Curriculum Vitae

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Education

Dec 2004 – Dec 2010 **Doctorate, Physics,** Georgia Institute of Technology *USA*

Aug 2003 – Dec 2004 **MS, Physics,** Georgia Institute of Technology *USA*

Jun 1996 – Jun 2000 **BS, Physics,** National Taiwan University *Taiwan*

Award and Honor

- A paper of [**Phys. Rev. A** 95, 043840 (2017)] selected as Kaleidoscope in the issue of April 2017
- Reviewer of Scientific Reports, invited by Prof. Sergiy Lysenko of Univ. of Puerto Rico in 2016
- Reviewer of the European Physical Journal-Plus, invited by Editor Kurt Busch in 2015
- 2014 NCTS Best postdoc paper award, Taiwan (bonus: 10000 TWD)
- 2012 NSC (now MOST) Postdoc academic publication award, Taiwan (bonus: 100000 TWD)
- 1996 ROC national contest for Asian Pacific Mathematics Olympiad (40 contestants nationally)

Grant

- MOST Grant of “multiphoton subradiant state engineering” for three years (2017-2020)

Research Areas

(I) Quantum optics:

- Cooperative spontaneous emission (super- and subradiance); Superradiant laser;
- Electromagnetically induced transparency.

(II) Quantum information processing and Quantum communication:

- Cascade-emission based multiphoton generation;
- Entropy of entanglement manipulation and spectral shaping.

(III) Bose-Einstein condensate:

- Spin-1 and spin-2 Bose Einstein condensates; Spin-incoherent Luttinger liquid (LL).

(IV) Strongly interacting ultracold atoms:

- Quantum optical probe of many-body systems; Single-particle Green’s function extraction.

Academic Employment

- Aug 2017 – Jul 2020 **Assistant research scholar,** MOST and IOP, Academia Sinica, *Taiwan*

Multiphoton subradiant state engineering:

- Investigated phase-imprinted multiphoton subradiant state preparation in 3D atomic arrays.
- Studied spectrally entangled multiphoton source in cascaded cold atomic ensembles.

- Aug 2014 – Jul 2017 **Postdoctoral researcher,** IOP, Academia Sinica *Taipei, Taiwan*

Spinor BEC: Collaborated with Dr. Sungkit Yip

- Investigated the exact many-body ground states in spin-2 fragmented Bose-Einstein condensate.
- Investigated the momentum (p) distributions of a spin-1 Bose gas in TG limit in the regime of spin-incoherent Luttinger liquid, and calculated the asymptotic 1/p^4 in large p limit.
- Investigating SU(κ) fermions in Tonks-Girardeau (TG) limit.

Cooperative spontaneous emissions: Collaborated with Dr. M.-S. Chang and Dr. Y.-C. Chen

- Studied spectral shaping and entropy of entanglement in the biphoton state from the cascade atomic ensemble via four-wave mixing.
- Studied superradiance, subradiance, and associated cooperative Lamb shift in atomic ensembles. Proposed single-photon subradiant states preparation in one-dimensional optical lattices by the magnetic field gradient with a prediction of 100 ms lifetime for quantum storage of light.
- Investigated the effects of the long-ranged dipole-dipole interaction on a superradiant laser.
- Investigating multiphoton subradiant states by phase imprinting in an array of two-level atoms.
- Investigating cooperative effect of spontaneous emission in laser-driven two-level atoms, electromagnetically induced transparency, and optical pumping.

- Aug 2013 – Jul 2014 **Postdoctoral researcher** TU of Kaiserslautern, *Germany*

DMRG simulation: Collaborated with Prof. Michael Fleischhauer

- Investigated the phase diagram and edge state of the superlattice Bose-Hubbard model with finite range interactions via Density Matrix Renormalization Group (DMRG) simulations.
- Investigated phase diagram of Luttinger liquid in a long-range Rydberg interaction and a periodic potential. Studying the incommensurate to commensurate phase transition for such system.

