Contents

Call for proposals

Deadline Jun 01, 2023, UT 15.00

Observing proposals are invited for the Effelsberg 100-meter Radio Telescope of the Max Planck Institute for Radio Astronomy (MPIfR).

The Effelsberg telescope is one of the World's largest fully steerable instruments. This extreme-precision antenna is used exclusively for research in radio astronomy, both as a stand-alone instrument as well as for Very Long Baseline Interferometry (VLBI) experiments.

Access to the telescope is open to all qualified astronomers. Use of the instrument by scientists from outside the MPIfR is strongly encouraged. The institute can provide support and advice on project preparation, observation, and data analysis.
The directors of the institute make observing time available to applicants based on the recommendations of the Program Committee for Effelsberg (PKE), which judges the scientific merit (and technical feasibility) of the observing requests.

Information about the telescope, its receivers and backends and the Program Committee can be found at
http://www.mpifr-bonn.mpg.de/effelsberg/astronomers
(potential observers are especially encouraged to visit the wiki pages!).

Observing modes

Possible observing modes include spectral line, continuum, and pulsar observations as well as VLBI. Available backends are several FFT spectrometers (with up to 65536 channels per subband/polarization), a digital continuum backend, a number of polarimeters, several pulsar systems (coherent and incoherent dedispersion), and two VLBI terminals (dBBC and RDBE type with MK6 recorders).

Receiving systems cover the frequency range from 0.3 to 96 GHz. The actual availability of the receivers depends on technical circumstances and proposal pressure. For a description of the receivers see the web pages.

How to submit

Applicants should use the NorthStar proposal tool for preparation and submission of their observing requests. North Star is reachable at https://northstar.mpifr-bonn.mpg.de .

For VLBI proposals special rules apply. For proposals which request Effelsberg as part of the European VLBI Network (EVN) see: http://www.evlbi.org/proposals/ .

Information on proposals for the Global mm-VLBI network can be found at http://www3.mpifr-bonn.mpg.de/div/vlbi/globalmm/index.html .

Other proposals which ask for Effelsberg plus (an)other antenna(s) should be submitted twice, one to the MPIfR and a second to the institute(s) operating the other telescope(s) (eg. to NRAO for the VLBA).

Important Remarks

Please note, that the Effelsberg Programme Committee (PKE) is composed of several scientist with different backgrounds. It is hence advisable to write the proposals in a way that they could be understood by readers who are not working in the particular field.
Furthermore, it should be noted that all proposals are treated confidentially. Therefore, it is not necessary to withhold or obscure information, which on the contrary might lead to a downgrading of the proposal.

The following deadlines will be on Sep 28th, 2023 and on Feb 5th, 2024.

Opticon-RadioNet-Pilot Transnational Access Programme

The new Opticon-RadioNet-Pilot (ORP) project (see http://www.orph2020.eu) includes a coherent set of Transnational Access (TA) programs aimed at significantly improving the access of European astronomers to the major astronomical infrastructures that exist in, or are owned and run by, European organizations.

Astronomers who are based in the EU and the Associated States but are not affiliated to a German astronomical institute, may also receive personal aid from the Transnational Access (TA) Program of the ORP. This will entail free access to the telescope, as well as financial support of travel and accommodation expenses for one of the proposal team members to visit the Effelsberg telescope for observations.

