

EON

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Electro-Optics News, University of Dayton

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Editor: Partha P. Banerjee

Director's corner



As the International Year of Light draws to a close, we have made some important strides in our program. I am happy to report that we have initiated the process to elevate the electro-optics (EO) program to a department. The proposal has been approved by the chairs of Electrical and Computer Engineering (ECE) and Physics, the Academic Leadership Committee in the School of Engineering (SoE), the respective deans of SoE and the College of Arts and Sciences, and by the graduate school. Now it awaits the decision of the academic senate. Additionally, EO also formed its first advisory board (see below) which met on campus in November.

This Fall, EO welcomed about 20 new students into our program, many of whom are being supported as teaching and research assistants. We are grateful

to the Sensors and Materials directorates of Air Force Research Labs, as well as local companies such as Applied Optimization and Protobox for supporting many of our students. 10 students graduated in Summer and Fall. For 2015, EO graduated 3 PhDs and 13 MS students (see p.4). Some of our MS graduates are now pursuing their PhD in EO.

2015 has also been a banner year for the Intelligent Optics Lab and Optonicus (p.2). Mikhail Vorontsov received an Air Force Office of Scientific Research (AFOSR) Defense University Research Instrumentation Program (DURIP) grant for high-performance cluster computing. These computers, which will be housed in Fitz Hall, will satisfy the computational needs for atmospheric optics, and dramatically improve the computational facilities of EO and ECE. Also, Mikhail and Thomas Weyrauch received a prestigious National Science Foundation (NSF) Major

Partha Banerjee

Research Instrumentation (MRI) grant for the development of a high-power adaptive phased fiber-array laser system, with applications in additive manufacturing.

Cong Deng, an alum of Huazong University of Science and Technology (HUST), and research scholar in EO, initiated negotiations between HUST and UD for future collaboration. Cong, Joe Haus, and I recently visited HUST, the largest optics institute in China, to discuss co-teaching of courses in Wuhan, and exchange of graduate students between the two institutions. Additionally, Qiwen Zhan initiated a visit of scholars and administrators from Centro de Investigaciones en Optica (CIO) in León, Mexico for similar student exchanges. We hope these efforts bring in students from these prestigious institutions to EO in the near future.

I wish you all a very happy, illuminating, and productive 2016!

EO welcomes board members to campus



EO recently formed its advisory board and the members came for their first meeting this Fall. Pictured here (from right to left) are: Chris Brewer (AFRL materials and EO alum), Tim Bunning (chief scientist, AFRL materials), Mark Greiner (L3), Akhlesh Lakhtakia (Charles Binder Endowed Professor, Penn State), Bahaa Saleh (dean of CREOL), and John Taranto (ThorLabs and EO alum). Mike Roggeman (professor, Michigan Tech), could not attend. John Erdei, Chair, Physics, is also pictured. The initial report from the committee noted that "by becoming an independent department, we are on the right track to becoming an internationally recognized premier EO program". Other suggestions included adding biophotonics as a growth area, and a name change to Optics and Photonics.

Optonicus, Intelligent Optics Lab have banner year

It was quite a successful year for the Intelligent Optics Laboratory and Optonicus LLC team.

Following a review meeting in Washington D.C., the MURI team headed up by Mikhail Vorontsov was approved for a 2 year extension. This project studying "Deep Atmospheric Optical Turbulence Physics and Predictive Modeling" brought together researchers from UD, U. of Miami, AFIT, Michigan Tech, New Mexico State, and NC State.

The MURI teams research will be enhanced by the upcoming acquisition of a computing cluster that was recently funded through a AFOSR-DURIP grant "High Performance Computational Cluster for Extended-Range

stricter requirements for power and control. The proposed equipment combines precise beam pointing and stabilization, and adaptive compensation for mechanical jitter, among other key features. The availability of this new laser system to both industrial researchers and University programs will also help the local area economy in its transition to high-tech industry.

