

# **SELIM M. SHAHRIAR**

## **Curriculum Vitae**

[*Note: In publications, my name appears as M.S. Shahriar (most often), S.M. Shahriar, Selim M. Shahriar, or Selim Shahriar*]

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## A. BIOGRAPHICAL SUMMARY

### Professional Preparation:

MIT	Physics	SB, 1986
MIT	EECS	SB, 1986
MIT	EECS	SM, 1989
MIT	EECS	Ph.D. 1992

Ph.D. Thesis Title: *Fundamental Studies and Applications in Three Level Atoms*  
SM Thesis Title: *Raman Atomic Clock Studies*  
Minor: *Relativistic Quantum Field Theory*

### Appointments:

AT&T Professor, ECE Dept., Northwestern University, 9/1/20-8/31/21  
Professor, ECE Dept., Northwestern University, 9/1/08-  
Professor, Physics and Astronomy Dept., Northwestern University, 9/1/08-  
Professor, Applied Physics Graduate Program, 9/1/11-  
Director, Solid State, Photonics and Quantum Technologies Division, ECE, Northwestern University, 9/1/08-  
Associate Professor, EECS Dept., Northwestern University, 2001-2008  
  
Research Laboratory of Electronics, MIT, Principal Research Scientist, 2001  
Research Laboratory of Electronics, MIT, Research Scientist, 1992-2000  
Research Laboratory of Electronics, MIT, Postdoctoral Associate, 1991-1992  
  
Founder, Chairman of the Board, and Chief Scientific Adviser,  
Digital Optics Technologies, Rolling Meadows, IL 60008, 6/1/98-

### Centers and Other Scientific Teams:

Director, NU Branch of Center of Excellence in Advanced Quantum Sensing (CoE-AQS), 2020-  
Member, Center for Interdisciplinary Exploration and Research in Astrophysics, 2009-  
Council Member, LIGO Scientific Collaboration, 2008-

### Professional Society Memberships:

- Optica (Formerly Optical Society of America)
- International Society for Optics and Photonics (SPIE)
- American Physical Society,
- IEEE
- Phi Beta Kappa
- Sigma Xi

**Honors and Awards:**

- Fellow, SPIE
- Fellow, Optica (Formerly OSA)
- Distinguished Science Award of the National Space Club - Huntsville Chapter (co-winner)
- Gruber Prize in Cosmology 2016 (co-winner)
- Special Breakthrough Prize in Fundamental Physics 2016 (co-winner)
- Best Teacher, ECE, 2018-19

**Current Research Interests:**

- Low Light Level Optical Switching with Nano-Fibers
- Quantum Communication and Quantum Computing
- Optical Data Buffering Using Fast Light
- Superluminal Ring Laser for Gyroscopes, Accelerometers, and Magnetometers
- Static and Dynamic Holographic Memory and Correlator
- Polarimetric Laser Radar and Optical Coherence Tomography
- Atom-Interferometric Rotation Sensing
- Gravitational Wave Detection
- Atomic Clock for GPS Applications
- Nanolithography using BEC
- Spin-Squeezed Precision Metrology

**Mentoring:**

- While at MIT, I graduated two Ph.D. students and six Master's students, and supervised three undergraduate theses.
- At NU, I have graduated seventeen Ph.D. students
- I have supervised seven post-doctoral associates while at MIT, and fifteen more post-doctoral associates at NU.
- I have supervised a number of undergraduate student research projects at MIT and at NU.
- Currently supervising four post-doctoral associates, five Ph.D. students, two undergraduate students and one high school student.

## Summary of Service at NU:

- **Currently serving** as Director of the Solid-state, Photonics and Quantum Technologies (SPQT) Division
- Served on many departmental committees
- Served on a sub-committee to restructure and formalize the policy for Teaching Trainees, and to streamline the process for allocating Teaching Assistants to courses
- Headed a Steering Committee for the proposed Northwestern Institute for Photonic Science and Technologies under the NOW initiative conducted by the Dean's Office
- Served on EECS Chair Search Committee
- Served on the Dean's committee on the energy initiative
- Served on the sub-committee for restructuring EECS 202
- Served on the EECS Mission and Planning Committee
- Served on the EECS Structure and Procedure Committee
- Headed the EECS Faculty Search Committee 2011
- Served on two Physics and Astronomy Faculty Search Committees
- **Currently serving** on the following committees:
  - Instructional Labs Committee
  - Computing Facilities Committee
  - McCormick Laser Safety Committee
  - Committee on Promotion and Tenure
  - Faculty Advisor, NU Student Chapter of SPIE
  - ECE Faculty Search Committee

## B. FACULTY/SCIENTIST COLLABORATORS

Prof. Shaoul Ezekiel, MIT, Thesis Supervisor  
Prof. Jeffrey Shapiro, MIT  
Prof. Seth Lloyd, MIT  
Prof. Philip Hemmer, Texas A&M  
Prof. Marlan Scully, Texas A&M, Princeton  
Prof. Suhail Zubairy, Texas A&M  
Prof. Mara Prentiss, Harvard University  
Prof. Peter Zoller, University of Innsbruck, Austria  
Prof. Nicholas Bigelow, University of Rochester  
Prof. Harold Metcalf, SUNY, Stonybrook  
Prof. Mark Cronin-Golomb, Tufts University  
Prof. Rudolph Bonafacio, Universita Di Milano, Italy  
Prof. Zameer Hasan, Temple University  
Prof. Nasser Pyghemebarian, University of Arizona  
Dr. Paul Raptis, ANL  
Dr. Sami Gopalasami, ANL  
Dr. Alexander Heifetz, ANL

Dr. Micah Yairi, LGR  
 Dr. Raymond Beausoleil, HP  
 Dr. Michi Yamamoto, NDT  
 Prof. Prem Kumar, NU  
 Prof. Seng Ho, NU  
 Prof. Hooman Mohseni, NU  
 Prof. Manijeh Razeghi, NU  
 Prof. Bruce Wessels, NU  
 Prof. Vicky Kalogera, NU  
 Prof. Thrassos Pappas, NU  
 Prof. Alan Sahakian, NU  
 Prof. Allen Taflove, NU  
 Prof. Aggelos Katsaggelos, NU  
 Prof. Ying Wu, NU  
 Prof. John Ketterson, NU  
 Prof. Timothy Kovachy, NU  
 Prof. Andrew Geraci, NU  
 Dr. Frank Narducci, NAVAIR  
 Dr. Sean Spillane, Los Gatos Research  
 Dr. Joseph Schaar, Los Gatos Research  
 Dr. Mary Salit, Honeywell  
 Dr. Kenneth Salit, Honeywell  
 Prof. Jonathan Dowling, LSU  
 Prof. Gour Pati, Delaware State University  
 Prof. Renu Tripathi, Delaware State University  
 Prof. Tony Abi-Salloum, Widener University  
 Prof. Milivoj Belic, Texas A&M University, Qatar Campus  
 Prof. Antun Balaz, Institute of Physics Belgrade, Serbia  
 Prof. Maura McLaughlin, West Virginia University  
 Prof. Jacob Scheuer, Tel Aviv University, Israel  
 Prof. Uriel Levy, Hebrew University of Jerusalem, Israel

### C. KEY RESEARCH ACCOMPLISHMENTS:

- Contributed to the **First Observation of Gravitational Waves**
- Demonstrated a **Superluminal Ring Laser** for the first time, with an enhancement in sensitivity by a factor of 1040
- Demonstrated a **Subluminal Ring Laser** for the first time, with an enhancement in stability by a factor of 660.
- Demonstrated **Shift, Rotation and Scale Invariant Image Recognition** using a Hybrid Opto-electronic Correlator
- Demonstrated **ultrafast polarizers and waveplates** using optical activity in Rb vapor

- Demonstrated a **Hybrid Opto-electronic Correlator** for ultra-fast automatic target recognition
- Developed the Design of an **All Optical Three Dimensional Spatio-Temporal Correlator** for Automatic Event Recognition using a Multi-photon Atomic System
- Identified a concrete scheme for **enhancing the sensitivity-bandwidth product of a gravitational wave detector by a factor of 18**, using a white light cavity that makes use of Gain with Electromagnetically Induced Transparency (GEIT), realizable using Rb vapor.
- Developed the concept of a **Spin Squeezed, Schroedinger Cat Collective State Atomic Clock** that can reach Heisenberg limited sensitivity, the ultimate limit allowed by laws of quantum mechanics. For a typical atomic clock, this would correspond to an improvement in sensitivity by a factor of 1000.
- Developed the concept of a **Spin Squeezed, Schroedinger Cat Collective State Atomic Interferometer** that can reach Heisenberg limited sensitivity, the ultimate limit allowed by laws of quantum mechanics. For a typical atomic interferometer, this would correspond to an improvement in sensitivity by a factor of 1000.
- Demonstrated an **ultra-low light level (few nW) optical switch** using a nano-fiber. In the future, this technique can be extended, via use of ultracold atoms, to produce optical switches controlled by only a few pW of light. It may also be useful for quantum non-demolition detection of single photons, for important applications in quantum information processing and quantum cryptography.
- Demonstrated a Fast-Light White Light Cavity, which can be used for enhancing the sensitivity of a **gravitational wave detector**, as well as to implement a **long-delay, high-bandwidth data buffering** system for optical communication.
- Demonstrated how the **sensitivity of a Ring Laser Gyroscope can be enhanced by as much as six orders of magnitude** using the Fast-Light effect.
- Demonstrated a **Holographic Smart Eye** which combines a Holographic Video Disc with a Joint Transform Correlator to perform high speed image search.
- Demonstrated a **Holographic Stokesmeter** for high-speed polarization imaging. This Stokesmeter, aside from being compact and high-speed, has the unique feature that it can perform spectral multiplexing simultaneously, a capability we have recently demonstrated.
- Developed an **In-Line, High-Speed Imaging Stokesmeter** that can be used with virtually any camera, including a flash ladar, for polarimetric imaging. This device can be used in a wide range of applications, including ladar based surveillance and biological imaging.
- Developed a model for realizing an **integrated quantum computer network** by using ensembles of atoms as quantum bits. This model has solved a key problem in using atomic ensembles for versatile quantum information processing using atomic ensembles, which are otherwise a leading contender for developing quantum memory and a quantum repeater. As such, this technique has

the potential to make an ensemble based quantum computer network a reality in not-too-distant future.

- Demonstrated, for the first time in a solid, **slowing to a terrestrial-scale velocity (45 m/sec) and eventually halting/restarting a light pulse, using a crystal of Pr:YSO**. This followed our demonstration, again for the first time in a solid, of *electromagnetically induced transparency*, and of optical data storage and recall using laser excited spin echo. The slowing of light to such a small velocity, especially in a solid medium, has sparked a strong interest in potential applications to buffering of high speed data streams. The halting/restarting of light pulse is one of the leading candidates for an easily retrievable storage system for single-photon quantum bits.
- Developed, and demonstrated in one dimension, **a novel theory of laser cooling**, which was instrumental in achieving a sub-recoil temperature in three dimensions by the group of Claude Cohen-Tannoudji. Two of my papers were referenced in this work, which in turn was cited by the Nobel Prize committee in awarding the prize to Prof. Cohen-Tannoudji. This process can be used to produce an atomic beam with a long coherence length, necessary for atomic beam lithography.
- Developed a novel protocol for realizing a **quantum internet**, using entangled photon pairs and trapped rubidium atoms. This includes an explicit model for measuring all four Bell states in a  $^{87}\text{Rb}$  atom, using Raman dark states, so that it would be possible to teleport the quantum state of a massive particle with near perfect fidelity.
- Invented and demonstrated the **super-parallel holographic optical correlator**, which is likely to be capable of searching through millions of images at once, taking only about 10 msec. This has a host of potential applications, including missile defense, computer vision, face recognition, and video data mining.
- Demonstrated a semiconductor laser pumped **optical phase conjugator using rubidium vapor, with high speed and high gain**, for only 100 mW of pump power. This will enable field deployment of phase conjugators for a host of applications. As an example, we have achieved dynamic aberration compensation in propagation through a turbulent medium. Several groups have adopted this phase conjugator as the device of choice for their work on adaptive optics. We also showed how this process can be used to produce **greater than 10 dB of squeezing**, which has now been demonstrated experimentally by several groups.
- Developed a novel model for **quantum computing, using spectrally selective bands of atoms in a solid**. This work forms the heart of the so-called Type II Quantum Computing Program launched by AFOSR. We have already demonstrated the first step in this process, namely initialization of the quantum bits in a pure state, in the form of optically induced spin alignment in NV-Diamond. We have also identified new QED techniques based on the cavity dark state suitable for such a quantum computer.
- Discovered and demonstrated a new effect, called the **Bloch Siegert Oscillation**, which results from the interference between the positive and negative frequency components of a strong oscillating electromagnetic field as it interacts with a resonant atomic system. This has many potential applications, including quantum teleportation of wavelengths for synchronization of

distant oscillators, controlling the precision of high-speed quantum bits, and high-resolution, in-situ mapping of the absolute phase distribution in microwave cavities.

- Invented and demonstrated the **continuously guided atom interferometer** which requires only a single optical zone. Because of its inherent simplicity, this device is potentially a better candidate for a practical rotation sensor than other interferometers that use multiple zones of excitations.
- Invented a technique for **arbitrary-pattern nanolithography with a resolution of 2 nm** via **Bose-Condensate based atom interferometry**. This process is suitable for taking a conventional optical lithography mask, and converting it to an atomic pattern, which in turn can be transferred to useful materials such as metals and semiconductors. With the emerging maturation of the technology for producing Bose-condensates, this technique may prove to be of practical interest in the near future.

## D. PUBLICATION SUMMARY:

*Google Scholar Profile:* <https://scholar.google.com/citations?user=ynFtpcwAAAAJ&hl=en>

*Google Scholar H-index:* 94

*Google Scholar i-10 index:* 265

*Total Number of Citations:* 82318

*Total Publications:* 665 (Journal plus Conference)

### *Summary of Journal Publication:*

- Number of Journal Papers Published: **316**
- Average Number of Journal Publications Per Year Since Getting Ph.D.: **9**

### *Summary of Conference Publication:*

- Number of Total Conference Publications: **349** (This includes **113** invited papers)
- Average Number of Conference Publications Per Year Since Getting Ph.D.: **12**

*Patents:* 3

## *Books, Book Chapters and Editing List*

1. “Advanced Optical and Quantum Memories and Computing IV,” Proceedings of Opto Conference 6482-07, SPIE Photonics West 2007, edited by Z.U. Hasan, A.E. Craig, M.S. Shahriar and Hans Coufal.  
(<https://www.spiedigitallibrary.org/conference-proceedings-of-SPIE/6482.toc> )



2. "Advances in Slow and Fast Light I," Proceedings, SPIE Photonics West 2008, edited by M.S. Shahriar, P.R. Hemmer, and John Lowell.  
(<https://www.spiedigitallibrary.org/conference-proceedings-of-SPIE/6904.toc> )
3. "Quantum Electronic Metrology I," Proceedings, SPIE Photonics West 2008, edited by A.E. Craig and M.S. Shahriar.  
(<https://www.spiedigitallibrary.org/conference-proceedings-of-SPIE/6906.toc> )
4. "Advances in Slow and Fast Light II," Proceedings, SPIE Photonics West 2009, edited by M.S. Shahriar, P.R. Hemmer, and John Lowell.  
(<https://www.spiedigitallibrary.org/conference-proceedings-of-SPIE/7226.toc> )
5. "Advances in Slow and Fast Light III," Proceedings, SPIE Photonics West 2010, edited by M.S. Shahriar and P.R. Hemmer.  
(<https://www.spiedigitallibrary.org/conference-proceedings-of-SPIE/7612.toc> )
6. "Advances in Slow and Fast Light IV," Proceedings, SPIE Photonics West 2011, edited by M.S. Shahriar and P.R. Hemmer.  
(<https://www.spiedigitallibrary.org/conference-proceedings-of-SPIE/7949.toc> )
7. "Advances in Slow and Fast Light V," Proceedings, SPIE Photonics West 2012, edited by M.S. Shahriar and F. Narducci.  
(<https://www.spiedigitallibrary.org/conference-proceedings-of-SPIE/8273.toc> )
8. "Advances in Slow and Fast Light VI," Proceedings, SPIE Photonics West 2013, edited by M.S. Shahriar and F. Narducci.  
(<https://www.spiedigitallibrary.org/conference-proceedings-of-SPIE/8636.toc> )
9. "Advances in Slow and Fast Light VII," Proceedings, SPIE Photonics West 2014, edited by M.S. Shahriar and F. Narducci.  
(<https://www.spiedigitallibrary.org/conference-proceedings-of-SPIE/8998.toc> )
10. "Slow Light, Fast Light and Optoatomic Precision Metrology VIII," Proceedings, SPIE Photonics West 2015, edited by M.S. Shahriar and J. Scheuer.  
(<https://www.spiedigitallibrary.org/conference-proceedings-of-SPIE/9378.toc> )
11. "Slow Light, Fast Light and Optoatomic Precision Metrology IX," Proceedings, SPIE Photonics West 2016, edited by M.S. Shahriar and J. Scheuer.  
(<https://www.spiedigitallibrary.org/conference-proceedings-of-SPIE/9763.toc> )
12. "Slow Light, Fast Light and Optoatomic Precision Metrology X," Proceedings, SPIE Photonics West 2017, edited by M.S. Shahriar and J. Scheuer.  
(<https://www.spiedigitallibrary.org/conference-proceedings-of-SPIE/10119.toc> )
13. "Steep Dispersion Engineering and Opto-Atomic Precision Metrology XI," Proceedings, SPIE Photonics West 2018, edited by M.S. Shahriar and J. Scheuer  
(<https://www.spiedigitallibrary.org/conference-proceedings-of-SPIE/10548.toc> )
14. "Optical, Opto-Atomic, and Entanglement-Enhanced Precision Metrology I," Proceedings, SPIE Photonics West 2019, edited by M.S. Shahriar and J. Scheuer.  
(<https://www.spiedigitallibrary.org/conference-proceedings-of-SPIE/10934.toc> )
15. "Optical, Opto-Atomic, and Entanglement-Enhanced Precision Metrology II," Proceedings, SPIE Photonics West 2020, edited by M.S. Shahriar and J. Scheuer.  
(<https://www.spiedigitallibrary.org/conference-proceedings-of-SPIE/11296.toc> )
16. "Optical and Quantum Sensing and Precision Metrology I," Proceedings, SPIE Photonics West 2021, edited by M.S. Shahriar and J. Scheuer.  
(<https://spie.org/Publications/Proceedings/Volume/11700?SSO=1> )
17. "Optical and Quantum Sensing and Precision Metrology II," Proceedings, SPIE Photonics West 2021, edited by M.S. Shahriar and J. Scheuer.