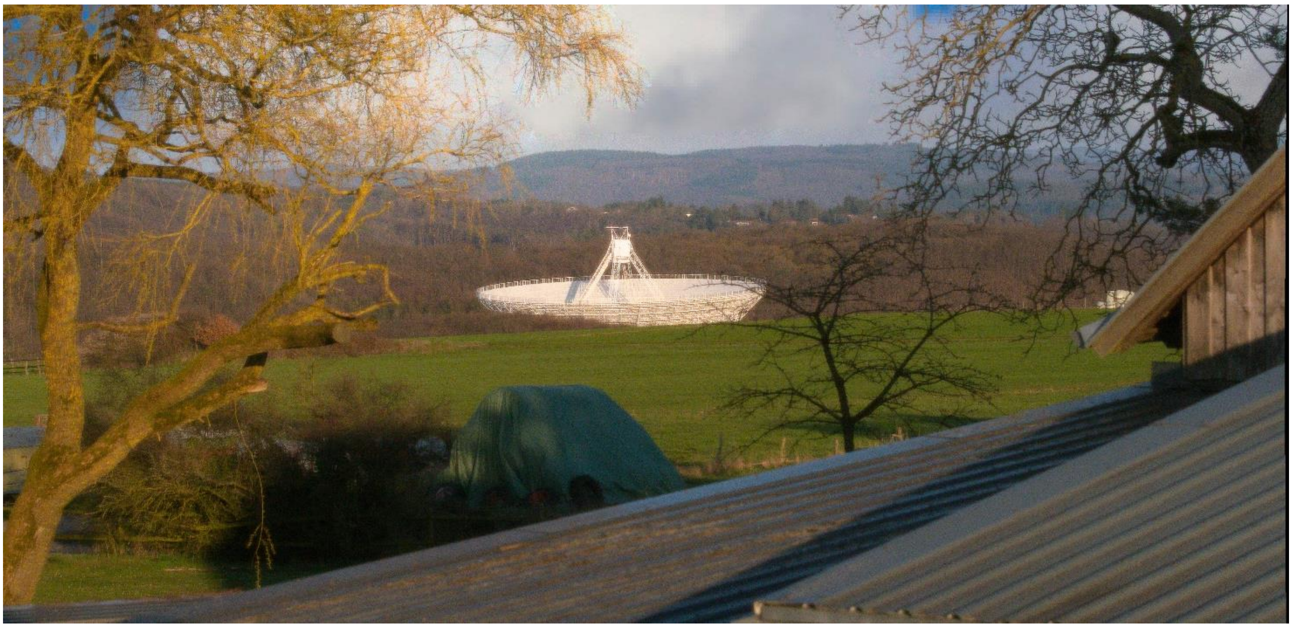
One – in exceptional cases more – scientists who are going to Effelsberg for observations can be supported, if the User Group Leader (i.e., the PI – a User Group is a team of one or more researchers) and the majority of the users work in (a) country(ies) other than the country where the installation is located. Only user groups that are allowed to disseminate the results they have generated under this program may benefit from the access.

For more details see http://www.orp-h2020.eu/TA-VA .

After completion of their observations, TA supported scientists are required to submit their feedback to the ORP project management and the EU. Publications based on these observations should be acknowledged accordingly:

The research leading to these results has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101004719 [ORP].

by Alex Kraus



How the black hole in M87 launches a jet

New observations reveal the powerful jet emerging from the black hole in the centre of the galaxy M87

An international team of scientists with participation of the Max Planck Institute for Radio Astronomy has used new millimetre-wavelength observations to image for the first time the link between the ring-like structure that reveals the matter falling into the central black hole and the powerful relativistic jet in the prominent radio galaxy Messier 87 (M87). These images show the origin of the jet and the accretion flow near the central supermassive black hole. The new observations were obtained with the Global Millimetre VLBI Array (GMVA), complemented by the phased Atacama Large Millimetre/submillimetre Array (ALMA) and the Greenland Telescope (GLT). The addition of these two observatories has greatly enhanced the imaging capabilities of the GMVA.

Artist's conception showing a close-up view to the accretion flow and the jet emerging from black hole region in Messier 87.
© Sophia Dagnello, NRAO/AUI/NSF

Ru-Sen Lu, leader of a Max Planck Research Group at the Shanghai Astronomical Observatory of the Chinese Academy is thrilled and puzzled: "Previously, we had seen both the supermassive black hole and the jet far away from it in separate images, but now with the new image we have taken a panoramic view of the black hole together with its jet in a new observing band." The matter surrounding the black hole is swallowed by a process called accretion. But no one has ever imaged this accretion flow directly. "The bigger and thicker ring we now see shows that the material falling into the black hole contributes significantly to the observed emission in the new image, which allows us to better understand the physical processes near the black hole," adds Ru-Sen Lu.

