

# Impact of the International Workshop on Quantum and Topological Nanophotonics (QTN) Series

Prof Nikolay Zheludev | CDPT NTU; IAS Distinguished Fellow



The International Workshop on Quantum and Topological Nanophotonics (QTN) is an invitation-only series, started in December 2016 and now at its fourth edition, organised by The Centre for Disruptive Photonic Technologies (CDPT) at NTU, with selected partner institutions and supported by the Institute of Advanced Studies at NTU. From the first workshop, we strategically targeted collaborations with leading research communities worldwide by jointly organising it. This included co-organisation with a leading research group in Spain, West Coast universities in the USA, South Korea institutions, East Coast universities in the USA.

The QTN series is a prime level event attracting top level international speakers at the platform of open discussion and exchange of ideas. The talks are open to the entire research community in Singapore growing in popularity: almost 200 local attendees attended the last edition, attracted by the opportunity to learn from and interact with leading international researchers brought to Singapore by the workshop.

The main aim of the workshops is to identify new direction and trends in photonics research and establishing NTU leadership on these topics. Indeed, the QTN series propelled NTU as a leading research institution in these fields internationally. This is well supported by numerous research awards (S\$48 million in competitive grants) received by NTU/CDPT researchers in this field:

- 1 MOE Tier 3
  - “Quantum and Topological Nanophotonics”
- 4 NRF CRPs
  - “Deeply Subwavelength Superoscillatory Imaging (DSSI)”
  - “Active Topological Photonics towards Robust Lasers and Efficient Sensors”
  - “On-chip Terahertz Topological Photonics for 6G Communication (TERACOMM)”
  - “The Next Generation of Spintronics with 2D Heterostructures”
- 1 NRF QEP-1
  - “Superconducting Nanowire Single Photon Detectors”
- 3 A\*STAR QTE
  - “Nanophotonic quantum toolkit on the fibre and SOI platforms”
  - “On-chip Elementary Quantum Logic: SiC Spin-Photon Entanglement”

- “3D Interconnects and Multi-chip Interposer Platform for Scalable Quantum Computing”

We are also proud to report substantial personal accolades including:

- The Nanyang Research Award (Individual) 2018 (N. Zheludev)
- The Nanyang Research Award (Teams) 2019 (Y. Chong, R. Singh, B. Zhang)
- The President’s Science Award 2020 (Y. Chong, B. Zhang, N. Zheludev)

Another goal of the QTN workshops series is to foster collaborations between the Singapore photonics community and other world-leading research groups. The QTN has fostered a number of durable connections:

- International speakers of the QTN workshops (e.g. H. Atwater, N. Engheta, J. Garcia de Abajo, Y. Kivshar, M. Segev, G. Shvets) have joined Singapore-funded research programs as collaborators and advisors.
- Exchange and visits of students and research fellows between NTU and international groups who joined the QTN workshops have been established (e.g. a PhD student from Prof. Shvets visited Prof Zhang; a PhD student from Prof Shin joined NTU as research fellow).
- More than 45 publications that include international speakers and NTU researchers reflect the high recognition of NTU in the field of Quantum and Topological Nanophotonics. See the list below.

### International Workshop on Quantum and Topological Nanophotonics (QTN) Series

<[website link](#)>

Workshop	Date	Organising Institutions	Invited International Speakers
<b>1<sup>st</sup> QTN</b> <b>127 attendees</b>	<b>Dec 2016</b>	CDPT/NTU ICFO (Spain)	Harry Atwater, California Institute of Technology Dimitri Basov, Columbia University Nader Engheta, University of Pennsylvania Daniele Faccio, Heriot-Watt University Javier Garcia de Abajo, ICFO Harald Giessen, University of Stuttgart Yuri Kivshar, Australian National University Fedor Kusmartsev, Loughborough University Meir Orenstein, TECHNION Valerio Pruneri, ICFO Romain Quidant, ICFO Arno Rauschenbeutel, TU Wien Janne Ruostekoski, University of Southampton Gennady Shvets, UT Austin and Cornell University Niek van Hulst, ICFO
<b>2<sup>nd</sup> QTN</b> <b>168 attendees</b>	<b>Apr 2018</b>	CDPT/NTU Seoul National Univ. (Korea)	Igor Aharonovich, University of Technology Sydney Harry Atwater, CALTECH Che Ting Chan, HKUST Jennifer Dionne, Stanford University Daniele Faccio, Heriot-Watt University Nicholas Fang, MIT Javier García de Abajo, ICFO Yuri Kivshar, Australian National University Frank Koppens, ICFO

