Sheperd Doeleman - CV

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Education

1986	BA in Physics, Reed College, Portland, OR.
1995	PhD in Physics, Massachusetts Institute of Technology, Cambridge, MA

Employment/Positions

1986-1988	Research Fellow, Bartol Research Institute, McMurdo Station Antarctica
1995-1998	Postdoctoral Fellow, MIT Haystack Observatory
1998-2009	Research Scientist, MIT Haystack Observatory
2009-2016	Principal Research Scientist, MIT Haystack Observatory
2010-2016	Assistant Director, MIT Haystack Observatory
2012-2016	Astrophysicist, Harvard-Smithsonian Center for Astrophysics
2016-2023	Senior General Engineer, Smithsonian Astrophysical Observatory
2016-present	Senior Research Fellow, Harvard University, Astronomy Dept.
2016-present	Assistant Director, Black Hole Initiative – Harvard University
2016-present	Founding Director, Event Horizon Telescope Consortium
2023-present	Astrophysicist, Smithsonian Astrophysical Observatory

Teaching/Mentoring

1991 – 1994	Graduate Teaching Assistant, MIT Physics Department
Spring 1993	Recitation Instructor, Introductory Mechanics, MIT Physics Department
Spring 2002	Recitation Instructor, Introductory E+M, MIT School of Engineering
Spring 2004	Course Instructor, Introductory E+M, MIT School of Engineering
1998-present	Mentor for 12 Undergraduate Students through the REU, UROP and SAO Research Intern programs.
2008-present	Postdoctoral Fellows: Vincent Fish, Rusen Lu, Laura Vertatschitsch, Michael Johnson, Lindy Blackburn, Andre Young, Hotaka Shiokawa, Kazu Akiyama, Katie Bouman, Alex Raymond, Dominic Pesce, Maciek Wielgus, Mislav Balokovic, Christian Fromm, Freek Roelofs, Sara Issaoun, Koushik Chatterjee, Prashant Kocherlakota, Paul Tiede, Alex (Sasha) Plavin.
2012-present	Graduate Students: Katherine Rosenfeld, Andrew Chael, Daniel Palumbo.

Professional Activities

Peer Reviewer: *Astrophysical Journal, Science, PASJ, Nature, MNRAS*
NSF Grant Reviewer: AST, OPP divisions
VLBI Future Committee (2003-2004)
Arecibo Users and Scientific Advisory Committee 2006-2008 (chair 2008)
NRAO Users Committee (2012 - 2015)
ALMA North America Science Advisory Committee – ANASAC (2012 – 2015)
Breakthrough Prize Committee (2020 - present)
Falling Walls Scientific Selection Jury (2020 - 2023)

Awards

To SD:

MIT Buechner Teaching Prize, 1993.
DAAD Grant for Research Visit to MPIfR in Bonn, 1996.
MIT Excellence Award – Awarded for Community Outreach, 2003.
Guggenheim Fellowship: "Building an event horizon telescope", 2012.
American Astronomical Society Lancelot M. Berkeley Prize, 2020
National Academy of Sciences Henry Draper Medal, 2021
Georges Lemaître International Prize, 2023

To SD & the EHT:

Smithsonian American Ingenuity Award (2019)
AAS High Energy Astrophysics Division Bruno Rossi Prize (2020)

To the EHT Collaboration:

NSF Diamond Achievement Award (2019)
Breakthrough Prize in Fundamental Physics (2020)
National Space Club & Foundation, Nelson P. Jackson Award (2020)
Albert Einstein Society, Einstein Medal (2020)

Grant History: $50M+ to create and sustain the EHT.

(Past Awards)

NSF AST-0096454
"Astronomical Research and Technical Support of Millimeter-Wavelength VLBI"
PI: A.E.E. Rogers co-PI: S.S. Doeleman, R.B. Phillips
May 2001 to April 2004, total amount $1.2M

NSF AST-0352953
"Ultra High Sensitivity VLBI: A Leap in Bandwidth"
PI: S.S. Doeleman co-PI: C.J. Lonsdale, A.R. Whitney
August 2004 to July 2008, total amount $950K

NSF AST-0521233
"Development of a Flexible Wideband Digital Backend for Radio Interferometry"
PI: A. Whitney co-PI: S.S. Doeleman, A.E.E. Rogers
April 2006 to April 2009, total amount $631K