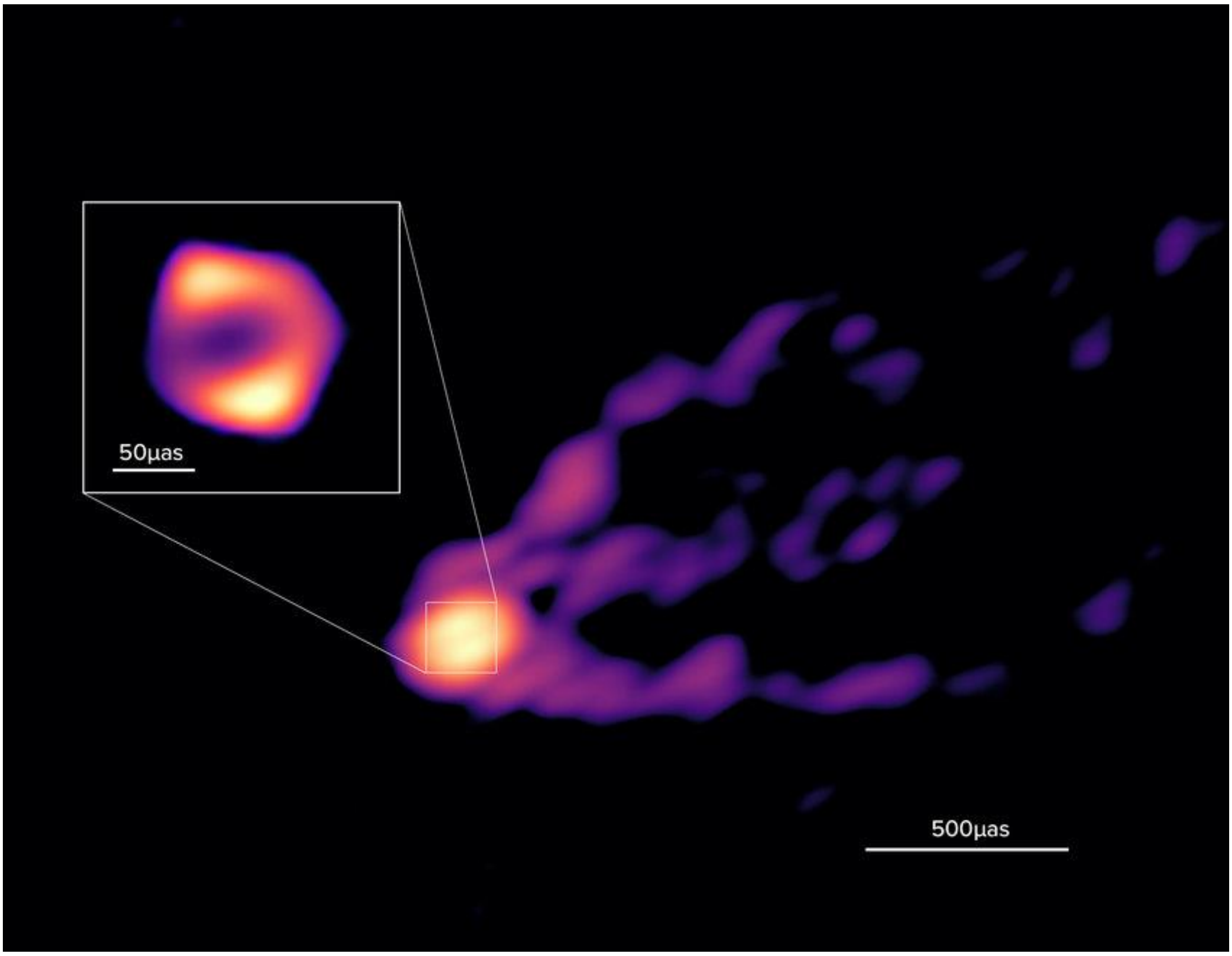
“Participation of ALMA in GMVA observations has provided a substantial increase in sensitivity of detecting and imaging the radio emission from M87. This further increased the effective angular resolution and allowed us for the first time to image the ring-like structure at the very heart of M87 at the wavelength of 3.5 mm,” says Andrei Lobanov from the Max Planck Institute for Radio Astronomy (MPIfR), a member of the team of researchers. The diameter of the ring measured by the GMVA is 64 microarcseconds, which corresponds to the size of a small (5-inch/13.5-cm) selfie ring light as seen by an astronaut on the Moon looking back at Earth. As expected from the emission properties of the relativistic plasma in this region, the outer diameter of this ring-like structure is about 1.5 times larger than the one measured in previous observations by the Event Horizon Telescope at 1.3 mm.

