

Stanford



Amir Safavi-Naeini

Associate Professor of Applied Physics

Bio

ACADEMIC APPOINTMENTS

- Associate Professor, Applied Physics

PROFESSIONAL EDUCATION

- Ph.D., California Institute of Technology , Applied Physics (2013)
- B.ASc., University of Waterloo , Electrical Engineering (2008)

PATENTS

- Jeremy D Witmer, Patricio Arrangoiz-Arriola, Jeff T Hill, Amir H Safavi-Naeini, Timothy Patrick McKenna. "United States Patent US20180113373A1 Doubly-resonant electro-optic conversion using a superconducting microwave resonator", Leland Stanford Junior University, Oct 23, 2017
- Oskar Painter, Martin WINGER, Qiang Lin, Amir SAFAVI-NAEINI, Thiago ALEGRE, Timothy Dobson BLASIUS, Alexander Grey KRAUSE. "United States Patent US20130121633 A1 Systems and methods for tuning a cavity", California Institute Of Technology, Nov 11, 2011

LINKS

- Lab Site: <https://web.stanford.edu/~safavi/>

Teaching

COURSES

2021-22

- Atoms, Fields and Photons: APPPHYS 203 (Aut)
- Quantum Hardware: APPPHYS 228 (Win)

2020-21

- Atoms, Fields and Photons: APPPHYS 203 (Aut)
- Quantum Hardware: APPPHYS 228 (Win)

2019-20

- Literature of Cavity QED and Cavity Optomechanics: APPPHYS 376 (Spr)

2018-19

- Atoms, Fields and Photons: APPPHYS 203 (Aut)
- Quantum Hardware: APPPHYS 228 (Win)

STANFORD ADVISEES

Doctoral Dissertation Reader (AC)

Okan Atalar, David Heydari, Jacob Hines, Stephen Kuenstner, Daniil Lukin, Jatadhari Mishra, Sattwik Deb Mishra, Edwin Ng, Tiffany Paul, Jiahui Wang, Yunfan Wu, Ryotatsu Yanagimoto, Joshua Yang

Postdoctoral Faculty Sponsor

Vahid Ansari, Yudan Guo

Doctoral Dissertation Advisor (AC)

Oguz Tolga Celik, Agnetta Cleland, Rachel Gruenke, Wentao Jiang, Nathan Lee, Kevin Multani, Taha Rajabzadeh, Hubert Stokowski, Zhaoyou Wang, Alex Wollack

Doctoral (Program)

Stephan Eismann, Jason Herrmann, Vasily Kruzhilin, Sze Cheung Lau, Kejun Xu

Publications

PUBLICATIONS

- **Mid-infrared nonlinear optics in thin-film lithium niobate on sapphire** *OPTICA*
Mishra, J., McKenna, T. P., Ng, E., Stokowski, H. S., Jankowski, M., Langrock, C., Heydari, D., Mabuchi, H., Fejer, M. M., Safavi-Naeini, A. H.
2021; 8 (6): 921-924
- **Number Partitioning With Grover's Algorithm in Central Spin Systems** *PRX QUANTUM*
Anikeeva, G., Markovic, O., Borish, V., Hines, J. A., Rajagopal, S., Cooper, E. S., Periwal, A., Safavi-Naeini, A., Davis, E. J., Schleier-Smith, M.
2021; 2 (2)
- **Acousto-optic modulation of a wavelength-scale waveguide** *OPTICA*
Sarabalis, C. J., Van Laer, R., Patel, R. N., Dahmani, Y. D., Jiang, W., Mayor, F. M., Safavi-Naeini, A. H.
2021; 8 (4): 477-483
- **Loss channels affecting lithium niobate phononic crystal resonators at cryogenic temperature** *APPLIED PHYSICS LETTERS*
Wollack, E., Cleland, A. Y., Arrangoiz-Arriola, P., McKenna, T. P., Gruenke, R. G., Patel, R. N., Jiang, W., Sarabalis, C. J., Safavi-Naeini, A. H.
2021; 118 (12)
- **Development of Quantum Interconnects (QuICs) for Next-Generation Information Technologies** *PRX QUANTUM*
Awschalom, D., Berggren, K. K., Bernien, H., Bhave, S., Carr, L. D., Davids, P., Economou, S. E., Englund, D., Faraon, A., Fejer, M., Guha, S., Gustafsson, M., Hu, et al
2021; 2 (1)
- **Gigahertz Phononic Integrated Circuits on Thin-Film Lithium Niobate on Sapphire** *PHYSICAL REVIEW APPLIED*
Mayor, F. M., Jiang, W., Sarabalis, C. J., McKenna, T. P., Witmer, J. D., Safavi-Naeini, A. H.
2021; 15 (1)
- **Photonic Modal Circulator Using Temporal Refractive-Index Modulation with Spatial Inversion Symmetry.** *Physical review letters*
Wang, J., Herrmann, J. F., Witmer, J. D., Safavi-Naeini, A. H., Fan, S.
2021; 126 (19): 193901
- **Cryogenic microwave-to-optical conversion using a triply resonant lithium-niobate-on-sapphire transducer** *OPTICA*
McKenna, T. P., Witmer, J. D., Patel, R. N., Jiang, W., Van Laer, R., Arrangoiz-Arriola, P., Wollack, E., Herrmann, J. F., Safavi-Naeini, A. H.
2020; 7 (12): 1737-45
- **Nanobenders as efficient piezoelectric actuators for widely tunable nanophotonics at CMOS-level voltages** *COMMUNICATIONS PHYSICS*
Jiang, W., Mayor, F. M., Patel, R. N., McKenna, T. P., Sarabalis, C. J., Safavi-Naeini, A. H.
2020; 3 (1)
- **Acousto-optic modulation in lithium niobate on sapphire** *APL PHOTONICS*
Sarabalis, C. J., McKenna, T. P., Patel, R. N., Van Laer, R., Safavi-Naeini, A. H.

