



MAX PLANCK  
GESELLSCHAFT



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# The European radio telescope NOEMA reaches full power

- NOEMA, Europe's new major radio astronomy facility, is to be inaugurated on 30 September 2022.
- Capable of carrying out unprecedented observations, it is already a member of the international EHT collaboration, which produced the very first images of black holes.
- NOEMA is the result of over 40 years of scientific cooperation between France, Germany and Spain.

**The NOEMA radio telescope, located on the Plateau de Bure in the French Alps, has now reached its full capacity, becoming the most powerful millimetre radio telescope in the Northern Hemisphere. It is the product of a collaboration between the CNRS, the Max-Planck-Gesellschaft (MPG, Germany) and the Instituto Geográfico Nacional (IGN, Spain). Built and operated by the Institut de Radioastronomie Millimétrique (IRAM) and already the source of major discoveries, NOEMA is now poised to make unprecedented observations.**

Eight years after its first antenna was inaugurated in 2014, this major project is now complete. NOEMA<sup>1</sup> has twelve 15-metre antennas that can be moved along tracks for a distance of up to 1.7 kilometres, making it a powerful new tool for astronomical research. Its resolving power as well as the sensitivity of its array enable scientists to collect light that has travelled for up to 13 billion years before reaching Earth.

NOEMA is the culmination of over 40 years of European scientific collaboration. Established in 1979 by the CNRS in France and the MPG in Germany, and joined in 1990 by Spain's IGN, IRAM is a world leader in the field of millimetre radio astronomy<sup>2</sup>. NOEMA is now its flagship instrument and the most powerful millimetre radio telescope in the northern hemisphere.

NOEMA's antennas are equipped with very high sensitivity receivers that operate at the quantum limits using a technique called interferometry: the antennas are all pointed towards the same region of space and the signals they receive are then combined by means of a supercomputer. This gives them a resolving power similar to that of a single huge telescope with a diameter covering the entire array.

By altering the configuration of the antennas, astronomers can 'zoom in' on a celestial object to observe its details. The different configurations can extend over a distance ranging from a few hundred metres to 1.7 km, enabling the array to work rather like a camera equipped with a zoom lens. The more extended the configuration, the more powerful is the zoom: NOEMA's maximum spatial resolution is so high that it would be able to detect a mobile phone at a distance of over 500 kilometres.

Equipped with pioneering technologies, it is one of the few radio observatories in the world that can carry out what scientists call multiline observations, i.e. the ability to detect a large number of molecular and atomic signatures simultaneously. These new observation capabilities, combined with high sensitivity and very high spectral and spatial resolution, make NOEMA a unique instrument for investigating the complexity of interstellar matter and of the building blocks of the Universe.



NOEMA provides scientists from France, Germany and Spain with preferential access and the opportunity to carry out unparalleled research. In all, IRAM supports over 5,000 scientists from all over the world. NOEMA enables them to study the Universe's cold matter, which is at only a few degrees above absolute zero. Its antennas can be used to analyse the formation, composition and dynamics of entire galaxies, of stars in formation and at the end of their lives, and of comets and the environment of black holes, with the aim of solving the most fundamental questions in modern astronomy.

NOEMA has already made major discoveries and produced some sensational findings. For example, it has observed the most distant galaxy known to date, which formed shortly after the Big Bang. Only recently, it measured the temperature of the cosmic background radiation at a very early stage of the Universe, a world first that should help to identify and better constrain the effects of dark energy. This year, NOEMA also discovered the first known example of a rapidly growing black hole in the dusty core of a starburst galaxy, with an age similar to that of the oldest known super-massive black hole in the Universe. The observatory is also responsible for the most recent discoveries of molecules in discs around young stars, which are major breeding grounds of planets.

In addition, NOEMA is a member of the Event Horizon Telescope (EHT) consortium, which in 2019 published the first image of a black hole, and then in early 2022 that of the black hole at the centre of our own Galaxy. NOEMA carried out its first observations for the consortium in 2021 and then again in 2022. With its twelve extremely sensitive antennas, it provides the EHT global array with unmatched spatial resolution and sensitivity. Together with IRAM's second radio observatory, the 30-metre telescope located on Pico Veleta in Spain's Sierra Nevada, NOEMA will enable the EHT to produce animations with even greater detail. Both facilities are of critical importance for the EHT collaboration, and for the study and understanding of the physics of black holes.

The observatory will be inaugurated on 30 September 2022 in the presence of Antoine Petit, President and CEO of the CNRS, Martin Stratmann, President of the MPG, Rafael Bachiller, Director of the Observatorio Astronómico Nacional of the IGN, Karl Schuster, Director of IRAM, Stéphane Guilloteau, Chairman of the IRAM Steering Committee, and Reinhard Genzel, 2020 Nobel Prize in Physics and member of the IRAM Steering Committee.

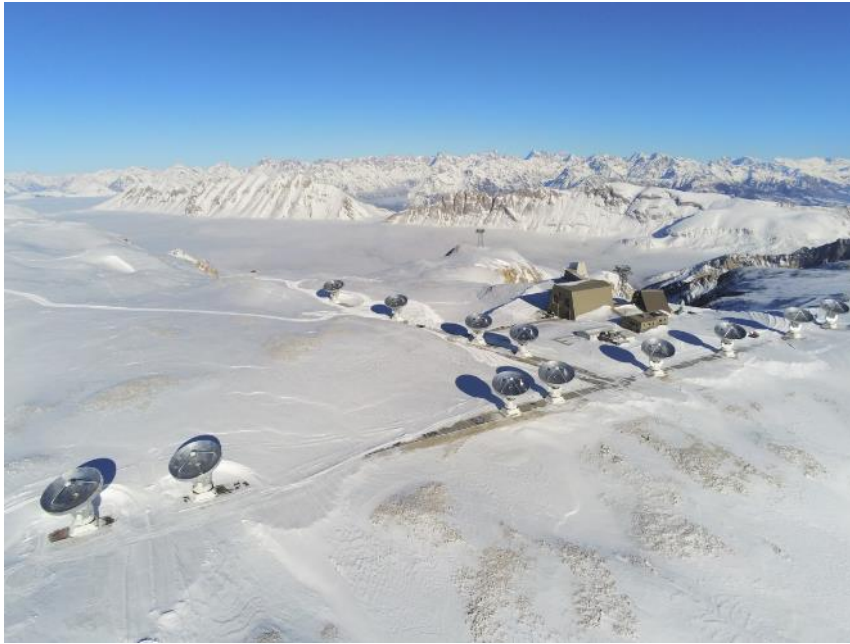
## Footnotes

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1- *NORthern Extended Millimeter Array*. The number of NOEMA antennas was increased from six in 2014 to twelve in 2022. The length of the tracks they move on has also been extended from 760 metres to 1.7 kilometres in order to allow them to be placed further apart from one another.

2- Millimetre radio astronomy studies light with wavelengths in the millimetre range. Every celestial object emits different types of light depending on its age, composition and temperature. In order to obtain a complete image of an object, modern astronomy combines observations at different wavelengths, all of which are complementary to each other.





**The NOEMA Observatory, with its array of twelve radio antennas.**  
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**The spiral galaxy IC342 in the constellation of Camelopardalis.**  
NOEMA revealed the presence of molecular gas throughout the multiple spirals and filaments, providing evidence that the galaxy is dotted with intense bursts of star formation.  
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**Two of the twelve antennas in the NOEMA radio telescope array.**

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**Other visual resources, photographs and videos are available on request.**

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