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Astronomy & Space
Science Institute (KASI)
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Sungwook E. HONG

Research Interests

Large-scale Structure of the Universe; Cosmological Simulations; Deep Learning in Astronomy; Astrobiology; Cosmic Reionization; Astronomical Instrumentation

Education

2004 – 2011, Korea Advanced Institute of Science and Technology
MS & PhD Integrated Degree in Physics

2000 – 2004, Korea Advanced Institute of Science and Technology
BS in Physics

Experience

Sep 2021 – , Astronomy Campus, University of Science and Technology
Associate Professor

Oct 2020 – , Korea Astronomy and Space Science Institute
Senior Researcher

Sep 2018 – Sep 2020, University of Seoul
Research Professor

Dec 2016 – Aug 2018, Korea Astronomy and Space Science Institute
Researcher

Jan 2013 – Nov 2016, Korea Institute for Advanced Study
KDES/QUC Research Fellow

Oct 2011 – Jan 2013, Chungnam National University
Postdoctoral Researcher

Mar 2011 – Sep 2011, Korea Advanced Institute of Science and Technology
Postdoctoral Researcher

Awards

2023, Oral Presentation Award, Korean Space Science Society

2020, Young Astronomer's Award, Korean Astronomical Society
for contributing the Korean astronomy by participation of large-volume numerical simulations for understanding the large-scale structures of the Universe, and by development of data analysis and application methods for understanding the nature of dark energy.

2015, Annual Best Science Paper Award, The Korea Federation of Science and Technology Societies

Title: 2D genus topology of 21-cm differential brightness temperature during cosmic reionization



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Service

Journal Reviewer

Monthly Notices of the Royal Astronomical Society; Journal of the Korean Astronomical Society; Publications of the Korean Astronomical Society; Journal of the Korean Physical Society; Journal of the Astronomical Instrumentation; New Physics

Conference Organizer

- 2021 – , Korea Astronomy Machine Learning Workshop
- 2020 – , Workshop on Instrumentation for Astronomy and Space Science
- 2019, Workshop on ML in Astronomy and Astrophysics
- 2017 – 2018, K-GMT Science Program Users Meeting
- 2014, 2016 & 2020, KIAS Workshop on Cosmology and Structure Formation

Committee

- 2022 – , Astrophysics Division, Korean Physics Society
- 2019 – , Instrumentation Division, Korean Astronomical Society
- 2019 – , Korea Astronomy Machine Learning (KAML)
- 2020 – 2021, Korean Astronomy Encyclopedia, Korean Astronomical Society
- 2017 – 2018, K-GMT Science & Instrumentation Working Group
- 2017 – 2018, The 2nd K-GMT Science White Paper Committee

Media Coverage

May 2023, 90 Nights of Universe (co-author)

- 2023, *Excellent General-reading Book for Youth*, Korean Publishing Foundation
- 2023, *Sejong Recommended Book*, Publication Industry Promotion Agency of Korea

Oct 2021 & Feb 2023, YTN Science: Docu S Prime

“Truth about UFO and extraterrestrial life” & “Scientific approach to exploring beyond the Earth” (*interviewee*)

Dec 2022 & Feb 2023, YTN Science: I’ll Here the Stars

“Is our world everything? — About multiverse & parallel universes” & “Unseen, but ever there — About dark matter & dark energy” (*interviewee*)

Jul 2021, Physics & High Technology

“A conversation among young astrophysicists” (*co-author*)

Apr & Sep 2017, The Math Donga Magazine

“Mathematics is the alien language!” & “Imagination with mathematics: How does the Universe look like?” (*consultant*)

Mar 2015 & 2017, Horizon

“Spatial and velocity distribution of galaxies in cluster from cosmological simulations” & “Analysis of 21cm radio signal from the epoch of cosmic reionization” (*author*)

Oct 2016, The Science Donga Magazine

“To the universe: Answer me, alien civilizations!” (*author*)



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Publications

64. Merger tree-based halo/galaxy matching between cosmological simulations with different resolutions: Galaxy-by-galaxy resolution study and the machine learning-based correction

Jung, M., Kim, J.-h., Oh, B.K. *et al.*, ApJ submitted, arXiv:2312.02466

63. Final parsec problem of black hole mergers and ultralight dark matter

Koo, H., Bak, D., Park, I., **Hong, S.E.** & Lee, J.-W., PLB submitted, arXiv:2311.03412