2020; 5 (8)

- **A silicon-organic hybrid platform for quantum microwave-to-optical transduction** *QUANTUM SCIENCE AND TECHNOLOGY*
Witmer, J. D., McKenna, T. P., Arrangoiz-Arriola, P., Van Laer, R., Alex Wollack, E., Lin, F., Jen, A., Luo, J., Safavi-Naeini, A. H.
2020; 5 (3)
- **Piezoelectric Transduction of a Wavelength-Scale Mechanical Waveguide** *PHYSICAL REVIEW APPLIED*
Dahmani, Y. D., Sarabalis, C. J., Jiang, W., Mayor, F. M., Safavi-Naeini, A. H.
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- **Time-of-flight imaging based on resonant photoelastic modulation (vol 58, pg 2235, 2019)** *APPLIED OPTICS*
Atalar, O., Van Laer, R., Sarabalis, C. J., Safavi-Naeini, A. H., Arbabian, A.
2020; 59 (5): 1430
- **S-band delay lines in suspended lithium niobate** *JOURNAL OF APPLIED PHYSICS*
Sarabalis, C. J., Dahmani, Y. D., Cleland, A. Y., Safavi-Naeini, A. H.
2020; 127 (5)
- **Lithium Niobate Resonant Photoelastic Modulator for Time-of-Flight Imaging**
Atalar, O., Van Laer, R., Sarabalis, C. J., Safavi-Naeini, A. H., Arbabian, A., IEEE
IEEE.2020
- **Development of a Millimeter-Wave Transducer for Quantum Networks**
Multani, K. S., Stokowski, H., Snively, E., Patel, R., Jiang, W., Lee, N., Welander, P. B., Nanni, E. A., Safavi-Naeini, A. H., IEEE
IEEE.2020
- **Efficient bidirectional piezo-optomechanical transduction between microwave and optical frequency.** *Nature communications*
Jiang, W. n., Sarabalis, C. J., Dahmani, Y. D., Patel, R. N., Mayor, F. M., McKenna, T. P., Van Laer, R. n., Safavi-Naeini, A. H.
2020; 11 (1): 1166
- **Photonics-to-Free-Space Interface in Lithium Niobate-on-Sapphire**
Rajabzadeh, T., Sarabalis, C. J., Atalar, O., Safavi-Naeini, A. H., IEEE
IEEE.2020
- **Acousto-Optics in Lithium Niobate-on-Sapphire**
Sarabalis, C. J., McKenna, T. P., Patel, R. N., Safavi-Naeini, A. H., IEEE
IEEE.2020
- **Efficient bidirectional piezo-optomechanical transduction between microwave and optical frequency**
Jiang, W., Sarabalis, C. J., Dahmani, Y. D., Patel, R. N., Mayor, F. M., McKenna, T. P., Van Laer, R., Safavi-Naeini, A. H., IEEE
IEEE.2020
- **Nanobenders: efficient piezoelectric actuators for widely tunable nanophotonics at CMOS-level voltages**
Jiang, W., Mayor, F. M., Patel, R. N., McKenna, T. P., Sarabalis, C. J., Safavi-Naeini, A. H., IEEE
IEEE.2020
- **Piezo-optomechanics in lithium niobate on silicon-on-insulator for microwave-to-optics transduction**
Van Laer, R., Jiang, W., Patel, R. N., Sarabalis, C. J., Cleland, A., McKenna, T. P., Wollack, E., Witmer, J. D., Safavi-Naeini, A. H., IEEE
IEEE.2020
- **Mechanical Purcell filters for microwave quantum machines** *APPLIED PHYSICS LETTERS*
Cleland, A. Y., Pechal, M., Stas, P. C., Sarabalis, C. J., Wollack, E., Safavi-Naeini, A. H.
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- **Cryogenic packaging of an optomechanical crystal** *OPTICS EXPRESS*