Optonicus also had a year of growth adding on two new

Phase I SBIR contracts and two new Phase II SBIR contracts. Additionally, the existing Phase II STTR project developing an "Extended Range Atmospheric Sensing Suite" received a 14 month extension to perform additional work. Optonicus also had the opportunity to showcase its systems at several exhibitions this year. In June, the MOR-SAPR complex field sensor was on display at the Navy Opportunity Forum. In September, the SEAHAWK fiber-



array cluster (above) was showcased at DARPA's "Wait What?" Technology Forum.

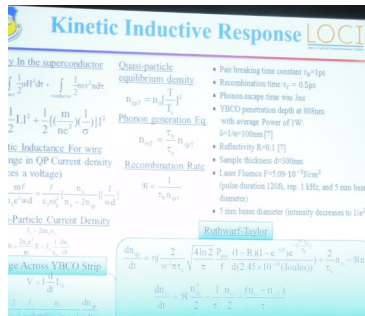
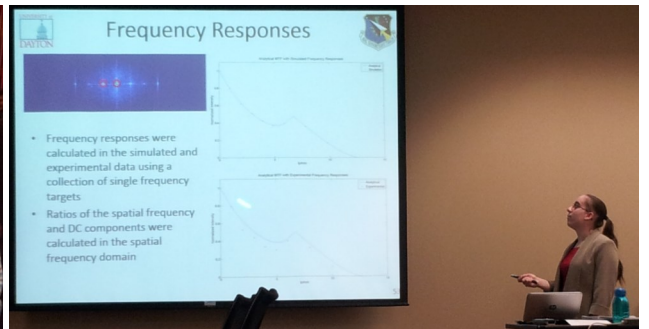
"Scientific discovery inspires us to continue learning more about our universe and ourselves. It is also difficult work and this (NSF) award is validation of your efforts. UD, the state of Ohio and our nation will benefit from the research you are undertaking."

Sherrod Brown, Ohio Senator

Atmospheric Optics Research". This new resource will dramatically increase EO's computational abilities through the purchase of a high performance computer housing 780 processing cores and 4 state of the art GPU units.

Recently Mikhail, along with co-Principal Investigator Thomas Weyrauch, were awarded an NSF MRI grant "Development of a High-Power Adaptive Phased Fiber-Array Laser System". This grant focuses on constructing a ~10kW class continuous wave fiber-array laser system for use in a wide variety of industries such as automotive, aerospace, defense, and nuclear and fusion energy. With the emerging development of additive manufacturing techniques, high-power laser energy sources must adapt to fit

Capturing EO in 2015



From top left (clockwise): Haipeng Liu, Chuan Ni and Junxing Wong with Prathan Buranisiri, Partha Banerjee and Andrew Sarangan at SPIE Annual meeting, San Diego; Dean Evans receiving his fellowship from OSA President Philip Russell at FiO, San Jose; Sarah Krug at her MS defense; Partha Banerjee, Joe Haus, and Cong Deng with Ling Fu (left) and Haibin Yang (right) at Wuhan National Labs at HUST, Wuhan, China; Brian Dolasinski at SPIE Photonics West, San Francisco; Ed Watson and Yun Zhao at OSA's International Year of Light reception in San Jose. Haipeng is with Newport, Junxing is a PhD student at U. California San Diego, and Prathan is faculty at King Mongkut U., Thailand. Chuan and Sarah received their MS in EO and are continuing on their PhD. Dean is with AFRL and is graduate faculty in EO. Brian is also employed at AFRL. Yun will complete his MS in EO in May of 2016.

