw the most attention due to their wide range of applications particularly in generating ultrafast pulses and light control technology Dark solitons are much less stable due to the cross interaction between the two polarization components The bus waveguides of the microring resonator are cladded by silica which serves both to improve modal confinement and facilitate wafer bonding for structural support The source of nonlinear reaction is related to harmonic motion of bound electrons under the influence of an applied field The total polarization  $P$  induced by electric dipoles is not linear in the electric field The extent that the signal degrades depends on the purity of the glass and the wavelength of the transmitted light This refractive index variation is responsible for the nonlinear optical effects of self focusing self phase modulation and modulation instability and is the basis for Kerr lens mode locking The quality factor of a resonator is a measure of the sharpness of the resonance Therefore the optimum fabrication process can be obtained with respect to higher quality factor of the device The phenomenon of optical bistability within the system arises from a combination of the nonlinearity in the radiation matter interaction and of a feedback mechanism **Optics Letters** ,2007

Integrated Micro-Ring Photonics Iraj Sadegh Amiri,Abdolkarim Afroozeh,Harith Ahmad,2016-12-08 Micro ring resonators MRRs are employed to generate signals used for optical communication applications where they can be integrated in a single system These structures are ideal candidates for very large scale integrated VLSI photonic circuits since they provide a wide range of optical signal processing functions while being ultra compact Soliton pulses have sufficient stability for preservation of their shape and velocity Technological progress in fields such as tunable narrow band laser systems multiple transmission and MRR systems constitute a base for the development of new transmission techniques Controlling the speed of a light signal has many potential applications in fiber optic communication and quantum computing The slow light effect has many important applications and is a key technology for all optical networks such as optical signal processing Generation of slow light in MRRs is based on the nonlinear optical fibers Slow light can be generated within the micro ring devices which will be able to be used with the mobile telephone Therefore the message can be kept encrypted via quantum cryptography Thus perfect security in a mobile telephone network is plausible This research study involves both numerical experiments and theoretical work based on MRRs for secured communication **Journal of the Optical Society of America** ,2003

**Optical Solitons in Nonlinear Micro Ring Resonators** N. Pornsuwanchaoen, Jalil Ali, Preecha P. Yupapin, 2009 Non linear behaviours of light have been recognised as the penalty in the subject of optical science and technology However the authors have shown the interesting results that the non linear property of light pulse especially an optical soliton can be probed into the specific device or system to be beneficial in various cases for instance a soliton pulse within a nano waveguide can form many unexpected applications Firstly the basic property of a soliton is analysed and described Secondly the use of a soliton pulse within a non linear waveguide that can perform the various cases of benefit and application is described The principle and application details of the systems such as soliton background soliton in communication sensing applications high resolution optical lithography and spectroscopy quantum measurement and metrology quantum information and finally the promising results of dark bright soliton behaviours and related applications are proposed The potential of applications using the proposed device and techniques for nanoscale technology is discussed herein This is a benefit to scientists engineers and technologists for a wide range of application in the area of optical science and technology

Nonlinear Optics, 2002      **Radio Over Fiber (Rof) Applications Using Soliton Generated by Optical Resonator** Iraj S. Amiri, 2015-12-08 A system of microring resonator MRR for wireless personal area networks WPAN indoor optical communication has been demonstrated The optical soliton is generated by the laser pulse that propagates within an MRR system connected to an add drop filter system A high frequency band of optical soliton pulses can be used in optical communication networks such as WPAN and IEEE 802 15 3c indoor systems in which very high bit rate connectivity can be provided The loss of the transmission system can be compensated by using the multiple optical soliton frequency bands ranging between 57 61 GHz where the receiver is provided at the end of the transmission link Here the single soliton pulses with FWHM in the range of MHz are generated where the multi soliton pulses have the same range of bandwidth These pulses can be transmitted along the wired wireless transmission link Therefore the WPAN indoor system which presents short distance optical communication can be performed using the generated GHz band frequency optical soliton pulses In this book we discuss about the different kinds of wireless systems and the generated pulses compare with the used current waves Related works of optical soliton signals have been reviewed We investigate the result based on the chaotic signal generated within the nonlinear optical microring resonators      **Using Microring Resonator Generated Soliton**

