

Young-Sik Ra

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Academic curriculum

- 2018–present **Assistant Professor**,
Korea Advanced Institute of Science and Technology (KAIST), Daejeon, Korea.
- 2015–2018 **Postdoctoral researcher**,
Laboratoire Kastler Brossel, Université Pierre et Marie Curie, Paris, France.
- 2014–2015 **Postdoctoral researcher**,
Pohang University of Science and Technology (POSTECH), Pohang, Korea.
- 2008–2014 **PhD in Physics**,
Pohang University of Science and Technology (POSTECH), Pohang, Korea.
- 2004–2008 **BS in Physics**,
Pohang University of Science and Technology (POSTECH), Pohang, Korea.

PhD thesis

- title *Decoherence in multi-photon interference and generation of multi-photon entangled states*
- supervisor Professor Yoon-Ho Kim

Research expertise: experimental quantum optics and quantum information

- **Major research achievement**
 - Observation of novel multiphoton quantum interference (*PNAS 2013, Nat. Comm. 2013*)
 - The first experiment on generating multimode non-Gaussian quantum states (*PRX 2017, Nat. Phys. 2020*)
 - The first experiment on generating three-dimensional cluster entanglement (*arXiv 2023*)
 - A new protocol of certifying quantum entanglement (*Sci. Adv. 2023*)
- **Research interests**
 - Realization of large-scale photonic quantum entanglement
 - Fundamental studies on continuous-variable quantum information
 - Measurement-based quantum computing and quantum error correction
 - Photonic quantum simulator
 - Ultrafast quantum metrology

Awards and Fellowships

1. Marie Skłodowska-Curie Individual Fellowships, European Commission, 2016.
2. 젊은 광과학자상, Optical Society of Korea, 2015.

Selected publications

1. Hyeon-Jin Kim, Ji-Hyeok Jung, Kyung-Jun Lee, and **Young-Sik Ra**, “Recovering quantum entanglement after its certification”, *Sci. Adv.* 9, eadi5261 (2023).
2. Chan Roh, Young-Do Yoon, Jiyong Park, and **Young-Sik Ra**, “Continuous-variable nonclassicality certification under coarse-grained measurement”, *Phys. Rev. Research* 5, 043057 (2023).
3. Chan Roh, Geunhee Gwak, and **Young-Sik Ra**, “Robust squeezed light against mode mismatch using a self imaging optical parametric oscillator”, *Sci. Rep.* 11, 18991 (2021).
4. **Young-Sik Ra**, Adrien Dufour, Mattia Walschaers, Clément Jacquard, Thibault Michel, Claude Fabre, and Nicolas Treps, “Non-Gaussian quantum states of a multimode light field”, *Nature Physics* 16, 144-147 (2020).
5. **Young-Sik Ra**, Clément Jacquard, Adrien Dufour, Claude Fabre, Nicolas Treps, “Tomography of a mode-tunable coherent single-photon subtractor”, *Phys. Rev. X* 7, 031012 (2017).

Full publications

Preprint

1. Chan Roh, Geunhee Gwak, Young-Do Yoon, and **Young-Sik Ra**, “Generation of three-dimensional cluster entangled state”, *arXiv:2309.05437* (2023).

Published

1. Hyeon-Jin Kim, Ji-Hyeok Jung, Kyung-Jun Lee, and **Young-Sik Ra**, “Recovering quantum entanglement after its certification”, *Sci. Adv.* 9, eadi5261 (2023).
2. Chan Roh, Young-Do Yoon, Jiyong Park, and **Young-Sik Ra**, “Continuous-variable nonclassicality certification under coarse-grained measurement”, *Phys. Rev. Research* 5, 043057 (2023).
3. Olena Kovalenko, **Young-Sik Ra**, Yin Cai, Vladyslav C. Usenko, Claude Fabre, Nicolas Treps, and Radim Filip, “Frequency multiplexed entanglement for continuous-variable quantum key distribution”, *Photon. Res.* 9, 2351-2359 (2021).
4. Chan Roh, Geunhee Gwak, and **Young-Sik Ra**, “Robust squeezed light against mode mismatch using a self imaging optical parametric oscillator”, *Sci. Rep.* 11, 18991 (2021).
5. **Young-Sik Ra**, Adrien Dufour, Mattia Walschaers, Clément Jacquard, Thibault Michel, Claude Fabre, and Nicolas Treps, “Non-Gaussian quantum states of a multimode light field”, *Nature Physics* 16, 144-147 (2020).
6. Mattia Walschaers, **Young-Sik Ra**, and Nicolas Treps, “Mode-dependent-loss model for multimode photon-subtracted states”, *Phys. Rev. A* 100, 023828 (2019).
7. **Young-Sik Ra**, Clément Jacquard, Adrien Dufour, Claude Fabre, Nicolas Treps, “Tomography of a mode-tunable coherent single-photon subtractor”, *Phys. Rev. X* 7, 031012 (2017).
8. **Young-Sik Ra**, Malte C. Tichy, Hyang-Tag Lim, Clemens Gneiting, Klaus Mølmer, Andreas Buchleitner, and Yoon-Ho Kim, “Reversed interplay of quantum interference and which-way information in multiphoton entangled states”, *Phys. Rev. A* 96, 023845 (2017).
9. **Young-Sik Ra**, Hyang-Tag Lim, and Yoon-Ho Kim, “Remote preparation of three-photon entangled states via single-photon measurement”, *Phys. Rev. A* 94, 042329 (2016).
10. **Young-Sik Ra**, Hyang-Tag Lim, Joo-Eon Oh, and Yoon-Ho Kim, “Phase and amplitude