Selected Journal Papers 2015

1. H. Li, J. W. Haus, and P. P. Banerjee, "Application of transfer matrix method to second-harmonic generation in nonlinear photonic bandgap structures: oblique incidence," *J. Opt. Soc. Am. B* **32**, 1456-1462 (2015).
2. G. Nehmetallah, P. Banerjee, and J. Khoury, "Adaptive defect and pattern detection in amplitude and phase structures via photorefractive four-wave mixing," *Appl. Opt.* **54**, 9622-9629 (2015).
3. L. A. Williams, G. Nehmetallah, R. Aylo, and P. P. Banerjee, "Application of up-sampling and resolution scaling to Fresnel reconstruction of digital holograms," *Appl. Opt.* **54**, 1443-1452 (2015).
4. U. Abeywickrema, P. P. Banerjee, and N. T. Banerjee, "Holographic assessment of self-phase modulation and blooming in a thermal medium," *Appl. Opt.* **54**, 2857-2865 (2015).
5. A. Chong, L. Wright, and F. W. Wise, "Ultrafast fiber lasers based on self-similar pulse evolution: a review of current progress," *Rep. Prog. Phys.* **78**, 113901 (2015).
6. Y. Tang, A. Chong, and F. W. Wise, "Generation of 8 nJ pulses from a normal-dispersion thulium fiber laser," *Opt. Lett.* **40**, 2361-2364 (2015).
7. B. Dolasinski, P. E. Powers, J. W. Haus, and A. Cooney, "Tunable narrow band difference frequency THz wave generation in DAST via dual seed PPLN OPG," *Opt. Exp.* **23**, 3669-3680 (2015).
8. M. Scalora, M. A. Vincenti, D. de Ceglia, C. M. Cojocar, M. Grande, and J. W. Haus, "Nonlinear Duffing oscillator model for third harmonic generation," *J. Opt. Soc. Am. B* **32**, 2129-2138 (2015).
9. D. Jauregui, J. W. Haus, A. Ben Harush Negari, J. M. Sierra Hernandez and K. Hansen, "Bitapered fiber sensor: Signal analysis," *Sensors and Actuators B* **218**, 105-110 (2015).
10. D. de Ceglia, M. A. Vincenti, C. De Angelis, A. Locatelli, J. W. Haus and M. Scalora, "Second harmonic generation from dipole nano-antennas: Role of antenna modes and field enhancement," *Opt. Exp.* **23**, 1715-1729 (2015).
11. J. Jia, C. Ni, A. Sarangan, and K. Hirakawa, "Fourier multispectral imaging," *Opt. Exp.* **23**, 22649-22657 (2015).
12. J. Wong, Y. Zhao, I. Agha, and A. Sarangan, "SU-8 nanoimprint fabrication of wire-grid polarizers using deep-UV interference lithography," *Opt. Lett.* **40**, 4396-4399 (2015).
13. C. Nunalee, P. He, S. Basu, J. Minet, and M. Vorontsov, "Mapping optical trajectories through island wake vortices," *Metrology Atm. Phys.* **127**, 355-368 (2015).
14. P. He, C. Nunalee, S. Basu, J. Minet, M. Vorontsov, and S. Fiorino, "Influence of heterogeneous refractivity on optical wave propagation in coastal environments," *Metrology Atm. Phys.* **127**, 685-699 (2015).
15. J. Lin, K. Yan, Y. Zhou, and L. Xu, C. Gu and Q. Zhan, "Tungsten disulphide based all fiber Q-switching cylindrical-vector beam generation," *Appl. Phys. Lett.* **107**, 191108 (2015).
16. S. Wang, D. C. Abeyasinghe and Q. Zhan, "Generation of vectorial optical fields with slot antenna-based metasurface," *Opt. Lett.* **40**, 4711-4713 (2015).
17. Y. Yu and Q. Zhan, "Creation of identical multiple focal spots with prescribed axial distribution," *Sci. Rep.*, **5**, 14673 (2015).
18. G. Rui, Q. Zhan and Y. Cui, "Tailoring optical complex field with spiral blade plasmonic vortex lens," *Sci. Rep.* **5**, 13732 (2015).
19. Y. Yu and Q. Zhan, "Generation of uniform three-dimensional optical chain with controllable characteristics," *J. Opt.* **17**, 105606 (2015).
20. B. Gu, D. Xu, G. Rui, M. Lian, Y. Cui and Q. Zhan, "Manipulation of dielectric Rayleigh particles using highly focused elliptically polarized vector fields," *Appl. Opt.* **54**, 8123-8129 (2015).
21. I. Saucedo-Orozco, R. Espinosa-Luna and Q. Zhan, "Angularly-resolved variable-wave-retarder using light scattering from a thin metallic cylinder," *Opt. Comm.* **352**, 135-139 (2015).
22. Y. Yu and Q. Zhan, "Generation of a spherical focal spot in a 4Pi focusing system through reversing the radiation of infinite biconical antenna," *Opt. Comm.* **350**, 217-221 (2015).
23. B. Sun, A. Wang, C. Gu, G. Chen, L. Xu, D. Chung, and Q. Zhan, "Mode-locked all-fiber laser producing radially polarized rectangular pulses," *Opt. Lett.* **40**, 1691-1694 (2015).
24. Y. Yu and Q. Zhan, "Optimization-free optical focal field engineering through reversing the radiation pattern from a uniform line source," *Opt. Exp.* **23**, 7527-7534 (2015).
25. W. Han, W. Cheng, and Q. Zhan, "Design and alignment strategies of 4f systems used in the vectorial optical field generator," *Appl. Opt.* **54**, 2275-2278 (2015).
26. Y. Pan, B. Gu, D. Xu, Q. Zhan and Y. Cui, "Varying focal fields with asymmetric-sector-shaped vector beams," *J. Opt.* **17**, 015603 (2015).
27. M. Wang, C. Zhao, X. Miao, Y. Zhao, J. Rufo, Y. Liu, T. J. Huang, Y. Zheng, "Plasmofluidics: Merging Light and Fluid at the Micro-/nano-Scale," *Small* **11**, 4423-4444 (2015).
28. J. Yang, C. Hu, Q. Wen, C. Zhao and J. Zhang, "Coupling between surface plasmon polaritons and transverse electric polarized light via L-shaped nano-apertures," *Opt. Lett.* **40**, 978-981 (2015).