- Mar 2011 – Jul 2013 **Postdoctoral researcher,** National Tsing Hua Univ., *Taiwan*

EIT in the ultracold quantum gases: Collaborated with Prof. Daw-Wei Wang

- Investigated the optical response of electromagnetically induced transparency (EIT) in strongly correlated atomic systems, for example, the Luttinger liquid and Mott insulator.
- Studied the extraction of Green's function from the EIT spectroscopy in strongly correlated atomic systems, which thus provided an alternative method for probing such quantum systems.
- Analyzed EIT spectroscopy in quantum degenerate gases with low-lying Rydberg excited states.
- Investigated the coupling strengths in Rydberg-dressed fermions of S and D orbital excitations.
- Organized "Workshop on the frontier studies of EIT and slow light" on Sep 24, 2012 in NCTS.

- Aug 2006 – Dec 2010 **Research Assistant,** Georgia Institute of Technology, *Atlanta, USA*

Cold atomic ensemble: Advised by Prof. T. A. B. Kennedy

- Computed and analyzed the superradiance and conversion efficiency in a cascade and diamond type atomic ensemble, and implemented stochastic differential equations with quantum noises (quantum fluctuations) in positive-P representation method.
- Investigated the entropy of entanglement in frequency space of the biphoton states from the cascade atomic system via four-wave mixing, and DLCZ protocols using such biphoton states.

- Aug 2005 – Aug 2006 **Research Assistant,** Georgia Institute of Technology, *Atlanta, USA*

Bose-Einstein condensate: Advised by Prof. Li You

- Simulated the vortices in a spin-1 Bose-Einstein condensate and their dynamics with Gross–Pitaevskii equation by Visual C++. Used high performance computing to expedite the simulation.

- Aug 2003 – Aug 2005 **Teaching Assistant,** Georgia Institute of Technology, *Atlanta, USA*

- Assisted and demonstrated undergraduate Physics laboratory.
- Grading of mathematical and computational physics courses. Weekly Q&A homework sessions.

- Jul 2002 – Jul 2003 **Research Assistant,** IAMS, Academia Sinica, *Taipei, Taiwan*

Surface plasmon: Advised by Dr. Juen-Kai Wang

- Simulated near-field optical spectroscopy by finite difference time domain method.
- Investigated the enhanced emission spectroscopy of the surface plasmon on a metal cluster.

Refereed Publication

1. **H. H. Jen**, M.-S. Chang, and Y.-C. Chen, "M*ultiphoton subradiant states in a ring-shaped atomic array*", in preparation. **(I-7)**
2. **H. H. Jen**, "*Phase-imprinted multiphoton subradiant states*", accepted in PRA. **(I-6)**
3. **H. H. Jen**, and S.-K.Yip, "*Spin-incoherent Luttinger liquid of one-dimensional spin-1 Tonks-Girardeau Bose gas: Spin-dependent properties*", **Phys. Rev. A** 95, 053631 (2017)**. (III-4)**
4. **H. H. Jen**, "*Cascaded cold atomic ensembles in a diamond configuration as a spectrally entangled multiphoton source*", **Phys. Rev. A** 95, 043840 (2017). **(II-6) **[selected as Kaleidoscope in the issue of April 2017, see https://journals.aps.org/pra/kaleidoscope].**
5. **H. H. Jen**, "*Superradiant laser: Effect of long-range dipole-dipole interaction*", **Phys. Rev. A** 94, 053813 (2016). **(I-5)**
6. **H. H. Jen**, and S.-K.Yip, "*Spin-incoherent one-dimensional spin-1 Bose Luttinger liquid*", **Phys. Rev. A** 94, 033601 (2016). **(III-3)**
7. **H. H. Jen**, "*Cooperative single-photon subradiant states in a three-dimensional atomic array*", **Annals of Physics** (N.Y.) 374, 27 (2016). **(I-4)**
8. **H. H. Jen**, M.-S. Chang, and Y.-C. Chen, "*Cooperative single-photon subradiant states*", **Phys. Rev. A** 94, 013803 (2016). **(I-3)**
9. **H. H. Jen**, "*Entropy of entanglement in continuous frequency space of the biphoton state from multiplexed cold atomic ensembles*", **J. Phys. B: At. Mol. Opt. Phys.** 49, 035503 (2016). **(II-5)**
10. **H. H. Jen**, Y.-C. Chen, "*Spectral shaping in cascade emissions from multiplexed cold atomic ensembles*", **Phys. Rev. A** 93, 013811 (2016). **(II-4)**
11. **H. H. Jen,** "*Superradiant cascade emission in an atomic ensemble via four-wave-mixing*", **Annals of Physics** (N.Y.) 360, 556 (2015). **(I-2)**
12. **H. H. Jen** and S.-K. Yip, "*Fragmented many-body states of a spin-2 Bose gas*", **Phys. Rev. A** 91, 063603 (2015). **(III-2)**
13. **H. H. Jen** and Daw-Wei Wang, "*Extracting dynamical Green's function of ultracold quantum gases via electromagnetically induced transparency*," **J. Opt. Soc. Am. B** Vol. 31, Iss. 12, pp. 2931-2937 (2014). arXiv:1403.2744. **(IV-4)**
14. Bo Xiong, **H. H. Jen**, and Daw-Wei Wang, "*Topological superfluidity by blockade effects in a Rydberg-dressed Fermi gas*", **Phys. Rev. A** 90, 013631 (2014). **(IV-3)**