62. The effects of non-linearity on the growth rate constraint from velocity correlation functions

Tonegawa, M., Appleby, S., Park, C., **Hong, S.E.** & Kim, J., MNRAS submitted, arXiv:2309.14457

61. MulGuisin, a topological clustering algorithm, and its performance as a cosmic structure finder

Ju, Y., Park, I., Sabiu, C.G. & **Hong, S.E.**, MNRAS submitted, arXiv:2301.03278

60. Panel discussion: Practical problem solving for machine learning

Cabrera, G., **Hong, S.E.**, Nakazono, L., Parkinson, D. & Ting, Y.-S., Proc. IAU accepted, arXiv:2211.16782

59. Maunakea Spectroscopic Explorer exposure time calculator for end-to-end simulator: to optimizing spectrograph design and observing simulation

Ji, T.-G., Sobeck, J., Kim, C. *et al.*, JATIS 10, 018001 (Jan 2024)

58. Modeling cosmological perturbations of thermal inflation

Bae, J.-M., **Hong, S.E.** & Zoe, H., CQG 41, 015024 (Dec 2023)

57. Cosmological parameter constraints from the SDSS density and momentum power spectra

Appleby, S., Tonegawa, M., Park, C. *et al.*, ApJ 958, 180 (Nov 2023)

56. The universe is worth 64^3 pixels: Convolution neural network and vision transformers for cosmology

Hwang, S.Y., Sabiu, C.G., Park, I. & **Hong, S.E.**, JCAP 11(2023), 075 (Nov 2023)

55. Detecting interstellar objects by using space weather data

Kwon, R.-Y., Kim, M., **Hong, S.E.** & Hoang, T., PKAS 38, 91 (Aug 2023)

54. Search for technosignature

Hong, S.E., Sohn, B.W., Jung, T. *et al.*, PKAS 38, 75 (Aug 2023)

53. Search for radio technosignature from the farside of the Moon

Kim, M., **Hong, S.E.**, Jung, T. *et al.*, PKAS 38, 59 (Aug 2023)

52. Search for biosignature in the solar system

Kim, M., Chung, S.-J., Shin, M.-S. & **Hong, S.E.**, PKAS 38, 37 (Aug 2023)

51. The prospect of interstellar object explorations for searching life in cosmos

Kim, M., Kwon, R.-Y., Hoang, T. & **Hong, S.E.**, PKAS 38, 25 (Aug 2023)

50. Exoplanets and habitability

Hong, S.E., Kwon, R.-Y., Kim, Y., Kang, H. & Kim, M., PKAS 38, 13 (Aug 2023)

49. Tomographic Alcock-Paczynski test with redshift-space correlation function: Evidence for the dark energy equation of state parameter $w > -1$

Dong, F., Park, C., **Hong, S.E.** *et al.*, ApJ 953, 98 (Aug 2023)

48. Cluster-counterpart voids: Void identification from galaxy density field

Shim, J., Park, C., Kim, J. & **Hong, S.E.**, ApJ 952, 59 (Jul 2023)



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47. Reconstructing the cosmological density and velocity fields from redshifted galaxy distributions using V-net

Qin, F., Parkinson, D., **Hong, S.E.** & Sabiu, C.G., JCAP 06(2023), 062 (Jun 2023)

46. Cosmic gas highways in C-EAGLE simulations

Vurm, I., Nevelainen, J., **Hong, S.E.** *et al.*, A&A 673, A62 (May 2023)

45. Machine-guided exploration and calibration of astrophysical simulations

Oh, B.K., An, H., Shin, E.-j., Kim, J.-h. & **Hong, S.E.**, MNRAS 515, 693 (Sep 2022); MNRAS 521, 5760 (Apr 2023)

44. An exposure time calculator for the Maunakea Spectroscopic Explorer

Ji, T.-G., Kim, T., Kim, C., *et al.* Proc. SPIE 12189, 121892N (Aug 2022)

43. Minkowski functionals of SDSS-III BOSS : Hints of possible anisotropy in the density field?

Appleby, S., Park, C., Pranav, P. *et al.*, ApJ 928, 108 (Apr 2022)