NSF AST-0603971
"Advanced Correlation Techniques for Next-Generation Radio Arrays"
PI: C. Lonsdale co-PI: S.S. Doeleman, D. Oberoi
May 2006 to May 2009, total amount $400K

NSF AST-0705062
"Development of a Burst Mode Data Recorder for Radio Astronomy"
PI: A. Whitney co-PI: S.S. Doeleman
June 2007 to June 2010, total amount $540K

NSF AST-0722168
"Development of a Cooled Sapphire Oscillator Frequency Standard for VLBI"
PI: A. Whitney co-PI: S.S. Doeleman
Aug 2007 to Aug 2011, total amount $460K

NSF AST-0807843
"Techniques of Submm-VLBI: Observing an Event Horizon"
PI: S.S. Doeleman co-PI: A. Rogers
June 2008 to June 2011, total amount $335K

NSF AST-0905844
"High Sensitivity VLBI Arrays: Towards Imaging an Event Horizon"
PI: S.S. Doeleman co-PI: A. Rogers, A. Whitney
Aug 2009 to July 2013, total amount $2.7M

NSF AST-0908731
"Ultra Wideband VLBI: Origins of Extragalactic Jets"
PI: S.S. Doeleman
July 2009 to July 2012, total amount $363K

NSF OIA-0922984
"MRI: Acquisition of a Stable Hydrogen Maser Frequency Standard for mm/submm VLBI Observations of a Black Hole Event Horizon"
PI: S.S. Doeleman
Sept 2009 to Sept 2012, total amount $288K (plus $123K international cost-sharing)

MIT International Science & Technology Initiatives (MISTI) Grant
"Phasing the Atacama Large Telescope Array for Observing a Black Hole Event Horizon"
PI: S.S. Doeleman
Jan 2012 – March 2015, total amount $30K

Smithsonian Astrophysical Observatory
"Chandra HETG Ultra-deep Gratings Spectroscopy of SgrA* (CHUGSS)"
PI: F. Baganoff (MIT) co-PI: (multiple, including S.S. Doeleman)
Jan 2012 to Jan 2015, total amount $4K

NSF OIA-1126433
"MRI: Development of an ALMA Beamformer for Ultra High Resolution VLBI and High Frequency Phased Array Science"
PI: S.S. Doeleman co-PI: A. Whitney
Aug 2011 to Aug 2015, total amount $2.76M (plus $1.3M international cost-sharing)
In 2016, PI of this grant was transferred to L. Matthews upon Doeleman's move to the Harvard Smithsonian Center for Astrophysics.

NSF AST-1207704
"Collaborative Research: Building an Event Horizon Telescope: (Sub)millimeter VLBI from the South Pole Telescope"
PI: S.S. Doeleman
July 2012 to July 2015, total amount $191K

NSF AST-1211539
"Spatially Resolving the Black Hole Event Horizon: (sub)mm VLBI of SgrA* and M87"
PI: S.S. Doeleman co-PI: V. Fish
July 2012 to July 2015, total amount $382K

NRAO ALMA Development Program
"ALMA Phasing Project Augmentation"
PI: S.S. Doeleman
Feb 2013 to Aug 2015, total amount $260K

Gordon & Betty Moore Foundation: GBMF-3561
"Imaging supermassive black holes with an Earth-sized radio telescope"
PI: S.S. Doeleman co-PI: J. Weintroub
Feb 2013 to Feb 2017, total amount $1.8M

NSF AST-1310896
"Building the Event Horizon Telescope: Observing Black Holes with Schwarzschild Radius Resolution"
PI: S.S. Doeleman
August 2013 to August 2017, total amount $2.29M

NSF AST-1337663
"Acquisition of Stable Hydrogen Maser Frequency Standards for Millimeter/Submillimeter VLBI Observations of a Black Hole Event Horizon"
PI: S.S. Doeleman co-PI: J. Weintroub
August 2013 to present, total amount $411K (plus $176K institutional cost-sharing from SAO).

