

# Guang-Yao Zhao

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## SUMMARY

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I am a radio astronomer, currently working at the Instituto de Astrofísica de Andalucía - CSIC as a postdoctoral researcher funded by the Severo-Ochoa project. I am also a member and a working group coordinator of the Event Horizon Telescope (EHT) Collaboration. My research interest is primarily high-angular resolution imaging and astrometric studies of supermassive black holes (SMBH) and active galactic nuclei (AGN) with very long baseline interferometry. My work also includes developing relevant calibration and imaging methods for radio interferometric data.

## EDUCATION

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- Ph.D. in Astrophysics at **University of Chinese Academy of Sciences** 09/2007 – 07/2013
- Bachelor in Applied Physics at **Shandong University at Weihai** 09/2003 – 06/2007

## CURRENT POSITION

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**Instituto de Astrofísica de Andalucía - CSIC** since 01/12/2019

- **Department:** Radioastronomy and galactic structure department
- **Job Title:** Severo Ochoa Postdoc
- **Research Topics:**
  - EHT data analyses (imaging; scattering mitigation; multi-wavelength support)
  - Data analyses of multi-epoch GMVA+ALMA observations of OJ 287

## PREVIOUS POSITIONS

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**Korea Astronomy and Space Science Institute** 01/01/2016 - 30/11/2019

- **Department:** Radio Astronomy Division
- **Job Title:** KRF (Korea research fellowship) Fellow
- **Research Topics:**
  - Multi-frequency AGN survey with the KVN (MASK)
  - Global implementation of simultaneous multi-frequency receiving systems
  - EHT observations and data analyses

**Korea Astronomy and Space Science Institute** 01/09/2013 - 31/12/2015

- **Department:** Radio Astronomy Division
- **Job Title:** Postdoctoral Researcher
- **Research Topics:**
  - Source-frequency phase-referencing (SFPR) observations of AGNs
  - 43 GHz monthly monitoring of Sgr A\* with KaVA

## RESEARCH PROJECTS

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**Supermassive black holes and relativistic jets at the highest resolution** 01/06/2020 - 31/05/2023

Agency: Ministerio de Ciencia e Innovación (Spain), PID2019-108995GB-C; PI: José Luis Gómez (IAA-CSIC); Amount: 223,850 €. Role: Team member;

**Supermassive black holes and blazar jets.** 01/01/2020 - 31/12/2022

Agency: Junta de Andalucía (Spain), P18-FR-1769; PI: José Luis Gómez (IAA-CSIC); Amount: 139,625 €. Role: Team member;

**Launching and evolution of AGN jets** 01/01/2016 - 31/12/2019

Agency: Ministry of Science, Technology, and ICT (S. Korea); PI: Bong Won Sohn (KASI); Amount: 1,280,000,000 ₩. Role: Team member;

**Multi-frequency VLBI studies of AGN jets (KRF Grant)** 01/01/2016 - 30/11/2019

Agency: National Research Foundation (S. Korea), NRF-2015H1D3A1066561; PI: Taehyun Jung (KASI); Amount: 270,000,000 ₩. Role: KRF Fellow;

**Core-shift in AGN jets** 01/01/2015 - 31/12/2015

Agency: Korea Astronomy and Space Science Institute (S. Korea); PI: Taehyun Jung (KASI); Amount: 100,000,000 ₩. Role: Team Member;

## TEACHING & MENTORING

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**Ph.D. Thesis: I. Cho** (Co-tutored with Dr. T. Jung) 09/2014 - 12/2020

Title: VLBI studies of Sagittarius A\* at centimeter-millimeter wavelengths

**MS Thesis: J.-U. Kim** (Co-tutored with Prof. S. Yoon & Dr. B. W. Sohn) 10/2018 - 06/2019

Title: Periodic Variation in the Inner Jet Direction of 3C 66A

**MS Thesis: R. Dahale** (Co-tutored with Dr. J. L. Gómez & Dr. R. Lico) 10/2021 - 07/2022

Title: Magnetic Fields in Relativistic Jets of Supermassive Black Holes

## AWARDS & FELLOWSHIPS

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- Group Award of the Royal Astronomical Society (*as a member of the EHT collaboration*) 2021
- Nelson P. Jackson Aerospace Award (*as a member of the EHT collaboration*) 2020
- Bruno Rossi Prize (*as a member of the EHT collaboration*) 2020
- Einstein Medal (*as a member of the EHT collaboration*) 2020
- Breakthrough Prize in Fundamental Physics (*as a member of the EHT collaboration*) 2020
- Diamond Achievement Award of the US National Science Foundation (*as a member of the EHT collaboration*) 2019
- Chief Director Prize of NST Korea (*as a member of the EHT-Korea team*) 2019
- Outstanding project award in the KRF annual evaluation 2017
- Korea Research Fellowship 2016-2019
- President Award of Shanghai Astronomical Observatory 2009

