Sheperd Doeleman - Curriculum Vitae

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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-present	Senior Research Fellow, Harvard University, Astronomy Dept.
2016-present	Senior General Engineer, Smithsonian Astrophysical Observatory
2016-present	Assistant Director, Black Hole Initiative – Harvard University
2016-2019	Director, Event Horizon Telescope Consortium
2019-present	Founding Director, Event Horizon Telescope Consortium

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.
2012-present	Graduate Students: Katherine Rosenfeld, Andrew Chael, Daniel Palumbo.

Awards

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, 2012: “Building an event horizon telescope”
AAS Lancelot M. Berkeley Prize, 2020
National Academy of Sciences Henry Draper Medal, 2021
Smithsonian American Ingenuity Award (2019) - to SD and the EHT
AAS HEAD Bruno Rossi Prize (2020) - to SD and the EHT
NSF Diamond Achievement Award (2019) - to the EHT
Breakthrough Prize in Fundamental Physics (2020) - to the EHT
National Space Club & Foundation, Nelson P. Jackson Award (2020) - to the EHT
Albert Einstein Society, Einstein Medal (2020) - to the EHT

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 - present)

Grant History: <u>More than $50M to create and sustain the EHT.</u>

(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)

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

(Current Awards)

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 2021, 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. Ozel, 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 2021, 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

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 2023, total projected amount $12.7M

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 ($2.5M 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

Refereed Journal Publications

1. 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*
2. 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*
3. 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*
4. 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*
5. 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*
6. 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*
7. 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*
8. 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).
9. 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).

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

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

12. 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).

13. 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).

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

15. 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

16. 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

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

18. 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).

19. 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*

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

21. 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*

22. 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).

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

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

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

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

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

28. 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*

29. 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

30. 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*

31. 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*

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

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

34. 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

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

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

37. Kim, J. et al, "The 1.4mm Core of Centaurus A: First VLBI Results with the South Pole Telescope," *ApJ*, **861**, 129, (2018). *https://arxiv.org/abs/1805.09344*

38. Lu, R-S., Krichbaum, T., Roy, A., Fish, V., Doeleman, S. et al, " Detection of Intrinsic Source Structure at ~3 Schwarzschild Radii with Millimeter-VLBI Observations of Sagittarius A*," *ApJ*, **859**, 60, (2018). *https://arxiv.org/abs/1805.09223*

39. Matthews, L., Crew, G., Doeleman, S. et al, "The ALMA Phasing System: A Beamforming Capability for Ultra-high-resolution Science at (Sub)Millimeter Wavelengths," *PASP*, **130**, 015002, (2018). *https://arxiv.org/abs/1711.06770*

40. Bouman, K. et al, "Reconstructing Video from Interferometric Measurements of Time-Varying Sources," *in IEEE Transactions on Computational Imaging,* **4**, 512, (2018). *https://arxiv.org/abs/1711.01357*

41. Johnson, M. et al, "Dynamical Imaging with Interferometry," *ApJ,* **850**, 172, (2017). *https://arxiv.org/abs/1711.01286*

42. Doeleman, S., "Seeing the Unseeable," *NatAs*, **1**, 646, (2017). *https://arxiv.org/abs/1710.03104*

43. Roelofs, F., Johnson, M., Shiokawa, H., Doeleman, S. & Falcke, H., "Quantifying Intrinsic Variability of Sagittarius A* Using Closure Phase Measurements of the Event Horizon Telescope," *ApJ*, **847**, 55, (2017). *https://arxiv.org/abs/1708.01056*

44. Shiokawa, H., Gammie, C. & Doeleman, S., "Time Domain Filtering of Resolved Images of SgrA*," *ApJ*, **846**, 29, (2017). *https://arxiv.org/abs/1708.02577*

45. Akiyama, K. et al, "Superresolution Full-polarimetric Imaging for Radio Interferometry with Sparse Modeling," *AJ*, **153**, 159, (2017). *https://arxiv.org/abs/1702.00424*

