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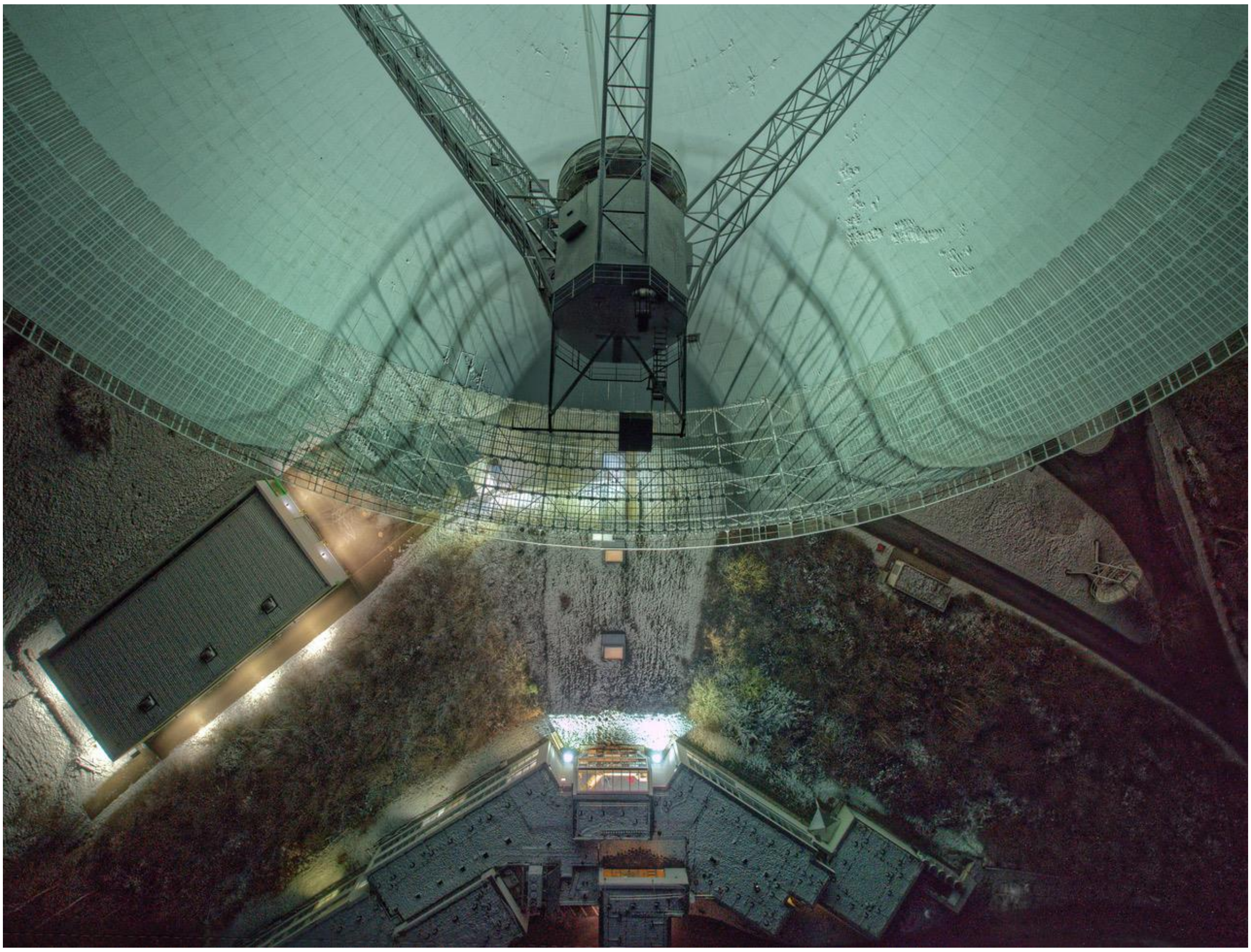

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Greetings from the director

Dear colleagues,

On behalf of the MPIfR, and especially on behalf of the dedicated staff of the Effelsberg Observatory, I wish you a happy and successful year 2024. The past year has been very exciting, with many interesting results. A particular highlight was certainly the announcement of significant evidence for a stochastic gravitational background, in which Effelsberg played an important role, providing the longest data set worldwide and being the backbone of the Large European Array for Pulsars (LEAP). Regular PTA observations started at Effelsberg in 1996, and the MPIfR looks forward to continuing to contribute to the European and International Pulsar Timing Arrays.

