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Advanced Optical and Quantum Memories and Computing IV

**Zameer U. Hasan
Alan E. Craig
Selim M. Shahriar
Hans J. Coufal**
Editors

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Contents

vii	Conference Committee
ix	Introduction

ADVANCED OPTICAL MEMORIES AND PROCESSORS

- 648203 **The homogeneous dispersive lineshape as a wavelet basis (Invited Paper)** [6482-02]
A. E. Craig, Montana State Univ. (USA)
- 648204 **Fabrication and spectroscopy of thin films for power-gated holeburning (Invited Paper)** [6482-03]
Z. Hasan, F. Bezares, J. Park, M. Campanelli, M. Aly, Temple Univ. (USA)
- 648205 **Sluggish light and its applications in true-time-delay beam forming for wideband RF phased-array antennas (Invited Paper)** [6482-04]
L. Gao, S. I. Herriot, K. H. Wagner, Univ. of Colorado, Boulder (USA)

QUANTUM COMPUTING: MATERIALS AND METHODS

- 648206 **Scalable quantum computing in diamond (Invited Paper)** [6482-05]
P. Hemmer, Texas A&M Univ. (USA); J. Wrachtrup, F. Jelezko, Univ. Stuttgart (Germany); P. Tamarat, Univ. Bordeaux I (France); S. Praver, Univ. of Melbourne (Australia); M. Lukin, Harvard Univ. (USA)
- 648207 **Optical manipulation of single spins in diamond (Invited Paper)** [6482-06]
C. Santori, Hewlett-Packard Labs. (USA); P. Tamarat, P. Neumann, J. Wrachtrup, Univ. Stuttgart (Germany); D. Fattal, R. G. Beausoleil, Hewlett-Packard Labs. (USA); J. Rabeau, P. Olivero, A. D. Greentree, S. Praver, The Univ. of Melbourne (Australia); F. Jelezko, Univ. Stuttgart (Germany); P. Hemmer, Texas A&M Univ. (USA)
- 648208 **Microcharacterization of spectral memory materials using nuclear forward scattering (Invited Paper)** [6482-07]
A. Konjodovic, Z. Hasan, Temple Univ. (USA); E. E. Alp, Argonne National Lab. (USA)
-

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The CID number appears on each page of the manuscript. The complete citation is used on the first page, and an abbreviated version on subsequent pages.

- 648209 **High-efficiency DOEs at large diffraction angles for quantum information and computing architectures** [6482-08]
A. A. Cruz-Cabrera, S. A. Kemme, J. R. Wendt, Sandia National Labs. (USA); D. Kielpinski, E. W. Streed, Griffith Univ. (Australia); T. R. Carter, S. Samora, L&M Technologies (USA)

MEMORIES AND METHODS FOR ADVANCED COMPUTING

- 64820B **Design and implementation of all-optical half adder using cross gain modulation in semiconductor optical amplifiers** [6482-10]
S. H. Kim, Korea Institute of Science and Technology (South Korea); J. H. Kim, Korea Institute of Science and Technology (South Korea) and Pennsylvania State Univ. (USA); C. W. Son, G. Kim, Y. T. Byun, Y. M. Jhon, S. Lee, D. H. Woo, S. H. Kim, Korea Institute of Science and Technology (South Korea)
- 64820C **Secure display that limits the viewing space by use of optically decodable encryption** [6482-11]
H. Yamamoto, Y. Hayasaki, The Univ. of Tokushima (Japan)
- 64820D **An evolutionary path toward quantum switching architectures** [6482-12]
F. Toudeh-Fallah, M. Carroll, Cisco Systems, Inc. (USA); A. Yavuz Oruc, Univ. of Maryland, College Park (USA)

APPLICATIONS OF SLOW AND FAST LIGHT I

- 64820I **Comparing slow-light properties of 10Gbps RZ data in dispersion shifted fibers and highly nonlinear fibers based on Raman-assisted optical parametric amplification (Invited Paper)** [6482-19]
Z. Hu, D. J. Blumenthal, Univ. of California, Santa Barbara (USA)