46. Akiyama, K. et al, "Imaging the Schwarzschild-radius-scale Structure of M87 with the Event Horizon Telescope Using Sparse Modeling," *ApJ*, **838**, 1, (2017). *https://arxiv.org/abs/1702.07361*

47. Gold, R., McKinney, J., Johnson, M.D. & Doeleman, S.S., "Probing the magnetic field structure in Sgr A* on Black Hole Horizon Scales with Polarized Radiative Transfer Simulations," *ApJ,* **837**, 180, (2017). *http://arxiv.org/abs/1601.05550*

48. Brinkerink, C. et al, "Asymmetric structure in SgrA* at 3mm from closure phase measurements with VLBA, GBT and LMT," *MNRAS*, **462**, 1382, (2016). *https://arxiv.org/abs/1608.06515*

49. Fish, V. et al, "Observing – and Imaging – Active Galactic Nuclei with the Event Horizon Telescope," *Galaxies,* **4**, 54, (2016). *https://arxiv.org/abs/1607.03034*

50. Chael, A., Johnson, M., Narayan, R., Doeleman, S., Wardle, J. & Bouman, K., "High-resolution Linear Polarimetric Imaging for the Event Horizon Telescope," *ApJ*, **829**, 11, (2016). *https://arxiv.org/abs/1605.06156*

51. Ortiz-Leon, G., Johnson, M.D., Doeleman, S.S., et al, "The Intrinsic Shape of Sagittarius A* at 3.5mm Wavelength," *ApJ,* **824**, 40, (2016). *http://arxiv.org/abs/1601.06571*

52. Johannsen, T., Wang, C., Broderick, A., Doeleman, S., et al, "Testing General Relativity with Accretion-Flow Imaging of SgrA*," *PhRvL*, **116**, 091101, (2016).

53. Bouman, K.L., Johnson, M.D., Zoran, D., Fish, V.L., Doeleman, S.S. & Freeman, W.T., "Computational Imaging for VLBI Image Reconstruction," *The IEEE Conference on Computer Vision and Pattern Recognition (CVPR),* p. 913-922, (2016). http://arxiv.org/abs/1512.01413

54. Broderick, A.E., Fish, V.L., Johnson, M., Rosenfeld, K., Wang, C., Doeleman, S.S., et al, "Modeling Seven Years of Event Horizon Telescope Observations with Radiatively Inefficient Accretion Flow Models," *ApJ*, **820**, 137, (2016).

55. Fish, V.L., Johnson, M.J., Doeleman, S.S., et al, "Persistent Asymmetric Structure of Sagittarius A* on Event Horizon Scales," *ApJ*, **820**, 90, (2016).

56. Lu, R., Roelofs, F., Fish, V., Shiokawa, H., Doeleman, S.S., et al, "Imaging an Event Horizon: Mitigation of Source Variability of Sagittarius A*," *ApJ*, **817***,* 173, (2016).

57. Johannsen, T., Broderick, A.E., Plewa, P.M., Chatzopoulos, S., Doeleman, S.S., et al, "Testing general relativity with the shadow size of SgrA*," *Phys Rev. Let,* **116**, 031101, (2016).

58. Vertatschitsch, L., et al, "R2DBE: A Wideband Digital Backend for the Event Horizon Telescope," *PASP*, **127**, 1226, (2015).

59. Johnson, M., Fish, V., Doeleman, S., et al, "Resolved Magnetic-Field Structure and Variability Near the Event Horizon of Sagittarius A*," *Science*, **350**, 1242, (2015).

60. Johnson, M., Loeb, A., Shiokawa, H., Chael, A. & Doeleman, S.S., "Measuring the Direction and Angular Velocity of a Black Hole Accretion Disk via Lagged Interferometric Covariance," *ApJ,* **813**, 132, (2015).

61. Wagner, J., et al "First 230 GHz VLBI Fringes on 3C 279 using the APEX Telescope," *A&A*, **581**, 32, (2015).

62. Akiyama, K., Ru-Sen, L., Fish, V., Doeleman, S.S., et al, "230 GHz VLBI observations of M87: event-horizon-scale structure at the enhanced very-high-energy gamma-ray state in 2012," *ApJ,* **807**, 150, (2015).