MIT International Science & Technology Initiatives (MISTI) Grant
"Imaging Black Holes with the Gran Telescopio Milimetrico"
PI: S.S. Doeleman
Jan 2014 – Jan 2016, total amount $30K

Smithsonian Institution Competitive Grants Program for Science (CGPS) Grant
"VLBI with the LMT: Bringing Black Holes into Focus"
PI: S.S. Doeleman
Jan 2014 – Jan 2016, total amount $100K

Smithsonian Institution Competitive Grants Program for Science (CGPS) Grant
"Weighing the neutrino with Radio Frequency Techniques"
PI: S.S. Doeleman
Jan 2015 – Jan 2017, total amount $60K

NSF AST-1555365
"MRI: Development of an ALMA Beamformer for Ultra High Resolution VLBI and High Frequency Phased Array Science [Extension]"
PI: S.S. Doeleman
Sept 2015 – Sept 2016, total projected amount $315K

NRAO: ALMA-NA Development Fund
"Digital Correlator and Phased Array Architectures for Upgrading ALMA"
PI: J. Weintroub co-PI's: S. Doeleman, R. Escoffier, A. Baudry, R. Lacasse, B. Carlson
Apr 2016 – Sept 2017, total amount $148K

NRAO: ALMA-NA Development Fund
"Pulsars, Magnetars, and Transients with Phased ALMA"
PI: J. Cordes co-PI's: S. Doeleman, M. Kramer, S. Ransom
Feb 2016 – June 2017, total amount $185K

NRAO: ALMA-NA Development Fund
"ALMA Study Project: Extensions and Enhancements to the ALMA Phasing System"
PI: L. Matthews co-PI's: S. Doeleman, G. Crew, V. Fish, M. Hecht
Feb 2016 – June 2017, total amount $200K

John Templeton Foundation (Grant #60477)
"The Black Hole Initiative: Towards a Center for Interdisciplinary Research"
PI: S. Doeleman co-I's: A. Loeb, R. Narayan, A. Strominger, P. Galison, S.T. Yau
Sept 2016 – Sept 2019, total amount $7.2M

NSF AST – 1716536 (Astronomy & Astrophysics Research Grants)
"Collaborative Research: Connecting 3D Simulations of Magnetized Disks and Jets with Direct Event Horizon Telescope Observations"
PI: S. Doeleman co-PI: M. Johnson
May 2017 – May 2020, total projected amount $126K

NSF AST- 1440254 & AST-1952099 (Mid-Scale Innovation Program)
"The Event Horizon Telescope Experiment"
PI: S.S. Doeleman co-I's: N. Erickson, V. Fish, D. Marrone, G. Narayanan
Jan 2015 – Jun 2021, total projected amount $7.8M

Gordon & Betty Moore Foundation: GBMF-5278
"Enhancing the Event Horizon Telescope: Sharpening Our Views of Black Holes"
PI: S.S. Doeleman co-PI: J. Weintroub, M. Johnson
Nov 2016 - Jan 2022, total projected amount $2.0M

NSF AST- 1726637 (Major Research Instrumentation)
"MRI: Development of Next Generation Digital Signal Processing Platforms for Astronomy"
PI: S.S. Doeleman co-PI: J. Weintroub
Aug 2017 – Aug 2022, total projected amount $1.2M ($371K SAO cost-sharing included).

NSF AST-1743747 (Partnership for International Research and Education)
"PIRE: Black Hole Astrophysics in the Era of Distributed Resources and Expertise"
PI: D. Psaltis co-PI's: S. Doeleman, D. Marrone, F. Özel, C. Gammie
Aug 2017 – Aug 2022, total projected amount $5.7M ($790K sub-award to SAO, PI Doeleman).

NSF AST- 1828513 (Major Research Instrumentation)
"MRI: Development of a Cloud Computing Platform for Interferometric Processing"
PI: S.S. Doeleman co-PI: J. Weintroub
Aug 2018 – Aug 2022, total projected amount $1.2M ($363K SAO cost-sharing included).