## INVITED & SOLICITED TALKS

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- [1] **EHT observations of supermassive black holes and relativistic jets** 21/10/2022  
The 9th Mid-Atlantic Radio-Loud AGN Meeting Online & JHU, Baltimore, USA
- [2] **Scientific results from FPT and SFPR at KVN** 13/10/2022  
Science Enabled with Multi-Band Receivers  
at High Radio Frequency Workshop MPIfR, Bonn, Germany
- [3] **Multi-frequency science with the KVN** 26/08/2022  
Broadening Horizons: exploring multi-band  
capabilities for the ngEHT Workshop Harvard Univ., USA
- [4] **Observing supermassive black holes and relativistic jets  
with the Event Horizon Telescope** 13/07/2022  
15th EVN Symposium and Users' Meeting UCC, Cork, Ireland
- [5] **Scattering properties of Sgr A\*** 22/06/2021  
EHT 2021 Summer Virtual Collaboration Meeting Online
- [6] **Application of FPT and SFPR with the KVN** 19/10/2020  
EHT/ngEHT miniworkshop: KVN and multi-frequency VLBI Online
- [7] **Multi- $\lambda$  VLBI view of Sgr A\*** 15/04/2019  
Eating VLBI workshop 2019 INAF-IRA, Bologna, Italy
- [8] **MWL VLBI observations of Sgr A\*** 07/11/2018  
EHT Collaboration Meeting 2018 Radboud Univ., Nijmegen, Netherlands
- [9] **Mm-VLBI observations of Sgr A\* with KaVA, KVN, and EAVN** 27/01/2018  
Dawn of a new era for black hole jets in  
active galaxies workshop Tohoku Univ., Sendai, Japan
- [10] **Multi-frequency VLBI studies of AGNs** 17/12/2017  
KRF Workshop 2017: Dissemination Forum  
For Invited Outstanding Overseas Scientists KOFST, Seoul, S. Korea
- [11] **KaVA AGN large program observations of Sgr A\*** 18/01/2017  
Workshop on "challenges of AGN jets" NAOJ, Tokyo, Japan
- [12] **Mm-VLBI observations of Sgr A\* with KaVA, and KVN** 18/07/2016  
IAU Symposium 322: The Multi-Messenger Astrophysics  
of the Galactic Centre Palm Cove, Australia

## PUBLICATIONS

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- [1] W. Jiang, G.-Y. Zhao, Z.-Q. Shen, *et al.*, "Applications of the Source-Frequency Phase-Referencing Technique for ngEHT Observations," *Galaxies*, vol. 11, no. 1, p. 3, Jan. 2023. DOI: [10.3390/galaxies11010003](https://doi.org/10.3390/galaxies11010003). arXiv: [2212.08994](https://arxiv.org/abs/2212.08994) [astro-ph.IM].