APPLICATIONS OF SLOW AND FAST LIGHT II

- 64820L **Demonstration of interferometer sensitivity varying as the inverse of the group index (Invited Paper)** [6482-22]
M. S. Shahriar, G. S. Pati, M. Messal, Northwestern Univ. (USA)
- 64820M **Optimization of slow and stored light in atomic vapor (Invited Paper)** [6482-23]
I. Novikova, Harvard-Smithsonian Ctr. for Astrophysics (USA) and College of William & Mary (USA); A. V. Gorshkov, Harvard Univ. (USA); D. F. Phillips, Y. Xiao, Harvard-Smithsonian Ctr. for Astrophysics (USA); M. Klein, R. L. Walsworth, Harvard-Smithsonian Ctr. for Astrophysics (USA) and Harvard Univ. (USA)
- 64820N **Demonstration of a white light interferometer using fast light** [6482-24]
G. S. Pati, M. Messal, M. S. Shahriar, Northwestern Univ. (USA)

APPLICATIONS OF SLOW AND FAST LIGHT III

- 64820P **Rubidium spectroscopy on a chip (Invited Paper)** [6482-26]
H. Schmidt, W. Yang, B. Wu, D. Yin, Univ. of California, Santa Cruz (USA); D. B. Conkey, J. Hulbert, A. R. Hawkins, Brigham Young Univ. (USA)

- 64820Q **Coherent few-photon quantum transport in one-dimensional systems (Invited Paper)** [6482-27]
J.-T. Shen, S. Fan, Stanford Univ. (USA)
- 64820R **Designing optimal gain profiles for slow-light applications (Invited Paper)** [6482-28]
R. Pant, College of Optical Sciences, Univ. of Arizona (USA); M. D. Stenner, M. A. Neifeld, College of Optical Sciences, Univ. of Arizona (USA) and Univ. of Arizona (USA)
- 64820S **Significant propagation reduction of an optical pulse in an active Raman gain scheme** [6482-29]
K. J. Jiang, National Institute of Standards and Technology (USA) and Wuhan Institute of Physics and Mathematics (China); L. Deng, M. G. Payne, National Institute of Standards and Technology (USA)
- 64820T **Electromagnetically induced backscattering via slow light (Invited Paper)** [6482-30]
Y. V. Rostovtsev, Z.-E. Sariyanni, Texas A&M Univ. (USA); M. O. Scully, Texas A&M Univ. (USA), Max-Planck Institute für Quantenoptik (Germany), and Princeton Univ. (USA)

APPLICATIONS OF SLOW AND FAST LIGHT IV

- 64820U **Ultralow-light level saturation spectroscopy and EIT using a tapered fiber in a hot vapor cell** [6482-32]
S. M. Spillane, Hewlett-Packard Labs. (USA); G. S. Pati, M. S. Shahriar, P. Kumar, Northwestern Univ. (USA); R. G. Beausoleil, Hewlett-Packard Labs. (USA)
- 64820V **Slow wave atom interferometers for rotation sensing** [6482-33]
M. Özcan, Sabanci Univ. (Turkey)
- 64820W **An optical prism based on resonance ultra-dispersive media** [6482-34]
V. A. Sautenkov, H. Li, Y. V. Rostovtsev, Texas A&M Univ. (USA); M. O. Scully, Texas A&M Univ. (USA) and Princeton Univ. (USA)
- 64820X **Reduced density matrix descriptions for electromagnetically induced transparency and related pump-probe optical phenomena in atomic systems (Invited Paper)** [6482-35]
V. Jacobs, Z. Dutton, M. Bashkansky, M. Steiner, J. Reintjes, Naval Research Lab. (USA)

POSTER SESSION

- 64820Z **Squeezing and squared-amplitude squeezing in a two-atom Jaynes-Cummings model with cavity damping and atomic dissipation** [6482-37]
E. K. Bashkurov, M. S. Rusakova, Samara State Univ. (Russia)
- 648210 **Nonblocking photonic switching for P2P self-organized optical concurrent communications network using pseudo-random numbers** [6482-38]
N. Oshima, Y. Nozaki, W. Sasaki, Doshisha Univ. (Japan)