<https://spie.org/Publications/Proceedings/Volume/PC12016?SSO=1>

18. "Holography for the New Millennium," Jacques E. Ludman, H. John Caulfield, Juanita Riccobono, edited, Springer, 2002, co-authored the chapter on "Page Oriented, Bragg Selective, Holographic Memories."
19. "Electronics and Communications for Scientists and Engineers," Martin Plonus, Academic Press, authored a chapter on "Quantum Computing."

## Journal Publication List:

### **Journal Papers Published/In-Press (Total: 316)**

1. J. Li, G. R. M. da Silva, S. Kain, and S. M. Shahriar, "Generalized echo squeezing protocol with near-Heisenberg-limit sensitivity and strong robustness against detection noise and variation in squeezing parameter," to appear in Phys. Rev. A
2. J. Gamboa, T. Hamidfar, X. Shen and S.M. Shahriar, "Elimination of optical phase sensitivity in a shift, scale, and rotation invariant hybrid opto-electronic correlator via off-axis operation," Optics Express Vol. 31, Issue 4, pp. 5990-6002 (2023) <https://doi.org/10.1364/OE.484149>
3. D. D. Smith, H. Chang, E. Mikhailov, and S. M. Shahriar, Physical Review A 106, 013520 (2022) <https://doi.org/10.1103/PhysRevA.106.013520> <https://doi.org/10.1364/OE.451132>
4. "Spin-squeezing-induced enhancement of the sensitivity of an atomic clock using coherent population trapping," J. Li, G. R. M. da Silva, S. Kain, G. Pati, R. Tripathi, and S. M. Shahriar, Physical Review A 106, 013112 (2022) <https://doi.org/10.1103/PhysRevA.106.013112>
5. "Bi-directional Superluminal Ring Lasers without Cross-talk and Gain Competition," Z. Zhou, R. Zhu, N. Condon, D. Hileman, J. Bonacum and S.M. Shahriar, Appl. Phys. Lett. 120, 251105 (2022); <https://doi.org/10.1063/5.0093164>
6. "Observation of a Highly Superluminal Laser Employing Optically Pumped Raman Gain and Depletion," Z. Zhou, N. Condon, D. Hileman, and S.M. Shahriar, Optics Express 30, 6746 (2022) <https://doi.org/10.1364/OE.451132>
7. "Integration of a PQ:PMMA holographic memory device into the hybrid opto-electronic correlator for shift, scale, and rotation invariant target recognition," J. Gamboa, T. Hamidfar, and S. M. Shahriar, Optics Express, Vol. 29, No. 24, 40194 (2021) (Nov. 22)

8. "Determination of the refractive index modulation of PQ:PMMA holographic phase gratings over a large spectral range through a two-level approximation of the electric susceptibility," J. Gamboa, T. Hamidfar, J. Bonacum, and S. M. Shahriar, *Optics Materials Express*, Vol. 11, No. 11, 3627 (2021) (Nov 1)
9. "Thick PQ:PMMA transmission holograms for free-space optical communication via wavelength-division multiplexing," J. Gamboa, T. Hamidfar, J. Vonckx, M. Fouda, and S. M. Shahriar, *Applied Optics*, Vol. 60, No. 28, 8851 (2021) (Oct 1)
10. "High Sensitivity Multi-Axes Rotation Sensing Using Large Momentum Transfer Point Source Atom Interferometry," J. Li, G. R. M. da Silva, W. C. Huang, M. Fouda, J. Bonacum, T. Kovachy, and S. M. Shahriar, *Atoms*, 2021, 9, 51, <https://doi.org/10.3390/atoms9030051> (2021) (Aug. 3)
11. "Electromagnetically induced transparency in Raman gain for realizing a superluminal ring laser," Y. Sternfeld, Z. Zhou, J. Scheuer and S. M. Shahriar, *Optics Express*, Vol. 29, No. 2, 1125 (2021) (Jan 18)
12. "Search for subsolar-mass black hole binaries in the second part of Advanced LIGO and Virgo's third observing run," R. Abbott, M.S. Shahriar, et al., to appear in *Monthly Notices of The Royal Astronomical Society* (2022)
13. "Tests of General Relativity with GWTC-3," R. Abbott, M.S. Shahriar, et al., to appear in *Phys. Rev. D* (2022)
14. "Constraints on the cosmic expansion history from the third LIGO-Virgo-KAGRA Gravitational-Wave Transient Catalog," R. Abbott, M.S. Shahriar, et al., to appear in *The Astrophysical Journal* (2022)
15. "The population of merging compact binaries inferred using gravitational waves through GWTC-3," R. Abbott, M.S. Shahriar, et al., to appear in *Phys. Rev. X* (2022)
16. "Model-based cross-correlation search for gravitational waves from the low-mass X-ray binary Scorpius X-1 in LIGO O3 data," R. Abbott, M.S. Shahriar, et al., *Astrophys. J. Lett.* 941, L30 (2022) (Dec 20)
17. "All-sky search for continuous gravitational waves from isolated neutron stars using Advanced LIGO and Advanced Virgo O3 data," R. Abbott, M.S. Shahriar, et al., *Phys. Rev. D* 106, 102008 (2022) (Nov 28)
18. "Search for gravitational waves from Scorpius X-1 with a hidden Markov model in O3 LIGO data," R. Abbott, M.S. Shahriar, et al., *Phys. Rev. D* 106, 062002 (2022) (Sep 21)
19. "Searches for Gravitational Waves from Known Pulsars at Two Harmonics in the Second and Third LIGO-Virgo Observing Runs," R. Abbott, M.S. Shahriar, et al., *The Astrophysical Journal* 935, 1 (2022) (Aug 10)

20. “Search for continuous gravitational wave emission from the Milky Way center in O3 LIGO-Virgo data,” R. Abbott, M.S. Shahriar, et al., *Phys. Rev. D* 106, 042003 (2022) (Aug 9)
21. “Search for subsolar-mass binaries in the first half of Advanced LIGO and Virgo's third observing run,” R. Abbott, M.S. Shahriar, et al., *Phys. Rev. Lett.* 129, 061104 (2022) (Aug 5)
22. “Narrowband searches for continuous and long-duration transient gravitational waves from known pulsars in the LIGO-Virgo third observing run,” R. Abbott, M.S. Shahriar, et al., *The Astrophysical Journal* 932, 133 (2022) (June 20)
23. “All-sky, all-frequency directional search for persistent gravitational waves from Advanced LIGO's and Advanced Virgo's first three observing runs,” R. Abbott, M.S. Shahriar, et al., *Phys. Rev. D* 105, 122001 (2022) (June 3)
24. “All-sky search for gravitational wave emission from scalar boson clouds around spinning black holes in LIGO O3 data,” R. Abbott, M.S. Shahriar, et al., *Phys. Rev. D* 105, 102001 (2022) (May 9)
25. “First joint observation by the underground gravitational-wave detector KAGRA with GEO 600,” R. Abbott, M.S. Shahriar, et al., *Progress of Theor. and Exp. Phys.* 2022, 063F01 (2022) (Apr 30)
26. “Search of the Early O3 LIGO Data for Continuous Gravitational Waves from the Cassiopeia A and Vela Jr. Supernova Remnants,” R. Abbott, M.S. Shahriar, et al., *Phys. Rev. D* 105, 082005 (2022) (Apr 28)
27. “Search for Gravitational Waves Associated with Gamma-Ray Bursts Detected by Fermi and Swift During the LIGO-Virgo Run O3b” R. Abbott, M.S. Shahriar, et al., *The Astrophysical Journal* 928, 186 (2022) (Apr 1)
28. “Constraints on dark photon dark matter using data from LIGO's and Virgo's third observing run,” R. Abbott, M.S. Shahriar, et al., *Phys. Rev. D* 105, 063030 (2022) (Mar 31)
29. “Search for intermediate mass black hole binaries in the third observing run of Advanced LIGO and Advanced Virgo,” R. Abbott, M.S. Shahriar, et al., *Astronomy & Astrophysics* 659, A84 (2022) (Mar 16)
30. “Search for continuous gravitational waves from 20 accreting millisecond X-ray pulsars in O3 LIGO data,” R. Abbott, M.S. Shahriar, et al., *Phys. Rev. D* 105, 022002 (2022) (Jan 19)
31. “All-sky search for short gravitational-wave bursts in the third Advanced LIGO and Advanced Virgo run,” R. Abbott, M.S. Shahriar, et al., *Physical Review D* 104, 122004 (2021) (Dec 23)
32. “Search for Lensing Signatures in the Gravitational-Wave Observations from the First Half of LIGO–Virgo’s Third Observing Run,” R. Abbott, M.S. Shahriar, et al., *The Astrophysical Journal*, 923,14 (2021) (Dec 10)

33. “Constraints from LIGO O3 Data on Gravitational-wave Emission Due to R-modes in the Glitching Pulsar PSR J0537–6910,” R. Abbott, M.S. Shahriar, et al., *The Astrophysical Journal*, 922, 71 (2021) (Nov 20)
34. “All-sky search for long-duration gravitational-wave bursts in the third Advanced LIGO and Advanced Virgo run,” R. Abbott, M.S. Shahriar, et al., *Physical Review D* 104, 102001 (2021) (Nov 11)
35. “Searches for Continuous Gravitational Waves from Young Supernova Remnants in the Early Third Observing Run of Advanced LIGO and Virgo,” R. Abbott, M.S. Shahriar, et al., *The Astrophysical Journal*, 921, 80 (2021) (Nov 1)
36. “All-sky search for continuous gravitational waves from isolated neutron stars in the early O3 LIGO data,” R. Abbott, M.S. Shahriar, et al., *Physical Review D* 104, 082004 (2021) (Oct 8)
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## Conference Publication List (Total: 349):

1. "Optical Phase Insensitive Off-axis Operation of the Hybrid Opto-electronic Correlator for Ultra-fast Shift, Scale, and Rotation Invariant Target Recognition," J. Gamboa, T. Hamidfar, X. Shen, and S. M. Shahriar, Proceedings of the Conference on Lasers and Electro-Optics, San Jose, CA, May 2023.
2. "Holographic diffraction of complex beams and gratings: theory and simulation," J. Gamboa, T. Hamidfar, X. Shen and S.M. Shahriar, SPIE Photonics West Conference on Practical Holography XXXVII: Displays, Materials, and Applications, January 2023, San Francisco, CA.
3. "Monocular passive ranging through a PQ:PMMA holographic wavelength division demultiplexer," J. Gamboa, T. Hamidfar, X. Shen and S.M. Shahriar, SPIE Photonics West Conference on Practical Holography XXXVII: Displays, Materials, and Applications, January 2023, San Francisco, CA.
4. "Slow-light Enhanced Mach-Zehnder Interferometer for Rotation Sensing and Accelerometry," Selim Shahriar, Ruoxi Zhu and Zifan Zhou, SPIE Quantum West Conference on Quantum Sensing, Imaging and Precision Metrology, January 2023, San Francisco, CA (**Invited**)
5. "Spin-squeezed Dual Species Atom Interferometry for Test of EP Violation," Jinyang Li, Selim Shahriar, Gregoria da Silva and Schuyler Kain, SPIE Quantum West Conference on Quantum Sensing, Imaging and Precision Metrology, January 2023, San Francisco, CA
6. "Optical Correlation of 1D Time-Domain Signals Through a Spectrogram Time-Space Transform," J. Gamboa, T. Hamidfar, X. Shen and S.M. Shahriar, Proceedings of the Frontiers in Optics and Laser Science Conference, Rochester, NY, October 2022. ID: JW5A.70
7. "Control of Orientation and Entanglement of Macroscopic Magnetization Using a Single Atom," : J. Li, G. R. M. da Silva, S. Kain, and S. M. Shahriar, Proceedings of the Frontiers in Optics and Laser Science Conference, Rochester, NY, October 2022.
8. "PQ:PMMA Holographic Optical Communication System for Free Space Wavelength Division Multiplexing and Demultiplexing at 1550 nm," T. Hamidfar, J. Gamboa, X. Shen, J. Vonckx, J. Bonacum, and S.M. Shahriar, Proceedings of the Frontiers in Optics and Laser Science Conference, Rochester, NY, October 2022. <https://opg.optica.org/abstract.cfm?uri=FiO-2020-FW7A.1>
9. "Slow Light Enhanced Accelerometry," R. Zhu, Z. Zhou, J. Bonacum, and S.M. Shahriar, Proceedings of the Frontiers in Optics and Laser Science Conference, Rochester, NY, October 2022.
10. "Ultrafast image retrieval from a holographic memory disc for high-speed operation of a shift, scale and rotation invariant target recognition system," J.Gamboa, X. Shen, T. Hamidfar and S.M. Shahriar, Proceedings of the Advanced Maui Optical and Space Surveillance

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11. "Dark Matter Search using a Subluminal Laser," S.M. Shahriar, R. Zhu and Z. Zhou, Proceedings of the 30th annual International Laser Physics Workshop, July 2022 **(Invited)**
12. "Superluminal Raman Lasing via Electromagnetically induced transparency," Z. Zhou, R. Zhu, Y. Sternfeld, J. Scheuer, J. Bonacum and S.M. Shahriar, Proceedings of the Frontiers in Optics and Laser Science Conference, Rochester, NY, October 2022.
13. "High-Speed Automatic Target Recognition using the Hybrid Opto-electronic Correlator with Multi-channel Detection," T. Hamidfar, J. Gamboa, Xi Shen and S.M. Shahriar, Proceedings of the Conference on Lasers and Electro-Optics, San Jose, CA, May 2022.  
[https://opg.optica.org/abstract.cfm?uri=CLEO\\_AT-2022-JW3A.4](https://opg.optica.org/abstract.cfm?uri=CLEO_AT-2022-JW3A.4)
14. "Single-wavelength writing for free space WDM holograms at arbitrary wavelengths," J. Gamboa, T. Hamidfar, J. Bonacum and S.M. Shahriar, Proceedings of the SPIE Photonics West Conference on Practical Holography XXXVI: Displays, Materials, and Applications, San Francisco, CA, Jan, 2022.
15. "A generalized echo squeezing protocol with near-Heisenberg-limit sensitivity over a large range of values of the squeezing parameter," J. Li, G. R. M. da Silva, S. Kain, and S.M. Shahriar, presented at the SPIE Photonics West Conference on Optical and Quantum Sensing and Precision Metrology II, San Francisco, CA, Jan, 2022 **(Invited)**
16. "Shift Invariant Correlation using the Hybrid Optoelectronic Correlator with a PQ:PMMA Holographic Memory Device," J. Gamboa, T. Hamidfar, and S. M. Shahriar, Proceedings of the Frontiers in Optics and Laser Science Conference, Washington, DC., September 2021.
17. "Free Space Wavelength Division Multiplexing Around 1550 nm Using PQ:PMMA Transmission Holograms," J. Gamboa, T. Hamidfar, J. Vonckx, M. Fouda, and S. M. Shahriar, Proceedings of the Frontiers in Optics and Laser Science Conference, Washington, DC., September 2021.
18. "Realization of Bi-directional Superluminal Ring Lasers Using Adjacent Transitions in Two Isotopes of Rubidium," Z. Zhou, N. J. Condon, D. J. Hileman, S. C. Tseng, and S. M. Shahriar, in Frontiers in Optics and Laser Science 2021, C. Mazzali, T. (T.-C.) Poon, R. Averitt, and R. Kaundl, eds., Technical Digest Series (Optica Publishing Group, 2021), paper JTh5A.25.  
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19. "Spin Squeezing for Coherent Population Trapping based Atomic Clocks." S. M. Shahriar, J. Li, G. R. M. da Silva, and S. Kain, presented at the SPIE Photonics West Conference, San Francisco, CA, March, 2021 **(invited)**.
20. "Limitations on maximum achievable enhancement in sensitivity using large momentum transfer for point source atom interferometry," J. Li, G. R. M. da Silva, W. C. Huang, M. Fouda,

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21. "Spin-Squeezed Atomic Sensors with Extreme Robustness Against Excess noise," M.S. Shahriar, R. Sarkar, R. Fang, and T. Kovachy, Proceedings of the Second International Conference on Optics and Photonics, Nice, France, October 2020 (**Invited**).
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  23. "Electromagnetically induced transparency in Raman gain for realizing a superluminal ring laser," Y. Sternfeld, Z. Zhou, J. Scheuer, and M. S. Shahriar, in Frontiers in Optics and Laser Science, B. Lee, C. Mazzali, K. Corwin, and R. Jason Jones, eds., OSA Technical Digest (Optica Publishing Group, 2020), paper FW5B.2.  
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  27. "Large Momentum Transfer Point Source Atom Interferometry," J. Li, W. Huang, M. Fouda, T. Kovachy and S.M. Shahriar, presented at the SPIE Photonics West Conference, San Francisco, CA, February, 2020.
  28. "Testing Collapse Models for Macroscopic Quantum Superpositions using an Atomic Interferometer without Entanglement," J. Li and S.M. Shahriar, presented at the SPIE Photonics West Conference, San Francisco, CA, February, 2020.
  29. "Heisenberg Limited Atomic Sensors using Schroedinger Cat States with Maximal Robustness Against Excess Noise," S.M. Shahriar, R. Fang, R. Sarkar, J. Li, W. Huang and T. Kovachy, presented at the Midwest Cold Atom Workshop, Evanston, IL, Nov. 2019. (**invited**)
  30. "Demonstration of Shift, Scale, and Rotation Invariant Target Recognition using Polar Mellin Transforms in a Hybrid Opto-Electronic Correlator," S.M. Shahriar, J. Gamboa, M. Fouda and S. Johnson, Proceedings of the Advanced Maui Optical and Space Surveillance Technologies Conference, Maui, HI, September 2019.