- [2] K. Akiyama, J.-C. Algaba, T. An, *et al.*, “Overview of the Observing System and Initial Scientific Accomplishments of the East Asian VLBI Network (EAVN),” *Galaxies*, vol. 10, no. 6, p. 113, Dec. 2022. DOI: [10.3390/galaxies10060113](https://doi.org/10.3390/galaxies10060113). arXiv: [2212.07040](https://arxiv.org/abs/2212.07040) [[astro-ph.IM](#)].
- [3] S. Issaoun, M. Wielgus, S. Jorstad, *et al.*, “Resolving the Inner Parsec of the Blazar J1924-2914 with the Event Horizon Telescope,” *ApJ*, vol. 934, no. 2, 145, p. 145, Aug. 2022. DOI: [10.3847/1538-4357/ac7a40](https://doi.org/10.3847/1538-4357/ac7a40). arXiv: [2208.01662](https://arxiv.org/abs/2208.01662) [[astro-ph.HE](#)].
- [4] G.-Y. Zhao, J. L. Gómez, A. Fuentes, *et al.*, “Unraveling the Innermost Jet Structure of OJ 287 with the First GMVA + ALMA Observations,” *ApJ*, vol. 932, no. 1, 72, p. 72, Jun. 2022. DOI: [10.3847/1538-4357/ac6b9c](https://doi.org/10.3847/1538-4357/ac6b9c). arXiv: [2205.00554](https://arxiv.org/abs/2205.00554) [[astro-ph.HE](#)].
- [5] A. E. Broderick, R. Gold, B. Georgiev, *et al.*, “Characterizing and Mitigating Intraday Variability: Reconstructing Source Structure in Accreting Black Holes with mm-VLBI,” *ApJL*, vol. 930, no. 2, L21, p. L21, May 2022. DOI: [10.3847/2041-8213/ac6584](https://doi.org/10.3847/2041-8213/ac6584). arXiv: [2205.00554](https://arxiv.org/abs/2205.00554) [[astro-ph.HE](#)].
- [6] B. Georgiev, D. W. Pesce, A. E. Broderick, *et al.*, “A Universal Power-law Prescription for Variability from Synthetic Images of Black Hole Accretion Flows,” *ApJL*, vol. 930, no. 2, L20, p. L20, May 2022. DOI: [10.3847/2041-8213/ac65eb](https://doi.org/10.3847/2041-8213/ac65eb). arXiv: [2205.00554](https://arxiv.org/abs/2205.00554) [[astro-ph.HE](#)].
- [7] M. Wielgus, N. Marchili, I. Martí-Vidal, *et al.*, “Millimeter Light Curves of Sagittarius A\* Observed during the 2017 Event Horizon Telescope Campaign,” *ApJL*, vol. 930, no. 2, L19, p. L19, May 2022. DOI: [10.3847/2041-8213/ac6428](https://doi.org/10.3847/2041-8213/ac6428). arXiv: [2207.06829](https://arxiv.org/abs/2207.06829) [[astro-ph.HE](#)].
- [8] J. Farah, P. Galison, K. Akiyama, *et al.*, “Selective Dynamical Imaging of Interferometric Data,” *ApJL*, vol. 930, no. 2, L18, p. L18, May 2022. DOI: [10.3847/2041-8213/ac6615](https://doi.org/10.3847/2041-8213/ac6615). arXiv: [2207.06829](https://arxiv.org/abs/2207.06829) [[astro-ph.HE](#)].
- [9] Event Horizon Telescope Collaboration, K. Akiyama, A. Alberdi, *et al.*, “First Sagittarius A\* Event Horizon Telescope Results. VI. Testing the Black Hole Metric,” *ApJL*, vol. 930, no. 2, L17, p. L17, May 2022. DOI: [10.3847/2041-8213/ac6756](https://doi.org/10.3847/2041-8213/ac6756). arXiv: [2207.06829](https://arxiv.org/abs/2207.06829) [[astro-ph.HE](#)].
- [10] Event Horizon Telescope Collaboration, K. Akiyama, A. Alberdi, *et al.*, “First Sagittarius A\* Event Horizon Telescope Results. V. Testing Astrophysical Models of the Galactic Center Black Hole,” *ApJL*, vol. 930, no. 2, L16, p. L16, May 2022. DOI: [10.3847/2041-8213/ac6672](https://doi.org/10.3847/2041-8213/ac6672). arXiv: [2207.06829](https://arxiv.org/abs/2207.06829) [[astro-ph.HE](#)].
- [11] Event Horizon Telescope Collaboration, K. Akiyama, A. Alberdi, *et al.*, “First Sagittarius A\* Event Horizon Telescope Results. IV. Variability, Morphology, and Black Hole Mass,” *ApJL*, vol. 930, no. 2, L15, p. L15, May 2022. DOI: [10.3847/2041-8213/ac6736](https://doi.org/10.3847/2041-8213/ac6736). arXiv: [2207.06829](https://arxiv.org/abs/2207.06829) [[astro-ph.HE](#)].
- [12] Event Horizon Telescope Collaboration, K. Akiyama, A. Alberdi, *et al.*, “First Sagittarius A\* Event Horizon Telescope Results. III. Imaging of the Galactic Center Supermassive Black Hole,” *ApJL*, vol. 930, no. 2, L14, p. L14, May 2022. DOI: [10.3847/2041-8213/ac6429](https://doi.org/10.3847/2041-8213/ac6429). arXiv: [2207.06829](https://arxiv.org/abs/2207.06829) [[astro-ph.HE](#)].
- [13] Event Horizon Telescope Collaboration, K. Akiyama, A. Alberdi, *et al.*, “First Sagittarius A\* Event Horizon Telescope Results. II. EHT and Multiwavelength Observations, Data Process-