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- **Lithium niobate piezo-optomechanical crystals** *OPTICA*
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- **Quantum Dynamics of a Few-Photon Parametric Oscillator** *PHYSICAL REVIEW X*
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- **Controlling phonons and photons at the wavelength scale: integrated photonics meets integrated phononics (vol 6, pg 213, 2019)** *OPTICA*
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2019; 6 (4): 410
- **Diamond optomechanical crystals with embedded nitrogen-vacancy centers** *QUANTUM SCIENCE AND TECHNOLOGY*
Cady, J., Michel, O., Lee, K. W., Patel, R. N., Sarabalis, C. J., Safavi-Naeini, A. H., Jayich, A.
2019; 4 (2)
- **Time-of-flight imaging based on resonant photoelastic modulation** *APPLIED OPTICS*
Atalar, O., Van Laer, R., Sarabalis, C. J., Safavi-Naeini, A. H., Arbabian, A.
2019; 58 (9): 2235–47
- **Controlling phonons and photons at the wavelength scale: integrated photonics meets integrated phononics** *OPTICA*
Safavi-Naeini, A. H., Van Thourhout, D., Baets, R., Van Laer, R.
2019; 6 (2): 213–32
- **Superconducting circuit quantum computing with nanomechanical resonators as storage** *QUANTUM SCIENCE AND TECHNOLOGY*
Pechal, M., Arrangoiz-Arriola, P., Safavi-Naeini, A. H.
2019; 4 (1)
- **Electro-Optics with Gigahertz Phonons in Silicon Photonics**
Van Laer, R., Patel, R. N., Witmer, J. D., McKenna, T. P., Safavi-Naeini, A. H., IEEE
IEEE.2019
- **High-quality Lithium Niobate Optomechanical Crystal**
Jiang, W., Patel, R. N., Mayor, F. M., McKenna, T. P., Arrangoiz-Arriola, P., Sarabalis, C. J., Van Laer, R., Safavi-Naeini, A. H., IEEE
IEEE.2019
- **Quantum Acoustics with Lithium Niobate Nanocavities**
Arrangoiz-Arriola, P., Wollack, E., Pechal, M., Jiang, W., Wang, Z., McKenna, T. P., Safavi-Naeini, A. H., IEEE
IEEE.2019
- **Frequency Tunable Single-Photon Emission From a Single Atomic Defect in a Solid**
Sun, S., Zhang, J., Fischer, K. A., Burek, M. J., Dory, C., Lagoudakis, K. G., Tzeng, Y., Radulaski, M., Kelaita, Y., Safavi-Naeini, A., Shen, Z., Melosh, N. A., Chu, et al
IEEE.2019
- **Microwave Quantum Acoustic Processor**
Arrangoiz-Arriola, P., Wollack, E., Pechal, M., Jiang, W., Wang, Z., McKenna, T. P., Witmer, J., Van Laer, R., Cleland, A., Lee, N., Sarabalis, C. J., Stas, P., Safavi-Naeini, et al
IEEE.2019: 255–58
- **Painting Nonclassical States of Spin or Motion with Shaped Single Photons** *PHYSICAL REVIEW LETTERS*
Davis, E. J., Wang, Z., Safavi-Naeini, A. H., Schleier-Smith, M. H.
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- **Cavity-Enhanced Raman Emission from a Single Color Center in a Solid.** *Physical review letters*
Sun, S., Zhang, J. L., Fischer, K. A., Burek, M. J., Dory, C., Lagoudakis, K. G., Tzeng, Y., Radulaski, M., Kelaita, Y., Safavi-Naeini, A., Shen, Z., Melosh, N. A., Chu, et al