31. "Heisenberg Limited Precision Metrology using Maximally Entangled Schroedinger Cat States with Increased Quantum Noise," S.M. Shahriar, presented at the International Conference on Quantum Computing, Seoul, S. Korea, July 2019 **(invited)**.
32. "Test of Gravitationally Induced Collapse of Quantum Superposition with an Atomic Interferometer without Forming a Schroedinger Cat State," S.M. Shahriar and J. Li, presented at the International Conference on Laser Physics, Gyeongju, S. Korea, 2019, (July) **(invited)**
33. "Table Top Ultrasensitive Gravitational Wave Detector Using Superluminal Ring Lasers," S.M. Shahriar, M. Zhou, Z. Zhou and J. Scheuer, presented at the Division of Atomic Molecular and Optical Physics Conference, Milwaukee, WI, June 2019.
34. "Demonstration of a Superluminal Ring Laser for Precision Metrology using Self-Pumped Raman Gain and Depletion in Two Isotopes of Rubidium," S.M. Shahriar, Z. Zhou and M. Zhou, presented at the Division of Atomic Molecular and Optical Physics Conference, Milwaukee, WI, June 2019.
35. "White Light Cavity Enhanced Spin Squeezing for Creating Schroedinger Cat States to Achieve Heisenberg Limited Sensitivity with Increased Quantum Noise," S.M. Shahriar and J. Li, presented at the Division of Atomic Molecular and Optical Physics Conference, Milwaukee, WI, June 2019.
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37. "Superluminal Laser Gravitational Wave Detector," M. Zhou, Z. Zhou, and S. M. Shahriar, in Conference on Lasers and Electro-Optics, OSA Technical Digest (Optica Publishing Group, 2019), paper JW2A.13. [https://opg.optica.org/abstract.cfm?URI=CLEO\\_SI-2019-JW2A.13](https://opg.optica.org/abstract.cfm?URI=CLEO_SI-2019-JW2A.13)
38. "A Superluminal Raman Laser with Enhanced Cavity Length Sensitivity," Z. Zhou, M. Zhou, and S. M. Shahriar, in Conference on Lasers and Electro-Optics, OSA Technical Digest (Optica Publishing Group, 2019), paper JTu2A.60. [https://opg.optica.org/aop/abstract.cfm?URI=CLEO\\_SI-2019-JTu2A.60](https://opg.optica.org/aop/abstract.cfm?URI=CLEO_SI-2019-JTu2A.60).
39. "Prospect of Verifying Gravity-Induced Collapse of Macroscopic Quantum Coherence Using a Schroedinger Cat Atom Interferometer," M.S. Shahriar, T.L. Kovachy, R. Fang, R. Sarkar, and J. Li, presented at the Physics of Quantum Electronics conference, Snowbird, Utah, January 2019 **(invited)**.
40. "New direction in laser technology: superluminal and subluminal lasers using rubidium atoms for precision metrology," M.S. Shahriar, Z. Zhou, M. Zhou, N.J. Condon, D. Hileman and S. Tseng, presented at the SPIE Photonics West Conference, San Francisco, CA, February, 2019 **(invited)**



41. "Enhancing sensitivity of an atom interferometer to the Heisenberg limit using increased quantum noise," M.S. Shahriar, R. Fang and R. Sarkar, presented at the SPIE Photonics West Conference, San Francisco, CA, February, 2019 (**invited**)
42. "Sensitivity-bandwidth Enhancement of Gravitational Wave Detector Without Using Dispersive Medium," M. Zhou, Z. Zhou and M.S. Shahriar, Proceedings of the Frontiers in Optics and Laser Science Conference (2018), Washington, DC. (September)
43. "Observed Phase-locking Between a Rubidium Raman Laser and its Pump Laser," N.J. Condon, D. Hileman, S. Tseng, Z. Zhou and M.S. Shahriar, Proceedings of at the Frontiers in Optics and Laser Science Conference (2018), Washington, DC. (September)
44. "Increasing Sensitivity of an Atom Interferometer to the Heisenberg Limit using Enhanced Quantum Noise," R. Fang, R. Sarkar and M.S. Shahriar, presented at the Frontiers in Optics and Laser Science Conference (2018), Washington, DC. (September)
45. "Superluminal Ring Laser Gyroscope and Accelerometer for Ultraprecise Inertial Navigation under GPS Denied Conditions," Conference on Space Situational Awareness, Maui, Hawaii, 2018 (September)
46. "Interference at Decillion Hz Compton Frequency: Enhancing Sensitivity of an Atomic Interferometer to the Heisenberg Limit using Increased Quantum Noise," M.S. Shahriar, R. Sarkar and R. Fang, International Conference on Laser Physics, Manchester, United Kingdom, 2018, (July) (**invited**)
47. "Schroedinger Cat atom interferometer using direct detection of atomic states and prospect for testing the Penrose-Diosi theory for gravity induced collapse of quantum superposition," R. Fang, R. Sarkar and S.M. Shahriar, presented at the SPIE Photonics West Conference, San Francisco, CA, January, 2018 (**invited**).
48. "Experimental demonstration of nearly three orders of magnitude suppression in sensitivity using a subluminal laser," Z. Zhou, J. Yablon, N. Condon, D. Hileman, S. Tseng and S.M. Shahriar, presented at the SPIE Photonics West Conference, San Francisco, CA, January, 2018.
49. "Ultrafast Event Recognition System for Surveillance and Reconnaissance," Conference on Space Situational Awareness, Maui, Hawaii, 2017 (September)
50. "Demonstration of a Self-Stabilized Highly Subluminal Laser with a Factor of 400 Suppression in Sensitivity to Fluctuations," J. Yablon, Z. Zhou, N. Condon, D. Hileman, S. Tseng, and Selim M. Shahriar, presented at the Frontiers in Optics and Laser Science Conference (2017), Washington, DC. (September)
51. "Extreme Phase-Amplification under Direct Detection of Atomic States for Heisenberg Limited Sensitivity in an Atomic Interferometer Employing Schroedinger Cat States," R. Fang, R. Sarkar, and Selim M. Shahriar, presented at the Frontiers in Optics and Laser Science Conference (2017), Washington, DC. (September)



52. “Ultra-high Compton Frequency, Parity Independent, Mesoscopic Schroedinger Cat Atom Interferometer with Heisenberg Limited Sensitivity,” R. Sarkar, R. Fang, and Selim M. Shahriar, presented at CLEO (2017), San Jose, CA, (June)
53. “Raman Ring Lasers using Rb Vapor for Precision Metrology,” J. Yablon, Z. Zhou, and M.S. Shahriar, presented at the SPIE Photonics West Conference, San Francisco, CA, February, 2017 **(invited)**.
54. “Ultra-high Compton Frequency, Parity Independent, Mesoscopic Schrödinger Cat Atom Interferometer with Heisenberg Limited Sensitivity,” R. Sarkar, M. Zhou, R. Fang and M.S. Shahriar, presented at the SPIE Photonics West Conference, San Francisco, CA, February, 2017 **(invited)**
55. “Realization of the GEIT Process in an Opto-mechanical Cavity for Enhancing the Sensitivity-Bandwidth Product in a Gravitational Wave Detector,” M. Zhou, S. Kim, G. Bahl, and M.S. Shahriar, presented at the SPIE Photonics West Conference, San Francisco, CA, February, 2017.
56. “Fast-light Enhanced Brillouin Laser Based Active Fiber Optics Sensor for Simultaneous Measurement of Rotation and Acceleration,” M. Zhou, Z. Zhou, M. Fouda, J. Scheuer and M.S. Shahriar, Proceedings of the Frontiers in Optics and Laser Science Conference, Rochester, NY, October 17, 2016.
57. “Realization of Gain with Electromagnetically Induced Transparency using Zeeman Sublevels in  $^{87}\text{Rb}$  for Gravitational Wave Detection,” M. Zhou, Z. Zhou, and M.S. Shahriar, presented at the Frontiers in Optics and Laser Science Conference, Rochester, NY, October 17, 2016.
58. “Effect of Spin Squeezing Followed by Anti-Squeezing in a Collective State Atomic Clock,” R. Sarkar, M. Zhou. R. Fang and M.S. Shahriar, presented at the Frontiers in Optics and Laser Science Conference, Rochester, NY, October 17, 2016.
59. “Realization of a superluminal Raman laser using adjacent transitions in two isotopes of Rb,” Z. Zhou, J. Yablon and M.S. Shahriar, presented at the Frontiers in Optics and Laser Science Conference, Rochester, NY, October 17, 2016.
60. “Fast Light for Precision Metrology: From Fiber-Optic Sensing to Gravitational Wave Detection,” M.S. Shahriar, M. Zhou, Z. Zhou, and J. Scheuer, presented at the Nice Optics Conference, Nice, France, October, 2016 **(keynote talk)**.
61. “Spin-Squeezing, Anti-Squeezing and Detection of Collective States for Heisenberg Limited Sensitivity in Atomic Clocks and Atomic Interferometers,” M.S. Shahriar, R. Sarkar, M. Zhou and R. Fang, presented at the 25th Conference on Laser Physics, Yerevan, Armenia, July 2016 **(invited)**.

62. “Experimental Demonstration and Theoretical Modeling of Raman Probe Induced Spectral Dip for Realizing a Superluminal Laser,” J. Yablon, Z. Zhou, M. Zhou, Y. Wang and M.S. Shahriar, presented at the Conference on Lasers and Electro-Optics, San Jose, CA, June, 2016.
63. “Realizing the GEIT System Using Zeeman Sublevels in Rb for Enhancing the Sensitivity-Bandwidth Product in Next Generation LIGO,” M. Zhou, Z. Zhou and M.S. Shahriar, LIGO-VIRGO Collaboration Meeting, Pasadena, CA, March, 2016
64. “Spin Squeezed Collective State Atomic Interferometer and Clock,” R. Sarkar, M. Kim, R. Fang, and S.M. Shahriar, presented at the SPIE Photonics West Conference, San Francisco, CA, February, 2016.
65. “Gain in EIT system for Broadband Gravitational Wave Detection,” M. Zhou, Z. Zhou and S.M. Shahriar, presented at the SPIE Photonics West Conference, San Francisco, CA, February, 2016 (**invited**).
66. “Spin Squeezed Scalar and Vector Magnetometry with Coherent Population Trapping,” R. Fang, R. Sarkar, M. Kim, Z. Zhou and S.M. Shahriar, presented at the SPIE Photonics West Conference, San Francisco, CA, February, 2016.
67. “Master Equation Approach for Quantum Noise in Atomic Systems for Gravitational-Wave Detection,” M. Zhou and S. M. Shahriar, in Proceedings of the Frontiers in Optics and Laser Science Conference, San Jose, CA, October, 2015
68. “Ultra-Fast All-Optical Modulator Using Nano-Waveguide Embedded in High Pressure Buffer Gas,” M. F. Fouda and S. M. Shahriar, in Proceedings of the Frontiers in Optics and Laser Science Conference, San Jose, CA, October, 2015
69. “Three-dimensional Transfer-function of an Inhomogeneously Broadened Atomic Medium for All Optical Spatio-Temporal Video Clip Correlation,” M.S. Monjur and S. M. Shahriar, in Proceedings of the Frontiers in Optics and Laser Science Conference, San Jose, CA, October, 2015.
70. “Collective State Atomic Clock: Experimental Investigation and Application to Spin-Squeezing,” R. Fang, M. Kim, R. Sarkar and S. M. Shahriar, in Proceedings of the Frontiers in Optics and Laser Science Conference, San Jose, CA, October, 2015.
71. “Enhancement of Sensitivity-Bandwidth Product in a Gravitational Wave Detector Using a White Light Cavity Based on Electromagnetically Induced Transparency in an Amplifying System,” M.S. Shahriar, and M. Zhou, in Proceedings of the 24th Conference on Laser Physics, Shanghai, China, August, 2015 (**Invited**).
72. “Factor of 18 Enhancement in the Sensitivity-Bandwidth Product of the aLIGO Gravitational Wave Detector Using a White Light Cavity,” M. Zhou, Z. Zhou, and S. M. Shahriar, in Proceedings of the Conference on Lasers and Electro-Optics, San Jose, CA, June, 2015.

73. "A Subluminal Laser with Extreme Insensitivity to Cavity Length Change," Z. Zhou, J. Yablon, Y. Wang, J. Scheuer, and S. M. Shahriar, in Proceedings of the Conference on Lasers and Electro-Optics, San Jose, CA, June, 2015.
74. "Effect of One Axis Twist and Two Axes Twist Spin Squeezing on Collective State Atomic Interferometer and Clock," R. Sarkar, R. Fang, M. Kim, and S.M. Shahriar, in Proceedings of the Division of Atomic, Molecular and Optical Physics Annual Meeting, Columbus, OH, June, 2015
75. "Coherent Population Trapping Based Collective State Atomic Clock Using Trapped Atoms," M. Kim, R. Fang, R. Sarkar and S.M. Shahriar, in Proceedings of the Division of Atomic, Molecular and Optical Physics Annual Meeting, Columbus, OH, June, 2015
76. "Master Equation approach for determining the quantum noise limit of the aLIGO apparatus augmented by a White Light Cavity," M. Zhou and M.S. Shahriar, LIGO-VIRGO Collaboration Meeting, Pasadena, CA, March, 2015.
77. "AC stark shift in Raman-Ramsey interference using a multi-level system calculation," G. S. Pati, Z. Warren, and S. M. Shahriar, SPIE Photonics West Conference, San Francisco, CA, February, 2015 (**Invited**).
78. "Superluminal enhancement of rotation sensitivity in a laser gyroscope based on stimulated Raman scattering," S. Spillane and S.M. Shahriar, SPIE Photonics West Conference, San Francisco, CA, February, 2015 (**Invited**).
79. "Enhancement of bandwidth of a LIGO interferometer using white light cavity and signal recycling," M. Zhou, Z. Zhou and S. M. Shahriar, SPIE Photonics West Conference, San Francisco, CA, February, 2015.
80. "The linewidth of Super and Sub-luminal lasers," J. Scheuer and S. M. Shahriar, SPIE Photonics West Conference, San Francisco, CA, February, 2015 (**Invited**).
81. "Suppression of sensitivity due to length variation in a subluminal ring laser, Z. Zhou and S. M. Shahriar, SPIE Photonics West Conference, San Francisco, CA, February, 2015.
82. "Collective state atomic interferometer with ultra-high Compton frequency," R. Sarkar, M. Kim and S. M. Shahriar, SPIE Photonics West Conference, San Francisco, CA, February, 2015.
83. "Collective state Raman-Ramsey atomic clock with trapped atoms," M. Kim, R. Sarkar, and S. M. Shahriar, SPIE Photonics West Conference, San Francisco, CA, February, 2015.
84. "Measurements and characterization of a Rb-based Raman-Ramsey vapor cell atomic clock," G. S. Pati, Z. Warren, R. Tripathi and S. M. Shahriar, SPIE Photonics West Conference, San Francisco, CA, February, 2015.

85. "Quantum Noise Limit of the Sensitivity of a White Light Cavity Enhanced, Signal Recycled GW Detector," M.S. Shahriar and M. Zhou, LIGO-VIRGO Collaboration Meeting, Stanford University, Stanford, CA, August, 2014.
86. "Constraints in Collective State Atomic Interferometry Due to Inhomogeneities in Laser Intensity and Atomic Velocity," R. Sarkar, M. E. Kim, R. Fang, and M.S. Shahriar, in Proceedings of the Frontiers in Optics and Laser Science Conference, Tucson, AZ, October, 2014.
87. "All Optical Three Dimensional Spatio-Temporal Correlator for Video Clip Recognition," M. S. Monjur and M.S. Shahriar, in Proceedings of the Frontiers in Optics and Laser Science Conference, Tucson, AZ, October, 2014.
88. "Broadening the Sub-Standard-Quantum-Limit Region in Quantum Noise Limited Sensitivity for Gravitational Wave Detectors," M. Zhou and M.S. Shahriar, in Proceedings of the Frontiers in Optics and Laser Science Conference, Tucson, AZ, October, 2014.
89. "Hybrid optoelectronic correlator (HOC) architecture for shift, scale, and rotation invariant target recognition incorporating polar mellin transform (PMT)," M. Monjur, S. Tseng, and M.S. Shahriar, in Proceedings of the SPIE OPTO Conference, San Diego, CA, August, 2014.
90. "Rydberg excitation assisted light shift blockade in Rb atoms for realizing a collective state quantum bit and quantum memory," M.S. Shahriar, M.E. Kim, and Y. Tu, in Proceedings of the SPIE OPTO Conference, San Diego, CA, August, 2014 (**Invited**) (published in Dec. 2014)
91. "Effect of Interatomic Separation in Ensembles in Determining the Fidelity of Collective Excitation," R. Sarkar, M.E. Kim, Y. Tu, R. Fang, and M.S. Shahriar, in Proceedings of the Division of Atomic, Molecular and Optical Physics Conference, Madison, WI, June, 2014.
92. "Collective State Raman Atomic Clock Using Trapped Atoms," M.E. Kim, R. Sarkar, R. Fang, Y. Tu, and M.S. Shahriar, in Proceedings of the Division of Atomic, Molecular and Optical Physics Conference, Madison, WI, June, 2014.
93. "Quantum Noise Limited Spectral Width of a Superluminal Laser for Gravitational Wave Detection," M.S. Shahriar, J. Scheuer, J. Yablon, and M. Zhou, in Proceedings of the 23rd Conference on Laser Physics, Sofia, Bulgaria, July, 2014 (**Invited**).
94. "Photon lifetime and the linewidth in a superluminal laser," J. Scheuer and M.S. Shahriar, in Proceedings of the Conference on Lasers and Electro-Optics, San Jose, CA, June, 2014.
95. "The Rydberg-assisted Light-shift Blockade for Ensemble Quantum Computing," M. E. Kim, Y. Tu, and M.S. Shahriar, in Proceedings of the Conference on Lasers and Electro-Optics, San Jose, CA, June, 2014.
96. "Quantum noise limit of the White-Light-Cavity assisted LIGO interferometer sensitivity," M. Zhou and M.S. Shahriar, in Proceedings of the Conference on Lasers and Electro-Optics, San Jose, CA, June, 2014.