"With the greatly improved imaging capabilities of the GMVA, we have gained a new perspective. We do indeed see the triple-ridged jet that we knew about from earlier VLBI observations," says Thomas Krichbaum, leading author from the MPIfR team. "But now we can see how the jet emerges from the emission ring around the central black hole and we can measure the ring diameter also at another wavelength.”

"*The spectacular image of the jet and ring in M87 is an important milestone, culminating in many years of collaborative efforts by our colleagues in Europe, including ESO, IRAM, Metsähovi, Yebes and Onsala, to align the GMVA array with phased ALMA for joint observations to reveal the finest details in the study of radio galaxies and quasars*," comments Eduardo Ros, scientist at MPIfR, European GMVA scheduler, and also a member of the research team.

Looking to next technological steps, Jae-Young Kim, from Kyungpook National University in Daegu, South Korea and MPIfR co-affiliated, says: "*The next steps in the high-resolution studies of M87 address the study of the radio colour of the jet and the black hole shadow, as well as polarisation measurements, which will reveal the magnetic field*.” Planned steps for further improving the performance and sensitivity of the GMVA network invoke receiver upgrades that will allow multi-frequency phase referencing, as it is done already on shorter baselines with the Korean VLBI network.

J. Anton Zensus, director at the MPIfR and co-author of the published work, concludes: "*These new results are so important because they give us for the first time a direct view on the region connecting the central accretion disc around the black hole and the jet in M87. Many years of developments of the VLBI technique have proved successful.*"



GMVA+ALMA image of the central black hole region in Messier 87 obtained on April 14-15, 2018 at 3.5 mm wavelength. The large image depicts the jet and central ring as reconstructed by the standard CLEAN method. The inset shows a magnification of the inner region obtained with the super-resolving SMILI method, revealing the ring shape with a diameter of 64 microarcseconds, which corresponds to 8.4 Schwarzschild radii.

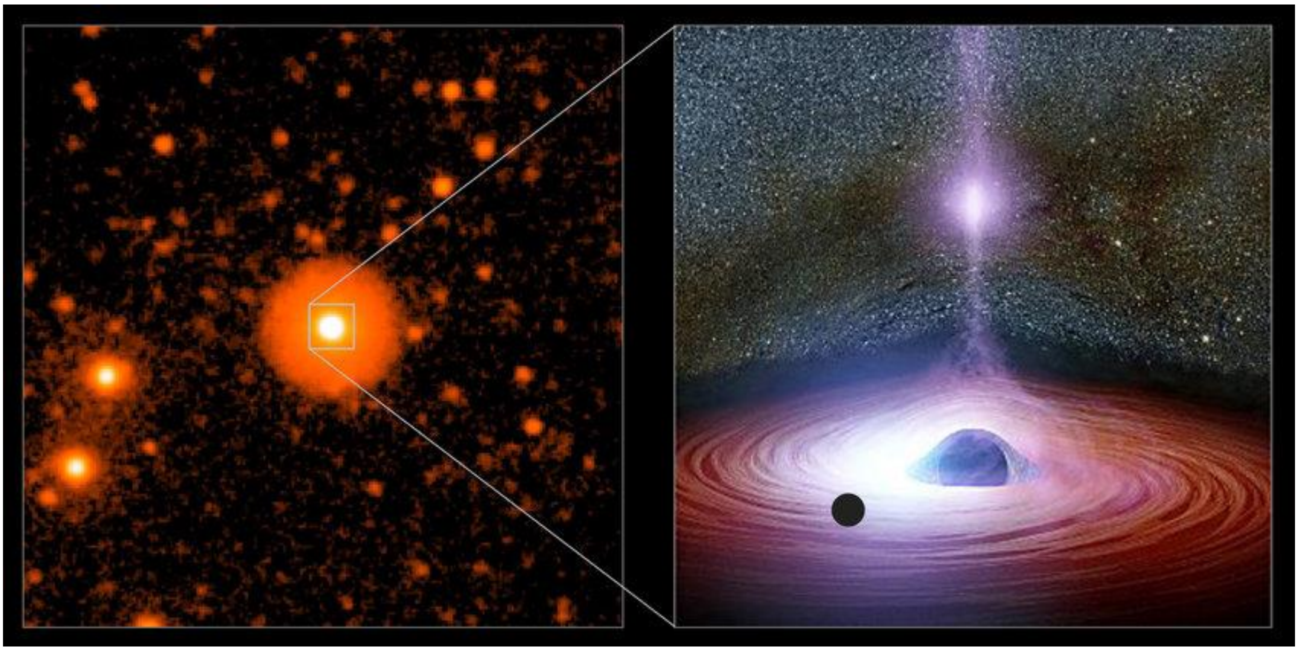
Original Paper: *A ring-like accretion structure in M87 connecting its black hole and jet*
R. Lu et al., Nature, Volume 616, Issue 7958, p.686-690,
DOI: [10.1038/s41586-023-05843-w](10.1038/s41586-023-05843-w)

