LOFAR and GLOW

The Low Frequency Array (LOFAR) is a new-generation radio telescope under construction in the Netherlands, Germany, the UK, France, and Sweden. Technologically and scientifically, it is a pathfinder of the Square Kilometre Array, which is planned by institutes all over the world. GLOW is the German Long Wavelength Consortium, which represents and coordinates German interests and contributions to LOFAR.

Built and planned international LOFAR stations
Spektrum der Wissenschaft / Emde Graphik

LOFAR operates in the widely unexplored frequency range between ~30 MHz to 240 MHz (wavelengths of 10 m to 1.25 m). It has been designed and is constructed by ASTRON in the Netherlands. LOFAR is fully digital, without moving parts, consisting of a large number of stationary antennas grouped in stations the size of a soccer field. 36 stations are planned in the Netherlands and at least 8 stations in other European countries. The sampled signals are transmitted via optical fibre networks to the central processor in Groningen, which correlates the signals and generates the radio images. The instantaneous field of view is the entire visible sky. It is expected that LOFAR will make significant discoveries in several areas of contemporary astronomy. A number of Key Science Projects (KSPs) have been identified, which shape the design of LOFAR: epoch of reionization (EoR), surveys, transients and pulsars, cosmic rays, solar radio emission, and magnetism.

LOFAR station at the Thüringische Landessternwarte

GLOW represents German interests in LOFAR. The current member institutes are: Universität Bielefeld, Astronomisches Institut der Ruhr-Universität Bochum, Argelander-Institut für Astronomie Bonn, Max-Planck-Institut für Radioastronomie Bonn, Jacobs University Bremen, Max-Planck-Institut für Astrophysik Garching, Sternwarte Hamburg, Forschungszentrum Jülich, 1. Physikalisches Institut der Universität Köln, Astrophysikalisches Institut Potsdam, Thüringische Landessternwarte Tautenburg and the Excellence Cluster "Origin and Structure of the Universe" Garching.

GLOW organizes regular meetings of the Scientific and Technical Working Groups, network access, and the two German Key Science Projects. GLOW also coordinates the German efforts to build new stations and to develop software needed for the KSPs.

Similar efforts are under way in other countries, so that this extended European LOFAR will have significantly higher sensitivity and resolution than the Dutch array alone.

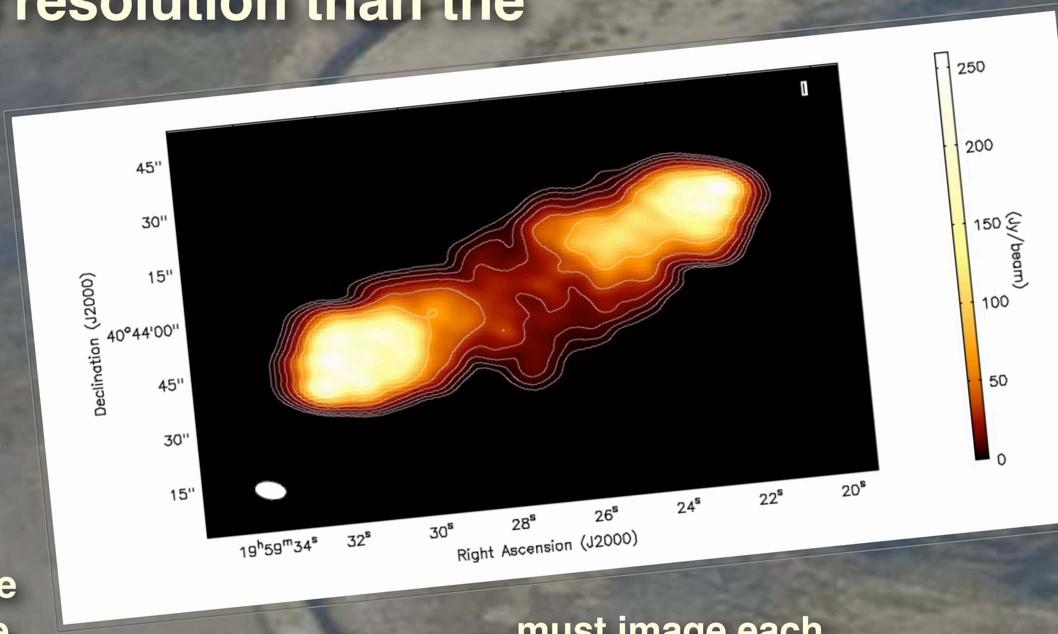
Science with LOFAR and GLOW

LOFAR has a wide range of applications, almost all of which will profit from the added sensitivity and resolution of international stations. Furthermore, Germany's astronomical institutes contribute expertise to the research in many areas.