63. Broderick, A., Narayan, R., Kormendy, J., Perlman, E., Rieke, M. & Doeleman, S.S., "The Event Horizon of M87," *ApJ*, **805**, 179*,* (2015).

64. Bower, G.C., et al "The Proper Motion of the Galactic Center Pulsar Relative to Sagittarius A*," *ApJ*, **798**, 120, (2015).

65. Psaltis, D., Narayan, R., Fish, V.L., Broderick, A., Loeb, A. & Doeleman, S.S., "Event Horizon Telescope Evidence for Alignment of the Black Hole in the Center of the Milky Way with the Inner Stellar Disk," *ApJ*, **798**, 15, (2015).

66. Plambeck, R., Bower, G.C., Rao, R., Marrone, D., Jorstad, S.G., Marcher, A., Doeleman, S.S., Fish, V.L. & Johnson, M.D., "Probing the Parsec-scale Accretion Flow of 3C 84 with Millimeter Wavelength Polarimetry," *ApJ*, **797**, 66, (2014).

67. Inoue, M. et al, "Greenland telescope project: Direct confirmation of black hole with sub-millimeter VLBI," *Radio Science*, **49**, 564, (2014). https://arxiv.org/abs/1407.2450

68. Fish, V.L., Johnson, M.D., Lu, R.-S., Doeleman, S.S., Bouman, K., Zoran, D., Freeman, W., Psaltis, D., Narayan, R., Pankratius, V., Broderick, A., Gwinn, C. & Vertatschitsch, L., "Imaging an Event Horizon: Mitigation of Scattering toward Sagittarius A*," *ApJ*, **795**, 134, (2014).

69. Johnson, M.D., Fish, V.L, Doeleman, S.S., Broderick, A.E., Wardle, J.F.C. & Marrone, D.P., "Relative Astrometry of Compact Flaring Structures in SgrA* with Polarimetric Very Long Baseline Interferometry," *ApJ*, **794**, 150, (2014).

70. Lu, R.-S., Broderick, Avery, A.E., Baron, F., Monnier, J.D., Fish, V.L., Doeleman, S.S. & Pankratius, V., "Imaging the Supermassive Black Hole Shadow and Jet Base of M87 with the Event Horizon Telescope," *ApJ*, **788**, 120L, (2014).

71. Lu, R.-S., Fish, V.L, Akiyama, K., Doeleman, S.S., et al, "Fine-scale structure of the quasar 3C279 measured with 1.3mm Very Long Baseline Interferometry," *ApJ,* **772**, 13L, (2013).

72. Whitney, A.R., Beaudoin, C.J., Cappallo, R.J., Corey, B.E., Crew, G.B., Doeleman, S.S., et al, "Demonstration of a 16 Gbps per Station Broadband-RF VLBI System," *PASP*, **125**, 196, (2013).

73. Doeleman, S.S., et al, "Jet launching structure resolved near the supermassive black hole in M87," *Science,* **338**, 355, (2012).

74. Johannsen, T., Psaltis, D., Gillessen, S., Marrone, D., Özel, F., Doeleman, S. & Fish, V., "Masses of Nearby Supermassive Black Holes with Very-Long Baseline Interferometry," *ApJ,* 758, 30, (2012).

75. Lu, R.-S., Fish, V., Weintroub, J., Doeleman, S., et al, "Resolving the Inner Jet Structure of 1924-292 with the Event Horizon Telescope," *ApJL*, **757**, L14, (2012).

76. Doeleman, S.S., Mai, T., Rogers, A.E.E., Hartnett, J.G., Tobar, M.E. & Nand, N., "Adapting a Cryogenic Sapphire Oscillator for Very Long Baseline Interferometry," *PASP*, **123**, 582, (2011).