- ing, and Calibration,” *ApJL*, vol. 930, no. 2, L13, p. L13, May 2022. DOI: [10.3847/2041-8213/ac6675](https://doi.org/10.3847/2041-8213/ac6675). *arXiv: 2207.06829 [astro-ph.HE]*.
- [14] Event Horizon Telescope Collaboration, K. Akiyama, A. Alberdi, *et al.*, “First Sagittarius A\* Event Horizon Telescope Results. I. The Shadow of the Supermassive Black Hole in the Center of the Milky Way,” *ApJL*, vol. 930, no. 2, L12, p. L12, May 2022. DOI: [10.3847/2041-8213/ac6674](https://doi.org/10.3847/2041-8213/ac6674). *arXiv: 2207.06829 [astro-ph.HE]*.
- [15] I. Cho, G.-Y. Zhao\*, T. Kawashima, *et al.*, “The Intrinsic Structure of Sagittarius A\* at 1.3 cm and 7 mm,” *ApJ*, vol. 926, no. 2, 108, p. 108, Feb. 2022. DOI: [10.3847/1538-4357/ac4165](https://doi.org/10.3847/1538-4357/ac4165). *arXiv: 2112.04929 [astro-ph.HE]*.
- [16] R. Lico, C. Casadio, S. G. Jorstad, *et al.*, “New jet feature in the parsec-scale jet of the blazar OJ 287 connected to the 2017 teraelectronvolt flaring activity,” *A&A*, vol. 658, no. 2, L10, p. L10, Feb. 2022. DOI: [10.1051/0004-6361/202142948](https://doi.org/10.1051/0004-6361/202142948). *arXiv: 2202.02523 [astro-ph.HE]*.
- [17] K. Satapathy, D. Psaltis, F. Özel, *et al.*, “The Variability of the Black Hole Image in M87 at the Dynamical Timescale,” *ApJ*, vol. 925, no. 1, 13, p. 13, Jan. 2022. DOI: [10.3847/1538-4357/ac332e](https://doi.org/10.3847/1538-4357/ac332e). *arXiv: 2111.01317 [astro-ph.HE]*.
- [18] J. L. Gómez, E. Traianou, T. P. Krichbaum, *et al.*, “Probing the Innermost Regions of AGN Jets and Their Magnetic Fields with RadioAstron. V. Space and Ground Millimeter-VLBI Imaging of OJ 287,” *ApJ*, vol. 924, no. 2, 122, p. 122, Jan. 2022. DOI: [10.3847/1538-4357/ac3bcc](https://doi.org/10.3847/1538-4357/ac3bcc). *arXiv: 2111.11200 [astro-ph.HE]*.
- [19] Y.-Z. Cui, K. Hada, M. Kino, *et al.*, “East Asian VLBI Network observations of active galactic nuclei jets: imaging with KaVA+Tianma+Nanshan,” *Research in Astronomy and Astrophysics*, vol. 21, no. 8, 205, p. 205, Oct. 2021. DOI: [10.1088/1674-4527/21/8/205](https://doi.org/10.1088/1674-4527/21/8/205). *arXiv: 2104.05525 [astro-ph.GA]*.
- [20] M. Janssen, H. Falcke, M. Kadler, *et al.*, “Event Horizon Telescope observations of the jet launching and collimation in Centaurus A,” *Nature Astronomy*, vol. 5, no. 2, 122, pp. 1017–1028, Jul. 2021. DOI: [10.1038/s41550-021-01417-w](https://doi.org/10.1038/s41550-021-01417-w). *arXiv: 2111.03356 [astro-ph.GA]*.
- [21] P. Kocherlakota, L. Rezzolla, H. Falcke, *et al.*, “Constraints on black-hole charges with the 2017 EHT observations of M87\*,” *Phys. Rev. D*, vol. 103, no. 10, 104047, p. 104047, May 2021. DOI: [10.1103/PhysRevD.103.104047](https://doi.org/10.1103/PhysRevD.103.104047). *arXiv: 2105.09343 [gr-qc]*.
- [22] R. Narayan, D. C. M. Palumbo, M. D. Johnson, *et al.*, “The Polarized Image of a Synchrotron-emitting Ring of Gas Orbiting a Black Hole,” *ApJ*, vol. 912, no. 1, 35, p. 35, May 2021. DOI: [10.3847/1538-4357/abf117](https://doi.org/10.3847/1538-4357/abf117). *arXiv: 2105.01804 [astro-ph.HE]*.
- [23] EHT MWL Science Working Group, J. C. Algaba, J. Anzarski, *et al.*, “Broadband Multi-wavelength Properties of M87 during the 2017 Event Horizon Telescope Campaign,” *ApJL*, vol. 911, no. 1, L11, p. L11, Apr. 2021. DOI: [10.3847/2041-8213/abef71](https://doi.org/10.3847/2041-8213/abef71). *arXiv: 2104.06855 [astro-ph.HE]*.
- [24] C. Goddi, I. Martí-Vidal, H. Messias, *et al.*, “Polarimetric Properties of Event Horizon Telescope Targets from ALMA,” *ApJL*, vol. 910, no. 1, L14, p. L14, Mar. 2021. DOI: [10.3847/2041-8213/abee6a](https://doi.org/10.3847/2041-8213/abee6a). *arXiv: 2105.02272 [astro-ph.GA]*.

