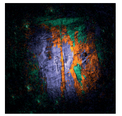
Our Research

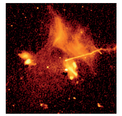
Radio astronomy
Visible light is the only kind of radiation that we can see with our eyes. However, many objects in the Universe emit other radiation, such as radio waves or X-rays. The same object (e.g. star or galaxy) in the sky can therefore look very different at different wavelengths. That is why astronomers use different types of telescopes to measure the different types of radiation. Our scientists measure radio waves with radio telescopes that help us learn more about the Universe.

History of the Universe
By collecting radio waves from the Universe, we can learn more and more about the history of the Universe. All sorts of celestial bodies emit these waves, such as black holes, galaxies and dying stars. The further you look into the Universe, the longer the waves have travelled to reach us on Earth. And the weaker the signals we can measure, the further away we can look. Nowadays we can already detect signals that have been emitted 12 billion years ago by galaxies far from here. As a result, we can observe galaxies just after they are born.



A part of the sky in radio waves, by LOFAR. © Jelic et al.

A spiral galaxy in radio waves, by WSRT. © Tom Oosterloo



A galaxy cluster in radio waves, by LOFAR. © Reinout van Weeren, on behalf of the LOFAR collaboration

Our Technologies

At ASTRON, we involve companies as much as possible in the development of new instruments and innovative high-tech systems. The technology developed for radio astronomy is applied in medicine (e.g. in MRI scanners), radio communication (police, fire brigade) and safety (RFID, radio frequency identification). Even wireless internet (Wi-Fi) has originated in radio astronomy research.

Uniboard²: processes extreme amounts of data

Photonics

Watercooling to cool down computers

Smart antenna for SKA

ASTRON
Netherlands Institute for Radio Astronomy

ASTRON is the Netherlands Institute for Radio Astronomy. Our mission is to make discoveries in radio astronomy happen. We do this by the development of new and innovative technologies, the operation of world-class radio astronomy facilities, and the pursuit of fundamental astronomical research. Engineers and astronomers at ASTRON have an outstanding international reputation for novel technology development, and fundamental research in galactic and extra-galactic astronomy.

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September 2018

ASTRON
Netherlands Institute for Radio Astronomy

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About ASTRON

ASTRON is the Netherlands Institute for Radio Astronomy. We investigate the signals that the Universe emits in the form of radio waves. Our mission is to make discoveries in radio astronomy happen. We therefore do not only do fundamental astronomical research. We also design, build and manage some of the world's leading radio telescopes, and push the boundaries of technology to make increasingly better and more sensitive instruments.

Our engineers and astronomers are renowned internationally. Our astronomers conduct pioneering research on our own Milky Way and distant galaxies. Our engineers develop innovative antennas, high-tech electronics and intuitive software. Thanks to a good cooperation between technicians and scientists, even after sixty years the Westerbork Synthesis Radio Telescope (WSRT) is still one of the best telescopes in the world. LOFAR (the LOw Frequency ARray), designed, developed and managed by us, is one unique instrument that measures the earliest phases of the universe, as well as transient flashes in the sky, rotating neutrons stars and colliding black holes. ASTRON is working with other institutes to prepare for the construction of the Square Kilometer Array (SKA), which will become the largest and most sensitive radio telescope in the world. The knowledge we have gained with LOFAR and WSRT is of great importance for the design and construction of SKA.

ASTRON is also hosts to the Optical / Infrared instrumentation group from the Netherlands Research School for Astronomy (NOVA) and JIVE, the Joint Institute for VLBI ERIC. At JIVE, signals are combined from radio telescopes from all over Europe, Asia and South Africa. ASTRON is part of the institutes organisation of the Netherlands Organisation for Scientific Research (NWO).

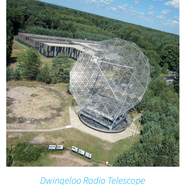
Our Telescopes

Radio waves are a form of electromagnetic radiation with wavelengths from a millimetre to kilometres. We can measure these waves with different types of antennas or dishes, also known as radio telescopes. At ASTRON, we are developing increasingly sensitive instruments and telescopes to measure the most distant radio waves in the Universe.

DRT
The Dwingeloo Radio Telescope (DRT) was opened in 1956 and was the largest telescope in the world at the time with a 25-meter diameter dish. The telescope was mainly used to map our own Milky Way by measuring neutral Hydrogen. The DRT has also discovered two small galaxies: Dwingeloo 1 and 2. Nowadays the DRT is a national monument that you can visit. The DRT is managed by the CAMRAS foundation.

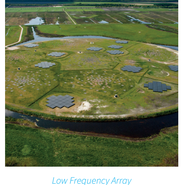
WSRT
The Westerbork Synthesis Radio Telescope (WSRT) was built in 1970. It consist of fourteen telescope dishes on a 2.7 kilometre East-West line. The telescope dishes contain special receivers for different radio wavelengths. Thanks to the latest receiver, called Apertif (APERture Tile in Focus), the area of the sky that can be measured in one observation is forty times larger than before. Apertif is very suitable for mapping the entire sky with great sharpness and sensitivity. Apertif is linked to a special supercomputer that constantly maps the sky and searches for explosive events in the distant Universe.