Faculty Spotlight:
Chenglong Zhao

Dr. Chenglong Zhao joined Physics and EO as an assistant professor in August, 2015. He received his Ph.D. from Peking University (Beijing, China) in 2011. Prior to UD, Chenglong was at Penn State and NIST.

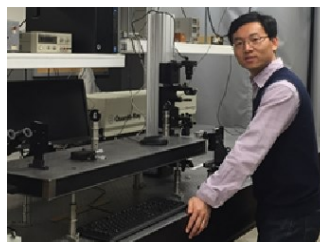
Chenglong's research interests include nanophotonics, graphene, plasmonics, metamaterials, and optical trapping and manipulation. He has authored and co-authored over 20 journal papers including *Nature Communications*, *Nano Let-*

Bending light beams to your whim sounds like a job for a wizard or an a complex array of bulky mirrors, lenses and prisms, but a few tiny liquid bubbles may be all that is necessary to open the doors for next-generation, high-speed circuits and displays.

Physic.org.com

ters, *ACS Nano*, *Nanoscale*, and *Lab Chip*. His research findings have been widely reported by *Science Daily*, *Physics News*, *National Science Foundation*, *Science Codex*, *Science News*, etc.

Chenglong currently leads the Nano-photonic & Nano-Manipulation (NPNM) Lab in the Physics building. The NPNM lab aims to develop cutting-edge nanotechnologies by utilizing the light-matter interaction at nanoscales for applications in 3D nano-fabrication, single molecule detection, portable on-chip nano-trapping, ultra-sensitive bio-sensing, and point-of-care diagnostics.



Chenglong in the NPNM Lab in the Physics building.

