First M87 Event Horizon Telescope Results: Shadow of the Supermassive Black Hole

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M87

First Image of a Black Hole

42 μas
$M_{BH} = 6.5 \pm 0.7 \times 10^9 M_{\text{sun}}$
Global Team at the EHT 2018 Conference
Members of the EHT team at Telescopes
EHT-M87 24 September 2019
Publications

Event Horizon Telescope
Strong Evidence for a Black Hole

GRAVITY Collaboration 2018
The Largest Black Holes on the Sky
Distance and Mass of M87

\[ D = 16.8 \pm 0.8 \text{ Mpc} \]

Walsh et al 2013, Gebhardt et al 2011

\[ \theta_{\text{shadow}} \sim 20 - 40 \text{ \mu as} \]
Light Bent by the Black Hole

Bardeen 1973

Luminet 1979
The Black Hole Shadow

\[ \theta_{\text{shadow}} \sim 10 \frac{GM}{Dc^2} \sim 50 \mu \text{as} \]
MM VLBI Imaging of M87

Doeleman et al 2012

Event Horizon Telescope

September 2019
Recording rate capability vs. time

EHT – 4x Mk6
64 Gbps

Whitney et al 2012

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Event Horizon Telescope in 2017

- Atacama Large Millimeter Array (ALMA), Chile
- ALMA Pathfinder Experiment (APEX), Chile
- James Clerk Maxwell Telescope (JCMT), Hawaii
- Large Millimeter Telescope (LMT), Mexico
- IRAM 30-meter Telescope, Spain
- South Pole Telescope (SPT), South Pole
- Submillimeter Array (SMA), Hawaii
- Submillimeter Telescope (SMT), Arizona
Extensive Cross-Comparisons
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Brightness Temp. ($10^9$ K)

April 5 | April 6 | April 10 | April 11

50 μas

Brightness Temp. ($10^9$ K)
Representative GRMHD Model Image of M87

EHT2017 image
M87 April 6

Simulated image from GRMHD model

Simulated image convolved with 20 μas beam

Brightness Temperature (10^9 K)
• Ring-like structure
• Some asymmetry
• Large-scale structure resolved
M87

First Image of a Black Hole

Circular
Flux depression > 10:1
Asymmetric brightness
Minor variability

42 μas
$M_{\text{BH}} = 6.5 \pm 0.7 \times 10^9 M_{\odot}$
EHT Future

- Sgr A*
- Polarimetry
- AGN
- 2018 & 2020 Epochs
- Multi-wavelength Data
- Movies
- Higher image fidelity
- More sources