John Templeton Foundation (Grant #61497)
"The Black Hole Initiative: Phase II"
PI: S. Doeleman co-I's: A. Loeb, R. Narayan, A. Strominger, P. Galison, S.T. Yau
Sept 2019 – Sept 2022, total projected amount $3.6M

(Current Awards)

NSF Mid-Scale Research Infrastructure (MSRI-I)
"Mid-scale RI-1 (M1:DP): Next Generation Event Horizon Telescope Design"
PI: S. Doeleman co-I's: M. Johnson, L. Blackburn, J. Weintroub
Oct 2019 – Oct 2024, total projected amount $14.7M

NSF Mid-Scale Innovation Program (MSIP)
"The Event Horizon Telescope: Resolving Black Holes in Time and Space"
PI: V. Fish co-I's: S. Doeleman, D. Marrone
Oct 2020 – Aug 2024, total requested amount $11.6M ($1.9M sub-award to SAO, PI Doeleman).

Gordon & Betty Moore Foundation: GBMF-10423
"Enabling the Next-Generation Event Horizon Telescope: Towards Movies of Black Holes"
PI: S.S. Doeleman co-PI: M. Johnson
Jun 2021 - May 2025, total projected amount $6.86M

John Templeton Foundation (Grant #62286)
"The Black Hole Initiative Phase 3"
PI: S. Doeleman co-I's: N. Engelhardt, P. Galison, A. Loeb, R. Narayan, P. Natarajan, A. Strominger, S.T. Yau
Sept 2022 – Sept 2025, total projected amount $4.4M

Refereed Journal Publications

1. Doeleman, S., et al, "Reference Array and Design Consideration for the next-generation Event Horizon Telescope", to appear in Galaxies (2023). https://arxiv.org/abs/2306.08787
2. Emami, R., Doeleman, S., Wielgus, M., et al., "The EB-correlation in Resolved Polarized Images: Connections to Astrophysics of Black Holes," *ApJ*, in press, 2023. 10.48550/arXiv.2305.00387
3. Johnson, M.J., et al., "Key Science Goals of the next-generation Event Horizon Telescope," *Galaxies,* vol. 11, no. 1, p. 61, 2023. https://doi.org/10.3390/galaxies11030061

4. Curd, B., Emami, R., Anantua, R., Palumbo, D., Doeleman, S., and Narayan, R., "Jets from SANE super-Eddington accretion discs: morphology, spectra, and their potential as targets for ngEHT",*MNRAS*, vol. 519, no. 2, pp. 2812–2837, 2023. doi:10.1093/mnras/stac3716.
5. Chatterjee, K., et al., "Accretion Flow Morphology in Numerical Simulations of Black Holes from the ngEHT Model Library: The Impact of Radiation Physics", *Galaxies*, vol. 11, no. 2, p. 38, 2023. doi:10.3390/galaxies11020038.
6. Issaoun, S., et al., "Enabling Transformational ngEHT Science via the Inclusion of 86 GHz Capabilities", *Galaxies*, vol. 11, no. 1, p. 28, 2023. doi:10.3390/galaxies11010028.
7. Jorstad, S., et al., "The Event Horizon Telescope Image of the Quasar NRAO 530", *ApJ*, vol. 943, no. 2, 2023. doi:10.3847/1538-4357/acaea8.
8. Emami, R., et al., "Tracing Hot Spot Motion in Sagittarius A* Using the Next-Generation Event Horizon Telescope (ngEHT)", *Galaxies*, vol. 11, no. 1, p. 23, 2023. doi:10.3390/galaxies11010023.
9. Ramakrishnan, V., et al., "Event Horizon and Environs (ETHER): A Curated Database for EHT and ngEHT Targets and Science", *Galaxies*, vol. 11, no. 1, p. 15, 2023. doi:10.3390/galaxies11010015.
10. Roelofs, F., et al., "The ngEHT Analysis Challenges", *Galaxies*, vol. 11, no. 1, p. 12, 2023. doi:10.3390/galaxies11010012.
11. Emami, R., et al., "Probing Plasma Composition with the Next Generation Event Horizon Telescope (ngEHT)", *Galaxies*, vol. 11, no. 1, p. 11, 2023. doi:10.3390/galaxies11010011.
12. Okino, H., et al., "Collimation of the Relativistic Jet in the Quasar 3C 273", *ApJ*, vol. 940, no. 1, 2022. doi:10.3847/1538-4357/ac97e5.
13. Kurczynski, P., et al., "The Event Horizon Explorer mission concept", in *Space Telescopes and Instrumentation 2022: Optical, Infrared, and Millimeter Wave*, 2022, vol. 12180. doi:10.1117/12.2630313.
14. Broderick, A. E., et al., "The Photon Ring in M87*", *ApJ*, vol. 935, no. 1, 2022. doi:10.3847/1538-4357/ac7c1d.
15. Issaoun, S., et al., "Resolving the Inner Parsec of the Blazar J1924-2914 with the Event Horizon Telescope", *ApJ*, vol. 934, no. 2, 2022. doi:10.3847/1538-4357/ac7a40.
16. Broderick, A. E.,, et al., "Characterizing and Mitigating Intraday Variability: Reconstructing Source Structure in Accreting Black Holes with mm-VLBI", *ApJ*, vol. 930, no. 2, 2022. doi:10.3847/2041-8213/ac6584.
17. Georgiev, B., et al., "A Universal Power-law Prescription for Variability from Synthetic Images of Black Hole Accretion Flows", *ApJ*, vol. 930, no. 2, 2022. doi:10.3847/2041-8213/ac65eb.
18. Wielgus, M., et al., "Millimeter Light Curves of Sagittarius A* Observed during the 2017 Event Horizon Telescope Campaign", *ApJ*, vol. 930, no. 2, 2022. doi:10.3847/2041-8213/ac6428.
19. Farah, J., et al., "Selective Dynamical Imaging of Interferometric Data", *ApJ*, vol. 930, no. 2, 2022. doi:10.3847/2041-8213/ac6615.
20. Event Horizon Telescope, et al, "First Sagittarius A* Event Horizon Telescope Results. I. The Shadow of the Supermassive Black Hole in the Center of the Milky Way," *ApJ*, **930L**, 12A, (2022). https://iopscience.iop.org/article/10.3847/2041-8213/ac6674
21. Event Horizon Telescope, et al, "First Sagittarius A* Event Horizon Telescope Results. II. EHT and Multiwavelength Observations, Data Processing, and Calibration," *ApJ*, **930L**, 13A, (2022). https://iopscience.iop.org/article/10.3847/2041-8213/ac6675
22. Event Horizon Telescope, et al, "First Sagittarius A* Event Horizon Telescope Results. III. Imaging of the Galactic Center Supermassive Black Hole," *ApJ*, **930L**, 14A, (2022). https://iopscience.iop.org/article/10.3847/2041-8213/ac6429