The mass of the black hole in OJ 287 and the project MOMO

An international research group led by Stefanie Komossa from the Max Planck Institute for Radio Astronomy in Bonn, Germany, presents important new results on the galaxy OJ 287, based on the most dense and longest radio-to-high-energy observations to date.

OJ 287 is a bright blazar in the direction of the constellation Cancer at a distance of about 5 billion light years. It is one of the best candidates for hosting a compact binary supermassive black hole. Exceptional outbursts of radiation which repeat every 11 to 12 years are OJ 287's claim to fame. Some of these are so bright, that OJ 287 temporarily becomes the brightest source of its type in the sky. Its repeating outbursts are so remarkable, that several different binary models have been proposed and discussed in the literature to explain them.

As the second black hole in the system orbits the other more massive black hole it imposes semi-periodic signals on the light output of the system by affecting either the jet or the accretion disk of the more massive black hole.



The left panel shows a deep ultraviolet image of OJ 287 and its environment taken with Swift. This is one of the deepest UV images of that part of the sky ever taken, combining 560 single exposures. The brightest source in the field is OJ 287. The black hole region itself cannot be resolved in the UV image. The right panel depicts an artist's view of the very center of OJ 287, including the accretion disk, the jet, and a second black hole orbiting the primary black hole which has a mass of 100 million solar masses.