EO @ UDA joint initiative between
electrons and photonsInstitute for Development and
Commercialization of Advanced
Sensor Technology

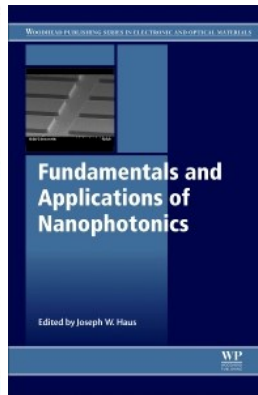
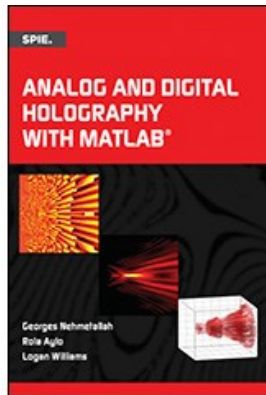
Intelligent Optical Systems



The Right Balance of Non-Conformity & Critical Thinking



Recent books by EO alumni, faculty

Authors of *Analog and Digital Holography*: George
Nehmetallah, Rola Aylo, Logan Williams. Author
of *Nanophotonics*: Joe Haus. **Congratulations!**Partha P. Banerjee
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We are on the Web:
[www.udayton.edu/engineering/
departments/electrooptics_grad/](http://www.udayton.edu/engineering/departments/electrooptics_grad/)

EO Graduates

May 2015

Ujitha Abeywickrema, PhD
Shiyi Wang, PhD
Zhicheng Xiao, MS
Katherine Duncan-
Chamberlin, MS
David Lombardo, MS
Yang Xu, MS

August 2015

Rahmah Alzahrani, MS
Sarah Krug, MS

December 2015

Han Li, PhD
Awatif Alshammari, MS
Hongwei Chen, MS
Xin Huang, MS
Peiyun Li, MS
Zairui Li, MS
Ying Xu, MS
Mengyang Zou, MS

Congratulations!

Let's get Digital...

Partha Banerjee was elected general chair of
the OSA Digital Holography Topical Meeting
at Heidelberg in July 2016. The meeting this
year is part of the OSA Imaging Congress. He
was general chair of DH in 2010 in Miami, and
technical chair of DH in Shanghai in 2015.

Student Spotlight: Shiyi Wang

It is probably common
knowledge that coat
hangers from your closet
can play an important role
in TV reception. Indeed,
there are YouTube® vide-
os showing how one can
make a good HDTV anten-
na using just a few coat-
hangers to form a bowtie
shape. Slot bowtie anten-
nas have the advantage ofwider bandwidth, good
impedance match, and bi-
directional radiation pat-
terns, and are widely used
in microwave communica-
tions. As optical counter-
part of microwave anten-
nas, optical nano-antennas
are important devices for
converting propagating
radiation into confined/
enhanced fields in the na-
noscale. Recent advances
in resonant sub-
wavelength optical anten-
nas have now offered re-
searchers the entire elec-
tromagnetic spectrum—
ranging from RF to X-
rays—to design, analyze
and predict new phenome-
na that were previously
unknown.Shiyi Wang (PhD, EO,
2015) proposed and
demonstrated a transmis-
sion-type metasurface
composed of carefully de-
signed rectangular slot
antennas for the genera-
tion of vectorial optical
fields. Acting as local line-
ar polarizers, these slot
antennas enable the spa-
tial modulation of optical
fields in amplitude, phase,
and polarization for the
cross-polarized compo-
nent of the scattered
field.Shiyi joined Qiwen
Zhan's research group in
the EO program at UD in
2010, having completed
his BS and MS from Harbin
Institute of Technology,China in 2008 and 2010,
respectively. He was sup-
ported one year as a teach-
ing assistant conducting
Physics labs (as is typical for
many EO students) before
switching over to a research
assistant under Dr. Zhan.
Shiyi is currently employed
as a Computational Pattern-
ing Engineer with Global
Foundries (formally incorpo-
rated with IBM) in New York.Shiyi was vice-president of
the SPIE student chapter
and attended the SPIE stu-
dent leadership workshop in
San Diego. An avid photog-
rapher, he was also exhibi-
tor for two years at the EO
booth in Dayton Techfest,
which draws thousands of
all ages every year.