EHT Releases Unprecedented Observations Of Famous Black Hole

Prof. Daryl Haggard is an Associate Professor in the Physics Department at McGill University and a Canada Research Chair in Multi-messenger Astrophysics. She is also a member of the Event Horizon Telescope Collaboration. MSI Prof. Ken Ragan (Professor, Physics Department), Dr. Stephan O'Brien, Dr. Sajan Kumar, and Mathew Lundy also contributed data to the observations as part of the VERITAS Collaboration.

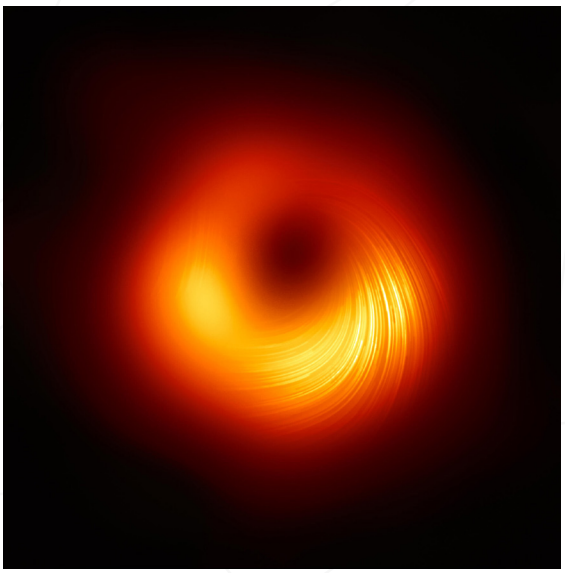
Two years ago, the Event Horizon Telescope (EHT) Collaboration (of which MSI Prof. Daryl Haggard is a member) unveiled the first direct image of a black hole. The image revealed the supermassive black hole at the centre of Messier 87 (M87), a galaxy in the nearby Virgo galaxy cluster. The shadow created by the gravitational bending and capture of light by the event horizon of the black hole allowed its enormous mass (6.5 million times that of our Sun) to be measured. The resulting image of a bright ring marking where light orbits the black hole, surrounding a dark region where light cannot escape the its gravitational pull, matched expectations from Einstein's theory of gravity.

That astonishing image was just the beginning. In April 2021, using data from 19 observatories, the EHT collaboration released images of how that same supermassive black hole at the centre of the M87 galaxy looks in polarised light. It's the first time that astronomers have been able to measure polarisation this close to the edge of a black hole. Polarisation lets astronomers map the magnetic field lines at the inner edge of a black hole. These new observations are key to explaining how M87 is able to launch powerful energetic jets from its core.

M87's jets produce light across the entire electromagnetic spectrum. This pattern of emission, which is different for each black hole, provides crucial insight into a black hole's properties. The pattern varies over time, posing an additional challenge. Scientists compensated for this variability by coordinating observations with many of the world's most powerful telescopes on the ground and in space, collecting light from across the spectrum. Each telescope delivers different information about the behaviour and impact of the black hole. The resulting multi-wavelength data set provides a "snapshot" of the black hole and its jet at the same moment in the time, allowing scientists to see how the energy and material are linked.

Why is this important?

The multtiwavelength observations of M87 by the 19 observatories that make up the Event Horizon Telescope collaborattion provide unparalleled insight into this black hole and the system it powers. The multiwavelentgh data will also be used to improve tests of Einstein's General Theory of Relativity.