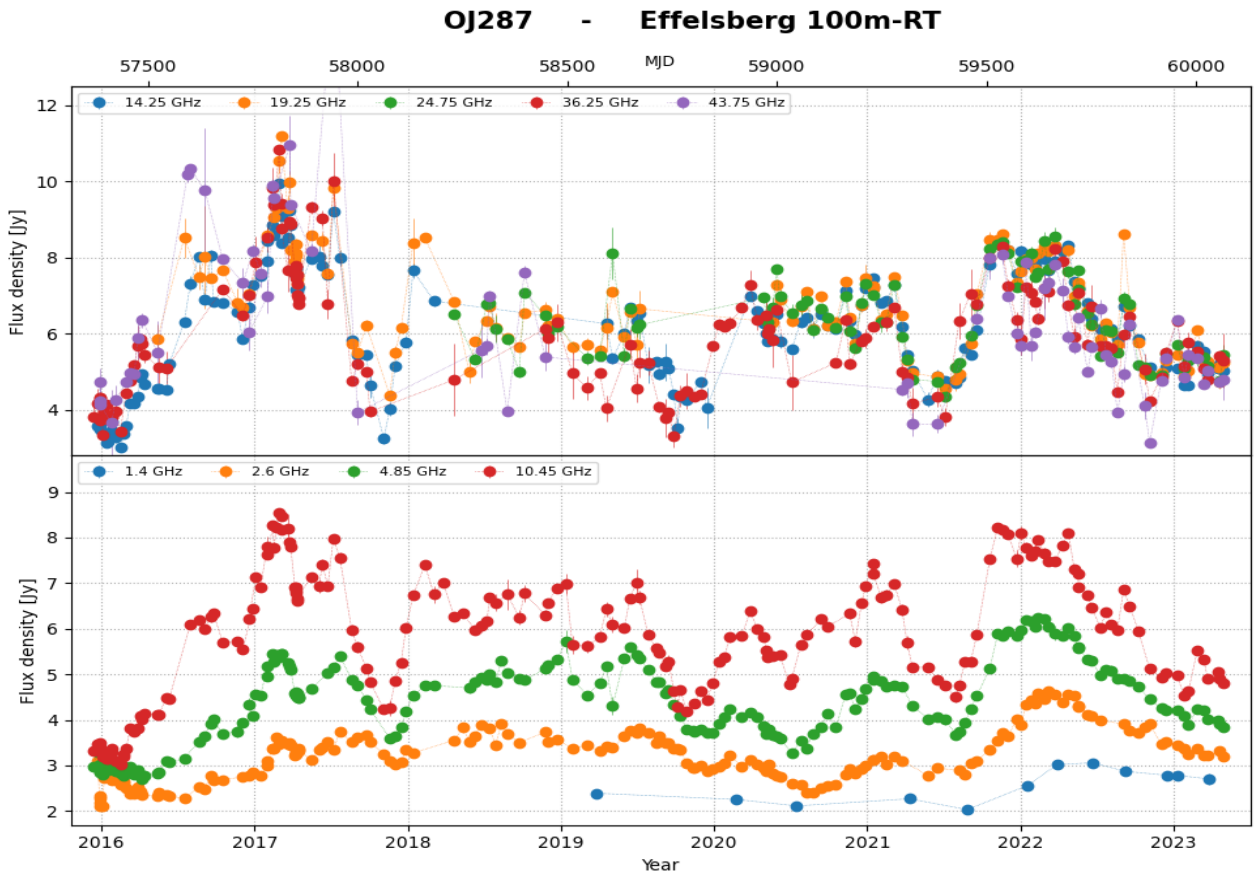
However, until now there has been no direct independent determination of the black hole mass, and none of the models could be critically tested in systematic observing campaigns, because these campaigns lacked a broad-band coverage involving radiation of many different frequencies. For the first time, multiple simultaneous X-ray, UV and radio observations, along with optical and gamma-ray bands were now used. The new findings were made possible by the MOMO project ("Multiwavelength Observations and Modelling of OJ 287"), which is one of the densest and longest-lasting multi-frequency monitoring projects of any blazar involving X-rays, and the densest ever of OJ 287.

"*OJ 287 is an excellent laboratory for studying the physical processes that reign in one of the most extreme astrophysical environments: disks and jets of matter in the immediate vicinity of one or two supermassive black holes*", says Stefanie Komossa from the Max Planck Institute for Radio Astronomy (MPIfR), the first author of the two studies presented here. "*Therefore, we initiated the project MOMO. It consists of high-cadence observations of OJ 287 at more than 14 frequencies from the radio to the high energy regime lasting for years, plus dedicated follow-ups at multiple ground- and space-based facilities when the blazar is found at exceptional states.*"

"*Thousands of data sets have already been taken and analyzed. This makes OJ 287 stand out as one of the best-monitored blazars ever in the UV-X-ray-radio regime*", adds co-author Alex Kraus from the MPIfR. "*The Effelsberg radio telescope and the space mission Swift play a central role in the project.*"

The Effelsberg telescope provides information at a broad range of radio frequencies, whereas the Neil Gehrels Swift observatory is used to obtain simultaneous UV, optical and X-ray data. High-energy gamma-ray data from the Fermi Gamma-Ray Space Observatory, as well as radio data from the Submillimeter Array (SMA) at Mauna Kea/Hawaii, have been added.