42. Weak-lensing mass reconstruction of galaxy clusters with convolutional neural network

Hong, S.E., Park, S., Jee, M.J., Bak, D., & Cha, S., ApJ 923, 266 (Dec 2021)

41. Proposal of joint planning working group for development of Korean Space Telescopes

Han, J.-Y., Park, W., Jun, Y. *et al.*, JSTA 1, 283 (Nov 2021)

40. Panspermia in a Milky Way-like galaxy

Gobat, R., **Hong, S.E.**, Snaith, O., & Hong, S., ApJ 921, 157 (Nov 2021)

39. Revealing the local cosmic web from galaxies by deep learning

Hong, S.E., Jeong, D., Hwang, H.S., & Kim, J., ApJ 913, 76 (May 2021)

38. The Horizon Run 5 cosmological hydrodynamic simulation: Probing galaxy formation from kilo- to giga-parsec scales

Lee, J., Shin, J., Snaith, O.N., *et al.*, ApJ 908, 11 (Feb 2021)

37. Cosmological parameter estimation from the two-dimensional genus topology — Measuring the expansion history using the genus amplitude as a standard ruler

Appleby, S., Park, C., **Hong, S.E.**, *et al.*, ApJ 907, 75 (Feb 2021)

36. Cosmological parameter estimation from the two-dimensional genus topology — Measuring the expansion history using the genus amplitude as a standard ruler

Appleby, S., Park, C., **Hong, S.E.**, *et al.*, ApJ 907, 75 (Feb 2021)

35. Deep-learning study of the 21-cm differential brightness temperature during the epoch of reionization

Kwon, Y., **Hong, S.E.**, & Park, I., JKPS 77, 49 (Jul 2020)

34. Cosmological information from the small-scale redshift space distortions

Tonegawa, M., Park, C., Zheng, Y., *et al.*, ApJ 897, 17 (Jun 2020)

33. Cosmological parameter estimation from the two-dimensional genus topology — Measuring the shape of the matter power spectrum

Appleby, S., Park, C., **Hong, S.E.**, Hwang, H.S., & Kim, J., ApJ 896, 145 (Jun 2020)

32. SCUBA-2 Ultra Deep Imaging EAO Survey (STUDIES) IV. Spatial clustering and halo masses of submillimeter galaxies

Lim, C.-F., Chen, C.-C., Wang, W.-H., *et al.*, ApJ 895, 104 (Jun 2020)

31. Constraining cosmology with big data statistics of cosmological graphs

Hong, S., Jeong, D., Hwang, H.S., *et al.*, MNRAS 493, 5972 (Feb 2020)

30. MANIFEST metrology toolkit

Goodwin, M. & **Hong, S.E.**, Proc. SPIE 11203, 112031C (Jan 2020)



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29. Alcock-Paczynski test with the evolution of redshift-space galaxy clustering anisotropy

Park, H., Park, C., Sabiu, C.G., *et al.* ApJ 881, 146 (Aug 2019)

28. Multiple rooks of chess: A generic integral field unit deployment technique

Chattopadhyay, S., Ramaprakash, A.N., Khodade, P., *et al.* Proc. SPIE 10706, 107065S (Jul 2018)

27. Noise characterization of IUCAA digital sampling array controller

Chattopadhyay, S., Ramaprakash, A.N., Joshi, B., *et al.* JATIS 4, 036002 (Jul 2018)

26. Wide-field multi-object spectroscopy with MANIFEST

Lawrence, J., Ben-Ami, S., Brown, D.M., *et al.* Proc. SPIE 10702, 10702A6 (Jul 2018)

25. DOTIFS: Spectrograph optical and opto-mechanical design

Chung, H., Ramaprakash, A.N., Khodade, P., *et al.* Proc. SPIE 10702, 107027A (Jul 2018)

24. Minkowski tensors in two dimensions: Probing the morphology and isotropy of the matter and galaxy density fields

Appleby, S., Chingangbam, P., Park, C., *et al.* ApJ 858, 87 (May 2018)

23. Cosmological constraints from the redshift dependence of the Alcock-Paczynski effect: Dynamical dark energy

Li, X.-D., Sabiu, C.G., Park, C., *et al.* ApJ 856, 88 (Apr 2018)