LOFAR
LOFAR, the LOw Frequency ARray, is a telescope that consists of thousands of small antennas that are combined in 51 stations spread throughout Europe. These stations are connected via a very fast fibre network, connected to a supercomputer in Groningen. This supercomputer combines the data from the antennas to a virtual radio telescope with a diameter of about 1200 kilometres. In the province Drenthe lies the heart, the central station of LOFAR. The telescope can measure very weak radio waves with the antennas operating in two frequency ranges: 10-90 MHz and 110-250 MHz. LOFAR is used to search for the origin of the first galaxies, black holes and gas clouds just after the birth of the Universe, the Big Bang.



Dwingeloo Radio Telescope

Westerbork Synthesis Radio Telescope



Low Frequency Array

Timeline - ASTRON highlights

1949
On 23 April 1949, the forerunner of ASTRON, SRZM (Stichting Radiostraling van Zon en Melkweg / Netherlands Foundation for Radio Astronomy) was officially founded with Prof. Jan Oort as chairman of the Board, a position he held until his retirement in 1970. SRZM was set up to prepare for the design, construction and operation of the Dwingeloo Telescope.

1956
Opening 25-meters DRT by HM Queen Juliana.

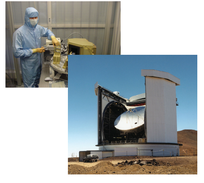
DRT makes a map of the Milky Way and discovers galaxies Dwingeloo 1 and 2 years later.

1960
The WSRT (Westerbork Synthesis Radio Telescope) is opened by HM Queen Juliana.

1960 – 1970
Design & construction of the Westerbork Synthesis Radio Telescope (WSRT).

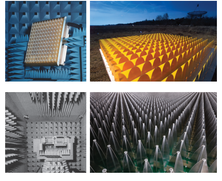
1970

1980
The European VLBI Network (EVN) is established with ASTRON as one of its founding members. The WSRT becomes a major component of the network, building on the first EVN experiment (1976) using the "ODE" network – Onsala (SE), Dwingeloo and Effelsberg (DE).



1981
ASTRON plays a major role in the design and construction of instruments for optical and mm-telescopes.

1995
ASTRON embarks on a major new R&D line, developing Aperture Arrays for Radio Astronomy. This has a major impact in the development of several next generation radio telescopes, including LOFAR and the SKA.



2010
LOFAR is opened by HM Queen Beatrix.

2010
A new upgrade of the WSRT commences with the installation of the first APERTIF PAFs (Phased Array Feeds) - providing an observing capability 40 times larger in area.

2015
Start construction of the Square Kilometre Array (SKA).

2020 and beyond

Future

LOFAR 2.0
In the coming years, ASTRON is working on improving and expanding the LOFAR telescope, so that it remains a world-class facility for future generations of astronomers. For example, we are engaging with international partners about more LOFAR stations in Europe. The electronics of the stations will also be modernised so that the telescope can absorb more sensitive radio waves from the Universe. In addition, LOFAR is used for research into space weather.

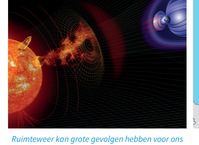
Space weather investigates the influence of the Sun and solar wind (a stream of charged particles that is emitted from the upper part of the solar atmosphere) on the Earth. Just like weather phenomena in our atmosphere, space weather can have major consequences for our daily lives. While a mild solar storm creates the beautiful northern light, a violent solar storm can cause power outages or disruptions of satellites. With LOFAR 2.0 we want to improve mapping space weather so that we can predict it better.

SKA
ASTRON is involved in the development of the Square Kilometre Array (SKA). SKA will become the world's largest and most sensitive radio telescope for astronomical research. Distributed over two locations in Western Australia and South Africa, antennas and dishes with associated (super) computers and infrastructure will be built.

The expectation is that SKA will give an enormous boost to the broad astronomical research: from testing Albert Einstein's general theory of relativity, researching the early Universe and the formation of the first stars and galaxies, mapping of the magnetic fields in the Universe, the discovery of fast radio flashes, the study of planets around nearby stars, and even the search for an answer to one of the greatest mysteries of mankind: are we alone in the Universe?

Science Data Centre
Astronomy has always dealt with large amounts of data. SKA will deliver more data than we have ever had to process and analyse: in the initial phase alone about one petabit per second (10^{15} bit / s) - more than five times the global internet traffic in 2015. The SKA telescopes provide a major boost for science and economy because Dutch companies can expect commissions for the construction of the giant telescope, even though SKA will not stand on Dutch soil.

The processing and final storage of the SKA data will be a huge challenge. This requires innovation in hardware, software and expertise. ASTRON therefore works together with the Dutch universities and companies to realise a Science Data Centre in the Northern Netherlands, facilitated by a public-private partnership between science, government and business.



Ruimteweer kan grote gevolgen hebben voor ons dagelijks leven. © NASA

ASTRON werkt aan het verbeteren van LOFAR, daarvoor wordt ook gekeken naar uitbreiding van LOFAR in meer landen.

SKA gaat meer data opleveren dan we ooit hebben moeten verwerken. © Elodie Burrillon