

# CHEN SUN

+1 (540) · 449 · 3577 ◇ chensun@mail.tau.ac.il ◇ [github.com/chensun-phys](https://github.com/chensun-phys) ◇ <https://cosmicdiscord.net>

## POSTDOC EXPERIENCE

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<b>Tel Aviv University</b> <i>Postdoctoral Researcher</i>	2019 - Present <i>Tel Aviv, Israel</i>
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## VISITING EXPERIENCE

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<b>Brown University</b> <i>Long-term visitor (KITPC Travel Award)</i>	2018 - 2019 <i>Providence, USA</i>
<b>Boston University</b> <i>Short-term visitor (three months)</i>	2018 <i>Boston, USA</i>
<b>Dartmouth College</b> <i>Long-term visitor (KITPC Travel Award)</i>	2017 - 2018 <i>Hanover, USA</i>

## EDUCATION

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<b>Virginia Tech</b> <i>Ph.D. in Particle Physics, Advisor: Tatsu Takeuchi</i>	2013 - 2017 <i>Blacksburg, USA</i>
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## RESEARCH INTERESTS

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### Astrophysical constraints of axion and dark matter

- supernova remnant echo *v.s.* axion dark matter stimulated decay
- cosmic distance measurement *v.s.* axion-photon coupling
- galaxy velocity dispersion *v.s.* ultralight dark matter

### Effective field theory

- dark matter direct detection *v.s.* EFT of stellar cooling
- muon  $g-2$  *v.s.* axion EFT and completion

### Gravitational wave from BSM sources

- neutron star binary mergers *v.s.* long range force
- gravitational wave of boson stars *v.s.* axion potential

### Neutrino phenomenology

- solar neutrino *v.s.* monopole
- solar neutrino *v.s.* large non-standard interaction
- DUNE *v.s.* supernova neutrino

### BSM Theory

- Pati-Salam extension from noncommutative geometry

## AWARDS

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| · Israel Academy of Sciences and Humanities (IASH)<br>Foreign Postdoctoral Fellowship from Israel Academy of Science | 2019-2021 |
| · Travel Award from the Chinese Academy of Science (KITPC)   | 2017-2019 |
| · Clayton Williams Graduate Fellowship   | 2015-2016 |
| · Sigma Xi Outstanding Ph.D. Research Award  | 2015      |

*Authorship is in alphabetical order following HEP standard. Up-to-date list can be found [here](#)*

### Novel astrophysical probes of axion

19. N. Bar, K. Blum, and C. Sun, “Galactic rotation curves vs. ultralight dark matter II,” [arXiv:2111.03070](#) [hep-ph]
18. M. A. Buen-Abad, J. Fan, and CS, “Axion Echos from the Supernova Graveyard,” [arXiv:2110.13916](#) [hep-ph]
17. J.-F. Fortin, H.-K. Guo, S. P. Harris, D. Kim, K. Sinha, and CS, “Axions: From magnetars and neutron star mergers to beam dumps and BECs,” *Int. J. Mod. Phys. D* **30** no. 07, (2021) 2130002, [arXiv:2102.12503](#) [hep-ph]
16. M. A. Buen-Abad, J. Fan, and CS, “Constraints on Axions from Cosmic Distance Measurements,” [arXiv:2011.05993](#) [hep-ph]
15. H.-K. Guo, K. Sinha, CS, J. Swaim, and D. Vagie, “Two-Scalar Bose-Einstein Condensates: From Stars to Galaxies,” *JCAP* **10** (2021) 028, [arXiv:2010.15977](#) [astro-ph.CO]

### Gravitational wave probe of light dark sector

14. H.-K. Guo, K. Sinha, and CS, “Probing Boson Stars with Extreme Mass Ratio Inspirals,” *JCAP* **09** (2019) 032, [arXiv:1904.07871](#) [hep-ph]
13. D. Croon, J. Fan, and CS, “Boson Star from Repulsive Light Scalars and Gravitational Waves,” *JCAP* **04** (2019) 008, [arXiv:1810.01420](#) [hep-ph]
12. D. Croon, M. Gleiser, S. Mohapatra, and CS, “Gravitational Radiation Background from Boson Star Binaries,” *Phys. Lett. B* **783** (2018) 158–162, [arXiv:1802.08259](#) [hep-ph]
11. D. Croon, A. E. Nelson, CS, D. G. E. Walker, and Z.-Z. Xianyu, “Hidden-Sector Spectroscopy with Gravitational Waves from Binary Neutron Stars,” *Astrophys. J. Lett.* **858** no. 1, (2018) L2, [arXiv:1711.02096](#) [hep-ph]