22. A question of separation: Disentangling tracer bias and gravitational non-linearity with counts-in-cells statistics

Uhlemann, C., Feix, M., Codis, S., *et al.* MNRAS 473, 5098 (Feb 2018)

21. Cosmological parameter estimation using the genus amplitude — Application to mock galaxy catalogs

Appleby, S., Park, C., **Hong, S.E.**, & Kim, J., ApJ 853, 17 (Jan 2018)

20. Small-scale effects of thermal inflation on halo abundance at high- z , galaxy substructure abundance, and 21-cm power spectrum

Hong, S.E., Zoe, H., & Ahn, K., PRD 96, 103515 (Nov 2017)

19. CMB spectral distortion constraints on thermal inflation

Cho, K., **Hong, S.E.**, Stewart, E.D., & Zoe, H., JCAP 08(2017), 002 (Aug 2017)

18. Cosmological constraints from the redshift dependence of the volume effect using the galaxy 2-point correlation function across the line of sight

Li, X.-D., Park, C., Sabiu, C.G., *et al.* ApJ 844, 91 (Aug 2017)

17. Topology of large-scale structure of galaxies in two dimensions — Systematic effects

Appleby, S., Park, C., **Hong, S.E.**, & Kim, J., ApJ 836, 45 (Feb 2017)

16. Cosmological constraints from the redshift dependence of the Alcock-Paczynski effect: Application to the SDSS-III BOSS DR12 galaxies

Li, X.-D., Park, C., Sabiu, C.G., *et al.* ApJ 832, 103 (Dec 2016)

15. AAO Starbugs: Software control and associated algorithms

Lorente, N.P.F., Vuong, M.V., Shortridge, K., *et al.* Proc. SPIE 9913, 99130U (Aug 2016)

14. Evolution of galaxy habitability

Gobat, R. & **Hong, S.E.**, A&A 592, 96 (Aug 2016)

13. The most bound halo particle-galaxy correspondence model: Comparison between models with different merger timescales

Hong, S.E., Park, C., & Kim, J., ApJ 823, 103 (May 2016)



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12. Radio and X-ray shocks in clusters of galaxies

Hong, S.E., Kang, H., & Ryu, D., ApJ 812, 49 (Oct 2015)

11. Horizon Run 4 simulation: Coupled evolution of galaxies and large-scale structures of the universe

Kim, J., Park, C., L'Huillier, B., & **Hong, S.E.**, JKAS 48, 213 (Aug 2015)

10. Effects of thermal inflation on small scale density perturbations

Hong, S.E., Lee, H.-J., Lee, Y.J., Stewart, E.D., & Zoe, H., JCAP 06(2015), 002 (Jun 2015)

9. March of the Starbugs: Configuring fibre-bearing robots on the UK-Schmidt optical plane

Lorente, N., Vuong, M., Satorre, C., *et al.* Proc. ADASS XXIV, 265 (Mar 2015)

8. Field target allocation and routing algorithms for Starbugs

Goodwin, M., Lorente, N., Satorre, C., *et al.* Proc. SPIE 9152, 91520S (Jul 2014)

7. 2D genus topology of 21-cm differential brightness temperature during cosmic reionization

Hong, S.E., Ahn, K., Park, C., *et al.* JKAS 47, 49 (Apr 2014)

6. Shock waves and cosmic ray acceleration in the outskirts of galaxy clusters

Hong, S.E., Ryu, D., Kang, H., & Cen, R., ApJ 785, 133 (Mar 2014)

5. The possibility of inflation in asymptotically safe gravity

Hong, S.E., Lee, Y.J., & Zoe, H., IJMPD 21, 1250062 (Jul 2012)

4. Anthropic likelihood for the cosmological constant and the primordial density perturbation amplitude

Hong, S.E., Stewart, E.D., & Zoe, H., PRD 85, 083510 (Apr 2012)

3. The causal structure of dynamical charged black holes

Hong, S.E., Hwang, D.-i., Stewart, E.D., & Yeom, D.-h., CQG 27, 045014 (Feb 2010)

2. Critical review on holographic measure over the multiverse

Hong, S.E., Yeom, D.-h., & Zoe, H., Int. J. Conf. Ser. 1, 377 (Dec 2009)