The jet dominates the electromagnetic emission of OJ 287 due to its blazar nature. The jet is so bright, that it outshines the radiation from the accretion disk (the radiation of matter falling into the black hole), making it hard to impossible to observe the emission from the accretion disk, as if we were looking directly into a car headlight. However, due to the large number of MOMO observations that densely covered the light output of OJ 287 (a new observation almost every other day with Swift), "deep fades" were discovered. These are times when the jet emission fades away rapidly, allowing the researchers to constrain the emission from the accretion disk. The results show that the disk of matter surrounding the black hole is at least a factor of 10 fainter than previously thought, with a luminosity estimated to be no more than 2 x 10^{46} erg/s, corresponding to about 5 trillion times the luminosity of our sun (5 x 10^{12} $L_\odot$).



Long-term multifrequency lightcurve of OJ287, obtained with the 100-m radio telescope at Effelsberg within the MOMO project
(by Alex Kraus, an updated version of the plot published in the Astrophysical Journal).

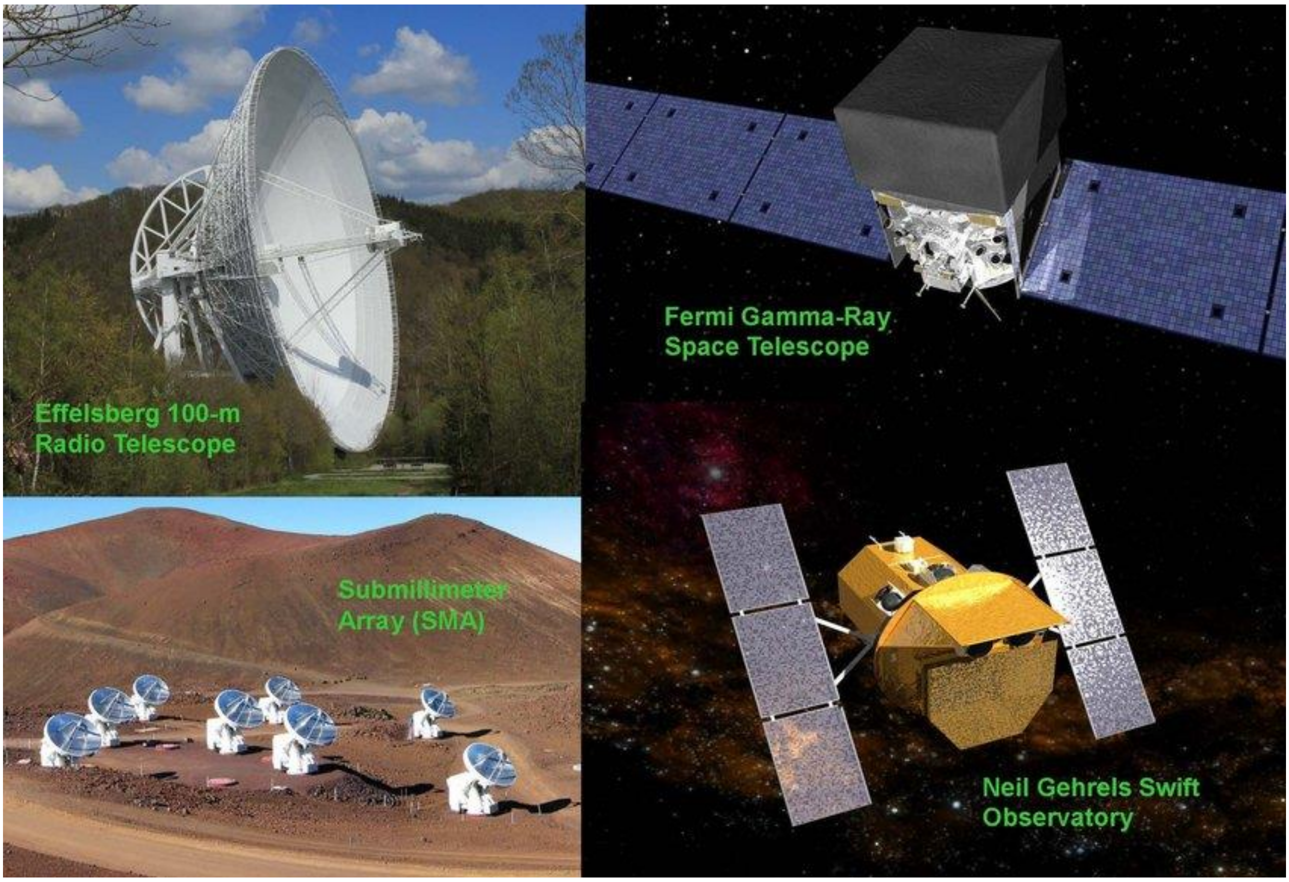
For the first time the mass of the primary black hole of OJ 287 was derived from the motion of gaseous matter bound to the black hole. The mass amounts to 100 million times the mass of our sun. "*This result is very important, as the mass is a key parameter in the models that study the evolution of this binary system: How far are the black holes separated, how quickly will they merge, how strong is their gravitational wave signal?*" comments Dirk Grupe of the Northern Kentucky University (USA), a co-author in both studies.