23. Event Horizon Telescope, et al, "First Sagittarius A* Event Horizon Telescope Results. IV. Variability, Morphology, and Black Hole Mass," *ApJ*, **930L**, 15A, (2022). https://iopscience.iop.org/article/10.3847/2041-8213/ac6736

24. Event Horizon Telescope, et al, "First Sagittarius A* Event Horizon Telescope Results. V. Testing Astrophysical Models of the Galactic Center Black Hole," *ApJ*, **930L**, 16A, (2022). https://iopscience.iop.org/article/10.3847/2041-8213/ac6672

25. Event Horizon Telescope, et al, "First Sagittarius A* Event Horizon Telescope Results. VI. Testing the Black Hole Metric," *ApJ*, **930L**, 17A, (2022). doi:10.3847/1538-4357/ac332e.

26. Satapathy, K., et al., "The Variability of the Black-Hole Image in M87 at the Dynamical Time Scale," *ApJ,* vol. 925, no. 1, (2021). https://ui.adsabs.harvard.edu/link_gateway/2022ApJ...925...13S/doi:10.3847/1538-4357/ac332e

27. Pesce, D., Palumbo, D., Narayan, R., Blackburn, L., Doeleman, S., et al., "Towards determining the number of observable supermassive black hole shadows," *ApJ, in press*, (2021). https://ui.adsabs.harvard.edu/abs/2021arXiv210805228P/abstract

28. Janssen, M., et al., "Event Horizon Telescope observations of the jet launching and collimation in Centaurus A," *NatAs*, **5**, p.1017, (2021). https://ui.adsabs.harvard.edu/abs/2021NatAs...5.1017J/abstract

29. Issaoun, S., et al., "Persistent Non-Gaussian Structure in the Image of Sagittarius A* at 86GHz," *ApJ*, **915**, 99, (2021). https://ui.adsabs.harvard.edu/abs/2021ApJ...915...99I/abstract