1. Black hole complementarity with local horizons and Horowitz-Maldacena's proposal

Hong, S.E., Hwang, D.-i., Yeom, D.-h., & Zoe, H., JHEP 12(2008), 080 (Dec 2008)



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Scientific Talks

Review on the recent studies about the habitability (+ α)

- Oct 2023, *Korean Space Science Society Fall Meeting 2023*, Yeosu, Korea
- Jun 2023, *KSAS Space Workshop 2023*, Yeosu, Korea
- Oct 2021, *Korean Astronomical Society Fall Meeting 2021*, Jeju, Korea

Emergence of galaxy morphology-star formation rate-clustercentric radius relation in galaxy clusters

- Oct 2023, *Korean Astronomical Society Fall Meeting 2023*, Jeju, Korea
- Aug 2023, *2023 Asia-Pacific Regional IAU Meeting*, Koriyama, Japan

Pre-study for Korean Large Spectroscopy Telescope

- Aug 2023, *The 4th Korea Geoscience Union Annual Meeting*, Busan, Korea
- Jan 2023, *Survey Science Group Workshop 2023*, Jeongseon, Korea (invited)

Dark matter and the large-scale structure of the universe

- Apr 2023, *Korean Physical Society Spring Meeting 2023*, Daejeon, Korea (invited)

Panspermia in a Milky Way-like galaxy

- Oct 2022, *The 10th KIAS Workshop on Cosmology and Structure Formation*, Seoul, Korea (invited)
- Oct 2021, *Korean Astronomical Society Fall Meeting 2021*, Jeju, Korea

Weak-lensing mass reconstruction of galaxy clusters with convolutional neural network

- Aug 2022, *IAU General Assembly 2022 Focus Meeting 3: Consensus Cosmic Shear in the 2020s*, Busan, Korea
- Sep 2021, *ESA/ESAC Galaxy Cluster Mass Meeting 2021*, Online
- Oct 2020, *Korean Astronomical Society Meeting 2020*, Daejeon, Korea
- Jul 2020, *Korean Physical Society Spring Meeting 2020*, Online
- Feb 2020, *The 9th Survey Science Group Workshop*, Jeongseon, Korea

Revealing the local cosmic web from galaxies by deep learning

- Aug 2022, *IAU General Assembly 2022 Symposium 368: Machine Learning in Astrophysics: Possibilities and Pitfalls*, Online
- Apr 2022, *TRP: The Origin and Evolution of the Universe*, Gwangju, Korea (invited)
- Apr 2022, *GW Universe Focus Workshop: Machine Learning & Artificial Intelligence in GW Universe Research*, Online (invited)
- Jul 2021, *CLUES Collaborational Meeting*, Online (invited)
- Dec 2020, *7th Korea-Japan Workshop on Dark Energy*, Online (invited)
- Nov 2020, *Astroparticle: The Next Frontier of Fundamental Physics*, Pohang, Korea (invited)
- Nov 2020, *AAPPS-DACG Workshop on Astrophysics, Cosmology and Gravitation*, Online
- Nov 2020, *The 9th KIAS Workshop on Cosmology and Structure Formation*, Seoul, Korea
- Aug 2020, *14th International Conference on Gravitation, Astrophysics, and Cosmology*, Online
- Oct 2019, *Korean Physical Society Fall Meeting 2019*, Gwangju, Korea
- Oct 2019, *Korean Astronomical Society Fall Meeting 2019*, Seoul, Korea

A-SPEC: Fiber cable management & Interface control software

- Feb 2022, *The 10th Survey Science Workshop*, Jeongseon, Korea (invited)

Machine learning in astrophysics

- Feb 2022, *Galaxy Evolution Workshop 2021*, Online (invited)
- Sep 2018, *The 2nd Deep Neural Network Workshop*, Seoul, Korea (invited)

Deep-learning study of the 21cm differential brightness temperature during the epoch of reionization

- May 2021, *East Asia SKA Workshop 2021*, Online



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Mock galaxy catalogs in Horizon Run 4 & Multiverse simulations