97. “Rotational sensitivity enhancement in a ring laser gyroscope using Raman gain,” Sean Spillane and M.S. Shahriar, SPIE Photonics West Conference, San Francisco, CA, February, 2014 (**Invited**).
98. “Coupled microrings data buffer using fast light,” Jacob Scheuer and M.S. Shahriar, SPIE Photonics West Conference, San Francisco, CA, February, 2014 (**Invited**).
99. “A subluminal ring laser: modeling, stability, and applications,” Zifan Zhou, Joshua Yablon, Minchuan Zhou, M.S. Shahriar, SPIE Photonics West Conference, San Francisco, CA, February, 2014.
100. “Quantum noise limits in fast-light enhanced gravitational wave detectors,” Minchuan Zhou, Jacob Scheuer, Joshua Yablon, M.S. Shahriar, SPIE Photonics West Conference, San Francisco, CA, February, 2014.
101. “Investigations of AC Stark Shift in Pulsed Raman-Ramsey Interaction for Vapor Cell Clock Development,” Gour Pati and M.S. Shahriar, SPIE Photonics West Conference, San Francisco, CA, February, 2014 (**Invited**).
102. “Theoretical modeling of a DPAL based superluminal laser and comparison with experiment ,” Zifan Zhou, Joshua Yablon, Ye Wang, Devin Hilleman, Shih Tseng, M.S. Shahriar, SPIE Photonics West Conference, San Francisco, CA, February, 2014.
103. “Superluminal laser using dual peak Raman gain,” Ye Wang, Zifan Zhou, Joshua Yablon, Shih Tseng, M.S. Shahriar, SPIE Photonics West Conference, San Francisco, CA, February, 2014.
104. “Gravitation Wave Detection with Superluminal Laser in the Adiabatic Following Limit,” Joshua Yablon, Zifan Zhou, Shih Tseng, Jacob Scheuer, and Selim Shahriar, OSA Annual Meeting, Orlando, FL, October 2013.
105. “Generation of Arbitrary Lithographic Patterns and Three-Dimensional Atomic Holograms Using BEC Interferometry,” M.F. Fouda, R. Fang, M.S. Monjur, J. Ketterson and M.S. Shahriar, OSA Annual Meeting, Orlando, FL, October 2013.
106. “Stabilization, Tuning and Optimization of Relative Phases of Reference Interferometers in a Hybrid Optoelectronic Correlator,” M.S. Monjur, S. Tseng, and M.S. Shahriar, OSA Annual Meeting, Orlando, FL, October 2013.
107. “Sensitivity Enhancement via Detection of Interference With All Orders in a Collective State Atom Interferometer,” Resham Sarkar, May E. Kim, Yanfei Tu, and Selim Shahriar, OSA Annual Meeting, Orlando, FL, October 2013.

108. “Buffer-Gas Assisted High Speed Optical Modulator using Ladder Transitions in Rb,” Subramanian Krishnamurthy, Y. Wang, Y. Tu, S. Tseng, and M.S. Shahriar, OSA Annual Meeting, Orlando, FL, October 2013.
109. “Rydberg Interaction Assisted Light Shift Blockade Of Collective Excitations For Quantum Information Processing,” Y. Tu, M. Kim, R. Sarkar, and M.S. Shahriar, OSA Annual Meeting, Orlando, FL, October 2013.
110. “Investigation of a Superluminal Ring Laser using Double-Raman Gain,” Y. Wang, J. Yablon, Zifan Zhou, S. Tseng, S. Neda, Y. Tu, T. Abi-Salloum, and M.S. Shahriar, OSA Annual Meeting, Orlando, FL, October 2013.
111. “From Hypersensitive Gyroscopy to Gravitational Wave Detection: Superluminal Ring Laser as a Holy Grail of Precision Metrology,” Selim M. Shahriar, Frontiers in Nonlinear Physics, Nizhniy Novgorod, Russia, July 2013 (**Invited**).
112. “New Directions in Atom Optics: Collective State Atomic Interferometry and Atomic Holography with BEC,” Selim M. Shahriar, Quantum Optics and Nanomaterials VI, Beijing, China, May 2013. (**Invited**).
113. “Superluminal ring laser gyroscopes and accelerometers for hypersensitive and compact inertial measurement units,” Selim M. Shahriar, Joshua Yablon, Zifan Zhou, Ye Wang, Shih Tseng, SPIE Optics and Photonics conference, San Diego, CA, August, 2013. (**Invited**).
114. “Verification of light shift blockade via collective state Raman-Rabi oscillations for ensemble based quantum computing,” Selim M. Shahriar, May Kim, Yanfei Tu, Resham Sarkar, SPIE Optics and Photonics conference, San Diego, CA, August, 2013. (**Invited**).
115. “Effect of Interatomic Separation and Spatial Spread of Individual Atoms in a Collective State Interferometer,” Resham Sarkar, May E. Kim, Yanfei Tu, and Selim M. Shahriar, Conference on Lasers and Electro-Optics, San Jose, CA, June 2013.
116. “Application of Hybrid Optoelectronic Correlator to Gabor Jet images for Rapid Object Recognition & Segmentation,” Mehjabin Sultana Monjur, Shih Tseng, Adnan Mujahid, Nasir Rajpoot, and Selim M. Shahriar, Conference on Lasers and Electro-Optics, San Jose, CA, June 2013.
117. “Observation of Raman Resonance of a Probe in a Rb Cell Added to an Ethane-Rb Laser for Realizing a Superluminal Laser,” Joshua Yablon, Shih Tseng, Zifan Zhou, Selim M. Shahriar, Conference on Lasers and Electro-Optics, San Jose, CA, June 2013.
118. “Double-Raman Gain for Realizing a Superluminal Ring Laser ,” Ye Wang, Tony Abi-Salloum, Joshua Yablon, Shih Tseng, Yanfei Tu and Selim M. Shahriar, Conference on Lasers and Electro-Optics, San Jose, CA, June 2013.

119. "All-Optical Switch at Telecom Wavelength based on the Quantum Zeno Effect (QZE)," Subramanian Krishnamurthy, Ye Wang, Yanfei Tu, Shih Tseng; Selim M. Shahriar, Conference on Lasers and Electro-Optics, San Jose, CA, June 2013.
120. "Experimental verification of light shift imbalance induced blockade in an atomic ensemble via collective state Rabi oscillation and coincidence detection," M. Kim, Y. Tu, Subramanian Krishnamurthy and M.S. Shahriar, APS DAMOP conference in Quebec City, Canada, June 2013.
121. "Generation of atomic holograms using interferometry, digital holography and BEC", R. Fang, M. Fouda, M. Monjoor, M. Kim, J. Trossman, J. Ketterson, and M.S. Shahriar, APS DAMOP conference in Quebec City, Canada, June 2013.
122. "Effect of Interatomic Separation and Wavepacket Spreading on the Behavior of a High Compton Frequency Collective State Interferometer, " R. Sarkar, M. Kim, Y. Tu, and M.S. Shahriar, APS DAMOP conference in Quebec City, Canada, June 2013.
123. "Optically controlled polarizer and waveplate at telecom wavelength for Quantum Zeno Effect based all-optical switch," Subramanian Krishnamurthy, Y. Wang, Y. Tu, S. Tseng and M.S. Shahriar, APS DAMOP conference in Quebec City, Canada, June 2013.
124. "Superluminal Ultrasensitive Optical Gyroscope in an Inverted Double-Raman Lambda System," T.Y. Abi-Salloum, Y. Wang, J. Yablon, S. Tseng, Z. Zhu and M.S. Shahriar, APS DAMOP conference in Quebec City, Canada, June 2013.
125. "Verification of light shift imbalance induced blockade in an atomic ensemble via collective state Rabi oscillations," M. Kim, Y. Tu, S. Tseng, R. Sarkar, M. Fouda, and M.S. Shahriar, Conference on Quantum Information And Computation XI (DS222), SPIE International Symposium on Defense, Security and Sensing, 29 April - 3 May 2013, Baltimore, MD, USA.
126. "Progress towards the demonstration of a superluminal DPAL ring laser," J. Yablon, S. Tseng and M.S. Shahriar, SPIE Photonics West, San Francisco, CA, 2013.
127. "Brillouin fast-light fiber laser super-sensor," O. Kotlicki, Jacob Scheuer, and M.S. Shahriar, SPIE Photonics West, San Francisco, CA, 2013 (invited).
128. "A comprehensive study of light shift in optical Ramsey interference for estimating the performance of a rubidium vapor cell atomic clock," G. S. Pati, Z. Warren and M.S. Shahriar, SPIE Photonics West, San Francisco, CA, 2013 (invited).
129. "A Brillouin fast light fiber laser sensor," O. Kotlicki, Jacob Scheuer, and M.S. Shahriar, Optical Fiber Sensor 22, Beijing, China, 2012 (invited).
130. "Interferometry with Atom Lasers and Schrodinger Cats: Nanolithography, Atomic Holograms, and High Compton Frequency Gyroscopes," M.S. Shahriar, M. Fouda, R.P. Fang,

- R. Sarkar, M. Kim, and Y. Tu, presented at the Laser Physics Conference 12, Calgary, Alberta, CA, 2012 (invited).
131. “Demonstration of a Tunable Narrowband-Pumped Ring Alkali Laser for Superluminal Applications,” J. Yablon, S. Tseng, Y. Wang, T. Abi-Salloum, and M.S. Shahriar, presented at the OSA annual meeting, Rochester, NY (2012).
  132. “An Optoelectronic Correlator Architecture for Shift, Scale & Rotation Invariant Target Recognition,” M.S. Monjur, S. Tseng, P. Schnettler, R. Tripathi, and M.S. Shahriar, presented at the OSA annual meeting, Rochester, NY (2012).
  133. “Cold Atom Based Ballistic Single Zone Atom Interferometer,” R. Sarkar, M.E. Kim, M. Fouda, Y. Tu, S. Tseng, and M.S. Shahriar, presented at the OSA annual meeting, Rochester, NY (2012).
  134. “Quantum Zeno effect based high speed optical modulator at a telecom wavelength in a ladder transition in Rb atoms,” Subramanian Krishnamurthy, Y. Wang, S. Tseng, Y. Tu, and M.S. Shahriar, presented at the OSA annual meeting, Rochester, NY (2012).
  135. “Ultra-low Power Optical Modulation within Tapered Nano-fiber using 5S-5P-5D Ladder Transition of Rb Atoms,” Y. Wang, Subramanian Krishnamurthy, S. Tseng, Y. Tu, and M.S. Shahriar, presented at the OSA annual meeting, Rochester, NY (2012).
  136. “A Schrödinger Cat Matter Wave Gyroscope Using Collective Excitation of Atomic Ensembles,” R. Sarkar, M. Kim and M.S. Shahriar, DAMOP, 2012, Anaheim, CA.
  137. “Atom Interferometric Holography and Arbitrary Pattern Nanolithography Using Bose-Einstein Condensates,” M. Fouda, R. Fang, M. Kim, J. Trossman, J. Ketterson, and M.S. Shahriar, DAMOP, 2012, Anaheim, CA.
  138. “Enhanced Sensitivity in a Superluminal Single Mode DPAL Cavity at Room Temperature,” Tony Abi-Salloum and M.S. Shahriar, DAMOP, 2012, Anaheim, CA
  139. “Light-Shift Blockaded Collective States for Atomic Interferometry and Quantum Information Processing,” M. Kim, Y. Tu, R.P. Fang and M.S. Shahriar, presented at the Midwest Cold Atom Workshop, Evanston, November 2011 (invited).
  140. “Ultra-High Compton Frequency Atomic Interferometric Gyroscope Using Collective States,” R. Sarkar, M. Kim, Y. Tu and M.S. Shahriar, presented at the Conference on Lasers and Electro-Optics, Anaheim, CA, May 2012
  141. “Enhancement of Sensitivity of an Atom Interferometer by a Factor of N Using High Compton Frequency of N-atom Collective-States,” R. Sarkar, M. Kim, Y. Tu and M.S. Shahriar, presented at the Physics of Quantum Electronics conference, Snowbird, Utah, January 2012 (invited).



142. "Effect of Zeeman sublevels on light shifts in CPT-based Raman-Ramsey atomic clocks," G.S. Pati and M.S. Shahriar, presented at the SPIE Photonics West, 2012, San Francisco, CA (invited).
143. "Sensitivity enhancement in a superluminal semiconductor optical amplifier ring laser," S. Spillane and M.S. Shahriar, presented at the SPIE Photonics West, 2012, San Francisco, CA (invited).
144. "A Brillouin gain based fast light fiber laser for sensing applications," J. Scheuer and M.S. Shahriar, presented at the SPIE Photonics West, 2012, San Francisco, CA (invited).
145. "Effect of inhomogeneous broadening and buffer-gas collisions on a DPAL based Superluminal laser for precision sensing," T. Abi-Salloum and M.S. Shahriar, presented at the SPIE Photonics West, 2012, San Francisco, CA (invited).
146. "Rb-based superluminal DPAL laser: properties and applications to sensing," J. Yablon, S. Tseng, and M.S. Shahriar, presented at the SPIE Photonics West, 2012, San Francisco, CA.
147. "Constant- and variable-chirp gratings for a broadband white light cavity for data buffering," X. Liu, H. Yum, P.R. Hemmer and M.S. Shahriar, presented at the SPIE Photonics West, 2012, San Francisco, CA.
148. "Ultrafast Automatic Target Recognition System using a Hybrid Holography-FPA-VLSI Correlator Invariant Under Shift, Rotation and Scaling," M.S. Shahriar, presented at the SPIE Photonics West, 2012, San Francisco, CA (invited).
149. "An Inhomogeneously Broadened Superluminal Ring Laser for Rotation Sensing and Accelerometry," J. Yablon, S. Tseng, M. Salit and M.S. Shahriar, presented at the OSA annual meeting, San Jose, CA, Oct. 2011.
150. "Optically Controlled Waveplate at a Telecom Wavelength Using a Ladder Transition in Rb Atoms for All-Optical Switching via the Quantum Zeno Effect," Subramanian Krishnamurthy, Y. Wang, S. Tseng, Y. Tu, and M.S. Shahriar, presented at the OSA annual meeting, San Jose, CA, Oct. 2011.
151. "High Efficiency, High Speed Optical Modulation at a Telecom Wavelength Using the Quantum Zeno Effect in a Ladder Transition in Rb Atoms," Subramanian Krishnamurthy, Y. Wang, Y. Tu, S. Tseng, and M.S. Shahriar, presented at the OSA annual meeting, San Jose, CA, Oct. 2011.
152. "A White Light Cavity Using Chirped Gratings for Optical Data Buffering," H. Yum, P.R. Hemmer, X. Liu, and M.S. Shahriar, presented at the OSA annual meeting, San Jose, CA, Oct. 2011.
153. "Quantum Information Processing with Light Shift Blockaded Atomic Ensembles Coupled to a Cavity," M.S. Shahriar, M. Kim and Y. Tu, presented at the SPIE Quantum

Communications and Quantum Imaging IX Conference (OP514), San Diego, California, August 2011 (**Invited**)

154. "An Ultra-sensitive DC and AC Accelerometer Using Dual Superluminal Zero-Area L-shaped Ring Lasers." S.M. Shahriar, S. Tseng, J. Yablon, and H. Yum, presented at the Conference on Lasers and Electro-Optics, Baltimore, MD 2011 (<http://www.opticsinfobase.org/abstract.cfm?URI=CLEO:%20A%20and%20T-2011-ATuE1>)
155. "Demonstration of a Video Frame Rate Full Muller-metric Eye-safe Imaging Laser Radar" S. M. Shahriar, S. Tseng and X. Liu, presented at the Conference on Lasers and Electro-Optics, Baltimore, MD 2011.
156. "A Chirped Grating Based White Light Cavity for High-Speed Data Buffering and Gravitational Wave Detection" Young Jang, Honam Yum, P.R. Hemmer, and M.S. Shahriar, presented at the SPIE Photonics West, 2011, San Francisco, CA.
157. "Optical Ramsey Interference and Its Performance in D1 Line Excitation in Rubidium Vapor for Implementation of a Vapor Cell Clock," Gour Pati, Fredrik Fatemi, Mark Bashkansky, and M.S. Shahriar, presented at the SPIE Photonics West, 2011, San Francisco, CA (invited).
158. "Theoretical Description and Design of a Fast-Light Enhanced Helium-Neon Ring-Laser Gyroscope", J. Schaar, H. Yum, and M.S. Shahriar, Proc. SPIE 7949, Advances in Slow and Fast Light IV, 794914 (February 17, 2011); doi:10.1117/12.880786; <http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=722633> presented at the SPIE Photonics West, 2011, San Francisco, CA (invited).
159. "Pulse propagation through a dispersive intracavity medium" Honam Yum, Young Jang, and M.S. Shahriar, presented at the SPIE Photonics West, 2011, San Francisco, CA.
160. "A zero-area Sagnac Superluminal Ring Laser for High-Sensitivity Accelerometry" Joshua Yablon, Honam Yum, Yanfei Tu, and M.S. Shahriar, presented at the SPIE Photonics West, 2011, San Francisco, CA.
161. "Ultra-sensitive Accelerometry Using Anomalous Dispersion in a Sagnac Laser," J. Yablon, H. Yum, and M.S. Shahriar, presented at the OSA Annual Meeting, Rochester, NY (2010)
162. "Ultra-sensitive Sensing with A Superluminal Ring Laser," H. Yum, J. Yablon, Y. Wang and M.S. Shahriar, presented at the OSA Annual Meeting, Rochester, NY (2010).
163. "Demonstration of a White Light Cavity for High-Speed Data Buffer Using Bi-Frequency Pumped Brillouin Gain," H. Yum, M. Kim, P.R. Hemmer and M.S. Shahriar, presented at the OSA Annual Meeting, Rochester, NY (2010).