30. Chesler, P.M., Blackburn, L., Doeleman, S., et al., "Light echos and coherent autocorrelations in a black hole spacetime," *Classical and Quantum Gravity*, **38**, 125006, (2021). https://ui.adsabs.harvard.edu/abs/2021CQGra..38l5006C/abstract

31. Kocherlakota, P., et al., "Constraints on black-hole charges with the 2017 EHT observations of M87*," *PhRvD,* **103**, 104047, (2021). *https://ui.adsabs.harvard.edu/abs/2021PhRvD.103j4047K/abstract*

32. Narayan, R., et al., "The Polarized Image of a Synchrotron-emitting Ring of Gas Orbiting a Black Hole," *ApJ,* **912**, 35, (2021). *https://iopscience.iop.org/article/10.3847/1538-4357/abf117*

33. EHT MWL Science Working Group, et al., "Broadband Multi-wavelength Properties of M87 during the 2017 Event Horizon Telescope Campaign," *ApJL,* **911**, 11, (2021). *https://iopscience.iop.org/article/10.3847/2041-8213/abef71*

34. Raymond, A., Palumbo, D., Paine, S., Blackburn, L., Córdova-Rosado, R., Doeleman, S. S., Farah, J. R., Johnson, M. D., Roelofs, F., Tilanus, R. P. J., Weintroub, J., "Evaluation of New Submillimeter VLBI Sites for the Event Horizon Telescope," *ApJS*, **253**, 5, (2021). *https://ui.adsabs.harvard.edu/abs/2021ApJS..253....5R/abstract*

35. Goddi, C, et al., "Polarimetric Properties of Event Horizon Telescope Targets from ALMA," *ApJL,* **910**, 14, (2021). *https://iopscience.iop.org/article/10.3847/2041-8213/abee6a*

36. Event Horizon Telescope Collaboration et al., "First M87 Event Horizon Telescope Results. VIII. Magnetic Field Structure near The Event Horizon," *ApJL,* **910**, 13, (2021). *https://iopscience.iop.org/journal/2041-8205/page/Focus_on_EHT*

37. Event Horizon Telescope Collaboration et al., "First M87 Event Horizon Telescope Results. VII. Polarization of the Ring," *ApJL,* **910**, 12, (2021). *https://iopscience.iop.org/journal/2041-8205/page/Focus_on_EHT*

38. Wielgus, M., Akiyama, K., Blackburn, L., Chan, C.-K., Dexter, J., Doeleman, S., et al. "Monitoring the Morphology of M87* in 2009-2017 with the Event Horizon Telescope," *ApJ*, **901**, 67, (2020).

39. Kim, J-Y., Krichbaum, T. P., Broderick, A. E., et al. "Event Horizon Telescope imaging of the archetypal blazar 3C 279 at an extreme 20 microarcsecond resolution," *A&A*, **640**, A69, (2020).

40. Gold, R., Broderick, A. E., Younsi, Z., et al. "Verification of Radiative Transfer Schemes for the EHT," *ApJ*, **897**, 148, (2020).

41. Broderick, A. E., Gold, R., Karami, M., et al. “THEMIS: A Parameter Estimation Framework for the Event Horizon Telescope,” *ApJ*, **897**, 139, (2020).

42. Blackburn, L., Pesce, D. W., Johnson, M. D., Wielgus, M., Chael, A. A., Christian, P., & Doeleman, S. S., “Closure Statistics in Interferometric Data,” *ApJ*, **894**, 31, (2020).

43. Roelofs, F., Janssen, M., Natarajan, I., et al. “SYMBA: An end-to-end VLBI synthetic data generation pipeline. Simulating Event Horizon Telescope observations of M 87,” *A&A*, **636**, A5, (2020).

44. Johnson, M. D., Lupsasca, A., Strominger, A., et al. "Universal interferometric signatures of a black hole's photon ring,” *Science Advances*, **6**, eaaz1310, (2020).

45. Doeleman, S., Blackburn, L., et al., “Studying Black Holes on Horizon Scales with VLBI Ground Arrays,” *BAAS*, **51**, 256, (2019). https://ui.adsabs.harvard.edu/abs/2019BAAS...51g.256D/abstract

46. Johnson, M. et al., “Studying black holes on horizon scales with space-VLBI,” *BAAS*, **51**, 235, (2019). https://ui.adsabs.harvard.edu/abs/2019BAAS...51g.235J/abstract

47. Liu, K. et al., “Detection of Pulses from the Vela Pulsar at Millimeter Wavelengths with Phased ALMA,” ApJL, **885**, 10, (2019).