			ByoungHo Lee, Seoul National University Uriel Levy, Hebrew University of Jerusalem Bumki Min, KAIST Namkyoo Park, Seoul National University Q-Han Park, Korea University Hannah Price, University of Birmingham Janne Ruostekoski, Lancaster University Junsuk Rho, POSTECH Moti Segev, Technion Jonghwa Shin, KAIST Gennady Shvets, Cornell University Jeong Weon Wu, Ewha Woman's University
<b>3<sup>rd</sup> QTN</b> <b>186 attendees</b>	<b>Dec</b> <b>2019</b>	CDPT/NTU Caltech, Stanford Univ. (USA)	Harry Atwater, Caltech, USA Mark Brongersma, Stanford University, USA Dimitri Basov, Columbia University, USA Shanhui Fan, Stanford University, USA Jelena Vučković, Stanford University, USA Alexander Khanikaev, CUNY, USA Mark Dennis, University of Birmingham, UK Mohammed Hafezi, University of Maryland, USA Kobus Kuipers, TU Delft, Netherlands Natalia Litchinitser, Duke University, USA Cun-Zheng Ning, Tsinghua University, China & Arizona State University, USA Harald Giessen, University of Stuttgart, Germany Javier Garcia de Abajo, ICFO, Spain Jean Jacques Greffet, Université Paris Sud, France
<b>4<sup>th</sup> QTN</b> <i>(upcoming)</i>	<b>Apr</b> <b>2022</b>	CDPT/NTU Univ. of Pennsylvania, CUNY, Columbia Univ., MIT (USA)	Andrea Alu, CUNY, USA Dmitri Basov, Columbia University, USA Mark Brongersma, Stanford University, USA Nader Engheta, UPenn, USA Andrew Forbes, University of the Witwatersrand, South Africa Harald Giessen, University of Stuttgart, Germany Ido Kaminer, Technion, Israel Yuri Kivshar, The Australian National University, Australia Franco Nori, RIKEN, Japan Mordechai Segev, Technion, Israel Val Zwiller, KTH, Royal Institute of Technology, Sweden

### “NTU-International speakers” joint papers and conferences following the QTN workshops

1. Li, YD; Yu, Y; Liu, FY; **Zhang, BL; Shvets, G**, “Topology-Controlled Photonic Cavity Based on the Near-Conservation of the Valley Degree of Freedom”, *Phys. Rev. Lett.* **125**, 213902 (2020)
2. Li, YD; Yu, Y; Liu, FY; **Zhang, BL; Shvets, G**, “Localizing a Topological Mode Using a Near-Conservation of the Valley Degree of Freedom”, *Conference on Lasers and Electro-Optics (CLEO)*(2020)
3. Lai, KEF; Yu, Y; Han, YC; Gao, F; **Zhang, BL; Shvets, G**, “Valley Waves Sorting and Routing Based on Photonic Topological Insulators”, *Conference on Lasers and Electro-Optics (CLEO)* (2018)