15. **H. H. Jen** and Daw-Wei Wang, "*Theory of Electromagnetically induced transparency in strongly correlated quantum gases*", **Phys. Rev. A** 87, 061802 (**R**) (2013). **(IV-2) **[2014 NCTS best postdoc paper award, Taiwan].**
16. **H. H. Jen**, Bo Xiong, Ite A. Yu, and Daw-Wei Wang, "*Electromagnetically induced transparency and slow light in interacting quantum degenerate atomic gas,*", **J. Opt. Soc. Am. B** Vol. 30, Iss. 11, pp. 2855-2863 (2013). **(IV-1)**
17. **H. H. Jen**, "*Spectral analysis for cascade-emission-based quantum communication in atomic ensembles*", **J. Phys. B: At. Mol. Opt. Phys.** 45, 165504 (2012). **(II-3)**
18. **H. H. Jen**, "*Positive-P phase space method simulation of superradiant emission from a cascade atomic ensemble*", **Phys. Rev. A** 85, 013835 (2012). **(I-1) **[2012 NSC (now MOST) postdoctoral research paper award, Taiwan].**
19. A. G. Radnaev, Y. O. Dudin, R. Zhao, **H. H. Jen**, S. D. Jenkins, A. Kuzmich, and T. A. B. Kennedy, "*A quantum memory with telecom wavelength conversion*", **Nature Physics** 6, 894 (2010). **(II-2)**
20. **H. H. Jen** and T. A. B. Kennedy, "*Efficiency of light-frequency conversion in an atomic ensemble*", **Phys. Rev. A** 82, 023815 (2010). **(II-1)**
21. P. Zhang, **H. H. Jen**, C. P. Sun, and L. You, "*Angular momentum of a magnetically trapped atomic condensate*", **Phys. Rev. Lett**. 98, 030403 (2007). **(III-1)**

Note: The parentheses in the end of listed papers denote the research areas and numbered sequences.

Other Publication

1. A. G. Radnaev, Y. O. Dudin, J. Z. Blumoff, R. Zhao, S. D. Jenkins, **H. H. Jen**, A. Kuzmich, and T. A. Brian Kennedy, "*Cold atom quantum memories and the telecom interface*," Photonics society summer topical meeting series, 2011 IEEE, 27-28, 18-20 July 2011.
2. **Hsiang-Hua Jen**, "*Theory of light-matter interactions in cascade and diamond type atomic ensembles*", PhD thesis, **arXiv:1106.2082**.
3. Jenkins, S.D., Collins, O.A., Lan, S.-Y., Chaneliere, T., Matsukevich, D.N., Campbell, C.J., Zhao, R., **Jen, H.-H.**, Kuzmich, A., Kennedy, T.A.B., "*Toward memory-insensitive quantum repeaters with dual species matter qubits*", *CLEO/Europe and IQEC 2007 Conference Digest*, (Optical Society of America, 2007), paper IF 1_4.