- [25] Event Horizon Telescope Collaboration, K. Akiyama, J. C. Algaba, *et al.*, “First M87 Event Horizon Telescope Results. VIII. Magnetic Field Structure near The Event Horizon,” *ApJL*, vol. 910, no. 1, L13, p. L13, Mar. 2021. DOI: [10.3847/2041-8213/abe4de](https://doi.org/10.3847/2041-8213/abe4de). arXiv: 2105.01173 [astro-ph.HE].
- [26] Event Horizon Telescope Collaboration, K. Akiyama, J. C. Algaba, *et al.*, “First M87 Event Horizon Telescope Results. VII. Polarization of the Ring,” *ApJL*, vol. 910, no. 1, L12, p. L12, Mar. 2021. DOI: [10.3847/2041-8213/abe71d](https://doi.org/10.3847/2041-8213/abe71d). arXiv: 2105.01169 [astro-ph.HE].
- [27] J. Park, K. Hada, M. Nakamura, *et al.*, “Jet Collimation and Acceleration in the Giant Radio Galaxy NGC 315,” *ApJ*, vol. 909, no. 1, 76, p. 76, Mar. 2021. DOI: [10.3847/1538-4357/abd6ee](https://doi.org/10.3847/1538-4357/abd6ee). arXiv: 2012.14154 [astro-ph.HE].
- [28] M. Wielgus, K. Akiyama, L. Blackburn, *et al.*, “Monitoring the Morphology of M87\* in 2009–2017 with the Event Horizon Telescope,” *ApJ*, vol. 901, no. 1, 67, p. 67, Sep. 2020. DOI: [10.3847/1538-4357/abac0d](https://doi.org/10.3847/1538-4357/abac0d). arXiv: 2009.11842 [astro-ph.HE].
- [29] J.-Y. Kim, T. P. Krichbaum, A. E. Broderick, *et al.*, “Event Horizon Telescope imaging of the archetypal blazar 3C 279 at an extreme 20 microarcsecond resolution,” *A&A*, vol. 640, no. 1, A69, A69, Aug. 2020. DOI: [10.1051/0004-6361/202037493](https://doi.org/10.1051/0004-6361/202037493). arXiv: 2009.11842 [astro-ph.HE].
- [30] R. Gold, A. E. Broderick, Z. Younsi, *et al.*, “Verification of Radiative Transfer Schemes for the EHT,” *ApJ*, vol. 897, no. 2, 148, p. 148, Jul. 2020. DOI: [10.3847/1538-4357/ab96c6](https://doi.org/10.3847/1538-4357/ab96c6). arXiv: 2009.11842 [astro-ph.HE].
- [31] A. E. Broderick, R. Gold, M. Karami, *et al.*, “THEMIS: A Parameter Estimation Framework for the Event Horizon Telescope,” *ApJ*, vol. 897, no. 2, 139, p. 139, Jul. 2020. DOI: [10.3847/1538-4357/ab91a4](https://doi.org/10.3847/1538-4357/ab91a4). arXiv: 2009.11842 [astro-ph.HE].
- [32] F. Roelofs, M. Janssen, I. Natarajan, *et al.*, “SYMBA: An end-to-end VLBI synthetic data generation pipeline. Simulating Event Horizon Telescope observations of M 87,” *A&A*, vol. 636, no. 2, A5, A5, Apr. 2020. DOI: [10.1051/0004-6361/201936622](https://doi.org/10.1051/0004-6361/201936622). arXiv: 2004.01161 [astro-ph.IM].
- [33] J. Park, K. Hada, M. Kino, *et al.*, “Kinematics of the M87 Jet in the Collimation Zone: Gradual Acceleration and Velocity Stratification,” *ApJ*, vol. 887, no. 2, 147, p. 147, Dec. 2019. DOI: [10.3847/1538-4357/ab5584](https://doi.org/10.3847/1538-4357/ab5584). arXiv: 1911.02279 [astro-ph.HE].
- [34] S. Koyama, M. Kino, A. Doi, *et al.*, “Stable Radio Core of the Blazar Mrk 501 during High-energy Active State in 2012,” *ApJ*, vol. 884, no. 2, 132, p. 132, Oct. 2019. DOI: [10.3847/1538-4357/ab4260](https://doi.org/10.3847/1538-4357/ab4260). arXiv: 1911.02279 [astro-ph.HE].
- [35] O. Porth, K. Chatterjee, R. Narayan, *et al.*, “The Event Horizon General Relativistic Magnetohydrodynamic Code Comparison Project,” vol. 243, no. 2, 26, p. 26, Aug. 2019. DOI: [10.3847/1538-4365/ab29fd](https://doi.org/10.3847/1538-4365/ab29fd). arXiv: 1904.04923 [astro-ph.HE].
- [36] T. Lee, S. Trippe, M. Kino, *et al.*, “Jet kinematics of the quasar 4C+21.35 from observations with the KaVA very long baseline interferometry array,” *MNRAS*, vol. 486, no. 2, 132, pp. 2412–2421, Jun. 2019. DOI: [10.1093/mnras/stz970](https://doi.org/10.1093/mnras/stz970). arXiv: 1904.02894 [astro-ph.GA].