48. Gill, A., Blackburn, L., Roshanineshat, A., Chan, C-K., Doeleman, S., Johnson, M., Raymond, A. & Weintroub, J., “Prospects for Wideband VLBI Correlation in the Cloud,” *PASP,* **131**, 124501, (2019).

49. Palumbo, D., Doeleman, S., Johnson, M., Bouman, K. & Chael, A., “Metrics and Motivations for Earth-Space VLBI: Time-Resolving SgrA* with the Event Horizon Telescope,” *ApJ*, **881**, 62, (2019). *https://arxiv.org/pdf/1906.08828.pdf*

50. Blackburn, L. et al., “EHT-HOPS pipeline for millimeter VLBI data reduction,” *ApJ*, **882**, 23, (2019). *https://arxiv.org/abs/1903.08832*

51. Doeleman, S. et al., “Black Hole Physics on Horizon Scales,” *BAAS* , **51** , 537, (2019). *https://baas.aas.org/wp-content/uploads/2019/05/537_doeleman.pdf*

52. Event Horizon Telescope Collaboration et al., “First M87 Event Horizon Telescope Results. VI. The Shadow and Mass of the Central Black Hole,” *ApJL,* **875**, 6, (2019).

53. Event Horizon Telescope Collaboration et al., “First M87 Event Horizon Telescope Results. V. Physical Origin of the Asymmetric Ring,” *ApJL,* **875**, 5, (2019).

54. Event Horizon Telescope Collaboration et al., “First M87 Event Horizon Telescope Results. IV. Imaging the Central Supermassive Black Hole,” *ApJL,* **875**, 4, (2019).

55. Event Horizon Telescope Collaboration et al., “First M87 Event Horizon Telescope Results. III. Data Processing and Calibration,” *ApJL,* **875**, 3, (2019).

56. Event Horizon Telescope Collaboration et al., “First M87 Event Horizon Telescope Results. II. Array and Instrumentation,” *ApJL,* **875**, 2, (2019).

57. Event Horizon Telescope Collaboration et al., “First M87 Event Horizon Telescope Results. I. The Shadow of the Supermassive Black Hole,” *ApJL,* **875**, 1, (2019).

58. Doeleman, S. et al, “Focus on the First Event Horizon Telescope Results,” *ApJL Focus Issue, https://iopscience.iop.org/journal/2041-8205/page/Focus_on_EHT*

59. Issaoun, S. et al, “The Size, Shape and Scattering of Sagittarius A* at 86GHz: First VLBI with ALMA,” *ApJ,* **871,** 30, (2019). https://arxiv.org/abs/1901.06226

60. Brinkerink, C. et al, “Micro-arcsecond structure of Sagittarius A* revealed by high-sensitivity 86GHz VLBI observations,” *A&A*, ***621,*** A119, (2019). *https://arxiv.org/abs/1811.08394*

61. Bower, G. et al, “ALMA Polarimetry of SgrA*: Probing the Accretion Flow from the Event Horizon to the Bondi Radius,” *ApJ,* **868**, 101, (2018). *https://arxiv.org/abs/1810.07317*

62. Kim, J. et al, “A VLBI receiving system for the South Pole Telescope,” *Proc. SPIE*, **10708**, 19, (2018). DOI: 10.1117/12.2301005

63. Kubo, D. et al, "Electronics instrumentation for the Greenland Telescope," *Proc. SPIE*, **10708**, 19, (2018). DOI: 10.1117/12.2312241

64. Nishioka, H. et al, "Control and monitoring system for the Greenland Telescope: computers, network and software," *Proc. SPIE*, **10700**, 11, (2018). DOI: 10.1117/12.2313104

65. Matsushita, S. et al, "Commissioning status of the Greenland Telescope (GLT)," *Proc. SPIE*, **10700**, 10, (2018). DOI: 10.1117/12.2310046

66. Chen, M-T. et al, "The Greenland telescope: Thule operations," *Proc. SPIE*, **10700**, 12, (2018). DOI: 10.1117/12.2313378

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