164. "An Automated Stokesmetric Imaging Laser Radar," S. Tseng, X. Liu, and M.S. Shahriar, presented at the OSA Annual Meeting, Rochester, NY (2010).
165. "Electromagnetically induced transparency inside the laser cavity: Switch between first-order and second-order phase transitions," Q. Sun, M.S. Shahriar, and S. Zubairy, Joint Fall Meeting of the Texas Sections of the APS, AAPT, and SPS, (2009), Postdeadline Paper.
166. Yum, H., Salit, M., Yablon, J., Salit, K., Wang, Y., and Shahriar, M. S. (2010). Ultra-precise Rotation Sensing with a Superluminal Ring Laser, Proceedings of IEEE SENSORS Conference, Hawaii, September (invited). Pages 10-14. Can be found on line at [http://ieeexplore.ieee.org/xpls/abs\\_all.jsp?arnumber=5690987](http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5690987)
167. "Properties and Applications of a Superluminal Ring Laser: Accelerometry, Rotation Sensing, and Gravitational Wave Detection," M.S. Shahriar, H. Yum, and J. Yablon, presented at the International Conference on Laser Physics 10, Iguazu Falls, Brazil, July 2010 (invited)
168. "Fast-Light in Optical Fiber Resonator: White Light Cavity, High Speed Data Buffering and Rotation Sensing," M.S. Shahriar, J. Yablon, M.E. Kim and H. Yum, European Conference on Optical Communication, Torino, Italy, October, 2010 (invited)
169. "High Bandwidth, Ultra-Low Power All Optical Modulation with a Nano-Fiber Embedded in Rb Vapor," K. Salit, M. Salit, Subramanian Krishnamurthy, Y. Wang, P. Kumar, and M.S. Shahriar, presented at the Conference on Lasers and Electro-Optics, San Jose, CA, May 2010.
170. "A Compound Mirror Incorporating a Fast-Light Medium for Gravitational Wave Detection with High Sensitivity, Broadband Signal Recycling," M.S. Shahriar and M. Salit, presented at the Conference on Lasers and Electro-Optics, San Jose, CA, May 2010.
171. "Prospect for Development of Pulsed CPT Raman Ramsey Clock using Atomic Vapor" G. S. Pati, F. K. Fatemi, M. Bashkansky, and M.S. Shahriar, proceedings of the SPIE Photonics West, San Francisco, CA, (January 2010) (invited).
172. "Superluminal Laser: Properties and Applications." H. Yum, J. Yablon, Y. Wang, P. Hemmer and M. S. Shahriar, presented at the SPIE Photonics West, San Francisco, CA, (January 2010).
173. "Superluminal Laser for Rotation Sensing and Other Application," M.S. Shahriar, H. Yum, J. Yablon, and Y. Wang, presented at the Stanford Photonic Research Center Annual Conference, Stanford, CA, Sept. 2009.
174. "Atto-Joules, High Bandwidth All Optical Modulation with a Nano-Fiber Embedded in Alkali Vapor," K. Salit, M. Salit, Subramanian Krishnamurthy, Y. Wang, P. Kumar, and M.S. Shahriar, presented at OSA Annual Meeting, San Jose, CA, Oct. 2009.
175. "A White Light Cavity as a Non-Invasive, Compound Mirror for High Sensitivity, Broadband Signal Recycling in a Gravitational Wave Detector," M. Salit, H. Yum, and M.S. Shahriar, presented at OSA Annual Meeting, San Jose, CA, Oct. 2009.

176. "A 3CCD Imaging System Based on Holographic Gratings," M.S. Shahriar, X. Liu, and S. Tseng, presented at OSA Annual Meeting, San Jose, CA, Oct. 2009.
177. "Complete Two-Dimensional Muellermetric Imaging of Biological Tissue Using Heterodyned Optical Coherence Tomography," M.S. Shahriar, X. Liu, and S. Tseng, presented at OSA Annual Meeting, San Jose, CA, Oct. 2009.
178. "Interdependence of Quantization of Massive Particles and Electromagnetic Fields, and the Need for Photons in Quantum Computing" M.S. Shahriar, SPIE Optical Engineering and Applications, Conference on *Nature of Light, What is a Photon*, San Diego, CA, August 2009, **(Plenary Talk)**.
179. "Fast Light in Optical Fiber for Trap-Door Data Buffering" M.S. Shahriar, M. Salit and H.N. Yum, OSA Topical Meeting on Slow and Fast Light, Honolulu, HI, July 2009 (invited).
180. "Distortion Free, High Delay-Bandwidth Product Data Buffer Using Fast-Light Based White Light Cavities," H.N. Yum, M. Salit, and M.S. Shahriar, presented at CLEO 2009 (Baltimore, MD)
181. "Putting Superluminality to Work: From Data Buffering to Ultraprecise Magnetometry" M.S. Shahriar, M. Salit, and H. Yum, Physics of Quantum Electronics Conference, 2009, Snowbird, Utah (invited).
182. "Gravitational Wave Detection with active and passive superluminal cavities," M.S. Shahriar, Laser Physics Conference, 2009, Barcelona, Spain.
183. "A Superluminal Ring Laser as a Versatile, Hypersensitive Sensor" M. Salit, H. Yum, and M.S. Shahriar, Proceedings of SPIE Photonics West, San Jose, CA, (January 2009) (invited).
184. "Buffering and Sensing Applications of SBS Induced Fast Light in a Fiber Resonator" H. Yum, P. Hemmer, M. Salit and M.S. Shahriar, Proceedings of SPIE Photonics West, San Jose, CA, (January 2009) (invited).
185. "High-Speed, Ultra-low Light Level Optical Switching with a Nano-fiber via Degenerate V-System EIT" K. Salit, M. Salit, Subramanian Krishnamurthy, and M.S. Shahriar, Proceedings of SPIE Photonics West, San Jose, CA, (January 2009).
186. "Fast light in a photorefractive crystal for broadband gravitational wave detection with an augmented advanced-LIGO interferometer," M. Salit, M. Kellner, Subramanian Krishnamurthy, M. S. Shahriar, H. Yum, P. Hemmer, Proceedings of SPIE Photonics West, San Jose, CA, (January 2009) (invited).
187. "Heterodyned Optical Coherence Tomography for Complete Stokesmetric Imaging," M.S. Shahriar, X. Liu, S. Tseng, and A. Heifetz, Frontiers in Optics and Laser Science, OSA Annual Meeting, Rochester, NY (2008).

188. "A Superluminal Ring Laser for Rotation Sensing," M.S. Shahriar and M. Salit, Frontiers in Optics and Laser Science, OSA Annual Meeting, Rochester, NY (2008).
189. "A Zero-Area Sagnac Ring Laser Gravitational Wave Detector with Fast-Light Enhanced Strain Sensitivity," M.S. Shahriar and M. Salit, Frontiers in Optics and Laser Science, OSA Annual Meeting, Rochester, NY (2008).
190. "Demonstration of Two-Pump Photorefractive Gain in a BaTiO<sub>3</sub> Crystal for Realizing a Whitelight Cavity," Gour S. Pati, M. Salit, M. S. Shahriar, CLEO 2008, San Jose, CA
191. "An Inline Automated Stokesmeter" Alexander Heifetz, Shih C. Tseng, M.S. Shahriar, , CLEO 2008, San Jose, CA
192. "Raman Resonant Probe Gain and Pump Depletion in Rubidium Vapor for Simultaneous Slow and Fast Light Effects," Gour S. Pati, M. Salit and M.S. Shahriar, CLEO 2008, San Jose, CA.
193. "Anomalous-Dispersion Enhanced Active Sagnac Interferometry for Gravitational Wave Detection," M.S. Shahriar, G.S. Pati, M. Salit, K. Salit, and K. Richardson, Proceedings of SPIE Photonics West, San Jose, CA, (January 2008) (invited)
194. "Study of Raman-Ramsey Fringes for Enhanced Precision in a Chip Scale Rb Clock," M.S. Shahriar, G.S. Pati, M. Salit, and K. Salit, Proceedings of SPIE Photonics West, San Jose, CA, (January 2008) (invited)
195. "Quantum Interference Spectroscopy in Vapors and Trapped Atoms with Nano-Fibers," K. Salit, M. Salit, S. Spillane, R. Beausoleil, P. Kumar, and M.S. Shahriar, presented at SPIE Photonics West, San Jose, CA, (January 2008) (invited).
196. "Simultaneous generation of slow and fast light for Raman coupled beams," G.S. Pati, K. Salit, and M.S. Shahriar, Proceedings of SPIE Photonics West, San Jose, CA, (January 2008).
197. "Angular Directivity of Diffracted Wave in Bragg-Mismatched Readout of Volume Holographic Gratings," A. Heifetz, J. T. Shen, S. C. Tsang, G. S. Pati, J-K. Lee, and M.S. Shahriar, presented at the OSA Annual Meeting (Oct. 2007).
198. "Observation of Raman Ramsey Fringes using Delayed Optical Pulses in Atomic vapor Medium," G.S. Pati, K. Salit, and M.S. Shahriar, presented at the OSA Annual Meeting (Oct. 2007).
199. "Low Light Level V-Type Electromagnetically Induced Transparency using Tapered Fiber Embedded in Rubidium Vapor," G.S. Pati, S. Spillane, R. Beausoleil, K. Salit, M. Hall, P. Kumar, and M.S. Shahriar, presented at the OSA Annual Meeting (Oct. 2007).

200. "Low Light Level Saturated Absorption in Tapered Fiber Embedded in Alkali Vapor," G.S. Pati, S. Spillane, R. Beausoleil, K. Salit, M. Hall, P. Kumar, and M.S. Shahriar, presented at the CLEO/QELS Meeting, Baltimore, MD (May 2007).
201. "A Tunable-Bandwidth White Light Interferometer Using Bi-frequency Raman Gain in Atomic Vapor," G.S. Pati, M. Messal, K. Salit, and M.S. Shahriar, presented at the CLEO/QELS Meeting, Baltimore, MD (May 2007).
202. "Sensitivity, bandwidth and SNR constraints in fast-light enhanced precision metrology for applications to rotation sensing and gravity wave detection," M.S. Shahriar, G. Pati, M. Messal, K. Salit, SPIE Symposium on Fluctuation and Noise, Florence, Italy (May, 2007) (invited).
203. "Anomalous Dispersion in Atomic Vapor for Measuring the Lense-Thirring Rotation and Detecting Gravitational Waves," MS. Shahriar, Princeton-TAMU Seminar Series, (April 2007) (invited).
204. "Fast-Light for Astrophysics: Testing Theories of Gravity and Detecting Gravitational Waves," M.S. Shahriar, Physics of Quantum Electronics Conference, Snowbird, Utah (Jan, 2007) (Plenary Talk).
205. "Application of Fast Light to Enhancing the Bandwidth-Sensitivity Product of a Gravitational Wave Detector," M.S. Shahriar, presented at the Slow-Light 2007 Conference of the Optical Society of America, Salt Lake City, Utah, (July 2007), (invited).
206. "Holographic polarimetry enhanced target recognition and remote sensing." M.S. Shahriar, proceedings of the SPIE Photonics West Conference, San Jose, CA, (Jan 2007) (invited).
207. "Ultra-low Light Level Saturation Spectroscopy and EIT using a tapered fiber in a hot vapor cell" G.S. Pati, M. Hall, K. Salit, P. Kumar, S. Spillane, R. Beausoleil, and M.S. Shahriar, proceedings of the SPIE Photonics West Conference, San Jose, CA, (Jan 2007).
208. "Demonstration of a White Light Interferometer Using Fast Light," G.S. Pati, M. Messal, and M.S. Shahriar, proceedings of the SPIE Photonics West Conference, San Jose, CA, (Jan 2007).
209. "Demonstration of Interferometer Sensitivity varying as the Inverse of the Group Index," M. S. Shahriar, G.S. Pati, and M. Messal, proceedings of the SPIE Photonics West Conference, San Jose, CA, (Jan 2007) (invited).
210. "An Optical Network Integration Platform Based On Holographic Super-Dense WDM Filters," M.S. Shahriar, M. Andrews, S. Tseng, J. Kuykendall, A. Meshal and N. Vallesterio, presented at the 25th Army Science Conference, Orlando, Fl (Nov. 2006).

211. "Multi-Spectral Raman Gain in Atomic Rubidium Vapor," J.E. Vornehm, G.S. Pati, K. Salit, and M.S. Shahriar, presented at the OSA Annual Meeting, Rochester, NY (Oct. 2006).
212. "Fast-Light For Enhanced-Sensitivity White-Light Resonant Interferometry," M.S. Shahriar, G.S. Pati, M. Messall, and K. Salit, presented at the OSA Annual Meeting, Rochester, NY (Oct. 2006).
213. "A Volume-Grating Stokesmeter Based on Photonic Band Gap Structures," J-K. Lee, J. Shen, S. Tseng, G.S. Pati, and M.S. Shahriar, presented at the OSA Annual Meeting, Rochester, NY (Oct. 2006).
214. "Slow-Light Based Control of Interferometer Sensitivity," M.S. Shahriar, G.S. Pati, M. Messall, and K. Salit, presented at the OSA Annual Meeting, Rochester, NY (Oct. 2006).
215. "Demonstration of a Spectrally Multiplexed Holographic Stokesmeter," J-K. Lee, J. Shen, S. Tseng, G.S. Pati, and M.S. Shahriar, presented at the OSA Annual Meeting, Rochester, NY (Oct. 2006).
216. "Deterministic quantum storage, communication, and computing with atomic ensembles using light-shift imbalance induced blockade of collective excitations," M.S. Shahriar, presented at the SPIE conference on Photonic Devices and Algorithms for Computing, San Diego, CA (Aug., 2006) (invited).
217. "Making a Quantum Internet Using Schroedinger Cats," M.S. Shahriar, presented at the Third Feynman Festival, University of Maryland, College Park, MD (August, 2006) (invited).
218. "Quantum-Interference Based White-Light Interferometry for Detection of Gravitational Waves," M.S. Shahriar, presented at the 31st International Nathiagali Summer College, Pakistan (June 2006) (invited).
219. "Quest for a Quantum Internet Using Schroedinger Cats," M.S. Shahriar, presented at the 31st International Nathiagali Summer College, Pakistan (June 2006) (invited).
220. "Shift-Invariant Real-Time Edge-Enhanced VanderLugt Correlator Using Video-Rate Compatible Photorefractive Polymer," A. Heifetz, G.S. Pati, J.T. Shen, J.-K. Lee, M.S. Shahriar, C. Phan, and M. Yamamoto, presented at CLEO, Long Beach, California, (May 2006).
221. "Demonstration Of A Spectrally Multiplexed Holographic Stokesmeter," Jong-Kwon Lee, John.T. Shen, Alex. Heifetz, and M.S. Shahriar," presented at CLEO, Long Beach, California, (May 2006).
222. "Controllable Anomalous Dispersion and Group Index Nulling via Bi-Frequency Raman Gain for Ultraprecision Rotation Sensing," G.S. Pati, R. Tripathi, M. Messall, V. Gopal, K. Salit and M.S. Shahriar, presented at CLEO, Long Beach, California, (May 2006).

223. “Deterministic Quantum Storage, Communication and Computing With Atomic Ensembles Using Light-Shift Imbalance Induced Blockade of Collective Excitations,” M.S. Shahriar, P. Pradhan, G.S. Pati, V. Gopal, and K. Salit, presented at CLEO, Long Beach, California, (May 2006).
224. “Slow- and Fast-Light Enhanced Rotation Sensing and Fabry-Perot Interferometry,” Renu Tripathi, Gour Pati, Venkatesh Gopal, Kenneth Salit, Mary Messal, M.S. Shahriar, presented at the SPIE Photonics West Conference, San Jose, CA, Jan 2006 (invited).
225. “Ensemble-based Quantum Memory, Quantum Communication, and Quantum Computing,” Gour Pati, Kenneth Salit, Prem Kumar, and M.S. Shahriar, presented at the SPIE Photonics West Conference, San Jose, CA, January 2006 (invited).
226. “Holographic Eye for UAV Navigation” M.S. Shahriar, presented at the SPIE Defense and Security Symposium, Orlando, FL, April 2006 (invited).
227. “Light-Shift Imbalance Induced Dipole Blockade for Deterministic Quantum Information Processing using Atomic Ensembles”, M.S. Shahriar, presented at the International Conference on Quantum Optics, Hong Kong, December, 2005 (invited).
228. “Slow-Light in Cold Atoms for Single Photon Detection,” M.S. Shahriar, Midwest Workshop on Cold Atoms, Urbana, IL, November, 2005 (invited).
229. “Observation of Slow-Light and Matched Dispersion in Sodium Vapor for Applications to Laub-Drag Enhanced Rotation Sensing,” Renu Tripathi, Gour Pati, Mary Messall, Kenneth Salit, Venkatesh Gopal, Selim M. Shahriar, presented at the OSA Annual Meeting, Tucson, AZ, October, 2005.
230. “Slow and Superluminal Light Enhanced Ultrahigh Precision Optical Rotation Sensing,” Selim M. Shahriar, Gour Pati, Renu Tripathi, Venkatesh Gopal, Mary Messall, Kenneth Salit, presented at the OSA Annual Meeting, Tucson, AZ, October, 2005.
231. “Poly(Methyl Methacrylate)-Based Material for Thick Holographic Memory Plates and Ultra-Narrow Filters,” John Shen, Jong-Kwon Lee, Alexander Heifetz, Gour Pati, Renu Tripathi, John Donoghue, Shih Tseng, Selim M. Shahriar, presented at the OSA Annual Meeting, Tucson, AZ, October, 2005.
232. “Enhancement of Interferometric Precision Using Fast Light,” Selim M. Shahriar, Renu Tripathi, Gour Pati, Venkatesh Gopal, Kenneth Salit, Mary Messall, presented at the OSA Annual Meeting, Tucson, AZ, October, 2005.
233. “Spectrally Scanned Polarimetric Imaging Using a Thick Holographic Stokesmeter,” Jong-Kwon Lee, John Shen, Alexander Heifetz, Renu Tripathi, Selim M. Shahriar, presented at the OSA Annual Meeting, Tucson, AZ, October, 2005.
234. “Demonstration of a Multiwave Coherent Holographic Beam Combiner in a Polymeric Substrate,” Ho Yum, Philip Hemmer, Alexander Heifetz, John Shen, Jong-Kwon Lee, Renu