- [37] J. Park, S.-S. Lee, J.-Y. Kim, *et al.*, “Ejection of Double Knots from the Radio Core of PKS 1510-089 during the Strong Gamma-Ray Flares in 2015,” *ApJ*, vol. 877, no. 2, p. 106, Jun. 2019. DOI: [10.3847/1538-4357/ab1b27](https://doi.org/10.3847/1538-4357/ab1b27). *arXiv: 1904.11118 [astro-ph.HE]*.
- [38] Event Horizon Telescope Collaboration, K. Akiyama, A. Alberdi, *et al.*, “First M87 Event Horizon Telescope Results. VI. The Shadow and Mass of the Central Black Hole,” *ApJL*, vol. 875, no. 1, L6, p. L6, Apr. 2019. DOI: [10.3847/2041-8213/ab1141](https://doi.org/10.3847/2041-8213/ab1141). *arXiv: 1906.11243 [astro-ph.GA]*.
- [39] Event Horizon Telescope Collaboration, K. Akiyama, A. Alberdi, *et al.*, “First M87 Event Horizon Telescope Results. V. Physical Origin of the Asymmetric Ring,” *ApJL*, vol. 875, no. 1, L5, p. L5, Apr. 2019. DOI: [10.3847/2041-8213/ab0f43](https://doi.org/10.3847/2041-8213/ab0f43). *arXiv: 1906.11242 [astro-ph.GA]*.
- [40] Event Horizon Telescope Collaboration, K. Akiyama, A. Alberdi, *et al.*, “First M87 Event Horizon Telescope Results. IV. Imaging the Central Supermassive Black Hole,” *ApJL*, vol. 875, no. 1, L4, p. L4, Apr. 2019. DOI: [10.3847/2041-8213/ab0e85](https://doi.org/10.3847/2041-8213/ab0e85). *arXiv: 1906.11241 [astro-ph.GA]*.
- [41] Event Horizon Telescope Collaboration, K. Akiyama, A. Alberdi, *et al.*, “First M87 Event Horizon Telescope Results. III. Data Processing and Calibration,” *ApJL*, vol. 875, no. 1, L3, p. L3, Apr. 2019. DOI: [10.3847/2041-8213/ab0c57](https://doi.org/10.3847/2041-8213/ab0c57). *arXiv: 1906.11240 [astro-ph.GA]*.
- [42] Event Horizon Telescope Collaboration, K. Akiyama, A. Alberdi, *et al.*, “First M87 Event Horizon Telescope Results. II. Array and Instrumentation,” *ApJL*, vol. 875, no. 1, L2, p. L2, Apr. 2019. DOI: [10.3847/2041-8213/ab0c96](https://doi.org/10.3847/2041-8213/ab0c96). *arXiv: 1906.11239 [astro-ph.IM]*.
- [43] Event Horizon Telescope Collaboration, K. Akiyama, A. Alberdi, *et al.*, “First M87 Event Horizon Telescope Results. I. The Shadow of the Supermassive Black Hole,” *ApJL*, vol. 875, no. 1, L1, p. L1, Apr. 2019. DOI: [10.3847/2041-8213/ab0ec7](https://doi.org/10.3847/2041-8213/ab0ec7). *arXiv: 1906.11238 [astro-ph.GA]*.
- [44] G.-Y. Zhao, T. Jung, B. W. Sohn, *et al.*, “Source-Frequency Phase-Referencing Observation of AGNS with KAVA Using Simultaneous Dual-Frequency Receiving,” *Journal of Korean Astronomical Society*, vol. 52, no. 1, L1, pp. 23–30, Feb. 2019. DOI: [10.5303/JKAS.2019.52.1.23](https://doi.org/10.5303/JKAS.2019.52.1.23). *arXiv: 1903.11796 [astro-ph.IM]*.
- [45] S. Issaoun, M. D. Johnson, L. Blackburn, *et al.*, “The Size, Shape, and Scattering of Sagittarius A\* at 86 GHz: First VLBI with ALMA,” *ApJ*, vol. 871, no. 1, 30, p. 30, Jan. 2019. DOI: [10.3847/1538-4357/aaf732](https://doi.org/10.3847/1538-4357/aaf732). *arXiv: 1901.06226 [astro-ph.HE]*.
- [46] D.-W. Kim, S. Trippe, S.-S. Lee, *et al.*, “Exploring the nature of the 2016  $\gamma$ -ray emission in the blazar 1749+096,” *MNRAS*, vol. 480, no. 2, 30, pp. 2324–2333, Oct. 2018. DOI: [10.1093/mnras/sty1993](https://doi.org/10.1093/mnras/sty1993). *arXiv: 1807.07252 [astro-ph.GA]*.
- [47] M. D. Johnson, R. Narayan, D. Psaltis, *et al.*, “The Scattering and Intrinsic Structure of Sagittarius A\* at Radio Wavelengths,” *ApJ*, vol. 865, no. 2, 104, p. 104, Oct. 2018. DOI: [10.3847/1538-4357/aadcff](https://doi.org/10.3847/1538-4357/aadcff). *arXiv: 1808.08966 [astro-ph.GA]*.
- [48] J. Park, M. Kam, S. Trippe, *et al.*, “Revealing the Nature of Blazar Radio Cores through Multifrequency Polarization Observations with the Korean VLBI Network,” *ApJ*, vol. 860,

no. 2, 112, p. 112, Jun. 2018. DOI: [10.3847/1538-4357/aac490](https://doi.org/10.3847/1538-4357/aac490). arXiv: [1805.04299](https://arxiv.org/abs/1805.04299) [[astro-ph.HE](#)].