4. Gao, F; Xue, HR; Yang, ZJ; Lai, KF; Yu, Y; Lin, X; **Chong, YD; Shvets, G; Zhang, BL**, "Topologically protected refraction of robust kink states in valley photonic crystals", *Nat. Phy.* **2**, 14 (2018)
5. Yang, QL; Liu, MK; Kruk, S; Xu, YH; Srivastava, YK; **Singh, R**; Han, JG; **Kivshar, Y**; Shadrivov, IV, "Polarization-Sensitive Dielectric Membrane Metasurfaces", *Adv. Opt. Mater.* **20**, 8 (2020)
6. Yang, QL; Kruk, S; Srivastava, YK; Koshelev, K; **Singh, R**; Han, JG; **Kivshar, Y**; Shadrivov, I, "Dielectric Membrane Mie-Resonant Metasurfaces", *Conference on Lasers and Electro-Optics (CLEO)*(2019)
7. Smirnova, D; Leykam, D; **Chong, YD; Kivshar, Y**, "Nonlinear topological photonics", *Appl. Phys. Rev.* **2**, 7 (2020)
8. Han, S; Rybin, MV; Pitchappa, P; Srivastava, YK; **Kivshar, YS; Singh, R**, "Guided-Mode Resonances in All-Dielectric Terahertz Metasurfaces", *Adv. Opt. Mater.* **3**, 8 (2020)
9. Han, S; Cong, LQ; Srivastava, YK; Qiang, B; Rybin, MV; Lim, WX; **Wang, QJ; Kivshar, YS; Singh, R**, "Active high-Q dielectric terahertz supercavities", *Conference on Lasers and Electro-Optics (CLEO)*(2018)
10. Yang, QL; Kruk, S; Xu, YC; Wang, QW; Srivastava, YK; Koshelev, K; Kravchenko, I; **Singh, R**; Han, JG; **Kivshar, Y**; Shadrivov, I, "Membrane Metasurfaces", *Conference on Lasers and Electro-Optics Pacific Rim (CLEO-PR)*(2020)
11. Han, S; Cong, LQ; Srivastava, YK; Qiang, B; Rybin, MV; Kumar, A; Jain, R; Lim, WX; Achanta, VC; Prabhu, SS; **Wang, QJ; Kivshar, YS; Singh, R**, "All-Dielectric Active Terahertz Photonics Driven by Bound States in the Continuum", *Adv. Mater.* **37**, 31 (2019)
12. Yang, QL; Kruk, S; Xu, YH; Wang, QW; Srivastava, YK; Koshelev, K; Kravchenko, I; **Singh, R**; Han, JG; **Kivshar, Y**; Shadrivov, I, "Mie-Resonant Membrane Huygens' Metasurfaces", *Adv. Funct. Mater.* **4**, 30 (2020)
13. Dai, SY; Fang, WJ; Rivera, N; Stehle, Y; Jiang, BY; Shen, JL; Tay, RY; Ciccarino, C; Ma, Q; Rodan-Legrain, D; Jarillo-Herrero, P; **Teo, EHT**; Fogler, MM; Narang, P; Kong, J; **Basov, DN**, "Phonon Polaritons in Monolayers of Hexagonal Boron Nitride", *Adv. Mater.* **37**, 31 (2019)
14. Lopez, JJ; Ambrosio, A; Dai, SY; Huynh, C; Bell, DC; Lin, X; Rivera, N; Huang, SX; Ma, Q; Eyhusen, S; Kaminer, IE; Watanabe, K; Taniguchi, T; Kong, J; **Basov, DN**; Jarillo-Herrero, P; Soljacic, M, "Large Photothermal Effect in Sub-40 nm h-BN Nanostructures Patterned Via High-Resolution Ion Beam", *Small.* **22**, 14 (2018)
15. Lim, J; Ang, YS; **de Abajo, FJG**; Kaminer, I; Ang, LK; **Wong, LJ**, "Efficient generation of extreme terahertz harmonics in three-dimensional Dirac semimetals", *Phys. Rev. Res.* **4**, 2 (2020)
16. Dror, B; Zheng, Y; Agrawal, M; **Radhakrishnan, K; Orenstein, M**; Bahir, G, "Mid-Infrared GaN/AlGaIn Quantum Cascade Detector Grown on Silicon", *IEEE Electron Device Lett.* **2**, 40 (2019)
17. Roger, T; Lyons, A; Oren, D; Savinov, V; Valente, J; Vezzoli, S; **Segev, M; Zheludev, NI; Faccio, D**, "Coherent absorption of two-photon states in metamaterials", *Conference on Lasers and Electro-Optics Europe & European Quantum Electronics Conference (CLEO/EUROPE-EQEC)* (2017)
18. **Altuzarra, C**; Lyons, A; **Yuan, GH**; Simpson, C; Roger, T; Ben-Benjamin, JS; **Faccio, D**, "Imaging of polarization-sensitive metasurfaces with quantum entanglement", *Phys. Rev. A.* **2**, 99 (2019)