- Tripathi, Selim M. Shahriar, presented at the OSA Annual Meeting, Tucson, AZ, October, 2005.
235. "Precision Rotation Sensing and Interferometry Using Slow Light," M.S. Shahriar, G.S. Pati, V. Gopal, R. Tripathi, G. Cardoso, P. Pradhan, M. Messal, and R. Nair, presented at CLEO/QELS, Baltimore, MD, May 2005.
236. "Demonstration of a Thick Holographic Stokesmeter," M.S. Shahriar, J-K. Lee, J. T. Shen, A. Heifetz, R. Tripathi, presented at CLEO/QELS, Baltimore, MD, May 2005.
237. "High speed data-search and pattern identification using a hybrid super-parallel holographic RAM-JTC geometry," M.S. Shahriar, R. Tripathi, and J.T. Shen, SPIE Defense & Security Symposium, Orlando, FL (2005).
238. "Pseudo-random noise in high-speed operation of quantum bits," M.S. Shahriar, P. Pradhan, and J. Morzinski, presented at the Conference on Fluctuations and Noise in Photonics and Quantum Optics III, SPIE, Austin, Texas, 2005. (invited)
239. "Investigation towards realizing a slow-light based rotation sensor" G.S. Pati, R. Tripathi, P. Pradhan, R. Nair, V. Gopal, G. Cardoso, and M.S. Shahriar, presented at SPIE, Photonics West, 2005, San Jose, CA (invited).
240. "A Landmark Identification Based Navigation System using A Hybrid Holographic Correlator" M.S. Shahriar, A. Heifetz, J.T. Shen, J-K. Lee, R. Tripathi, presented at SPIE, Photonics West, 2005, San Jose, CA (invited).
241. "High speed data search and pattern identification using a hybrid super-parallel holographic RAM-JTC geometry," M.S. Shahriar, Renu Tripathi, J.T. Shen, A. Heifetz, J-K. Lee, presented at SPIE Aerosense, 2005 (invited).
242. "Solid State Quantum Computing Via Spectral Hole Burning," M.S. Shahriar, presented at the International Workshop on Quantum Informatics, Dec 2004, Hong Kong (invited).
243. "Integrated Quantum Communication and Computing: The Quantum Internet," M.S. Shahriar, presented at the International Workshop on Quantum Informatics, Dec 2004, Hong Kong (invited).
244. "Quantum Teleportation Using Neutral Atoms and Cavity-QED," M.S. Shahriar, presented at the International Workshop on Quantum Informatics, Dec 2004, Hong Kong (invited).
245. "Holographic Polarimeter Utilizing the Polarization Dependency of Thick Holographic Substrates," M.S. Shahriar, J.T. Shen, J-K. Lee, R. Tripathi, and A. Heifetz, presented at the OSA Annual Meeting, Rochester, NY (2004).

246. "Effects of the Bloch-Siegert Oscillation on the Precision of Qubit Rotations: Direct Two-Level vs. Off-Resonant Raman Excitation," P. Pradhan, G. Cardoso, J. Morzinski, and M.S. Shahriar, presented at the OSA Annual Meeting, Rochester, NY (2004).
247. "Spatio-Angular Parallelism in a Holographic Correlator and Random Access Memory," M.S. Shahriar, J.T. Shen, R. Tripathi, J-K. Lee, and A. Heifetz, presented at the OSA Annual Meeting, Rochester, NY (2004).
248. "Single-Photon Raman Gain for Single-Photon Detection," G. Cardoso, G.S. Pati, V. Gopal, A. Heifetz, M.S. Shahriar, and P. Kumar, presented at the OSA Annual Meeting, Rochester, NY (2004).
249. "Application of Slow-Light to Quantum Information Processing," presented at the OSA Annual Meeting, Rochester, NY (2004) (Invited Paper).
250. "Quantum Communication and Computing Using Neutral Atoms," M.S. Shahriar, presented at The Feynman Festival, University of Maryland (2004) (Invited Paper).
251. "Quantum communication via atomic-state teleportation for game theoretic applications, M. S. Shahriar, presented at the Quantum Communications and Quantum Imaging II session of SPIE Annual Meeting, Denver, CO (August, 2004) (Invited Paper).
252. "Super-parallel holography and holographic polarimetry for optical pattern recognition," M.S. Shahriar, J.T. Shen, J.K. Lee, R. Tripathi, SPIE Defense & Security Symposium, Orlando, FL (2004).
253. "Single Atom Interferometry and Its Application to Generation of Motional Entanglement," M.S. Shahriar, A. Heifetz, K. Salit, G. Pati, and V. Gopal, presented at Progress in Quantum Electronics, Snowbird, Utah (January 2004) (Invited Paper).
254. "Atomic Ensemble Quantum Memory Using Rb Vapor for Quantum Entanglement and Teleportation," G. Cardoso, A. Heifetz, V. Gopal, G.S. Pati, and M.S. Shahriar, presented at the SPIE Photonics West, San Jose, CA (Jan., 2004) (Invited Paper).
255. " Photonic Bandgap Structures In NV-Diamond For Quantum Computing" R. Tripathi, J.K. Lee, and M.S. Shahriar, presented at the SPIE Photonics West, San Jose, CA (Jan., 2004) (Invited Paper).
256. "A Hybrid Correlator and RAM Using Super-Parallel Holography," M. Andrews, M. Huq, J. Shen, R. Tripathi, and M.S. Shahriar, presented at the SPIE Photonics West, San Jose, CA (Jan., 2004). (Invited Paper).
257. "Demonstration of a single exposure technique for determining the M/# of a holographic substrate," H.N. Yum, P.R. Hemmer, R. Tripathi, J. T. Shen, and M.S. Shahriar, presented at the CLEO/IQEC, San Francisco, CA (2004).

258. "Holographic Stokesmeter Using Polarization-Sensitive Volume Gratings," M.S. Shahriar, J.T. Shen, Renu Tripathi, J.K Lee, and M.A. Hall, presented at CLEO/IQEC, San Francisco, CA (2004).
259. "Demonstration of a super-parallel holographic RAM using the super-parallel holographic optical correlator architecture," M.S. Shahriar, R. Tripathi, M. Huq, and J.T. Shen, presented at CLEO/IQEC, San Francisco, CA (2004).
260. "Local observation of the absolute phase of a microwave field," G. Cardoso, J. Morzinski, P. Pradhan, and M.S. Shahriar, presented at CLEO/IQEC, San Francisco, CA (2004).
261. "Observation of the Phase Of a Microwave Field via the Bloch-Siegert Oscillation," G. Cardoso, P. Pradhan, and M.S. Shahriar, the OSA Annual Meeting, Tucson, Az (October 2003) (Postdeadline Paper).
262. "Strongly Pump-Suppressed Raman Gain in 85Rb for Generation of Macroscopic Entanglement of Vapor Cells," A. Agarwal, A. Heifetz, A. Agarwal, A. Heifetz, G. Cardoso, V. Gopal, P. Kumar, and M.S. Shahriar, presented at the Progress In Electromagnetic Research Symposium 2003, Honolulu, HI, (October 2003) (Invited Paper).
263. "Observation of the Phase Of a Microwave Field Using Single-Atom Nonlinear Optics," G. Cardoso, P. Pradhan, and M.S. Shahriar, presented at the Progress In Electromagnetic Research Symposium 2003, Honolulu, HI, (October 2003) (Invited Paper).
264. "Progress toward long-distance, high-fidelity quantum communication," N.C. Wong, P. Kumar, M.S. Shahriar, and Jeffrey Shapiro, presented at the OSA Annual Meeting, Tucson, AZ (October 2003) (Invited Paper).
265. "Absence of Bloch-Siegert shift and oscillation in optically excited microwave transitions," M.S. Shahriar, P. Pradhan, and G. Cardoso, presented at CLEO, Baltimore, MD, 2003.
266. "Imaging Stokesmeter utilizing holographic diffraction gratings," M.S. Shahriar, R. Tripathi, M. Kleinschmit, and T. Nee, presented at CLEO, Baltimore, MD, 2003.
267. "Ultrafast Database Search Using Holographic Memory Vs. Quantum Computing," M.S. Shahriar, SPIE Photonic West, San Jose, CA, Jan 2003. (Invited Paper).
268. "Quantum Versus Super-Parallel Holographic Database Search," M.S. Shahriar, presented at the SPIE Aerosense Meeting, Orlando, FL, April 2003.
269. "Experimental Demonstration of a Continuously Guided, Single-Zone Atom Interferometer," M.S. Shahriar, Y. Tan, J. Morzinski, M. Jheeta, and P.R. Hemmer, presented at the Annual Meeting of the Optical Society of America, Orlando, FL (2002).

270. "Measurement and Teleportation of The Phase of An Electromagnetic Field via Fluorescence Detection," M.S. Shahriar, P. Pradhan, and J. Morzinski, presented at the Annual Meeting of the Optical Society of America, Orlando, FL (2002).
271. "A Super-Parallel Holographic Correlator for Ultrafast Database Search," M.S. Shahriar, M. Kleinschmit, W. Weathers, J. Donoghue, and J. Shen, presented at the Annual Meeting of the Optical Society of America, Orlando, FL (2002).
272. "Determination and Teleportation Of The Phase Of An Electromagnetic Field Via Incoherent Detection Of Fluorescence," M. S. Shahriar and P. Pradhan, presented at the APS Annual Meeting, March 2002.
273. "Measurement and Teleportation of The Phase of An Electromagnetic Wave using the Bloch-Siegert Oscillation," P. Pradhan, J. Morzinski, and M.S. Shahriar, proceedings of the 6th International Conference on Quantum Communication Measurement and Computing, , Cambridge, MA (July 2002).
274. "Teleportation of Atomic States via Complete Measurement of Bell States" V. Gopal, J. Morzinsky, and M.S. Shahriar, presented at the Progress In Electromagnetic Research Symposium 2002, Cambridge, MA (July 2002).
275. "Determination of the Phase of an Electromagnetic Field via Incoherent Detection of Fluorescence using the Bloch-Siegert Oscillation," P. Pradhan, J. Morzinsky and M.S. Shahriar, presented at the Progress In Electromagnetic Research Symposium 2002, Cambridge, MA (July 2002).
276. "Demonstration of a Super-Parallel Holographic Optical Correlator for Ultrafast Database Search," M.S. Shahriar, M. Kleinschmit, W. Weathers, and R. Tripathi, , CLEO 2002 (Post-Deadline).
277. "Quantum Computing using NV-Diamond," M.S. Shahriar and P.R. Hemmer, presented at the Progress in Quantum Electronics conference, Snowbird, UT, Jan. 2002 (Invited).
278. "Applications of Slow and Stopped Light in Solid," P.R. Hemmer and M.S. Shahriar, presented at the Progress in Quantum Electronics conference, Snowbird, UT, Jan. 2002 (Invited).
279. "Long-distance, unconditional teleportation of atomic states via complete measurement of all Bell-states," M.S. Shahriar, S. Lloyd, J.H. Shapiro, and P.R. Hemmer, proceedings of the International Conference on Quantum Information, Rochester, NY, July 2001.
280. M.S. Shahriar, "Bloch-Siegert oscillation for detection and quantum teleportation of the phase of an oscillating field," proceedings of the Conference on Quantum Optics 8, Rochester, NY, July 2001.

281. "Raman Excited Spin Coherence in NV Diamond," P.R. Hemmer, A. Turukhin, M.S. Shahriar, and J.A. Musser, proceedings of the SPIE Conference, San Diego, CA August 2001 (Invited).
282. "First Observation of Ultraslow Group Velocity of Light in a Solid," Turukhin, V.S. Sudarshanam, M.S. Shahriar, J.A. Musser, and P.R. Hemmer, proceedings of the SPIE Conference, San Diego, CA August 2001 (Invited).
283. A.V. Turukhin, M.S. Shahriar, J.A. Musser, and P.R. Hemmer, "Spin Mediated Slowing and Stoppage of Light in a Solid," presented at Spintech 1, Maui, Hawaii, May 2001.
284. "First Observation of Ultraslow Group Velocity of Light in a Solid," A. Turukhin, V.S. Sudarshanam, M.S. Shahriar, J.A. Musser, and P.R. Hemmer, presented at the International Quantum Electronics Conference, Baltimore, MD, May 2001.
285. "Observation of Ultraslow Group Velocity of Light in a Pr:YSO crystal," V.S. Sudarshanam, M.S. Shahriar, and P.R. Hemmer, 31st Winter Colloquium in Quantum Electronics, Snowbird, Utah (Jan 2001).
286. P.R. Hemmer, A. Turukhin, M.S. Shahriar, and J.A. Musser, "Raman Excited Spin Coherence in NV Diamond," presented at the International Quantum Electronics Conference, Baltimore, MD, May 2001.
287. P.R. Hemmer, A. Turukhin, M.S. Shahriar, and J.A. Musser, "Raman Excited Spin Coherence in NV Diamond," Optical Society of America Annual Meeting, Providence, RI, October 2000 (postdeadline).
288. M.S. Shahriar, A.V. Turukhin, P.R. Hemmer, and S. Lloyd, "Quantum Computing in Diamond," presented at the International Conference on Experimental Implementation of Quantum Computing, 16-19 January, 2000, Sydney, Australia (Invited).
289. M.S. Shahriar, S. Lloyd, and P.R. Hemmer, "Type II Quantum Computing in Spectrally Selective Solids," Quantum Computing for Physical Modeling conference, Oct. 18-19, 2000, North Falmouth, MA.
290. J.H. Shapiro, F. Wong, M.S. Shahriar, and S. Lloyd, "Long-distance high-fidelity teleportation using singlet states," Quantum Communication, Measurement and Computing, Capri, Italy, July 3-8, 2000.
291. P.R. Hemmer, M.S. Shahriar, and A. Turukhin, "Raman excited spin coherences for high-temperature spectral hole-burning memories" Conference on Lasers and Electro-Optics, San Francisco, CA, 2000.
292. M.K. Kim, B. Ham, M.S. Shahriar, and P.R. Hemmer, "Sub-kHz resonance structure in rf-optical double resonance of rare-earth ions in solids," OSA Annual Meeting, Santa Clara, CA, 1999.

293. B. Ham, M.S. Shahriar, and P.R. Hemmer, "Enhancement of Four-wave-mixing and Line-narrowing using EIT in an optically dense double-lambda solid," OSA Annual Meeting, Santa Clara, CA, 1999.
294. B. Ham, M.S. Shahriar, and P.R. Hemmer, "Observation of Laser Jitter Enhanced Hyperfine Spectroscopy," OSA Annual Meeting, Santa Clara, CA, 1999.
295. B. Ham, M.S. Shahriar, and P.R. Hemmer, "Electromagnetically induced transparency over spectral hole-burning temperature in an inhomogeneously broadened solid," Conference on Lasers and Electro-Optics, Baltimore, MD, 1999.
296. B. Ham, M.S. Shahriar, and P.R. Hemmer, "Efficient Phase Conjugation using Raman dark resonances in an optically dense solid," Conference on Lasers and Electro-Optics, Baltimore, MD, 1999.
297. M.S. Shahriar, J. Riccobono, W. Weathers, "Holographic Beam Combiner," International Microwaves and Optics Conference, Rio De Janeiro, Brazil, 1999.
298. M.S. Shahriar, J. Bowers, S. Lloyd, A. Craig and P.R. Hemmer "Quantum Computing via Cavity Induced Coupling of Spectrally Selective Bands of Particles in a Solid," presented at the OSA Topical Meeting on Optics in Computing, 1999, Snowmass, CO. (invited).
299. M.S. Shahriar, L. Wong, M. Bock, J. Kierstead, P.R. Hemmer, M. Henrion, and J. Ludman, "Angle and space multiplexed holographic optical memory using thick, diffusion amplified photopolymer," the OSA Annual Meeting, 1998, Baltimore, MD.
300. M.S. Shahriar, J. Bowers, S. Lloyd, A. Craig and P.R. Hemmer, "Quantum Computation via Coherent Population Trapping in an Inhomogeneously Broadened Crystal," the 4th International Conference on Quantum Communication, Measurement, and Computing, 1998, Evanston, IL.
301. M.S. Shahriar, D. Hsiung, X. Xia, T.T. Grove, and P.R. Hemmer, "Demonstration of a Phase Conjugate Resonator using Degenerate Four Wave Mixing via Coherent Population Trapping," presented at the IEEE/LEOS Topical Meeting on Nonlinear Optics, Materials and Applications, 1998, Kauai, Hawaii.
302. M.S. Shahriar, J. Bowers, S. Lloyd, A. Craig and P.R. Hemmer, "Quantum Computation via Spectral Holeburning in a Crystal," IX Conference on Laser Optics, June 1998, St. Petersburg, Russia (invited).
303. M.S. Shahriar, B.S. Ham, V.S. Sudarshanam, and P.R. Hemmer, "Nonlinear Optics in Resonant Systems Applied to Signal Processing," the OSA Annual Meeting, 1998, Baltimore, MD (invited).