Extragalactic surveys and EoR observations: Both of these projects will profit enormously from a European participation. An array with baselines that are confined to the Netherlands will have too little resolution and will be confusion-limited. Long baselines are needed to disentangle emission from separate sources and to resolve their fine structure. Similarly, observations looking for the EoR signature rely on accurate removal of foreground sources, which again requires long baselines.

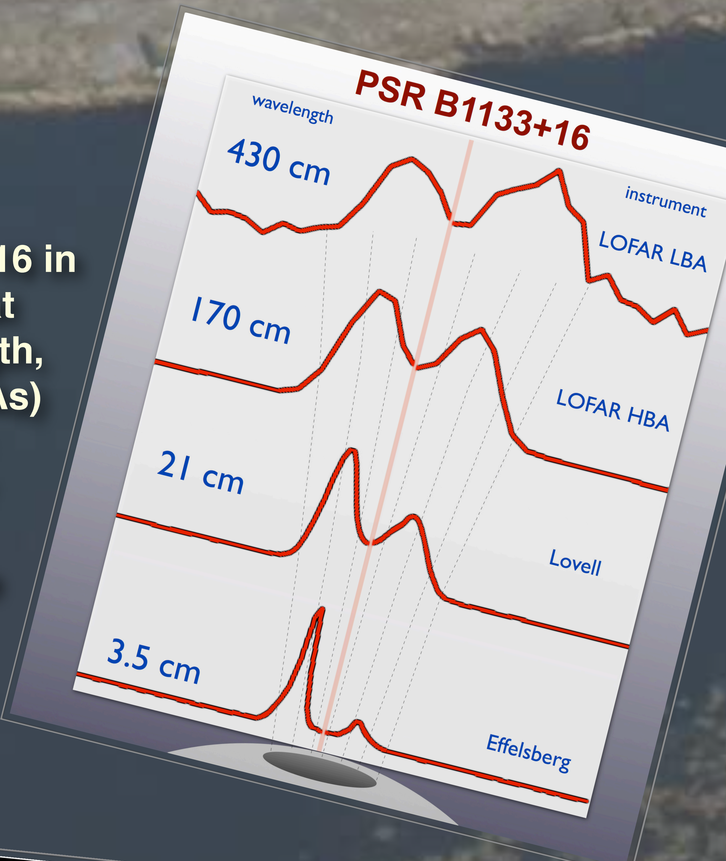
Solar physics: This German KSP, led by the AIP, aims at monitoring the sun continuously at several frequencies, which correspond to different distances from the sun's surface (1.2 to 2.5 solar radii). These observations aim at clarifying the emission processes, studying coronal shock waves and mass ejections and how magnetic field energy is transferred into the plasma.

Magnetism: The second German KSP, led by the MPIfR, will study magnetic fields. Their origin is unknown, but they play important roles in almost every astronomical object. Magnetic fields can be studied through polarization-sensitive observations of synchrotron emission. They yield the degree of ordering and the orientation of underlying fields, and can reveal field strengths by observing the Faraday rotation of the polarization plane of background sources in an intervening medium.