- controlled heralding of NOON states”, *Opt. Express* 23, 30807 (2015).
11. Malte C. Tichy, **Young-Sik Ra**, Hyang-Tag Lim, Clemens Gneiting, Yoon-Ho Kim, and Klaus Mølmer, “Double-Fock superposition interferometry for differential diagnosis of decoherence”, *New J. of Phys.* 17, 023008 (2015).
 12. Osung Kwon, **Young-Sik Ra**, Hyang-Tag Lim, Yong-Su Kim, and Yoon-Ho Kim, “Entangling two separate photonic ququarts using linear optical elements”, *Phys. Rev. A* 90, 063830 (2014).
 13. **Young-Sik Ra**, Malte C. Tichy, Hyang-Tag Lim, Osung Kwon, Florian Mintert, Andreas Buchleitner, and Yoon-Ho Kim, “Comment on ‘Non-monotonic projection probabilities as a function of distinguishability’”, *New J. of Phys.* 16, 118003 (2014).
 14. Hyang-Tag Lim, **Young-Sik Ra**, Kang-Hee Hong, Seung-Woo Lee, and Yoon-Ho Kim, “Fundamental bounds in measurements for estimating quantum states”, *Phys. Rev. Lett.* 113, 020504 (2014).
 15. **Young-Sik Ra**, Malte C. Tichy, Hyang-Tag Lim, Osung Kwon, Florian Mintert, Andreas Buchleitner, and Yoon-Ho Kim, “Observation of detection-dependent multi-photon coherence times”, *Nat. Commun.* 4, 2451 (2013).
 16. **Young-Sik Ra**, Malte C. Tichy, Hyang-Tag Lim, Osung Kwon, Florian Mintert, Andreas Buchleitner, and Yoon-Ho Kim, “Nonmonotonic quantum-to-classical transition in multiparticle interference”, *Proc. Natl. Acad. Sci. USA* 110, 1227-1231 (2013).
 17. Osung Kwon, Kwang-Kyoon Park, **Young-Sik Ra**, Yong-Su Kim, and Yoon-Ho Kim, “Time-bin entangled photon pairs from spontaneous parametric down-conversion pumped by a cw multi-mode diode laser”, *Opt. Express* 21, 25492-25500 (2013).
 18. Hyang-Tag Lim, Yong-Su Kim, **Young-Sik Ra**, Joonwoo Bae, and Yoon-Ho Kim, “Experimental realization of an approximate transpose operation for qutrit systems using a structural physical approximation”, *Phys. Rev. A* 86, 042334 (2012).
 19. Jong-Chan Lee, Yong-Su Kim, **Young-Sik Ra**, Hyang-Tag Lim, and Yoon-Ho Kim, “Scheme for directly observing the noncommutativity of the position and the momentum operators with interference”, *Phys. Rev. A* 86, 042112 (2012).
 20. Gunnar Björk, Jonas Söderholm, Yong-Su Kim, **Young-Sik Ra**, Hyang-Tag Lim, Christian Kothe, Yoon-Ho Kim, Luis L. Sánchez-Soto, and Andrei B. Klimov, “Central-moment description of polarization for quantum states of light”, *Phys. Rev. A* 85, 053835 (2012).
 21. Hyang-Tag Lim, Yong-Su Kim, **Young-Sik Ra**, Joonwoo Bae and Yoon-Ho Kim, “Experimental Realization of an Approximate Partial Transpose for Photonic Two-Qubit Systems”, *Phys. Rev. Lett.* 107, 160401 (2011).
 22. Malte C. Tichy, Hyang-Tag Lim, **Young-Sik Ra**, Florian Mintert, Yoon-Ho Kim, and Andreas Buchleitner, “Four-photon indistinguishability transition”, *Phys. Rev. A* 83, 062111 (2011).
 23. Hyang-Tag Lim, **Young-Sik Ra**, Yong-Su Kim, Joonwoo Bae and Yoon-Ho Kim, “Experimental implementation of the universal transpose operation using the structural physical approximation”, *Phys. Rev. A* 83, 020301(R) (2011).
 24. Yong-Su Kim, Hyang-Tag Lim, **Young-Sik Ra** and Yoon-Ho Kim, “Experimental verification of the commutation relation for Pauli spin operators using single-photon quantum interference”, *Phys. Lett. A* 374, 4393 (2010).
 25. Osung Kwon, **Young-Sik Ra** and Yoon-Ho Kim, “Observing photonic de Broglie waves without the maximally-path-entangled $|N, 0\rangle + |0, N\rangle$ state”, *Phys. Rev. A* 81, 063801 (2010).

26. Young-Wook Cho, Hyang-Tag Lim, **Young-Sik Ra** and Yoon-Ho Kim, “Weak Value Measurement with an Incoherent Measuring Device”, *New J. of Phys.* 12, 023036 (2010).
27. Osung Kwon, **Young-Sik Ra** and Yoon-Ho Kim, “Coherence properties of spontaneous parametric down-conversion pumped by a multi-mode cw diode laser”, *Opt. Express* 17, 13059 (2009).
28. Yong-Su Kim, Young-Wook Cho, **Young-Sik Ra**, and Yoon-Ho Kim, “Reversing the weak quantum measurement for a photonic qubit”, *Opt. Express* 17, 11978 (2009).