304. Y.Tan, M.S. Shahriar, and P.R. Hemmer, "Limits on the sensitivity of an atomic interferometer imposed by the phase noise of a blazed grating optical beam splitter," presented at the OSA Annual Meeting, 1998, Baltimore, MD.
305. M.S. Shahriar, J. Bowers, S. Lloyd, and P.R. Hemmer, "Quantum Computing via Cavity-coupled Bands in a Spectral Hole-Burning Solid," OSA Annual Meeting, 1998, Baltimore, MD.
306. B.S. Ham, P.R. Hemmer, and M.S. Shahriar, "RF-induced Gain of Laser Beams in an Optically Dense Rare Earth Doped Solid," OSA Annual Meeting, 1998, Baltimore, MD.
307. V.S. Sudarshanam, M. Cronin-Golomb, P.R. Hemmer, and M.S. Shahriar, "Intra-cavity High-Speed Turbulence Aberration Correction in a Sodium Raman Phase Conjugate Resonator," OSA Annual Meeting, 1998, Baltimore, MD.
308. B.S. Ham, P.R. Hemmer, and M.S. Shahriar, "Optical Memory using Resonant Raman Excited Spin Echoes," OSA Optical Data Storage Topical Meeting, May 1998, Aspen, CO.
309. M.S. Shahriar, J. Bowers, S. Lloyd, A.Craig and P.R. Hemmer, 'Multi-atom Quantum Bits and Cavity Dark States for Quantum Computing in Spectral Holeburning Media," First NASA conference on Quantum Computing and Quantum Communications, Feb. 17-20, 1998, Palm Springs, CA.
310. V.S. Sudarshanam, M. Cronin-Golomb, P.R. Hemmer, and M.S. Shahriar, "Aero-Optic Raman Phase Conjugator," Conference on Lasers and Electro Optics, May 1998, San Francisco, CA. (postdeadline).
311. B. Ham, M.S. Shahriar, P.K. Kim, and P.R. Hemmer, "Optical Data Storage by Electromagnetically Induced Transparency and Nondegenerate Four-wave Mixing in a Spectral Hole-burning solid," Conference on Lasers and Electro Optics, May 1998, San Francisco, CA.
312. X. Xia, D. Hsiung, M.S. Shahriar, T.T. Grove, and P.R. Hemmer, "High Gain Optical Phase Conjugation Using Degenerate Four Wave Mixing via Coherent Population Trapping in Moving Atoms," Quantum Electronics and Laser Science Conference, May 1998, San Francisco, CA.
313. B.S. Ham, P.R. Hemmer, and M.S. Shahriar, "Observation of Enhanced Non-Degenerate Four Wave Mixing and Efficient Electromagnetically Induced Transparency in an Optically Dense Rare-Earth Doped Crystal," OSA Annual Meeting Technical Digest 1997 (Opt. Soc. of Am., Washington, D.C.,1997).
314. "Turbulence Aberration Correction with High-Speed High-Gain Optical Phase Conjugation in Sodium," V.S. Sudarshanam, M. Cronin-Golomb, P.R. Hemmer, and M.S. Shahriar, Progress in Electromagnetic Research Symposium, July 1997.

315. E. Rousseau, T.T. Grove, D. Hsiung, X. -W. Xia, P.R. Hemmer, and M.S. Shahriar, "Efficient, Fast, Low Power Optical Phase Conjugator using Two-Photon Induced Zeeman Coherence in Rubidium," Quantum Electronics and Laser Science Conference, 1997.
316. V.S. Sudarshanam, M. Cronin-Golomb, P.R. Hemmer, and M.S. Shahriar, "High Speed Turbulence Aberration Correction with High-Gain Optical Phase Conjugation in Sodium", Conference on Lasers and Electro Optics, 1997.
317. M.S. Shahriar, P.R. Hemmer, T.T. Grove, M. Cronin-Golomb, and P. Kumar, "Unbounded Cooling Force in Traveling Waves Excitation of a Four Level System," Quantum Electronics and Laser Science Conference, 1996, OSA Technical Digest Series, (Opt. Soc. of Am., Washington, D.C., 1996) p. 240.
318. M.S. Shahriar, P.R. Hemmer, T.T. Grove, M. Cronin-Golomb, and P. Kumar, "Diffraction Limited Propagation and High Gain in Optically Dense Sodium Vapor at Low Pump Intensity," Quantum Electronics and Laser Science Conference, 1996, OSA Technical Digest Series, (Opt. Soc. of Am., Washington, D.C., 1996) p. 194.
319. P.R. Hemmer, M.S. Shahriar, D.P. Katz, R. Bonifacio, and N.P. Bigelow, "Collective Atomic Recoil Laser in Sodium Vapor," Quantum Electronics and Laser Science Conference, 1995 OSA Technical Digest Series, (Opt. Soc. of Am., Washington, D.C., 1995) (post-deadline)
320. K.S. Johnson, J.R. Lawall, A. Chu, T.W. Lynn, K.K. Berggren, M.S. Shahriar. and M.G. Prentiss, "Large-angle Atomic Beam Splitters," Quantum Electronics and Laser Science Conference, 1995 OSA Technical Digest Series, (Opt. Soc. of Am., Washington, D.C., 1995) QW13 (invited).
321. P.R. Hemmer, M.S. Shahriar, D.P. Katz, P. Kumar, J. Donoghue, and M. Cronin-Golomb, "Optical Phase Conjugation in the Double Raman System," Coherence and Quantum Optics VII, proceedings of the seventh international conference on Coherence and Quantum Optics, University of Rochester, June 7-10, 1995, Plenum Press, NY, p. 435.
322. P.R. Hemmer, M.S. Shahriar, D.P. Katz, R. Bonifacio, E.J. D'Angelo, and N.P. Bigelow, "Grating Enhanced Gain and Reverse Oscillations in a Sodium Vapor," Coherence and Quantum Optics VII, proceedings of the seventh international conference on Coherence and Quantum Optics, University of Rochester, June 7-10, 1995, Plenum Press, NY, p. 707 (invited).
323. M.S. Shahriar and P.R. Hemmer, "Generation of Squeezed States via Non-Degenerate Four Wave Mixing in an Ideal  $\chi$  System," Coherence and Quantum Optics VII, proceedings of the seventh international conference on Coherence and Quantum Optics, University of Rochester, June 7-10, 1995, Plenum Press, NY, p. 479.
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327. P.R. Hemmer, J. Donoghue, M.S. Shahriar, P. Kumar, M. Cronin-Golomb, "Optical phase conjugation via gain without inversion in the double  $\Lambda$  system," OSA Annual Meeting Technical Digest 1994 (Opt. Soc. of Am., Washington, D.C.,1994), Vol. 5, p. 184.
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330. M.S. Shahriar, T.W. Lynn, D.P. Katz, M.G. Prentiss, P.R. Hemmer, "Resonance Fluorescence, Gain, and Momentum Diffusion of Atoms Moving in Standing Wave Fields," OSA Annual Meeting Technical Digest 1994 (Opt. Soc. of Am., Washington, D.C.,1994), Vol. 5, p. 134.
331. S. Ezekiel, S.P. Smith, M.S. Shahriar and P.R. Hemmer, "New Opportunities in Fiberoptic Sensors," Plenary session paper, 10th Optical Fiber Sensors conference, Glasgow, England, 1994.(invited)
332. K. Johnson, J.D. Paul, A. Chu, M.S. Shahriar, K. Berggren and M.G. Prentiss, "Creating a large angle coherent atomic beamsplitter without a magnetic field," International Quantum Electronics Conference, 1994 OSA Technical Digest Series, Vol. 9 (Opt. Soc. of Am., Washington, D.C., 1994) p 35
333. M.S. Shahriar, P.R. Hemmer and M.G. Prentiss, "Suppression of absorption of resonance fluorescence in a folded three level atom," International Quantum Electronics Conference, 1994 OSA Technical Digest Series, Vol. 9 (Opt. Soc. of Am., Washington, D.C., 1994) p 181.
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Quantum Electronics Conference, 1994 OSA Technical Digest Series, Vol. 9 (Opt. Soc. of Am., Washington, D.C., 1994) p 238.

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342. "Optical Data Storage with Raman Excited Microwave Spin Echoes," P.R Hemmer, M.S. Shahriar, Quantum Electronics and Laser Science Conference, 1992 OSA Technical Digest Series, Vol. 13 (Opt. Soc. of Am., Washington, D.C., 1992), pp 6-7 (postdeadline).
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Fields," Quantum Electronics and Laser Science Conference, 1992 OSA Technical Digest Series, Vol. 13 (Opt. Soc. of Am., Washington, D.C., 1992) p. 68-9.

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346. M.S. Shahriar, P. Hemmer, N. Bigelow and M. Prentiss, "Forces on Three Level Atoms Including Trapped State Contribution," in Quantum Electronics and Laser Science Conference, 1991 Technical Digest Series, Vol. 11 (Opt. Soc. of Am., Washington, D.C., 1991) pp 118-9.
347. M.S. Shahriar and P. Hemmer, "Bloch Vector Model For Dressed States of Resonant Raman Interaction," in OSA Annual Meeting Technical Digest 1990 (Opt. Soc. of Am., Washington, D.C., 1990), Vol. 21, p 186.
348. M.S. Shahriar and P. Hemmer, "Microwave Phase-Dependent Optical Absorption," in International Quantum Electronics Conference, 1990 OSA Technical Digest Series, Vol. 8 (Opt. Soc. of Am., Washington, D.C., 1990) pp 286-7.
349. P. Hemmer, V. Natoli, M.S. Shahriar, B. Bernacki, H. Rivera, S. Smith and S. Ezekiel, "Study of Several Error Sources in a Laser Raman Clock," in Proceedings of the 41st Annual Symposium on Frequency Control (IEEE, New York, 1987), p.42.

## Patents List:

1. Patent Number: 10386187; "Rotation and acceleration sensor based on nondegenerate ring lasers." Inventors: Selim M. Shahriar, Nicholas J. Condon, Devin J. Hileman, Shih C. Tseng
2. Patent Number: 10371523; "Rotation and acceleration sensor based on superluminal ring lasers." Inventors: Selim M. Shahriar, Nicholas J. Condon, Devin J. Hileman, Shih C. Tseng
3. Patent Application Number: 15/085,681; "Quantum Wave-Converter," Inventors: Jun Ai, Fedor Dimov, Xiaowei Xia, Selim Shahriar, Russell Kurtz and Chris Griffo

## **E. INVITED PRESENTATIONS, SEMINARS AND PUBLICITIES:**

### **1. INVITED CONFERENCE PRESENTATIONS:**

As shown in the list of conference papers, I presented 110 invited papers at conferences. I have also presented 6 post-deadline papers, and 3 plenary talks.

### **2. INVITED SEMINARS AT UNIVERSITIES AND ORGANIZATIONS:**

Korea Institute of Advanced Studies (2019)  
Tel Aviv University, Israel (2018)  
Bar Ilan University, Israel (2018)  
Naval Post-Graduate School (2018)  
AFOSR Imaging Workshop, Maui Institute for Astronomy (2018)  
Stevens Institute of Technology (2017)  
Alabama A&M University (2017)  
NASA Marshall Space Flight Center (2017)  
AFOSR Imaging Workshop, Maui Institute for Astronomy (2017)  
Lincoln Laboratory, MIT (2016)  
University of Memphis, Tennessee (2015)  
California Institute of Technology (2015)  
Hebrew University of Jerusalem (2015)  
Tel Aviv University (2015)  
Argonne National Laboratory (2015)  
Northrop-Grumman Corporation (2015)  
University of Nice, France (2014)  
Eglin Air Force Base (2014)  
College of William and Mary, Physics Colloquium (2014)  
Draper Laboratory, MIT (2013)  
University of Ottawa, Canada (2013)  
University of Nevada, Las Vegas (2013)  
Wright Patterson Air Force Base, Dayton, OH (2013)  
Fudan University, Shanghai, China (2012)  
Eglin Air Force Base, Eglin, FL (2011)  
Naval Research Laboratory, Patuxent, MD (2011)  
Hebrew University in Jerusalem (2010)  
Tel Aviv University (2010)  
University of Rochester (2010)  
Temple University (2010)  
Bangladesh University of Engineering and Technology (2010)  
Jawaharlal Nehru University (2010)  
Stanford University (2009)  
Delaware State University (2009)  
Princeton University (2006)

University of Illinois, Chicago (2005)  
University of Illinois, Urbana-Champaign (2004)  
Temple University (2003)  
MIT (2002)  
Texas A&M University (2000)  
SUNY, Buffalo, NY (1999)  
SUNY, Stonybrook, NY (1998)  
Stanford University (1997)  
JILA, University of Colorado (1996)  
Michigan State University (1995)

### 3. PUBLICITY:

The popular articles and references to my work, as listed below, can be viewed at:  
**<http://lapt.eecs.northwestern.edu/publicity>**

[a]. The content of the following paper:

*"Observation of Ultraslow and Stored Light Pulses in a Solid," A. V. Turukhin, V.S. Sudarshanam, M.S. Shahriar, J.A. Musser, B.S. Ham, and P.R. Hemmer, Phys. Rev. Lett. **88**, 023602 (2002).*

generated world-wide publicity, and was reported in ( among possibly others),

- **Nature News,**
- **Science News,**
- **Business Week,**
- **New Scientist,**
- **Laser Focus World,**
- **Photonic Spectra,**
- **EE-Times,**
- **A German Radio Station,**
- **An Italian Daily, and**
- **The Physics News Update**

[b]. The content of the following paper:

*"Demonstration of a super-parallel holographic correlator for ultrafast database search," M.S. Shahriar, R. Tripathi, M. Kleinschmit, J. Donoghue, W. Weathers, and J. Shen, Opt. Letts. **28**, 7, pp. 525-527(2003).*

was featured in an article in the **Laser Focus World**

[c]. My other work on holographic and spectral-holeburning memory has been mentioned in articles in the following publications:

- **Photonic Spectra**
- **Laser Focus World**

- **Optics and Photonics News**

[d]. The content of the following paper:

*“Long Distance, Unconditional Teleportation of Atomic States via Complete Bell State Measurements,” S. Lloyd, M.S. Shahriar, J.H. Shapiro, and P.R. Hemmer, Phys. Rev. Lett. **87**, 167903 (2001).*

was featured in a cover article in **the New Scientist**

[e] The superluminal ring laser gyroscope, invented by me, was recently selected as one of five **“Game Changing Technologies”** by NASA. See the following URL for the NASA news release: <http://www.nasa.gov/centers/marshall/news/news/releases/2012/12-111.html>. See the following URL for a news article about it: <http://www.eecs.northwestern.edu/the-news/1618-superluminal-ring-laser-gyroscope-invented-by-selim-shahriar-is-selected-as-one-of-five-game-changing-technologies-by-nasa-and-awarded-a-three-year-grant-for-development.html>

[f] The first detection of gravitational waves produced by the merger of a pair of black holes has received world-wide publicity in almost all media. My role in this project was highlighted in several articles published at NU. See, for example, <http://www.mccormick.northwestern.edu/news/articles/2016/02/selim-shahriah-contributes-to-gravitational-waves-discovery.html>

[g] The first detection of gravitational waves produced by the merger of a pair of neutron stars, and the corresponding observations across the whole of electromagnetic spectra represents the birth of multi-messenger astronomy, and has also received world-wide publicity in almost all media. See, for example, <https://news.northwestern.edu/stories/2017/october/neutron-stars/>

## **F. UNIVERSITY AND PROFESSIONAL SERVICES**

### **F.1. PROFESSIONAL AND SYNERGISTIC ACTIVITIES:**

- I have served as an Associate Editor for the journal Optical Engineering, from July, 2013, through June, 2015, in the areas of Quantum Optics and Photonics, Nonlinear Optics, Ultrafast Optics, and Slow and Fast Light
- I have created two new conferences under SPIE Photonics West. These are: (a) Optical, Opto-Atomic and Entanglement Enhanced Precision Metrology, and (b) Advanced Optical Concepts in Quantum Computing, Memory, and Communication.
- I currently serve as Chair of one of these new conferences (Optical, Opto-Atomic and Entanglement Enhanced Precision Metrology), and on the program committee for another one (Advanced Optical Concepts in Quantum Computing, Memory, and Communication), under SPIE Photonics West.

- I currently serve on the program committee for the Quantum Communication, Measurement and Computing conference
- I currently serve as a member of the scientific committee for the Nice Optics Conference, 2020.
- I served on the organizing committee for the 8th International Conference and Exhibition on Lasers, Optics & Photonics
- I served as a member of the scientific committee for the Nice Optics Conference, 2016.
- I have joined the editorial board of the journal ISRN Optics.
- I participated in the National Nanotechnology Initiative workshop on Nanotechnology-Enabled Sensing, 2009, and helped write the final report for it.
- I have served on the Program Committee of Conference on Lasers and Electro-Optics (CLEO) and the Quantum Electronics and Laser Science conference (QELS), sponsored by the Optical Society of America and the American Physical Society
- I have served on the Program Committee for SPIE Symposium on Fluctuations and Noise, 2007.
- I have served as a Session Organizer for Progress In Electromagnetics Research Symposium 2002, sponsored by the IEEE.
- I founded a company called Digital Optics Technologies, Inc.
- I have served on NSF Review Panel for Information Technology Research
- I have served on NSF Review Panel for Atomic, Molecular and Optical Physics
- I have served on NSF Review Panel for Quantum Information Processing under EMT
- I have served on NSF Review Panel for Emerging Technologies for Computing
- I have served twice on NASA Review Panels for Space-borne Atomic Physics Projects
- I have served as a reviewer for many journals, including Physical Review Letters, Physical Review A, Optics Letters, Optics Communications, Journal of Modern Optics, Optics Express, Optica, and Journal of Lightwave Technology.
- I have served as a reviewer for Qatar National Research Foundation
- I have served as a reviewer for European Research Council
- I have served as a reviewer for the Austrian Science Fund

- I have served as a reviewer for the US-Israel Bi-national Science Foundation

## **F.2. SERVICE AT NU:**

- Currently serving on the following committees:
  - Instructional Labs Committee
  - Distinguished Seminar Committee
  - Computing Facilities Committee
  - McCormick Laser Safety Committee
  - Faculty Advisor, NU Student Chapter of SPIE
  - Advisory Committee for the Initiative at Northwestern for Quantum Information Research and Engineering (INQUIRE)
- Served on the McCormick Promotion and Tenure Committee
- Served on Graduate Admission Committee for Physics and Astronomy
- Served on the Graduate Admission Committee for Applied Physics
- Served on the EECS Mission and Planning Committee
- Served on the EECS Structure and Procedure Committee
- Headed the EECS Faculty Search Committee 2011
- Served on several Physics and Astronomy Faculty Search Committees
- Served on several EECS Faculty Search Committees
- Previously, I have served on many departmental committees.
- I am currently serving also as the Faculty Adviser for the NU Student Chapter of SPIE. In this role, I have met with members of the chapter several times, and have provided guidance to them for making this chapter a vibrant one, with national visibility.
- I served on a sub-committee for Teaching Trainees and Teaching Assistants. As part of this sub-committee, I played a key role in formulating a comprehensive policy for Teaching Trainees, and in restructuring the manner in which Teaching Assistance is to be allocated to courses. For example, a spread-sheet, accessible on the web, has been created to document the teaching assistance need for each course. The spread-sheet uses an algorithm we developed to determine the exact amount of teaching help a course would need, based on factors such as enrollment, laboratory requirements, etc. This spread-sheet is now routinely and effectively used by all faculty members. Establishment of this process has eliminated any source of randomness that may have existed in assigning teaching help to courses.
- I have served on an ad hoc committee convened by the Dean of McCormick school for studying the prospect of starting an Energy-oriented initiative. The work of this committee, headed by Prof. Kung, has culminated in establishing the Center for Energy Efficient Transportation (CEET), with initial seed funding approved by the Dean's office.