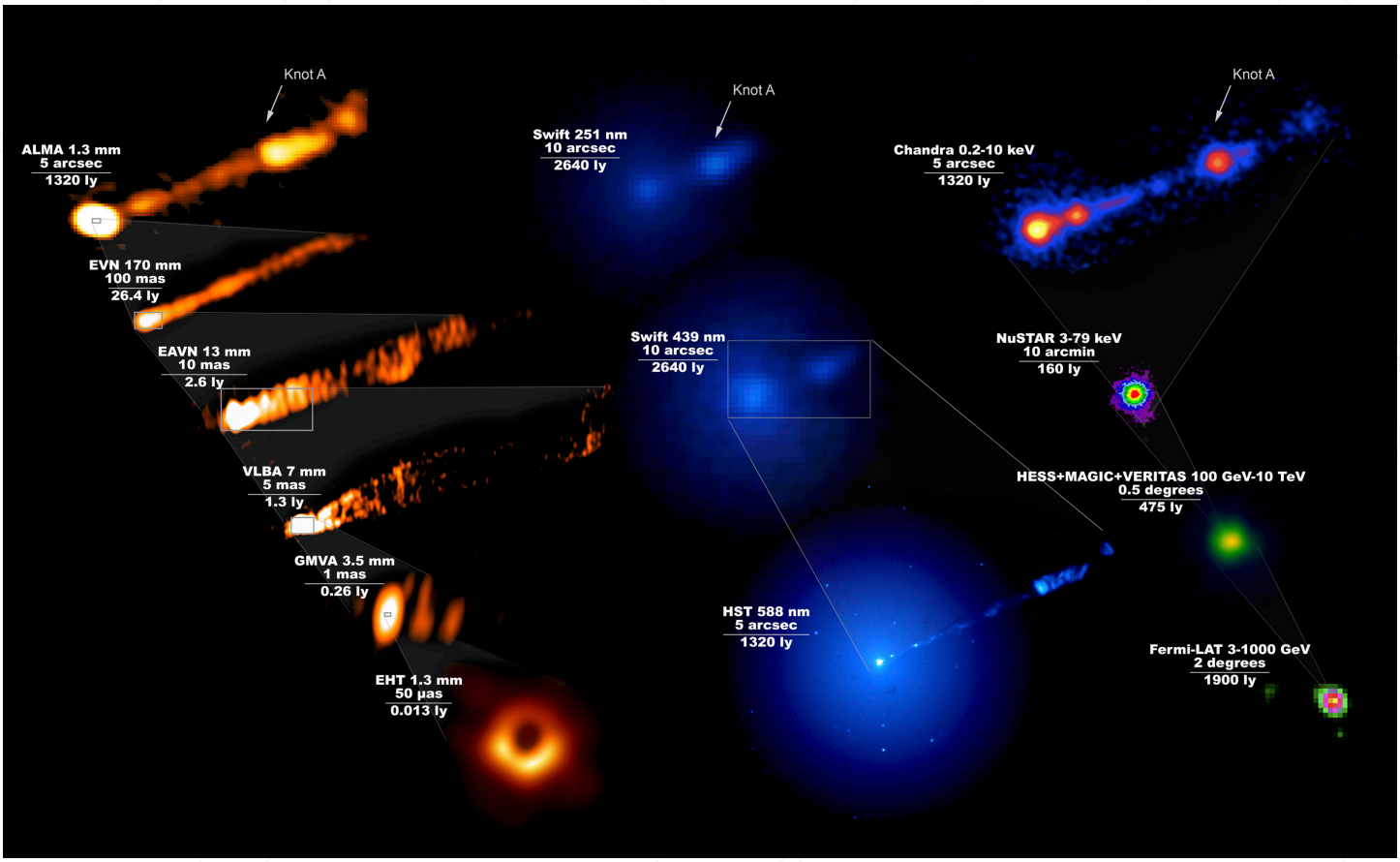


Right: A view of the M87 supermassive black hole in polarised light. The lines mark the orientation of polarisation, which is related to the magnetic field around the shadow of the black hole. Credit: EHT Collaboration

Prof. Haggard and MSI graduate student Hope Boyce helped lead the acquisition and analysis of X-ray data from the Chandra Telescope, and coordination of the multi-wavelength campaign. The X-ray data, in particular, are key for understanding the total energy output of the core (near the black hole) and the jet, and to figuring out whether the black hole is in the midst of an outburst or in a quiet state.

Current and future EHT observations will allow scientists to delve into some of astrophysics' most significant and challenging questions, including using the multi-wavelength data to improve tests of Einstein's Theory of General Relativity. More exciting science is on the horizon; EHT began another observing run in April 2021 targeting M87 again and several other black holes, including Sagittarius A*, the black hole at the centre of our galaxy.

Citation: Event Horizon Telescope Multi-Wavelength Science Working Group et al.: Broadband Multi-wavelength Properties of M87 During the 2017 Event Horizon Telescope Campaign, The Astrophysical Journal Letters, 911, L11, April 14, *2021*



Above: Composite image showing how the M87 system looked, across the entire electromagnetic spectrum, during the Event Horizon Telescope's April 2017 campaign to take the iconic first image of a black hole. Requiring 19 different facilities on the Earth and in space, this image reveals the enormous scales spanned by the black hole and it forward-pointing jet, launched just outside the event horizon and spanning the entire galaxy.

Image Credit: the EHT Multi-Wavelength Science Working Group; the EHT Collaboration; ALMA (ESO/NAOJ/NRAO); the EVN; the EAVN Collaboration; VLBA (NRAO); the GMVA; the Hubble Space Telescope, the Neil Gehrels Swift Observatory; the Chandra X-ray Observatory; the Nuclear Spectroscopic Telescope Array; the Fermi-LAT Collaboration; the H.E.S.S. Collaboration; the MAGIC collaboration; the VERITAS collaboration; NASA and ESA. Composition by J.C. Algaba.