- Oct 2020, *Korean Astronomical Society Meeting 2020*, Daejeon, Korea (acceptance speech of the *Young Astronomer's Award*)
- Jan 2019, *IMS Workshop 2019*, Seoul, Korea
- Nov 2016, *The 7th KIAS Workshop on Cosmology and Structure Formation*, Seoul, Korea
- Oct 2015, *Korean Astronomical Society Fall Meeting 2015*, Hongcheon, Korea
- Jun 2015, *Innovative Cosmological Simulations with Machine Learning and Statistics in the Era of LSST*, Pittsburgh, USA
- Feb 2009, *SDSS-KSG Winter Workshop*, Jeongseon, Korea

Repeatability of very-large-scale structures in the Horizon Run 4 simulation

- Apr 2019, *CosKASI Conference 2019—The Correlated Universe*, Jeju, Korea
- Feb 2019, *XVI Tartu-Tuorla Cosmology Meeting*, Tartu, Estonia (*invited*)
- Nov 2018, *The 8th KIAS Workshop on Cosmology and Structure Formation*, Seoul, Korea
- Oct 2018, *Korean Physics Society Fall Meeting 2018*, Changwon, Korea
- Jan 2018, *The 7th Survey Science Group Workshop*, Jeongseon, Korea

Small-scale features of thermal inflation: CMB distortion, substructure abundance, and 21cm power spectrum

- Apr 2018, *Korean Physic Society Spring Meeting 2018*, Daejeon, Korea
- Jul 2017, *13th International Conference on Gravitation, Astrophysics, and Cosmology*, Seoul, Korea
- Oct 2015, *FRP: The Origin and Evolution of the Universe*, Pohang, Korea

Concept design of fiber-fed kilo-object spectrograph

- Apr 2017, *CosKASI Conference 2017—Cosmological Quests for the Next Decade*, Daejeon, Korea
- Oct 2016, *Korean Astronomical Society Fall Meeting 2016*, Daejeon, Korea

Algorithm development for Starbugs: Robotic positioner for MANIFEST

- Feb 2015, *The 3rd Survey Science Group Workshop*, Jeongseon, Korea
- Feb 2014, *The 2nd Survey Science Group Workshop*, Jeongseon, Korea

Effect of the cosmological constant on the number density of Milky-way-like galaxies

- Nov 2012, *The 5th KIAS Workshop on Cosmology and Structure Formation*, Seoul, Korea (*invited*)
- May 2012, *The KASI-APCTP Joint Mini-workshop on Science and Technology of BigBOSS*, Jeju, Korea
- Feb 2012, *Survey Science Group Workshop*, Jeongseon, Korea
- Jul 2011, *11th RESCEU/DENET Summer School: Dark Energy in the Universe*, Kumamoto, Japan

Strong accretion shock waves in cluster outskirts and possibility of cosmic ray population inversion

- Nov 2012, *APCTP Workshop on Magnetic Fields in Astrophysics*, Pohang, Korea
- Oct 2012, *Korean Astronomical Society Fall Meeting 2012*, Gwangju, Korea
- Sep 2012, *TRP Mini Workshop on Theories and Practices in Large Scale Structure Formation*, Gwangju, Korea (*invited*)
- Apr 2012, *Korean Astronomical Society Spring Meeting 2012*, Gyeongju, Korea

2D genus topology of 21cm differential brightness temperature during cosmic reionization

- Dec 2011, *APCTP Mini-Workshop on Recent Progresses in Dark Universe and Astro-Particle Physics*, Seoul, Korea
- Feb 2011, *East Asia Young Astronomers Meeting 2011*, Jeju, Korea
- Aug 2010, *10th RESCEU/DENET Summer School: Dark Energy in the Universe*, Kochi, Japan



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Lectures

Astronomical Instrumentation

- Fall 2023 –, *University of Science and Technology*, Daejeon, Korea

Modern Astronomy & Cosmology

- Spring 2022 –, *University of Science and Technology*, Daejeon, Korea
- Spring 2020, *University of Seoul*, Seoul, Korea
- Jan 2019 – Sep 2020, *Schools for Korea Astronomical Olympiad*, Goheung & Yangju, Korea

Astrophysics & Artificial Intelligence

- Feb 2023, *Yonsei University*, Seoul, Korea
- Jul 2020 – Jul 2021, *KIAS Astrophysics Summer School*, Online

Man, Universe & Civilization

- Fall 2019 – Spring 2020, *University of Seoul*, Seoul, Korea