77. Broderick, A.E., Fish, V.L., Doeleman, S.S., & Loeb, A., "Constraining the Structure of Sagittarius A*'s Accretion Flow with Millimeter Very Long Baseline Interferometry Closure Phases," *ApJ*, **738**, 38, (2011).

78. Broderick, A.E., Fish, V.L., Doeleman, S.S. & Loeb, A., "Evidence for Low Black Hole Spin and Physically Motivated Accretion Models from Millimeter VLBI Observations of Sagittarius A*," *ApJ*., **735**, 110, (2011).

79. Fish, V.L., Doeleman, S.S., et al, "1.3 mm Wavelength VLBI of Sagittarius A*: Detection of Time-Variable Emission on Event Horizon Scales," *ApJL*, **727**, L36, (2011).

80. Fish, V.L., Doeleman, S.S., Broderick, A.E., Loeb, A. & Rogers, A.E.E., "Detecting Changing Polarization Structures in Sagittarius A* with High Frequency VLBI," *ApJ*, **706**, 1353, (2009).

81. Broderick, A., Fish, V., Doeleman, S., Loeb, A., "Estimating the Parameters of SgrA*'s Accretion Flow via Millimeter VLBI", *ApJ*, **697**, 45, 2009.

82. Doeleman, S., Fish, V., Broderick, A., Loeb, A. & Rogers, A.E.E, "Detecting flaring structures in Sagittarius A* with high frequency VLBI", *ApJ*, **695**, 59, 2009

83. Fish, V., Broderick, A., Doeleman, S., Loeb, A., "Using Millimeter VLBI to Constrain RIAF Models of Sagittarius A*", *ApJL*, **692**, L14, 2009.

84. Doeleman, S. et al, "Imaging an Event Horizon: submm-VLBI of a Super Massive Black Hole," *astro2010: The Astronomy and Astrophysics Decadal Survey,* 68, (2009). *https://arxiv.org/abs/0906.3899*

85. Doeleman, S. et al, "Event-horizon-scale structure in the supermassive black hole candidate at the Galactic Centre", *Nature*, **455**, 78, 2008.

86. Pihlstrom, Y., Taylor, G., Granot, J. & Doeleman, S., "Stirring the Embers: High-Sensitivity VLBI Observations of GRB 030329", *ApJ*, **664**, 411, 2007.

87. Bowman, J.D. et al, "Field Deployment of Prototype Antenna Tiles for the Mileura Widefield Array Low Frequency Demonstrator", *AJ*, **133**, 1505, 2007.

88. Lonsdale, C.J., Doeleman, S., D. Oberoi, "Imaging Strategies and Postprocessing Computing Costs for Large-N SKA Designs", *Experimental Astronomy*, **17**, 345, 2004.

89. Doeleman, S., Lonsdale, C., Kondratko, P., Predmore, C.R., "Using VLBI to Probe the Orion KL Outflow on AU Scales", *ApJ*, **607**, 361, 2004.

90. Phillips, R.B., Straughn, A.H., Doeleman, S.S., Lonsdale, C.J., "R Cassiopeiae: Relative Strengths of SiO Masers at 43 and 86 GHz," *ApJ*, **588**, L105, 2003.

91. Doeleman, S.S., Rogers, A.E.E., Crowley, J.W., Wright, M.C.H., Backer, D.C., Bower, G.C., Freund, R.W., Woody, D.P., Lo, K.Y., Shen, Z.Q., Zhao, J.H., Ho, P.T.P., "Structure of Sgr A* at 86 GHz using VLBI Closure Quantities," *AJ*, **121**, 2610, 2001.