These and other observing programmes will benefit from new instruments, such as the new version of the Ultra Broadband Receiver (UBB), a much improved version of the first UBB receiver installed in 2012. This newsletter contains more information on the UBB, which will be available for general use by the next deadline.

Another important progress reported in this newsletter is the recent success at the last World Radio Conference, and I would like to express our thanks to Benjamin Winkel and Gyula Józsa for their commitment to help us protect the precious frequencies allocated to radio astronomy.

Please note that during the summer we will be replacing the telescope's current main axis control, which will require a break in observations for about six weeks. After that, however, the telescope will be in even better shape to deliver excellent results in the future.

With this, I'd like to add my personal wishes to everyone for a healthy and peaceful 2024, and many successful observing hours at the observatory.

Michael Kramer

Call for proposals

Deadline Feb 5, 2024, 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!).

New broad-band receiver

The new “Ultra-Broad-Band”-Receiver (UBB) is a prime focus system covering the frequency range of 1.3-6 GHz. The system is now ready for regular observations. For more information, see the description of the system in this newsletter.

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). Furthermore, the new flexible, fully-digital backend system EDD ("Effelsberg Direct Digitization") is currently being implemented and will be available for an increasing number of observations in the near future.

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/using-evn.

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 May 30th, 2024, and on Sep 26th, 2024.

Opticon-RadioNet-Pilot Transnational Access Programme

The new Opticon-RadioNet-Pilot (ORP) project (see http://www.orp-h2020.eu/TA-VA) 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

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The new Ultra Broad Band receiver for the 100m-telescope

By Gundolf Wieching

The new Ultra Broad Band (UBB) receiver for Effelsberg has replaced the narrower-band first-generation UBB receiver. The new system has a nearly continuous RF frequency coverage from 1.3 to 6 GHz. It has 2 polarisations with 2 digitising units (ADC's) each. The lower frequency range of 1.3 - 2.6 GHz and the upper frequency range of 3 - 6 GHz will be converted with a 2-channel digitizer each. As one of the first fully Effelsberg Direct Digitisation (EDD) Receivers the digitisation takes place directly in the receiver and the digital data obtained is then transmitted via optical fibres at a data rate of approx. 130 Gb/sec. to the generic EDD backend instrumentation for further processing. Commissioning took place last year and could be completed by the end of 2023, making this newly developed and novel Rx available to the scientific community.

Figure 1: Picture of the UBB Rx in the laboratory. The feed points downwards and is automatically pulled up into the Rx box for storage. In the centre left is the highly integrated EDD front-end unit, which provides control, monitoring, RF conditioning and digitization.

The UBB's ultra-broadband feed was designed and built by CSIRO and is unique of its kind. It has been integrated into a receiver for prime focus observations on the 100m Effelsberg by the receiver group led by Christoph Kasemann. The receiver not only provides direct digitisation, which ensures a highly stable (phase and amplitude) system, but also includes all receiver-related control and monitoring. This makes the Rx a self-contained and self-describing system, simplifying future operation and maintenance.

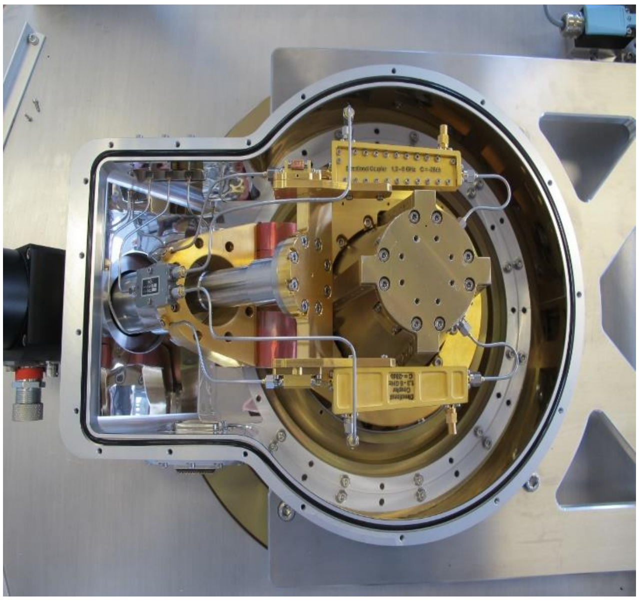


Figure 2: Picture inside the UBB cryostat. The feed can be seen in the centre, while on the left-hand side the cold finger of the cryco cooler is sticking in. The square boxes above and below are RF filters to cope with the strong external RFI.