Author Index

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M. Suhail Zubairy, Texas A&M University (USA)

Session Chairs

- 1 Advanced Optical Memories and Processors
 Alan E. Craig, Montana State University, Bozeman (USA)
- 2 Quantum Computing: Materials and Methods
 Alan E. Craig, Montana State University, Bozeman (USA)
- 3 Memories and Methods for Advanced Computing
 Zameer U. Hasan, Temple University (USA)
- 4 Photonics in Silicon and Organic Materials
 Alex K. Rebane, Montana State University, Bozeman (USA)
- 5 Applications of Slow and Fast Light I
 Alan E. Craig, Montana State University, Bozeman (USA)

- 6 Applications of Slow and Fast Light II
Selim M. Shahriar, Northwestern University (USA)
- 7 Applications of Slow and Fast Light III
Shanhui L. Fan, Stanford University (USA)
- 8 Applications of Slow and Fast Light IV
Shanhui L. Fan, Stanford University (USA)

Introduction

This conference addresses the future applications of the interactions of light with matter. Appropriately, this agenda aims to accommodate a moving target. Historically, it served as a venue for exploring the prospects of optically addressed memory: holographic, volumetric two-photon, and spectroscopic. The first of these is now commercial, the second reformatted into multiplayer compact disk. The third still exhibits the penultimate density and transfer rates for memory; the conference continues to present contributions to spectroscopic memory. This ancestry spawned and nurtured many of the leaders in the investigation and application of slow and (ironically, later) fast light, which have become the current mainstays of the conference program. Materials and techniques presented here that will bring quantum computing to reality also derive from this lineage. The program also presented various system-level themes, ranging from demonstration of a cross-gain modulation half-adder in semiconductor optical amplifiers to a non-blocking photonic switch using pseudo-random number encoding.

This year's proceedings report major insights in two areas. First, quantum encryption is a real and commercial technology. Quite likely, quantum routers (or repeaters, or delay registers) will be next, pressed into viability by the accelerating advancement of qubit materials. Specifically, the papers by Philip Hemmer and collaborators describe entanglement initiation, control, and transfer feasibility using long-lived optically addressed spin echoes in room temperature diamond. In other work, Selim Shahriar's group reports ultra-broadband resonators; intra-cavity incorporation of fast-light dispersive material shifts the cavity line continuously with the optical frequency.

Recent discoveries in light-matter interactions address quantum themes: more pronounced effects at lower optical powers and accommodating higher bandwidths in smaller volumes at higher temperatures and lower cost; pick any three. Recent excitement in this arena is evidenced by materials systems, interaction schemes, and applications that commandeer uncommon dispersion effects to slow or accelerate the group velocity of light. Consequently, a large number of proceedings papers discuss these developments. Dispersive atomic and geometric resonances of many types appear in vapors, in fibers, in semiconductors – even incorporated on chips. The properties of dispersive resonances with gain are presented. Quantum switching architectures and two-photon quantum transport are proffered as operations dependent on the success of these schemes. Perhaps surprisingly, new physical effects continue to be predicted, such as backscattering in EIT processes. Analogs to optical interferometry in atom-based gyroscopes make an appearance. Conversely, the issue of enhanced bandwidth single-channel slow light continues to bedevil the field, and perhaps will be resolved by next year's meeting.

Returning to the issue of its beginnings, this conference was founded and promoted through the years by the intuition and energy of one of our staunchest colleagues. During the retrenchment in optics that followed the overzealous Internet expansion, he defended its pertinence to future technologies and retained its viability. Hans Coufal, who led the optical computing and memory investigations for IBM at the Almaden Research Center for nearly twenty years, died this past autumn. This year's proceedings is dedicated to commemorating his insights and leadership, and to anticipating the technologies that will continue to derive from them.

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