Presentation

1. "*Effect of resonant dipole-dipole interaction in EIT and Slow light Experiments,*" Y.-C. Chen and H. H. Jen, NCTS seminar, Hsinchu, 30th June, 2017.
2. "*Spin-incoherent Luttinger liquid of one-dimensional spin-1 Bose gas***," H. H. Jen** and S.-K. Yip (oral), and "*Cooperative spontaneous emissions from resonant long-range dipole-dipole interactions: Super- and subradiance, and superradiant laser,*" **H. H. Jen,** M.-S. Chang, and Y.-C. Chen (poster) in APS DAMOP 2017 in Sacramento, California, USA.
3. **Invited talk for faculty interview in NCKU, Tainan, 2nd March, 2017.
4. **Invited talk for faculty interview in CCU, Chiayi, 22nd February, 2017.
5. "*Coherent scattering of near-resonant light by optically dense cold atomic cloud*", S.-X. Lin, **H. H. Jen**, and Y.-C. Chen, poster in 2017 Annual Meeting of the Physical Society of ROC.
6. "*Cooperative single-photon subradiant states"*, poster in ICAP 2016, Seoul, Korea.
7. Invited talk for faculty interview in IAMS, Taipei, 22th July, 2016, on "*Cooperativity in quantum many-body systems*".
8. "*Exact many-body ground states of a spin-1 Bose gas in Tonks-Girardeau limit"*, and "*Entropy of entanglement in continuous frequency space of the biphoton state from multiplexed cold atomic ensembles*", posters in APS Damop 2016, Providence, Rhode Island, USA.
9. "*Cooperative single-photon subradiant states*", colloquium in NKNU, 31th March, 2016.
10. **Invited talk for faculty interview in TKU, Taipei, 22th March, 2016.
11. **Invited talk for faculty interview in NYSU, Kaohsiung, 16th March, 2016.
12. "*Cooperative single-photon subradiant states*", ECP meeting in NCTS, Hsinchu, 24th Feb., 2016.
13. "*Fragmented many-body states of a spin-2 Bose gas*", Annual Meeting 2015: Condensed Matter Physics, in NCTS, Hsinchu, 17th December.
14. "*Superradiant cascade emissions and spectral shaping from multiplexed cold atomic ensembles,*" workshop on atom-photon interactions with Rydberg atom, superradiance, and EIT. NCTS in NTHU, Hsinchu, 5th and 6th November 2015.
15. "*Superradiant cascade emissions in an atomic ensemble via four-wave mixing,*" CQSE seminar, NTU, 18th September 2015.
16. "*Fragmented many-body states of a spin-2 Bose gas*", poster session in APS Damop 2015, Columbus, Ohio, USA.
17. "*Collective Lamb shift of superradiant cascade emission in an atomic ensemble,*" AMO seminar, IAMS Academia Sinica, Taiwan, 9th March 2015.
18. "*Bulk phases and topological edge state in the extended 1D superlattice Bose-Hubbard model,*" **H. H. Jen**, in conference "Topological aspects of quantum matter", Hsinchu, 11th Dec. 2014.
19. NCTS best postdoc paper award presentation, Taiwan, 26th September 2014.
20. IAMS seminar, Academia Sinica, Taiwan, 16th April 2014.
21. Seminar, Tamkang University, Taiwan, 15th April 2014.
22. Seminar, National Dong Hwa University, Taiwan, 14th April 2014.