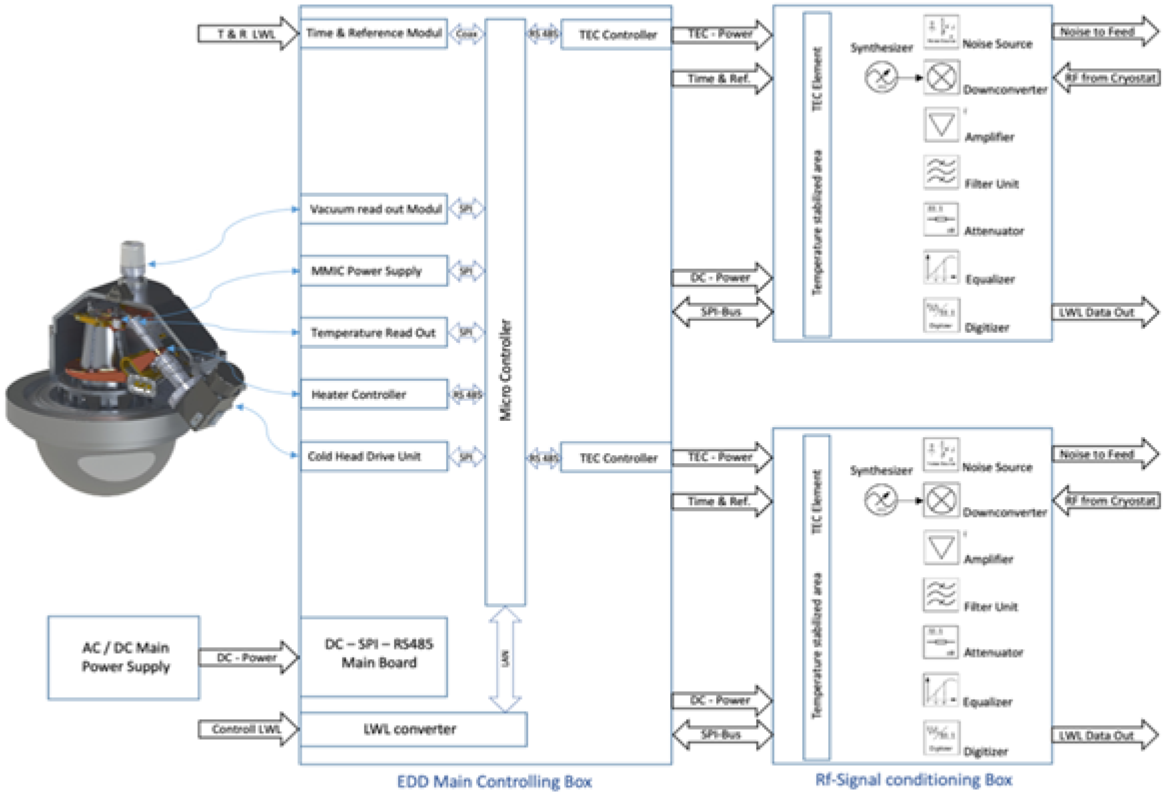


Figure 1: Setup of the UBB Receiver with the fully integrated system.