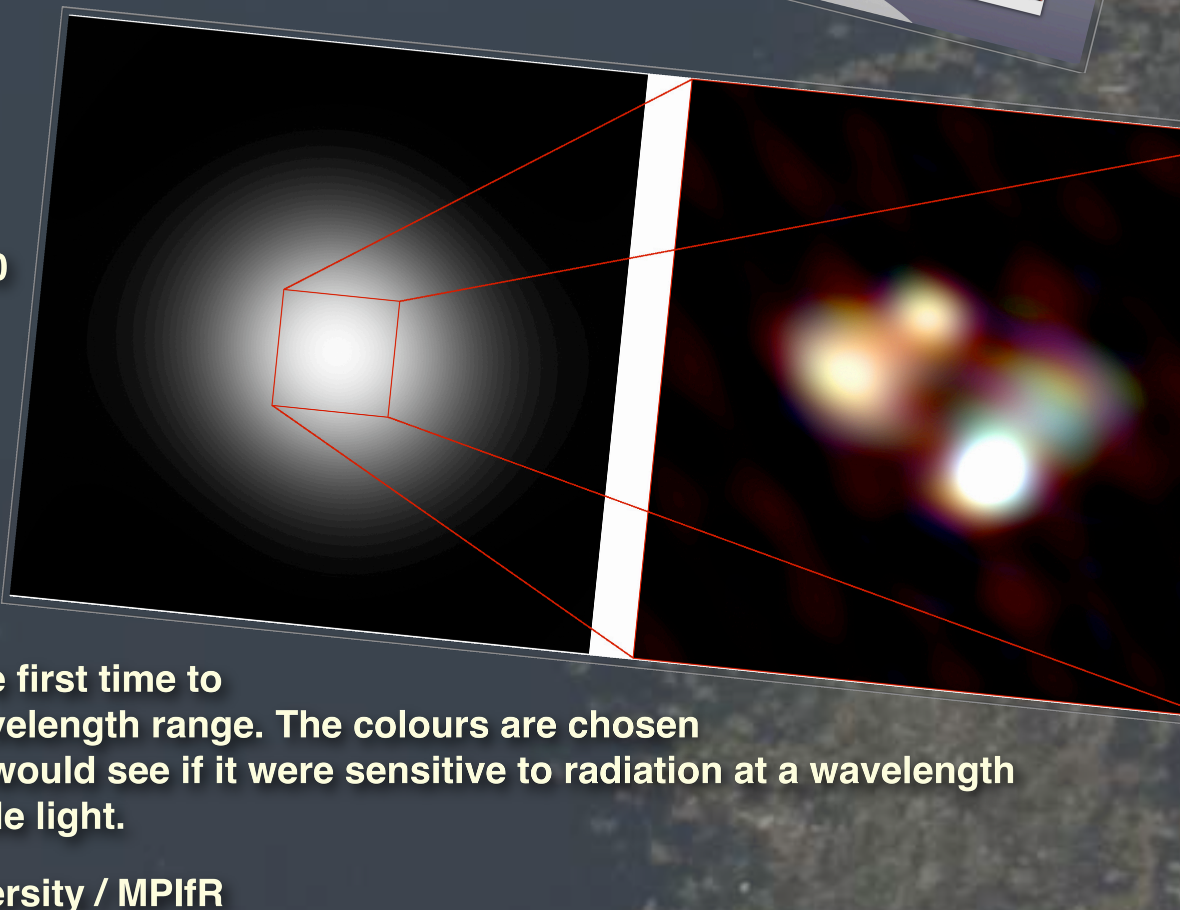
The enigmatic radio galaxy Cygnus A is one of the brightest sources in the LOFAR sky. It is one of the objects that makes up the `A-team'; a small number of very strong radio sources that can potentially contaminate every LOFAR observation. To reduce the effect of these sources on our science observations, we must image each member of the A-team over the LOFAR observing band and remove them from the uv-data of our target fields. The large luminosity and small distance to Cygnus A also makes this source interesting for studying the properties of AGN, for example, to investigate feedback processes. Its complex double structure also makes for an excellent commissioning target to test the LOFAR system.

Credit: John McKean / LOFAR



Simultaneous detection of pulses from pulsar PSR B1133+16 in four widely spaced bands, using the Effelsberg telescope at 3.5 cm wavelength, the Lovell telescope at 21 cm wavelength, and LOFAR high-band (HBAs) and low-band antennas (LBAs) at 170 cm and 430 cm wavelength, respectively. The figure shows the pulse intensity as a function of time for the four observed wavelengths. The shape of the pulsar's pulsed emission maps the spreading of magnetic field lines above the pulsar's magnetic poles.

Credit: Aris Karastergiou, University of Oxford / MPIfR



Radio images of the quasar 3C 196 at 4 - 10 m wavelength (30 - 80 MHz frequency). Left: Data from LOFAR stations in the Netherlands only. The resolution is not sufficient to identify any substructure. Right: Blow-up produced with data from the German stations included. The resolution of this image is about ten times better and allows for the first time to distinguish fine details in this wavelength range. The colours are chosen to resemble what the human eye would see if it were sensitive to radiation at a wavelength ten million times larger than visible light.

Credit: Olaf Wucknitz, Bonn University / MPIfR

LOFAR

Poster design: E. Middelberg & M. Hoeft