### Neutrino probe of BSM

10. S. K. Agarwalla *et al.*, “Constraints on flavor-diagonal non-standard neutrino interactions from Borexino Phase-II,” *JHEP* **02** (2020) 038, [arXiv:1905.03512](#) [hep-ph]
9. N. Houston, T. Li, and CS, “A new solar neutrino channel for grand-unification monopole searches,” *JCAP* **10** (2018) 034, [arXiv:1803.02835](#) [hep-ph]
8. A. Ankowski *et al.*, “Supernova Physics at DUNE,” in *Supernova Physics at DUNE*. 8, 2016. [arXiv:1608.07853](#) [hep-ex]

### Particle physics and model building

7. M. A. Buen-Abad, J. Fan, M. Reece, and CS, “Challenges for an axion explanation of the muon  $g - 2$  measurement,” *JHEP* **09** (2021) 101, [arXiv:2104.03267](#) [hep-ph]
6. U. Aydemir, D. Minic, CS, and T. Takeuchi, “ $B$ -decay anomalies and scalar leptoquarks in unified Pati-Salam models from noncommutative geometry,” *JHEP* **09** (2018) 117, [arXiv:1804.05844](#) [hep-ph]
5. U. Aydemir, D. Minic, CS, and T. Takeuchi, “Pati-Salam unification from noncommutative geometry and the TeV-scale  $W_R$  boson,” *Int. J. Mod. Phys. A* **31** no. 01, (2016) 1550223, [arXiv:1509.01606](#) [hep-ph]
4. L. N. Chang, D. Minic, A. Roman, CS, and T. Takeuchi, “On the Physics of the Minimal Length: The Question of Gauge Invariance,” *Int. J. Mod. Phys. A* **31** (2016) 1630012, [arXiv:1602.07752](#) [hep-th]

3. U. Aydemir, D. Minic, **CS**, and T. Takeuchi, “The 750 GeV diphoton excess in unified  $SU(2)_L \times SU(2)_R \times SU(4)$  models from noncommutative geometry,” *Mod. Phys. Lett. A* **31** no. 18, (2016) 1650101, [arXiv:1603.01756 \[hep-ph\]](#)
2. L. N. Chang, D. Minic, **CS**, and T. Takeuchi, “Observable Effects of Quantum Gravity,” [arXiv:1605.04361 \[gr-qc\]](#)
1. U. Aydemir, D. Minic, **CS**, and T. Takeuchi, “Higgs mass, superconnections, and the TeV-scale left-right symmetric model,” *Phys. Rev. D* **91** (2015) 045020, [arXiv:1409.7574 \[hep-ph\]](#)

## INVITED TALKS

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<b>LBNL Theory 4D Seminar</b>	2021/12
· Galactic Rotation Curves vs. Ultralight Dark Matter	
<b>UC Irvine</b>	2021/12
· Axion Archaeology – Echos from Ancient Supernova Remnants	
<b>Fermilab Theory Seminar</b>	2021/11
· Axion Archaeology – Echos from Ancient Supernova Remnants	
<b>University of Amsterdam</b>	2021/11
· Axion Archaeology – Echos from Ancient Supernova Remnants	
<b>University of Chicago KCTP</b>	2021/11
· Axion Archaeology – Echos from Ancient Supernova Remnants	
<b>University of Maryland</b>	2021/11
· Novel Astrophysical Probes of Axion Dark Matter	
<b>UC Santa Cruz</b>	2021/11
· Axion Echoes from Supernova Remnants	
<b>Hebrew University</b>	2021/05
· Constraints on Axions from Cosmic Distance Measurements	
<b>Notre Dame</b>	2021/02
· Constraints on Axions from Cosmic Distance Measurements	
<b>U. Oklahoma</b>	2019/05
· Gravitational Wave Signatures of Beyond Standard Model Physics	
<b>Neutrino-Electron Scattering at Low Energies Workshop</b>	2019/04
<i>UMass, Amherst</i>	
· Constraints on Non-Standard Neutrino Interactions from Borexino Phase-II	
<b>Signals of Dark Matter in its Natural Habitat Workshop</b>	2019/02
<i>TRIUMF</i>	
· Boson Star from Repulsive Scalars, at LIGO and LISA	
<b>Carleton</b>	2018/10
· Particle Phenomenology in the Era of Gravitational Wave Astronomy	
<b>Perimeter Institute</b>	2018/10
· Particle Phenomenology in the Era of Gravitational Wave Astronomy	
<b>Joint Tufts/MIT Cosmology Seminars</b>	2018/10
<i>MIT</i>	
· Boson Star from Repulsive Light Scalars and Gravitational Waves	
<b>Queen’s University</b>	2018/10
· Particle Phenomenology in the Era of Gravitational Wave Astronomy	