23. "*Bulk phases and topological edge state in the extended 1D superlattice Bose-Hubbard model*," **H. H. Jen** and M. Höning, F. Grusdt, M. Fleischhauer, DPG Berlin 2014, Germany.
24. **Invited talk for faculty interview, National Central University, Taiwan, February 19th 2014.
25. Seminar, Chung Cheng University, Taiwan, 3rd January 2014.
26. Seminar, National Sun Yat-Sen University, Taiwan, 2nd January 2014.
27. "*Electromagnetically induced transparency in strongly correlated quantum gases*," **H. H. Jen** and Daw-Wei Wang, poster session in Damop 2013, Quebec, Canada.
28. AMO seminar, IAMS Academia Sinica, Taiwan, 22th October 2012.
29. "*Superradiant emission from a cascade atomic ensemble by positive-P phase space method simulation*," **H. H. Jen** (oral), and "*Long distance quantum communication using cascade emission in atomic ensembles*," **H. H. Jen** (poster) in APS DAMOP 2012, Ca., USA.
30. "*Long distance quantum communication using cascade emission*," **Hsiang-Hua Jen**, 2012 Annual Meeting of the Physical Society of ROC.
31. Condensed matter seminar, National Taiwan Normal University, Taiwan, 10th November 2011.
32. Seminar, National Taiwan University, Taiwan, 27th September 2011.
33. "*Quantum Interface between Light and Atoms - Quantum Network, Quantum Communication, Quantum Repeater*," **Hsiang-Hua Jen**, AMO summer school 2011, NCKU, Tainan, Taiwan.
34. QIS seminar, National Cheng Kung University, 2nd May 2011.
35. AMO seminar, National Tsing Hua University, Taiwan, 7th March 2011.
36. "*Efficiency of light-frequency conversion in an atomic ensemble*," **Hsiang-Hua Jen** and T. A. B. Kennedy, OCPA7 2011, Kaohsiung, Taiwan, ROC.
37. "*Superradiant cascade emission*," **H. H. Jen**, S. D. Jenkins and T. A. B. Kennedy, APS DAMOP 2009, Virginia, USA.
38. "*Superradiant emission from a cold atomic ensemble*," **H. H. Jen**, S. D. Jenkins, A. Kuzmich, and T. A. B. Kennedy, APS DAMOP 2007, Calgary, Canada.
39. "*The angular momentum of a magnetically trapped atomic condensate*," **H. H. Jen**, P. Zhang, and L. You, APS DAMOP 2006, Tennessee, USA.

Course and Activity

Dec 2004 – Dec 2010 **Georgia Institute of Technology** *Atlanta, GA, USA*
Doctorate, Physics, GPA 3.95/4.00

- Highlighted courses: Quantum field theory, Gravity, Bose-Einstein Condensate, Quantum optics.
- President of Taiwanese Student Association (TSA, 100+ members), Jan 2005 – May 2005. Managed and fund-raised TSA sports activity, and arranged Chinese New Year banquet.

Aug 2003 – Dec 2004 **Georgia Institute of Technology** *Atlanta, GA, USA*
MS, Physics, GPA 4.00/4.00

- Highlighted courses: Mathematical methods I and II.
- Toefl computer test 2002, listening/structure/reading: 21/24/30, essay rating 4.0.
- GRE computer test 2002, verbal/quantitative/analytical: 670/800/670.

Jun 1996 – Jun 2000 **National Taiwan University** *Taipei, Taiwan*
BS, Physics, major GPA 3.81/4.00, overall GPA 3.74/4.00

- Highlighted courses: Applied mathematics I, II, III and IV, Computer programming and practice, Numerical method, Economics, English and American essays, Western drama and dramatists.
- Highlighted projects: Numerical simulation of semiconductor laser by C program.
- Leader of activity department of badminton club (50+ members), Sep 1998 – Jun 1999. Responsible for regular meetings and annual club tours.

Technical Skill

- Matlab, Mathematica, and C program.
- Numerical simulation of stochastic differential equation (SDE).
- Density Matrix Renormalization Group (DMRG) simulation.
- Monte Carlo integration using parallel computations with MPI in Linux.

Reference Writer

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