- [49] J.-C. Algaba, S.-S. Lee, B. Rani, *et al.*, “Exploring the Variability of the Flat-spectrum Radio Source 1633+382. II. Physical Properties,” *ApJ*, vol. 859, no. 2, 128, p. 128, Jun. 2018. DOI: [10.3847/1538-4357/aac2e7](https://doi.org/10.3847/1538-4357/aac2e7). arXiv: [1805.02849](https://arxiv.org/abs/1805.02849) [[astro-ph.HE](#)].
- [50] J. A. Hodgson, B. Rani, S.-S. Lee, *et al.*, “KVN observations reveal multiple  $\gamma$ -ray emission regions in 3C 84?” *MNRAS*, vol. 475, no. 1, 128, pp. 368–378, Mar. 2018. DOI: [10.1093/mnras/stx3041](https://doi.org/10.1093/mnras/stx3041). arXiv: [1802.02763](https://arxiv.org/abs/1802.02763) [[astro-ph.HE](#)].
- [51] J.-Y. Kim, S.-S. Lee, J. A. Hodgson, *et al.*, “Long-term millimeter VLBI monitoring of M 87 with KVN at milliarcsecond resolution: nuclear spectrum,” *A&A*, vol. 610, no. 2, L5, p. L5, Feb. 2018. DOI: [10.1051/0004-6361/201732421](https://doi.org/10.1051/0004-6361/201732421). arXiv: [1801.10038](https://arxiv.org/abs/1801.10038) [[astro-ph.GA](#)].
- [52] J.-C. Algaba, S.-S. Lee, D.-W. Kim, *et al.*, “Exploring the Variability of the Flat Spectrum Radio Source 1633+382. I. Phenomenology of the Light Curves,” *ApJ*, vol. 852, no. 1, 30, p. 30, Jan. 2018. DOI: [10.3847/1538-4357/aa9e50](https://doi.org/10.3847/1538-4357/aa9e50). arXiv: [1711.10120](https://arxiv.org/abs/1711.10120) [[astro-ph.HE](#)].
- [53] G.-Y. Zhao, J. C. Algaba, S. S. Lee, *et al.*, “The Power of Simultaneous Multi-frequency Observations for mm-VLBI: Beyond Frequency Phase Transfer,” *AJ*, vol. 155, no. 1, 26, p. 26, Jan. 2018. DOI: [10.3847/1538-3881/aa99e0](https://doi.org/10.3847/1538-3881/aa99e0). arXiv: [1712.06243](https://arxiv.org/abs/1712.06243) [[astro-ph.IM](#)].
- [54] I. Cho, T. Jung, G.-Y. Zhao, *et al.*, “A comparative study of amplitude calibrations for the East Asia VLBI Network: A priori and template spectrum methods,” *PASJ*, vol. 69, no. 6, 87, p. 87, Dec. 2017. DOI: [10.1093/pasj/psx090](https://doi.org/10.1093/pasj/psx090). arXiv: [1710.10041](https://arxiv.org/abs/1710.10041) [[astro-ph.IM](#)].
- [55] D.-W. Kim, S. Trippe, S.-S. Lee, *et al.*, “The Millimeter-Radio Emission of BL Lacertae During Two  $\gamma$ -ray Outbursts,” *Journal of Korean Astronomical Society*, vol. 50, no. 6, 87, pp. 167–178, Dec. 2017. DOI: [10.5303/JKAS.2017.50.6.167](https://doi.org/10.5303/JKAS.2017.50.6.167). arXiv: [1711.05952](https://arxiv.org/abs/1711.05952) [[astro-ph.GA](#)].
- [56] K. Hada, J. H. Park, M. Kino, *et al.*, “Pilot KaVA monitoring on the M 87 jet: Confirming the inner jet structure and superluminal motions at sub-pc scales,” *PASJ*, vol. 69, no. 4, 71, p. 71, Aug. 2017. DOI: [10.1093/pasj/psx054](https://doi.org/10.1093/pasj/psx054). arXiv: [1706.02066](https://arxiv.org/abs/1706.02066) [[astro-ph.HE](#)].
- [57] H. Sudou, S. Iguchi, and G.-Y. Zhao, “VLBI Monitoring of the Sub-parsec-scale Jet in the Radio Galaxy 3C 66B at 22 GHz,” *ApJ*, vol. 841, no. 2, 103, p. 103, Jun. 2017. DOI: [10.3847/1538-4357/aa720a](https://doi.org/10.3847/1538-4357/aa720a). arXiv: [1706.05159](https://arxiv.org/abs/1706.05159) [[astro-ph.GA](#)].
- [58] S.-S. Lee, K. Wajima, J.-C. Algaba, *et al.*, “Interferometric Monitoring of Gamma-Ray Bright AGNs. I. The Results of Single-epoch Multifrequency Observations,” vol. 227, no. 1, 8, p. 8, Nov. 2016. DOI: [10.3847/0067-0049/227/1/8](https://doi.org/10.3847/0067-0049/227/1/8). arXiv: [1610.09121](https://arxiv.org/abs/1610.09121) [[astro-ph.GA](#)].
- [59] J. A. Hodgson, S.-S. Lee, G.-Y. Zhao, *et al.*, “The Automatic Calibration of Korean VLBI Network Data,” *Journal of Korean Astronomical Society*, vol. 49, no. 4, 103, pp. 137–144, Aug. 2016. DOI: [10.5303/JKAS.2016.49.4.137](https://doi.org/10.5303/JKAS.2016.49.4.137). arXiv: [1607.07969](https://arxiv.org/abs/1607.07969) [[astro-ph.IM](#)].
- [60] J.-C. Algaba, G.-Y. Zhao, S.-S. Lee, *et al.*, “Interferometric Monitoring of GAMMA-RAY Bright Active Galactic Nuclei II: Frequency Phase Transfer,” *Journal of Korean Astronomical Society*, vol. 48, no. 5, 103, pp. 237–255, Oct. 2015. DOI: [10.5303/JKAS.2015.48.5.237](https://doi.org/10.5303/JKAS.2015.48.5.237). arXiv: [1510.05817](https://arxiv.org/abs/1510.05817) [[astro-ph.IM](#)].