<b>McGill</b>	2018/10
· Particle Phenomenology in the Era of Gravitational Wave Astronomy	
<b>Stanford</b>	2018/11
· Boson Star from Repulsive Light Scalars and Gravitational Waves	
<b>UC Irvine</b>	2018/11
· Boson Star from Repulsive Light Scalars and Gravitational Waves	
<b>U. Utah</b>	2018/11
· Boson Star from Repulsive Light Scalars and Gravitational Waves	
<b>North-East Cosmology Workshop 2018, McGill University</b>	2018/03
<i>McGill</i>	
· New Astrophysical Probes of Beyond SM Physics	
<b>Brown University</b>	2017/12
· Gravitational Wave Cosmology & Particle Physics	
<b>New England Theoretical Cosmology and Gravity Workshop</b>	2017/10
<i>MIT</i>	
· The Limits of Dark Matter from Electroweak Symmetry Breaking	
<b>Duke Regional String Meeting</b>	2015/10
<i>Duke University</i>	
· Rethinking Gauge Theory through Connes' Noncommutative Geometry	
<b>SPOCK meeting</b>	2015/08
<i>University of Cincinnati</i>	
· Rethinking Gauge Theory through Connes' Noncommutative Geometry	

## PROGRAMMING

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<b>Languages</b>	Python, C, regex, bash, MATLAB, C++, Mathematica
<b>ODE Solving</b>	Shooting and relaxation for Singular Boundary Value problems
<b>Boltzmann Solver</b>	CLASS
<b>MCMC</b>	emcee, MontePython, GENIE, MadGraph
<b>Parallel Computation</b>	mpi4py, multiprocessing, ipyparallel, TensorFlow-GPU
<b>Machine Learning</b>	TensorFlow, Keras
<b>CMB Analysis</b>	healpy


## DATA ANALYSIS

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<b>Data Acquisition</b>	Scrapy web scraping, Regex parsing
<b>Data Simulation</b>	CMB pixel level local non-Gaussian map simulation
<b>Data Sets</b>	BOSS DR12 (real/ $k$ space), Pantheon SNIa, SPARC, Bonamente galaxy clusters, Green's Catalog of SN Remnants, Planck 2018 likelihood, Borexino Phase II

## CODING PROJECTS

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<b>CMB Machine Learning (on-going)</b>	2021
· simulate CMB maps (gaussian and non-gaussian) at the pixel level	
· process with noise maps from Planck FFP10	
· apply neural network for anomaly hunting that gives well-defined statistics	
<b>Ultralight Dark Matter from Galaxy Dispersion </b>	2021
· load and parse SPARC data set	
· construct $\chi^2$ estimator and perform Frequentist analysis using <code>emcee</code> as a smart grid	

## Axion Echo from Supernova Remnant

2021

- regex parse SNR catalog (Green 2019), scrapy crawler of SN data, process of Haslam 408 MHz map
- construct supernova remnant light curve, compute echo signal from stimulated decay

## Constraining Axions from Cosmic Distance Measurement

2020

- construct axion-photon conversion model inside IGM and ICM
- load and process Pantheon, Bonamente galaxy clusters, BOSS DR12
- perform Bayesian and Frequentist analysis with `emcee` sampler

## Self-gravitating Bose-Einstein Condensate Solver

2019

- relaxation solver of Bose-Einstein condensate system with two axions
- shooting solver of Bose-Einstein condensate system with one axion, stiffness detection and switch

## OUTREACH AND COMMUNITY

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### Cosmicdicord.net

2019-present

A blog that features background of my research, fun facts of astroparticle physic, as well as tutorials of simple coding projects.

### Women in Science Project (WISP)

2018

Introduction of physics research to female starting undergraduates. Co-mentoring short term interns from selected groups.

### Dartmouth-TRIUMF HEP Tools Bootcamp

2017

One of the three organizers. Invited authors of computational programs in both high energy physics and cosmology to give online lectures series through the Vidyio platform. The workshop had nearly 200 participants from six continents and received very positive feedback.

## REFERENCES

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Kfir Blum	Department of Particle Physics and Astrophysics, Weizmann Institute of Science Phone: +972-8-934-3181 Email: kfir.blum@weizmann.ac.il
Raffaele Tito D'Agnolo	Institut de Physique Théorique, Université Paris Saclay, CEA Phone: +33 (0)169087385 Email: raffaele-tito.dagnolo@ipht.fr
JiJi Fan	Department of Physics, Brown University, Providence, RI 02912 Phone: +1-401-863-2641 Email: jijj_fan@brown.edu
Tatsu Takeuchi	Department of Physics, Virginia Tech, Blacksburg, VA 24061-0435 Phone: +1-540-231-5333 Email: takeuchi@vt.edu
Tomer Volansky	School of Physics and Astronomy, Tel-Aviv University, Tel-Aviv 69978 Phone: +972-3-6407026 Email: tomerv@post.tau.ac.il