19. Altuzarra, C; Vezzoli, S; Valente, J; **Soci, C; Faccio, D**; Couteau, C; **Zheludev, NI**, “Remote Control of coherent light absorption with entangled photons”, *Conference on Lasers and Electro-Optics (CLEO)* (2016)
20. Altuzarra, C; Vezzoli, S; Valente, J; **Gao, WB; Soci, C; Faccio, D**; Couteau, C, “Coherent Perfect Absorption in Metamaterials with Entangled Photons”, *ACS Photonics*. **9**, 4 (2017)
21. Wittek, S; Harari, G; Bandres, MA; Hodaei, H; Parto, M; Aleahmad, P; Rechtsman, MC; **Chong, YD**; Christodoulides, DN; Khajavikhan, M; **Segev, M**, “Towards the Experimental Realization of the Topological Insulator Laser”, *Conference on Lasers and Electro-Optics (CLEO)* (2017)
22. Klemmt, S; Harder, TH; Egorov, OA; Winkler, K; Ge, R; Bandres, MA; Emmerling, M; Worschech, L; **Liew, TCH; Segev, M**; Schneider, C; Hofling, S, “Exciton-polariton topological insulator”, *Nature*. **7728**, 562 (2018)
23. Harari, G; Bandres, MA; Lumer, Y; Rechtsman, MC; **Chong, YD**; Khajavikhan, M; Christodoulides, DN; **Segev, M**, “Topological insulator laser: Theory”, *Science*. **6381**, 359 (2018)
24. **Wang, Q**; Ding, K; Liu, H; Zhu, SN; **Chan, CT**, “Exceptional cones in 4D parameter space”, *Opt. Express*. **2**, 28 (2020)
25. Shi, YZ; Zhao, HT; Nguyen, KT; Zhang, Y; Chin, LK; Zhu, TT; Yu, YF; Cai, H; Yap, PH; Liu, PY; Xiong, S; **Zhang, JB**; Qu, CW; **Chan, CT; Liu, AQ**, “Nanophotonic Array-Induced Dynamic Behavior for Label-Free Shape-Selective Bacteria Sieving”, *ACS Nano*. **10**, 13 (2019)
26. Yu, S; Qiu, CW; **Chong, YD**; Torquato, S; **Park, N**, “Engineered disorder in photonics”, *Nat. Rev. Mater.* **3**, 6 (2021)
27. Li, ZL; Kim, I; Zhang, L; Mehmood, MQ; Anwar, MS; Saleem, M; Lee, D; Nam, KT; Zhang, S; **Luk'yanchuk, B**; Wang, Y; Zheng, GX; **Rho, J**; Qiu, CW, “Dielectric Meta-Holograms Enabled with Dual Magnetic Resonances in Visible Light”, *ACS Nano*. **9**, 11 (2017)
28. Wang, Y; **Price, HM; Zhang, BL; Chong, YD**, “Circuit implementation of a four-dimensional topological insulator”, *Nat. Commun.* **1**, 11 (2020)
29. Zhou, Y; Rasmita, A; Li, K; Xiong, QH; **Aharonovich, I; Gao, WB**, “Coherent control of a strongly driven silicon vacancy optical transition in diamond”, *Nat. Commun.* **8**, 14451 (2017)
30. Zhou, Y; Mu, Z; Adamo, G; Bauerdick, S; Rudzinski, A; **Aharonovich, I; Gao, WB**, “Direct writing of single germanium vacancy center arrays in diamond”, *New J. Phys.* **20**, 125004 (2018)
31. Schaeper, OC; Froch, JE; Kim, S; Mu, Z; Toth, M; **Gao, WB; Aharonovich, I**, “Fabrication of Photonic Resonators in Bulk 4H-SiC”, *Adv. Mater. Technol.* **11**, 6 (2021)
32. Mu, Z; Zhou, Y; Chen, DS; Froch, JE; Yang, JQ; Li, XJ; **Aharonovich, I; Gao, WB**, “Observation of Binary Spectral Jumps in Color Centers in Diamond”, *Adv. Opt. Mater.* **19**, 8 (2020)
33. Mu, Z; Zargaleh, SA; von Bardeleben, HJ; Froch, JE; Nonahal, M; Cai, HB; Yang, XG; Yang, JQ; Li, XJ; **Aharonovich, I; Gao, WB**, “Coherent Manipulation with Resonant Excitation and Single Emitter Creation of Nitrogen Vacancy Centers in 4H Silicon Carbide”, *Nano Lett.* **8**, 20 (2020)
34. Tran, TT; Regan, B; Ekimov, EA; Mu, Z; Zhou, Y; **Gao, WB**; Narang, P; Solntsev, AS; Toth, M; **Aharonovich, I**; Bradac, C, “Anti-Stokes excitation of solid-state quantum emitters for nanoscale thermometry”, *Sci. Adv.* **5**, 5 (2019)
35. Sandstrom, R; Ke, L; Martin, A; Wang, ZY; Kianinia, M; Green, B; **Gao, WB; Aharonovich, I**, “Optical properties of implanted Xe color centers in diamond”, *Opt. Commun.* **411** (2018)
36. Zhou, Y; Wang, ZY; Rasmita, A; Kim, S; Berhane, A; Bodrog, Z; Adamo, G; Gali, A; **Aharonovich, I; Gao, WB**, “Room temperature solid-state quantum emitters in the telecom range”, *Sci. Adv.* **3**, 4 (2018)