- [61] K. Hayasaki, B. W. Sohn, A. T. Okazaki, *et al.*, “Warping and tearing of misaligned circumbinary disks around eccentric supermassive black hole binaries,” *JCAP*, vol. 2015, no. 7, 103, pp. 005–005, Jul. 2015. DOI: [10.1088/1475-7516/2015/07/005](https://doi.org/10.1088/1475-7516/2015/07/005). arXiv: [1502.00181](https://arxiv.org/abs/1502.00181) [[astro-ph.GA](#)].
- [62] G.-Y. Zhao, Y.-J. Chen, Z.-Q. Shen, *et al.*, “Multi-Epoch Multi-Frequency VLBI Study of the Parsec-Scale Jet in the Blazar 3C 66A,” *AJ*, vol. 149, no. 2, 46, p. 46, Feb. 2015. DOI: [10.1088/0004-6256/149/2/46](https://doi.org/10.1088/0004-6256/149/2/46). arXiv: [1501.02413](https://arxiv.org/abs/1501.02413) [[astro-ph.HE](#)].
- [63] K. Niinuma, S.-S. Lee, M. Kino, *et al.*, “VLBI observations of bright AGN jets with the KVN and VERA Array (KaVA): Evaluation of imaging capability,” *PASJ*, vol. 66, no. 6, 103, p. 103, Dec. 2014. DOI: [10.1093/pasj/psu104](https://doi.org/10.1093/pasj/psu104). arXiv: [1406.4356](https://arxiv.org/abs/1406.4356) [[astro-ph.IM](#)].
- [64] K. Hayasaki, B. W. Sohn, A. T. Okazaki, *et al.*, “Radiation-driven Warping of Circumbinary Disks around Eccentric Young Star Binaries,” *ApJ*, vol. 797, no. 1, 68, p. 68, Dec. 2014. DOI: [10.1088/0004-637X/797/1/68](https://doi.org/10.1088/0004-637X/797/1/68). arXiv: [1410.8128](https://arxiv.org/abs/1410.8128) [[astro-ph.EP](#)].
- [65] G.-Y. Zhao, Y.-J. Chen, Z.-Q. Shen, *et al.*, “Multi-Frequency VLBA Studies of the Parsec-Scale Jets in 3C 66A and 3C 66B,” *Journal of Astrophysics and Astronomy*, vol. 35, no. 3, 68, pp. 209–213, Sep. 2014. DOI: [10.1007/s12036-014-9196-x](https://doi.org/10.1007/s12036-014-9196-x). arXiv: [1410.8128](https://arxiv.org/abs/1410.8128) [[astro-ph.EP](#)].
- [66] K. Hayasaki, B. W. Sohn, A. T. Okazaki, *et al.*, “Warped Circumbinary Disks in Active Galactic Nuclei,” *ApJ*, vol. 790, no. 1, 62, p. 62, Jul. 2014. DOI: [10.1088/0004-637X/790/1/62](https://doi.org/10.1088/0004-637X/790/1/62). arXiv: [1406.2317](https://arxiv.org/abs/1406.2317) [[astro-ph.GA](#)].
- [67] W.-P. Liu, G.-Y. Zhao, Y. J. Chen, *et al.*, “An Hourglass Model for the Flare of HST-1 in M87,” *AJ*, vol. 146, no. 6, 155, p. 155, Dec. 2013. DOI: [10.1088/0004-6256/146/6/155](https://doi.org/10.1088/0004-6256/146/6/155). arXiv: [1311.2457](https://arxiv.org/abs/1311.2457) [[astro-ph.HE](#)].
- [68] Y. J. Chen, G.-Y. Zhao, and Z.-Q. Shen, “The core-like nature of HST-1 in the M87 jet,” *MNRAS*, vol. 416, no. 1, 155, pp. L109–L113, Sep. 2011. DOI: [10.1111/j.1745-3933.2011.01110.x](https://doi.org/10.1111/j.1745-3933.2011.01110.x). arXiv: [1107.0769](https://arxiv.org/abs/1107.0769) [[astro-ph.CO](#)].
- [69] G.-Y. Zhao, Y.-J. Chen, Z.-Q. Shen, *et al.*, “Position Measurements of the Core in 3C 66B,” *Journal of Astrophysics and Astronomy*, vol. 32, no. 1-2, 155, pp. 61–63, Jun. 2011. DOI: [10.1007/s12036-011-9019-2](https://doi.org/10.1007/s12036-011-9019-2). arXiv: [1311.2457](https://arxiv.org/abs/1311.2457) [[astro-ph.HE](#)].