"*The new results imply that an exceptionally large mass of the black hole of OJ 287, exceeding 10 billion solar masses, is no longer required; neither is a particularly luminous disk of matter accreting onto the black hole required*", adds Thomas Krichbaum from the MPIfR, a co-author of the ApJ paper. The results rather favor a binary model of more modest mass.

The study also resolves two old puzzles: the apparent absence of the latest of the bright outbursts which OJ 287 is famous for, and the emission mechanism behind the outbursts. The MOMO observations allow for the precise timing of the latest outburst. It did not occur in October 2022, as predicted by the "huge-mass" model, but rather in 2016-2017, which MOMO extensively covered. Furthermore, radio observations with the Effelsberg 100-m telescope reveal that these outbursts are non-thermal in nature, implying that jet processes are the power source of the outbursts.

The MOMO results affect ongoing and future search strategies for additional binary systems using major large observatories such as the Event Horizon Telescope and, in the future, the SKA Observatory. They could enable direct radio detection and spatial resolution of the binary sources in OJ 287 and similar systems, as well as the detection of gravitational waves from these systems in the future. OJ 287 will no longer serve as a target for pulsar-timing arrays due to the derived black hole mass of 100 million solar masses, but will be within the range of future space-based observatories (upon coalescence).

"*Our results have strong implications for theoretical modeling of binary supermassive black hole systems and their evolution, for understanding the physics of accretion and ejection of matter in the vicinity of supermassive black holes, and for the electromagnetic identification of binary systems in genera*l", concludes Stefanie Komossa.



The telescopes used for the observations include two radio telescopes, the Effelsberg 100-m dish in Germany and the Submillimeter Array in Hawaii, moreover two satellite observatories: Fermi in the gamma-ray range and the Neil Gehrels Swift Observatory in the optical, UV and X-ray regime.
© NASA (Fermi & Swift satellite images), N. Junkes (Effelsberg), J. Weintroub (SMA).

Original Papers:

Absence of the predicted 2022 October outburst of OJ 287 and implications for binary SMBH scenarios
S. Komossa et al., Monthly Notices of the Royal Astronomical Society: Letters, Volume 522, Issue 1, pp.L84-L88
DOI: [10.48550/arXiv.2302.11646](https://doi.org/10.48550/arXiv.2302.11646)

https://academic.oup.com/mnrasl/article/522/1/L84/7044769

MOMO. VI. Multifrequency Radio Variability of the Blazar OJ 287 from 2015 to 2022, Absence of Predicted 2021 Pecursor-flare Activity, and a New Binary Interpretation of the 2016/2017 Outburst
S. Komossa et al., The Astrophysical Journal, Volume 944, Issue 2, id.177, 16 pp.
DOI: [10.48550/arXiv.2302.11486](https://doi.org/10.48550/arXiv.2302.11486)

https://iopscience.iop.org/article/10.3847/1538-4357/acaf71