## G. ENTREPRENEURIAL ACTIVITY

I founded Digital Optics Technologies, Inc., a start-up company, in July 1998. The goal of DOT is to carry out research activities in the fields of optical memory, holography and precision metrology. I am the majority stock-holder for DOT, and serve as the Chairman of the Board for DOT. I also do consulting work for DOT.

Under my guidance, DOT has received funding from non-SBIR and SBIR sources of federal funding, as well as private investments. To date, it has received 18 Phase I SBIR/STTR grants, and 14 SBIR/STTR Phase II grants. It has also received subcontracts for several SBIR Phase II grant, an STTR Phase II grant, and an SBIR Phase I grant. It has developed several commercial products, mostly resulting from projects supported by SBIR funding.

## H. COMPLETED RESEARCH PROJECTS

1. **“Application of Multiphoton Resonance Technologies to *Data Storage, High Speed Imaging, and Precision Metrology.*”**  
*Co-Principal Investigators:* M.S. Shahriar and S. Ezekiel  
*Funding Source:* Rome Laboratory, US Air Force  
*Amount:* **\$160K/year**  
*Duration:* **Renewed annually since 1994 to 2000.**
2. **“Studies of Optical Spectral Holeburning using Raman Coherent Population Trapping.”**  
*Co-Principal Investigators:* M.S. Shahriar and S. Ezekiel  
*Funding Source:* NSF  
*Amount:* **\$460K**  
*Duration:* **August 96 - July 99 (3 Years)**
3. **“Non-Spatial Filters for Laser Beams.”**  
*Co-Principal Investigators:* M.S. Shahriar and S. Ezekiel  
*Funding Source:* BMDO STTR, Phase I  
*Amount:* **\$16K** (Shahriar share)  
*Duration:* **January 95 - June 95.**
4. **“Non-spatial Filters for Laser Beams.”**  
*Co-Principal Investigators:* M.S. Shahriar and S. Ezekiel  
*Funding Source:* BMDO STTR Phase II  
*Amount:* **\$150K** (Shahriar share)  
*Duration:* **November 95 – October 97 (2 Years).**
5. **“Holographic Beam Shaper for Master Oscillator Power Amplifiers.”**  
*Co-Principal Investigators:* M.S. Shahriar and S. Ezekiel  
*Funding Source:* BMDO SBIR, Phase II  
*Amount:* **\$100K** (Shahriar share)  
*Duration:* **November 97 – October 99 (2 Years).**
6. **“Read-Write Head for Room Temperature Holographic Optical Memory.”**  
*Co-Principal Investigators:* M.S. Shahriar, S. Ezekiel, and C. Warde.  
*Funding Source:* BMDO STTR Phase I  
*Amount:* **\$18K** (Shahriar share)

*Duration: August 97 – February 98.*

7. ***“Application of Porous Glass Based Thick Holograms for Optical Data Storage and Narrow-band Wavelength Filtering.”***  
*Co-Principal Investigators:* M.S. Shahriar and S. Ezekiel  
*Funding Source:* BMDO AASERT  
*Amount:* \$270K  
*Duration:* July 96 – June 99
8. ***“Nano-Kelvin Cooling of Dense Atoms for an Ultra-Stable Fountain Atomic Clock.”***  
*Co-Principal Investigators:* M.S. Shahriar and S. Ezekiel  
*Funding Source:* AFOSR DURIP  
*Amount:* \$132K  
*Duration:* September 95 – August 96.
9. ***“Generation of Nanometer Scale Structures Using Atom Interferometry and Creation of a Coherent Atomic Source.”***  
*Co-Principal Investigators:* M.S. Shahriar and S. Ezekiel  
*Funding Source:* ARO DURIP  
*Amount:* \$145K  
*Duration:* May 97 – April 98.
10. ***“Quantum Computing and Optical Memory using Spectral Hole-Burning Techniques.”***  
*Co-Principal Investigators:* M.S. Shahriar, S. Ezekiel, and S. Lloyd  
*Funding Source:* AFOSR DURIP  
*Amount:* \$158K  
*Duration:* February 98 – January 99.
11. ***“Quantum Logic and Parallel Computing Using Spectral Hole Burning Techniques.”***  
*Co-Principal Investigators:* M.S. Shahriar, S. Ezekiel, and S. Lloyd  
*Funding Source:* AFOSR  
*Amount:* \$615K  
*Duration:* February 98 – January 01 (3 Years)
12. ***“Quantum Computing using the Dark Resonance.”***  
*Co-Principal Investigators:* M.S. Shahriar and S. Ezekiel  
*Funding Source:* ARO and NSA  
*Amount:* \$300K  
*Duration:* April 98 – March 01 (3 Years)
13. ***“Quantum Computing in Solids via the Dark Resonance”***  
*Co-Principal Investigators:* M.S. Shahriar, S. Ezekiel, and S. Lloyd  
*Funding Source:* AFOSR DURIP  
*Amount:* \$100K  
*Duration:* February 99 – January 01.
14. ***“Feasibility of Spectral Holeburning Memories and Processors for Space Based Applications”***  
*Co-Principal Investigators:* M.S. Shahriar, S. Ezekiel, and C. Warde  
*Funding Source:* AFOSR  
*Amount:* \$330K  
*Duration:* April 99 – March 02.
15. ***“Quantum Information Technology: Entanglement, Teleportation, and Quantum Memory.”***  
*Co-Principal Investigators:* M.S. Shahriar, S. Lloyd, J. Shapiro, P. Kumar, and H. Yuen  
*Funding Source:* ARO MURI 2000.  
*Amount:* \$5.25 MILLION (Shahriar share: \$1.15 Million)

*Duration: April 2000 – March 2005.*

**16. “Development of Multispectral Detector and Source for a ladar system using two-photon resonant techniques.”**

*Co-Principal Investigators:* M.S. Shahriar, S.Ezekiel, and J. Shapiro

*Funding Source:* AFRL.

*Amount:* **\$160K**

*Duration:* **August 2000 – February 2002**

**17. “Utility of Quantum Entangled State Transfer (QUEST) for Time Synchronization”**

*Co-Principal Investigators:* M.S. Shahriar, J. Shapiro, F. Wong, and S. Lloyd

*Funding Source:* NRO.

*Amount:* **\$525K**

*Duration:* **August 2000 – July 2003**

**18. “Ultra-Precise Clock Synchronization Via Distant Entanglement”**

*Principal Investigator for Whole Project:* M.S. Shahriar

*Subcontractor:* JPL, Caltech

*Funding Source:* DARPA Quist Program

*Amount:* **\$1.2 Million (Shahriar share: \$840 K)**

*Duration:* **January 2002 – September 2006**

**19. “Spin-Based Lattice Gas Quantum Optics in Solids Using Optical Addressing”**

*Principal Investigator for Whole Project:* Marlan Scully, Texas A&M University

*Subcontractor PI:* M.S. Shahriar

*Funding Source:* DARPA Quist Program

*Amount:* **\$3.2 Million (Shahriar share: \$533 K)**

*Duration:* **June 2002 – September 2007**

**20. “Large Scale Type II Quantum Computing in NV-Diamond Using PBG-Based Cavities”**

*Principal Investigator:* M.S. Shahriar

*Funding Source:* AFOSR

*Amount:* **\$425 K**

*Duration:* **October 2001 – December 2004**

**21. “Ultrafast Target Recognition VIA Super-Parallel Holography BASED Correlator, RAM, And Associative Memory”**

*Principal Investigator:* M.S. Shahriar

*Funding Source:* AFOSR

*Amount:* **\$270 K**

*Duration:* **July 2003 – July 2006**

**22. “Nanophotonic Modulator Using Electromagnetically Induced Transparency”**

*Co-Principal Investigators:* M.S. Shahriar and B. Wessels

*Funding Source:* AFOSR STTR Phase I (Prime: Chronochrome; PI: Alan Craig)

*Amount:* **\$30 K (Shahriar share)**

*Duration:* **January 2003 – September 2003**

**23. “Instrumentation For Ultrafast Target Recognition Via Super-Parallel Holography Based Joint Transform Correlator ”**

*Principal Investigator:* M.S. Shahriar

*Funding Source:* AFOSR DURIP

*Amount:* **\$225 K**

*Duration:* **March 2004 – February 2005**

24. **“Type-Two Quantum Computing in PBG-Based Cavities for Efficient Simulation of Lattice Gas Dynamics”**  
*Principal Investigator:* M.S. Shahriar  
*Funding Source:* AFOSR  
*Amount:* **\$265 K**  
*Duration:* **April 2004 – September 2006**
  
25. **“Bootstrapping a Quantum Information Technology Industry”**  
*Principal Investigator:* Ray Beausoleil, HP  
*Subcontractor PI:* M.S. Shahriar (*Subcontractor Co-PI:* Prem Kumar)  
*Funding Source:* DARPA Seed Fund  
*Amount:* **\$500 K** (NU share: \$100K; Shahriar share: \$67K)  
*Duration:* **February 2005 – January 2006**
  
26. **“Applications of Slow Light to Information Processing ”**  
*Principal Investigator:* Ray Beausoleil, HP  
*Subcontractor PI:* M.S. Shahriar (*Subcontractor Co-PI:* Prem Kumar)  
*Funding Source:* DARPA Slow Light Program  
*Amount:* **\$4.45 Million K** (NU share: \$1.475 Million; Shahriar share: \$985K)  
*Duration:* **March 2005 – December 2009**
  
27. **“Polarimetric Smart Eye For UAV Navigation And Spatio-Spectral Correlator For Video Clip Correlation Using Holography”**  
*Principal Investigator:* M.S. Shahriar  
*Funding Source:* AFOSR  
*Amount:* **\$516 K**  
*Duration:* **August 2006 – September 2009**
  
28. **“Cognitive Processing of Biometric Information for Determination of Intent”**  
*Principal Investigator:* Apostolos Raptis, Argonne National Laboratory  
*Subcontractor Co-PIs at NU:* M.S. Shahriar, A. Katsaggelos, T. Pappas  
*Funding Source:* DTO (Disruptive Technology Office)  
*Amount:* **\$3 Million** (NU Share: \$1.05 Million)  
*Duration:* **June 2008 – May 2011**
  
29. **“SBIR Phase I: High Power DBR Lasers for Optimized Pumping of Chip-scale He:Rb Alkali Lasers”**  
*Principal Investigator:* M.S. Shahriar  
*Funding Source:* Photodigm, Inc. / AFRL  
*Amount:* **\$45 K**  
*Duration:* **November 2011 – August 2012**
  
30. **“DARPA ZOE Program: Quantum Zeno Blockade for Next Generation Optical Switching in Fiber Systems”**  
*Principal Investigator:* Prem Kumar, NU  
*Co-Principal Investigator:* M.S. Shahriar  
*Funding Source:* DARPA (administered by ARO)  
*Amount:* **\$750K** (Co-PI Share)  
*Duration:* **September 2009 – September 2012**
  
31. **“STTR Phase II: Highly Sensitive Light-Weight Gyroscope”**  
*Award Number:* Agmt 12/23/10 // MDA08-T005  
*Project Dates:* 9/6/10 - 6/4/14  
*Sponsor (include prime if a subcontract):* Los Gatos Research, Inc./Missile Defense Agency  
*Amount (NU portion only):* \$300,000

32. **“IGERT: Quantum Coherent Optical and Matter Fields” (PI: John Ketterson, Northwestern U.)**  
Award Number: DGE-0801685  
Project Dates: 09/01/08 – 08/31/13  
Sponsor (include prime if a subcontract): National Science Foundation  
Amount: \$3,000,000 (Student Support Only)
  
33. **“SBIR Phase II : Novel Precision Fiber Optic Gyroscope”**  
Award Number: Agmt 10-26-09//HQ0006-09-C-7029  
Project Dates: 8/17/09 - 8/6/13  
Sponsor (include prime if a subcontract): Los Gatos Research, Inc./ Missile Defense Agency  
Amount (NU portion only): \$379,977
  
34. **“STTR Phase I: Development of high energy laser analysis software along with experimental verification of DPAL rate constants”**  
Award Number: Agmt 3/26/2013 // HQ0277-13-C-7404  
Project Dates: 3/1/13- 8/31/13  
Sponsor (include prime if a subcontract): Digital Optics Technologies, Inc./Missile Defense Agency  
Amount (NU portion only): \$30,001
  
35. **“NASA HSBC Center for Optical Sciences”**  
Award Number: NNX09AU90A  
Project Dates: 11/01/09 – 10/31/14  
Sponsor (include prime if a subcontract): Delaware State University / NASA  
Amount (NU portion only): \$425,000
  
36. **“Development of a Portable Microwave Atomic Clock Using Pulsed Coherent Population Trapping”**  
Award Number: Subcontract Agreement//D14PC00134  
Project Dates: 6/17/14 – 08/31/15  
Sponsor (include prime if a subcontract): Digital Optics Technologies, Inc./Defense Advanced Research Projects Agency  
Amount (NU portion only): \$22,453
  
37. **“Optically Controlled Distributed Quantum Computing Using Atomic Ensembles as Qubits”**  
Award Number: FA9550-09-1-0652/P00006  
Project Dates: 8/15/09 - 8/14/15  
Sponsor (include prime if a subcontract): Air Force Office of Scientific Research  
Amount : \$738,624
  
38. **“Optical Buffering Switching and On-Line Data Sampling via Engineered Dispersion”**  
Award Number: FA9550-10-1-0228/P00005  
Project Dates: 5/15/10 - 11/14/15  
Sponsor (include prime if a subcontract): Air Force Office of Scientific Research  
Amount: \$815,999
  
39. **Compact and Integrated IMU for GPS Denied Navigation Using Fast-Light Gyroscopes and Accelerometers**  
Source of support: Digital Optics Technologies, Inc./Air Force Research Laboratory  
Total award amount: \$224,999  
Period of performance: 1/22/13 - 11/31/16
  
40. ***REU Site: Preparing a Diverse Workforce through Interdisciplinary Astrophysics Research*** (Research Mentor, Main PI: Kalogera, Vicky)  
Source of support: National Science Foundation  
Total award amount: \$287,785  
Period of performance: 9/1/14 - 8/31/17

41. **An Ultra-Sensitive and Compact Superluminal Ring Laser Gyroscope**  
 Source of support: Army Research Office and Defense Advanced Research Projects Agency  
 Total award amount: \$150,000  
 Period of performance: 10/5/15 - 12/31/16
42. **Realization of a High Power MWIR Laser Using Coherent Combination of Emitters**  
 Source of support: Digital Optics Technologies, Inc./ Army Research Laboratory  
 Total award amount: \$29,952  
 Period of performance: 8/1/17 – 1/31/18
43. **Novel Light Sources Based On Nonlinearity Enhanced By Nano-Antennas**  
 Source of support: Govt. of Israel Ministry of Defense / Defense Security Cooperation Agency  
 Total award amount: \$260,000  
 Period of performance: 2/8/13 - 3/31/18
44. **Fast Light Enhanced Active Gyroscopes, Accelerometers and Fiber-Optic Sensors**  
 Source of support: Digital Optics Technologies, Inc./ NASA  
 Total award amount: \$260,000  
 Period of performance: 5/1/16 - 8/31/18

## **I. CURRENT RESEARCH PROJECTS**

1. **DOD Center of Excellence in Advanced Quantum Sensing: NU Branch**
  - Funding Agency: Army Research Office
  - Five Year Grant for \$2.0 Million
2. **Rotation, Shift and Scale Invariant Ultrafast Automatic Image Recognition**
  - Funding Agency: Air Force Office of Scientific Research
  - Five Year Grant for \$900 K
3. **Investigation of Experimental and Theoretical Challenges for Developing Superluminal Sensors**
  - Funding Agency: Air Force Office of Scientific Research
  - Four Year Grant for \$630 K
4. **A Fast-Light Enhanced Ring Laser Vibrometer for Detection of Extremely Small Vibrations**
  - Funding Agency: Defense Security Cooperation Agency
  - Four Year Grant for \$450 K
5. **Superconducting Quantum Materials and Systems Center**
  - Funding Agency: Department of Energy via Fermilab
  - Five Year Grant for \$500 K
6. **Laser and Spatial Light Modulators for Ultrafast Automatic Image Recognition Using an Opto-Electronic Correlator: Equipment Grant**
  - Funding Agency: Air Force Office of Scientific Research via the DURIP program
  - One Year Grant for \$141 K
7. **Isotopic Quantum Non-Degeneracy based Superluminal Laser Gyroscopes and Accelerometers for GPS Denied Navigation**
  - Funding Agency: Air Force Research Laboratory
  - Two Year Grant for \$490 K
8. **Compact and Highly-Sensitive Multi-Axes Gyroscope using Large Momentum Transfer Point Source Atom Interferometry**

- Funding Agency: National Aeronautics and Space Administration
- Two Year Grant for \$250 K

**9. PMMA Based Holographic Optical Elements for Free Space Optical Communication Systems on Mobile Platforms**

- Funding Agency: Naval Research Laboratory
- Three Year Grant for \$303 K

**10. Theoretical and Experimental Investigation of Quantum Noise Induced Sensitivity Limit of a Fast Light Ring Laser Gyroscope**

- Funding Agency: National Aeronautics and Space Administration
- Two Year Grant for \$240 K

**11. Chip-Scale Superluminal IMU Using Rubidium Atoms and Integrated Photonics**

- Funding Agency: Air Force Office of Scientific Research
- Two Year Grant for \$230 K