37. Froch, JE; Bahm, A; Kianinia, M; Mu, Z; Bhatia, V; Kim, S; Cairney, JM; **Gao, WB**; Bradac, C; **Aharonovich, I**; Toth, M, "Versatile direct-writing of dopants in a solid state host through recoil implantation", *Nat. Commun.* **1**, 11 (2020)
38. Bradac, C; **Gao, WB**; Forneris, J; Trusheim, ME; **Aharonovich, I**, "Quantum nanophotonics with group IV defects in diamond", *Nat. Commun.* **10**, 5625 (2019)
39. Chen, DS; Mu, Z; Zhou, Y; Froch, JE; Rasmit, A; Diederichs, C; Theludev, N; **Aharonovich, I**; **Gao, WB**, "Optical Gating of Resonance Fluorescence from a Single Germanium Vacancy Color Center in Diamond", *Phys. Rev. Lett.* **3**, 123 (2019)
40. Shentcic, M; Budniak, AK; Shi, XH; Dahan, R; Kurman, Y; Kalina, M; Sheinfux, HH; Blei, M; Svendsen, MK; Amouyal, Y; Tongay, S; Thygesen, KS; **Koppens, FHL**; Lifshitz, E; **de Abajo, FJG**; **Wong, LJ**; Kaminer, I, "Tunable free-electron X-ray radiation from van der Waals materials", *Nat. Photonics.* **11**, 14 (2020)
41. Reserbat-Plantey, A; Epstein, I; Torre, I; Costa, AT; Goncalves, PAD; Mortensen, NA; Polini, M; **Song, JCW**; Peres, NMR; **Koppens, FHL**, "Quantum Nanophotonics in Two-Dimensional Materials", *ACS Photonics.* **1**, 8 (2021)
42. Talker, E; Arora, P; Barash, Y; **Wilkowski, D**; **Levy, U**, "Efficient optical pumping of alkaline atoms for evanescent fields at dielectric-vapor interfaces", *Opt. Express.* **23**, 27 (2019)
43. Talker, E; Arora, P; Barash, Y; **Wilkowski, D**; **Levy, U**, "Highly efficient optical pumping of Rb atoms for evanescent fields at dielectric-vapor interfaces", *Conference on Lasers and Electro-Optics (CLEO)* (2019)
44. Ni, X; Smirnova, D; Poddubny, A; Leykam, D; **Chong, YD**; **Khanikaev, AB**, "PT phase transitions of edge states at PT symmetric interfaces in non-Hermitian topological insulators", *Phys. Rev. B.* **16**, 98 (2018)
45. Ni, X; Smirnova, D; Poddubny-, A; Leykam, D; **Chong, YD**; **Khanikaev, A**, "Lossless Edge States Protected by PT-Symmetric Phase", *Conference on Lasers and Electro-Optics (CLEO)* (2018)
46. Soskin, M; Boriskina, SV; **Chong, YD**; **Dennis, MR**; Desyatnikov, A, "Singular optics and topological photonics", *J Opt.* **1**, 19 (2017)