**Waveforms to Improve Wavelength Division Multiplexing-based Optical Wireless Communications** Ali

Shahidinejad, 2015      **Microring Resonator for Secured Optical Communication** Iraj Sadegh Amiri, Sayed Ehsan Alavi, Sevia Mahdaliza Idrus, Mojgan Kouhnavard, 2014-07-21 A novel system of dark soliton array DSA for secured communication generated by using the multiplexed dark soliton pulses is proposed The multi soliton pulses with relevant parameters are input into the micro ring resonators system with the radii of 10 m and 5 m where the dynamic dark solitons can be controlled and generated The DSA are obtained by using a series micro ring resonators with parameters where in the

wavelength range of 1.56–1.58 and 1.60. For security applications the DSA can be tuned and amplified. Thus the use of DSA for high capacity which can be realized by using proposed secured system. In transmission the long distance link of the multi variable network can be performed by this DSA.

**Evaluation of a Microring Resonator's Performance for Optical Soliton Communication System** Kunju Raman Ragawan, 2012

**Optical Soliton Based Communication Using Ring Resonators** Iraj Sadegh Amiri, 2013

**Soliton and Radio Over Fiber (RoF) Applications** Iraj Sadegh Amiri, Ali Nikoukar, Sayed Ehsan Alavi, 2014-02

A system of microring resonators (MRRs) connected to an optical modified add drop filter system is used. The optical soliton pulse of 60 GHz frequency band can be generated and used for millimeter waves in radio over fiber (RoF) applications. Wireless Personal Area Network (WPAN) as IEEE 802.15.3c is one of the applications for the RoF. The system uses chaotic signals generated by a Gaussian laser pulse propagating within a nonlinear MRRs system. The chaotic signals can be generated via a series of MRRs. The IEEE 802.15.3c standard operates at the 60 GHz frequency band and it is applicable for a short distance optical communication such as indoor systems where the higher transmission data rate can be performed using a high frequency band of the output optical soliton pulses.

Optical Microring Resonators Vien Van, 2016-12-19

a detailed cognizant account of numerous crucial aspects of optical microring resonators. Amr S. Helmy, Professor of Electrical Computer Engineering, University of Toronto, an excellent choice for gaining an insight into the vast potential of microring resonators. Jalil Ali, Professor, Laser Center, ISI SIR, University of Technology, Malaysia, a thorough treatment appeals to a wide range of audiences. L. Jay Guo, Professor of Electrical Engineering, Computer Science, The University of Michigan. The field of microring resonator research has seen tremendous growth over the past decade with microring resonators now becoming a ubiquitous element in integrated photonics technology. This book fills the need for a cohesive and comprehensive treatment of the subject given its importance and the proliferation of new research in the field. The expert author has, as an introductory guide for beginners as well as a reference source for more experienced researchers. This book aims to fulfill this need by providing a concise and detailed treatment of the fundamental concepts and theories that underpin the various applications. To appeal to as wide a readership as possible, major areas of applications of microring resonators will also be covered in depth.

## Unveiling the Energy of Verbal Art: An Psychological Sojourn through **Soliton Based Microring Resonators Application Communication**

In some sort of inundated with displays and the cacophony of immediate interaction, the profound power and psychological resonance of verbal beauty frequently fade in to obscurity, eclipsed by the regular assault of sound and distractions. Yet, situated within the lyrical pages of **Soliton Based Microring Resonators Application Communication**, a charming work of fictional elegance that impulses with fresh emotions, lies an memorable journey waiting to be embarked upon. Penned by way of a virtuoso wordsmith, this interesting opus books visitors on a psychological odyssey, delicately exposing the latent potential and profound influence stuck within the delicate web of language. Within the heart-wrenching expanse of the evocative examination, we shall embark upon an introspective exploration of the book is main styles, dissect its charming writing model, and immerse ourselves in the indelible impression it leaves upon the depths of readers souls.

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### **Soliton Based Microring Resonators Application Communication Introduction**

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