92. Phillips, R.B., Sivakoff, G.R., Lonsdale, C.J., Doeleman, S.S. "Coordinated Millimeter VLBI Array Observations of R Cassiopeiae: 86GHz SiO Masers and Envelope Dynamics," *AJ*, **122**, 2679, 2001.
93. Doeleman, S., Lonsdale, C., Pelkey, S., "A Molecular Outflow Traced by SIO Masers in Orion KL", *ApJL*, **510**, L55, 1999.
94. Lonsdale, C., Doeleman, S., Phillips, R., "A 3mm VLBI Continuum Source Survey", *AJ*, **116**, 8, 1998.
95. Doeleman, S, Lonsdale, C., Greenhill, L., "VLBI Imaging of the 86 GHz SiO Maser Emission in the Circumstellar Envelope of VX Sgr", *ApJ*, **494**, 400, 1998.
96. Alberdi, A. et al, "The high-frequency compact radio structure of the peculiar quasar 4C 39.25", *A&A*, **327**, 513, 1997.
97. Rogers, A.E.E., Doeleman, S. & Moran, J.M., "Fringe detection methods for very long baseline arrays", *AJ*, **109**, 1391, 1995.
98. Rogers, A.E.E.R., Doeleman, S., et al, "Small-scale structure and position of Sagittarius A* from VLBI at 3 millimeter wavelength", *ApJL*, **434**, L59, 1994.

Conference Proceedings and Reviews

Doeleman, S., "Building an Event Horizon Telescope: (sub)mm VLBI in the ALMA era", *10th European VLBI Network Symposium and EVN Users Meeting: VLBI and the new generation of radio arrays, Sept 20-24,* p. 53, (2010). https://pos.sissa.it/125/053/pdf

Fish, V. L. & Doeleman, S. S., "Observing a black hole event Horizon: (sub)millimeter VLBI of SgrA*", Proceedings of "Relativity in Fundamental Astronomy: Dynamics, Reference Frames, and Data Analysis", IAU Symposium, v. 261, p. 271-276, (2010).

Doeleman, S., "High Frequency Very Long Baseline Interferometry: Frequency Standards and Imaging an Event Horizon", Proceedings of the 7th Frequency Standards and Metrology Symposium, held 6-10 October 2008, ed. L. Maleki, World Scientific 2009.

Doeleman, S., "Approaching the event horizon: 1.3mmλ VLBI of SgrA*", Journal of Physics: Conference Series, v.131, Proceedings of "The Universe Under the Microscope – Astrophysics at High Angular Resolution", held 21-25 April 2008.

Doeleman, S. & Bower, G.C., "Approaching the Event Horizon through VLBI Imaging of Sagittarius A*", Galactic Center Newsletter, v.18, p.6-12, eds. S. Markoff, L. Sjouwerman, J. Lazio, C. Lang, R. Schödel & R. Herrnstein, July 2004.

Phillips, R.B., Straughn, A.H., Lonsdale, C.J. & Doeleman, S., "Simultaneous 3mm and 7mm Observations of SiO Masers around R Cassiopeiae: The Maser Line Ratios", in Proceedings of the 6th European VLBI Network Symposium on New Developments in VLBI Science and Technology, held 25-28 June 2002, eds. E. Ros, R. Porcas, A. Lobanov & J.A. Zensus, p. 231, 2002.

Doeleman, S. et al, "2mm VLBI of SiO Masers and AGN", in Proceedings of the 6th European VLBI Network Symposium on New Developments in VLBI Science and Technology, held 25-28 June 2002, eds. E. Ros, R. Porcas, A. Lobanov & J.A. Zensus, p. 223, 2002.

Doeleman, S., Rogers, A.E.E., Backer, D.C, Wright, M. & Bower, G.C., "Structure of SGR A* from 3mmλ-VLBI", ASP Conference Series, v. 186, Proceedings of "The Central Parsecs of the Galaxy", held June 1999, eds. H. Falcke, A. Cotera, W. Duschl, F. Melia & M. Rieke, p. 98, 1999.

Doeleman, S. & Krichbaum, T.P., "Status of VLBI Observations at 1mm Wavelength at Future Prospects", in Proceedings of the 2nd mm-VLBI science workshop, held 27-29 May 1999, eds. A. Greve & T. Krichbaum, p. 73, 1999.

