## PROCEEDINGS OF SPIE

## Quantum Information Science, Sensing, and Computation XI

Eric Donkor Michael Hayduk Michael R. Frey Samuel J. Lomonaco Jr. John M. Myers Editors

18 April 2019 Baltimore, Maryland, United States

Sponsored and Published by SPIE

**Volume 10984** 

The papers in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. Additional papers and presentation recordings may be available online in the SPIE Digital Library at SPIEDigitalLibrary.org.

The papers reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from these proceedings:

Author(s), "Title of Paper," in *Quantum Information Science, Sensing, and Computation XI*, edited by Eric Donkor, Michael Hayduk, Michael R. Frey, Samuel J. Lomonaco Jr., John M. Myers, Proceedings of SPIE Vol. 10984 (SPIE, Bellingham, WA, 2019) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510626331

ISBN: 9781510626348 (electronic)

Published by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445 SPIF ora

Copyright © 2019, Society of Photo-Optical Instrumentation Engineers.

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$18.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at copyright.com. Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 0277-786X/19/\$18.00.

Printed in the United States of America By Curran Associates, Inc., under license from SPIE.

Publication of record for individual papers is online in the SPIE Digital Library.



**Paper Numbering:** Proceedings of SPIE follow an e-First publication model. A unique citation identifier (CID) number is assigned to each article at the time of publication. Utilization of CIDs allows articles to be fully citable as soon as they are published online, and connects the same identifier to all online and print versions of the publication. SPIE uses a seven-digit CID article numbering system structured as follows:

- The first five digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc. The CID Number appears on each page of the manuscript.

## Contents

v vii	Authors Conference Committee
SESSION 1	QUANTUM COMPUTING, SENSORS, QUANTUM MEMORIES
10984 02	Properties of quantum reactivity for a multipartite state (Invited Paper) [10984-1]
10984 03	Computing using quantum dynamics of nanostructured arrays [10984-2]
10984 04	Experimental evidence supportive of the quantum DNA model [10984-3]
10984 05	Experimental demonstration of a passive temperature stabilized quantum memory for storage of polarization qubits in a cold atomic ensemble [10984-4]
10984 06	GaN laser diodes for quantum sensors, clocks, systems and computing [10984-5]
SESSION 2	QUANTUM CRYTOGRAPHY AND QUANTUM NETWORKS
10984 07	A testbed for quantum communication and quantum networks [10984-6]
10984 08	Multi-variable quantum key distribution based on optical bistability [10984-7]
10984 09	Silicon photonics for quantum optical communication and processing [10984-8]
SESSION 3	QUANTUM INFORMATION SCIENCE
10984 0A	Quantum knots and knotted zeros [10984-10]
10984 OC	The physics of symbols and the coin on edge: introducing two-clock physics [10984-13]
10984 OD	Probing the quantum depolarizing channel with mixed Indefinite causal order [10984-14]
10984 OE	On-chip demonstration of Hong-Ou-Mandel effect using quantum-optical ring resonators [10984-15]

SESSION 4	QUANTUM ENTANGLEMENT AND QUANTUM SYSTEMS
10984 OF	Improving sensor performance by combining entanglement, networks and waveform design [10984-16]
10984 0G	Enhanced sensing through multiphoton derived hyper-entanglement and networks [10984-17]
10984 OH	Spatial resolution in entangled ghost imaging [10984-18]
10984 OJ	Approximating large scale arbitrary unitaries with integrated multimode interferometers [10984-20]