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- **Optomechanical antennas for on-chip beam-steering** *OPTICS EXPRESS*
Sarabalis, C. J., Van Laer, R., Safavi-Naeini, A. H.
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- **Single-Mode Phononic Wire** *PHYSICAL REVIEW LETTERS*
Patel, R. N., Wang, Z., Jiang, W., Sarabalis, C. J., Hill, J. T., Safavi-Naeini, A. H.
2018; 121 (4)
- **Coupling a Superconducting Quantum Circuit to a Phononic Crystal Defect Cavity** *PHYSICAL REVIEW X*
Arrangoiz-Arriola, P., Wollack, E., Pechal, M., Witmer, J. D., Hill, J. T., Safavi-Naeini, A. H.
2018; 8 (3)
- **Single-Mode Phononic Wire.** *Physical review letters*
Patel, R. N., Wang, Z. n., Jiang, W. n., Sarabalis, C. J., Hill, J. T., Safavi-Naeini, A. H.
2018; 121 (4): 040501
- **Painting Nonclassical States of Spin or Motion with Shaped Single Photons.** *Physical review letters*
Davis, E. J., Wang, Z. n., Safavi-Naeini, A. H., Schleier-Smith, M. H.
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- **Enhancing a slow and weak optomechanical nonlinearity with delayed quantum feedback** *NATURE COMMUNICATIONS*
Wang, Z., Safavi-Naeini, A. H.
2017; 8: 15886
- **High-Q photonic resonators and electro-optic coupling using silicon-on-lithium-niobate** *SCIENTIFIC REPORTS*
Witmer, J. D., Valery, J. A., Arrangoiz-Arriola, P., Sarabalis, C. J., Hill, J. T., Safavi-Naeini, A. H.
2017; 7
- **Thermal Brillouin noise observed in silicon optomechanical waveguide** *JOURNAL OF OPTICS*
Van Laer, R., Sarabalis, C. J., Baets, R., Van Thourhout, D., Safavi-Naeini, A. H.
2017; 19 (4)
- **Enabling Strong Coupling in Nanoscale Silicon Optomechanical Waveguides**
Van Laer, R., Safavi-Naeini, A., IEEE
IEEE.2017
- **Engineering interactions between superconducting qubits and phononic nanostructures** *PHYSICAL REVIEW A*
Arrangoiz-Arriola, P., Safavi-Naeini, A. H.
2016; 94 (6)
- **Design of nanobeam photonic crystal resonators for a silicon-on-lithium-niobate platform** *OPTICS EXPRESS*
Witmer, J. D., Hill, J. T., Safavi-Naeini, A. H.
2016; 24 (6): 5876-5885
- **Nonlinear Radiation Pressure Dynamics in an Optomechanical Crystal** *PHYSICAL REVIEW LETTERS*
Krause, A. G., Hill, J. T., Ludwig, M., Safavi-Naeini, A. H., Chan, J., Marquardt, F., Painter, O.
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Cohen, J. D., Meenehan, S. M., MacCabe, G. S., Groeblacher, S., Safavi-Naeini, A. H., Marsili, F., Shaw, M. D., Painter, O.
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- **Strong opto-electro-mechanical coupling in a silicon photonic crystal cavity** *OPTICS EXPRESS*
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- **Silicon optomechanical crystal resonator at millikelvin temperatures** *PHYSICAL REVIEW A*
Meenehan, S. M., Cohen, J. D., Groeblacher, S., Hill, J. T., Safavi-Naeini, A. H., Aspelmeyer, M., Painter, O.
2014; 90 (1)