Lonsdale, C.J. & Doeleman, S., "Using SiO Masers to Probe the Bipolar Outflow in Orion. I", in Proceedings of the 2nd mm-VLBI science workshop, held 27-29 May 1999, eds. A. Greve & T. Krichbaum, p. 25, 1999.

Doeleman, S., Lonsdale, C.J., Predmore, C.R. & Greenhill, L. "Using SiO Masers to Probe the Bipolar Outflow in Orion. II", in Proceedings of the 2nd mm-VLBI science workshop, held 27-29 May 1999, eds. A. Greve & T. Krichbaum, p. 29, 1999.

Doeleman, S., Lonsdale, C.J. & Greenhill, L., "86GHz VLBI Imaging of the SiO Masers in VX SGR", ASP Conference Series, v. 144, IAU Colloquium 164, in Proceedings of "Radio Emission from Galactic and Extragalactic Compact Sources", eds. J.A. Zensus, G.B. Taylor & J.M. Wrobel, p.363, 1998.

Lonsdale, C.J & Doeleman, S., "Techniques for Analyzing Short Coherence Time VLBI Data", ASP Conference Series, v. 144, IAU Colloquium 164, in Proceedings of "Radio Emission from Galactic and Extragalactic Compact Sources", eds. J.A. Zensus, G.B. Taylor & J.M. Wrobel, p.407, 1998.

Wardle, J., Brown, L., Roberts, D., Phillips, R & Doeleman, S., "Polarization Sensitive Observations with the CMVA", in Proceedings of the Millimeter-VLBI Science Workshop, held 22-23 Nov 1996, eds. R. Barvainis & R. Phillips, p.63, 1997.

Lonsdale, C., Doeleman, S. & Phillips, R., "A 3mm VLBI Continuum Source Survey", in Proceedings of the Millimeter-VLBI Science Workshop, held 22-23 Nov 1996, eds. R. Barvainis & R. Phillips, p.57, 1997.

Beasley, A., Dhawan, V., Doeleman, S. & Phillips, R., "CMVA Observations of Compact AGNs", in Proceedings of the Millimeter-VLBI Science Workshop, held 22-23 Nov 1996, eds. R. Barvainis & R. Phillips, p.53, 1997.

Doeleman, S. & Claussen, M., "Evolution of a New Radio Flare in N-Galaxy 3C111", in Proceedings of the Millimeter-VLBI Science Workshop, held 22-23 Nov 1996, eds. R. Barvainis & R. Phillips, p.37, 1997.

Doeleman, S. et al, "86GHz Global VLBI Progress Report", in Proceedings of VLBI Technology: Progress and Future Observational Possibilities", held 6-10 Sept 1993 in Kyoto, Japan, eds. T. Sasao, S. Manabe, O. Kameya & M. Inoue, p.89, 1994.

Doeleman, S., Rogers, A.E.E. & Moran, J., "Fringe Finding for 3mm VLBI: Application to 3C111", in Proceedings of the 2nd EVN/JIVE Symposium, held 21 Oct 1994, eds. A.J. Kus, R.T. Schilizzi, K.M. Borkowski, and L.I. Gurvits, p. 39, 1994.

Selected Research Described in the Popular Press

Overbye, D., "Darkness Visible, Finally: Astronomers Capture First Ever Image of a Black Hole," *New York Times,* April 10, 2019.
https://www.nytimes.com/2019/04/10/science/black-hole-picture.html

Overbye, D., "Black Hole Hunters,", *New York Times*, June 8, 2015.
http://www.nytimes.com/2015/06/09/science/black-hole-event-horizon-telescope.html

Cowen, R., "Closest look yet at a distant black hole," *Nature*, September 2012.
http://www.nature.com/news/closest-look-yet-at-a-distant-black-hole-1.11498

Fletcher, S., "Signals from the Void," *Popular Science*, August 2012.
https://www.popsci.com/science/article/2012-07/signals-void

Schwarzschild, B., "Radio interferometry measures the black hole at the Milky Way's center", *Physics Today*, Nov 2008.
https://physicstoday.scitation.org/doi/10.1063/1.3027977