- **Two-Dimensional Phononic-Photonic Band Gap Optomechanical Crystal Cavity** *PHYSICAL REVIEW LETTERS*
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- **Highly efficient coupling from an optical fiber to a nanoscale silicon optomechanical cavity** *APPLIED PHYSICS LETTERS*
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Safavi-Naeini, A. H., Groeblacher, S., Hill, J. T., Chan, J., Aspelmeyer, M., Painter, O.
2013; 500 (7461): 185-189
- **Laser noise in cavity-optomechanical cooling and thermometry** *NEW JOURNAL OF PHYSICS*
Safavi-Naeini, A. H., Chan, J., Hill, J. T., Groeblacher, S., Miao, H., Chen, Y., Aspelmeyer, M., Painter, O.
2013; 15
- **Si₃N₄ nanobeam optomechanical crystals** *2013 CONFERENCE ON LASERS AND ELECTRO-OPTICS (CLEO)*
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2013
- **Coherent optical wavelength conversion via cavity optomechanics** *NATURE COMMUNICATIONS*
Hill, J. T., Safavi-Naeini, A. H., Chan, J., Painter, O.
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- **Slot-mode-coupled optomechanical crystals** *OPTICS EXPRESS*
Davanco, M., Chan, J., Safavi-Naeini, A. H., Painter, O., Srinivasan, K.
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- **Quantum back-action in measurements of zero-point mechanical oscillations** *PHYSICAL REVIEW A*
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- **Enhanced Quantum Nonlinearities in a Two-Mode Optomechanical System** *PHYSICAL REVIEW LETTERS*
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- **Observation of Quantum Motion of a Nanomechanical Resonator** *PHYSICAL REVIEW LETTERS*
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2012; 108 (3)
- **A chip-scale integrated cavity-electro-optomechanics platform** *OPTICS EXPRESS*
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- **Laser cooling of a nanomechanical oscillator into its quantum ground state.** *Nature*
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- **Laser cooling of a nanomechanical oscillator into its quantum ground state** *NATURE*
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- **Electromagnetically induced transparency and slow light with optomechanics** *NATURE*
Safavi-Naeini, A. H., Alegre, T. P., Chan, J., Eichenfield, M., Winger, M., Lin, Q., Hill, J. T., Chang, D. E., Painter, O.
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- **Quasi-two-dimensional optomechanical crystals with a complete phononic bandgap** *OPTICS EXPRESS*
Alegre, T. P., Safavi-Naeini, A., Winger, M., Painter, O.
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- **Slowing and stopping light using an optomechanical crystal array** *NEW JOURNAL OF PHYSICS*
Chang, D. E., Safavi-Naeini, A. H., Hafezi, M., Painter, O.
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- **Proposal for an optomechanical traveling wave phonon-photon translator** *NEW JOURNAL OF PHYSICS*
Safavi-Naeini, A. H., Painter, O.
2011; 13
- **Tunable 2D Photonic Crystal Cavities for Cavity Electro-Optomechanics** *2011 CONFERENCE ON LASERS AND ELECTRO-OPTICS (CLEO)*
Winger, M., Alegre, T. P., Safavi-Naeini, A. H., Painter, O.
2011
- **Full Phononic Bandgap in 2D-Optomechanical Crystals** *2011 CONFERENCE ON LASERS AND ELECTRO-OPTICS (CLEO)*
Alegre, T. P., Safavi-Naeini, A. H., Winger, M., Painter, O.
2011
- **Optomechanics in an ultrahigh-Q two-dimensional photonic crystal cavity** *APPLIED PHYSICS LETTERS*
Safavi-Naeini, A. H., Alegre, T. P., Winger, M., Painter, O.
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- **Design of optomechanical cavities and waveguides on a simultaneous bandgap phononic-photonic crystal slab** *OPTICS EXPRESS*
Safavi-Naeini, A. H., Painter, O.
2010; 18 (14): 14926-14943
- **Optical Probing and Actuation of Microwave Frequency Phononic Crystal Resonators without Clamping Losses** *2010 CONFERENCE ON LASERS AND ELECTRO-OPTICS (CLEO) AND QUANTUM ELECTRONICS AND LASER SCIENCE CONFERENCE (QELS)*
Eichenfield, M., Chan, J., Safavi-Naeini, A. H., Painter, O. J.
2010
- **Slowing and stopping light with an optomechanical crystal array** *THIRD INTERNATIONAL WORKSHOP ON THEORETICAL AND COMPUTATIONAL NANOPHOTONICS - TACONA-PHOTONICS 2010*
Chang, D. E., Safavi-Naeini, A. H., Hafezi, M., Painter, O.
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- **Efficient On-Chip Phonon-Photon Translation** *2010 CONFERENCE ON LASERS AND ELECTRO-OPTICS (CLEO) AND QUANTUM ELECTRONICS AND LASER SCIENCE CONFERENCE (QELS)*
Safavi-Naeini, A. H., Alegre, T. P., Painter, O. J.
2010
- **Surface-plasmon mode hybridization in subwavelength microdisk lasers** *APPLIED PHYSICS LETTERS*
Perahia, R., Alegre, T. P., Safavi-Naeini, A. H., Painter, O.
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- **Modeling dispersive coupling and losses of localized optical and mechanical modes in optomechanical crystals** *OPTICS EXPRESS*
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2009; 17 (22): 20078-20098
- **Surface Plasmon Waveguide Mode Hybridization and Lasing in Sub-wavelength Microdisks at 1.3 μm** *2009 CONFERENCE ON LASERS AND ELECTRO-OPTICS AND QUANTUM ELECTRONICS AND LASER SCIENCE CONFERENCE (CLEO/QELS 2009), VOLS 1-5*
Perahia, R., Alegre, T. P., Safavi-Naeini, A., Painter, O.
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