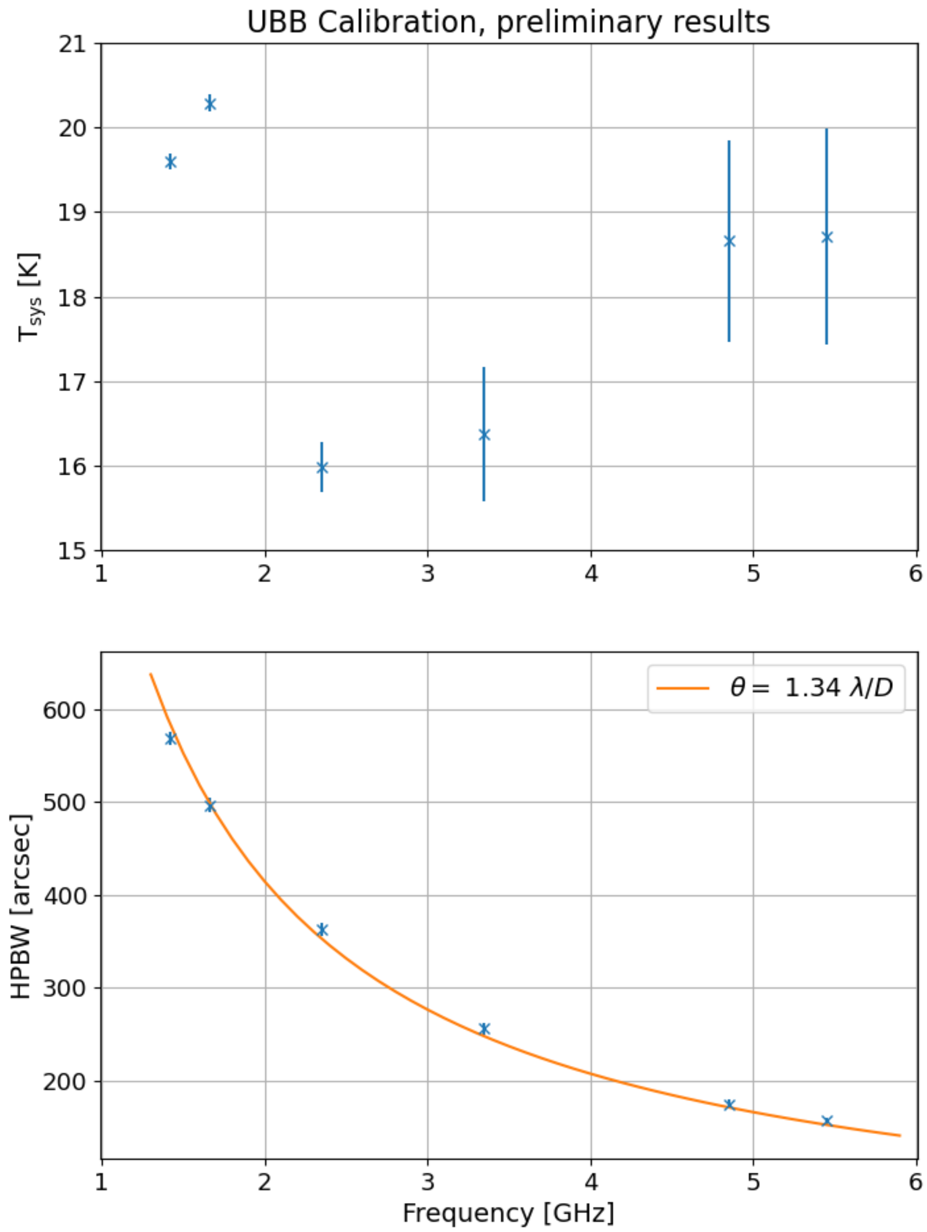


Figure 4: Results of calibration observations performed in January 2024.

The operation of the UBB is supported by the EDD backend system, a multi-purpose data reduction and analysis system developed by the Backend Development Group led by Ewan Barr. The processing of the data takes place in the RFI shielded Room, aka Faraday Room. This allows the backend, to be based on off-the-shelf FPGA accelerators and GPU servers. It has been deployed in Effelsberg for several years, being principally used for pulsar timing and search observations. However, last year saw the commencement of science observations using the backend's spectroscopic mode.

Here, the EDD system differs from previous receiving and backend systems at Effelsberg. As a fully digital system, the data arriving at the backend from the receiver is richer in metadata and encodes information about the receiver state, including the state of the receiver's calibration noise diode. By using this embedded noise diode information, the EDD backend can perform on-the-fly gating, integrating spectra into ON and OFF noise diode channels. The benefits of such gating are many. They remove down time in the instrumentation when switching between noise diode states and most importantly they open a previously unavailable path to commensality between spectroscopic and pulsar observations. By operating the EDD receiver noise diodes at frequencies faster than the highest Nyquist frequency of interest for pulsar searching observations (typically around 5 kHz) we may conduct simultaneous time and spectral domain observations without significant reduction in data quality for either. The GPU-nature of the backend will also provide Effelsberg with unprecedented spectral resolution, being capable of producing many millions of frequency channels across its observing bands. As both polarisations are available with a high phase stability the EDD also provides the polarisation information commensally. The last default observing mode that has being implemented is the VLBI mode. Testing of this currently in the final stage. Work is currently ongoing to update Effelsberg's infrastructure to ensure that the highest possible resolutions can be made available to astronomers also for the other Effelsberg receivers.

Extreme stars share unique properties that may provide a link to mysterious sources

A universal relation for pulsars, magnetars and potentially fast radio bursts

An international research team led by Michael Kramer and Kuo Liu from the Max Planck Institute for Radio Astronomy in Bonn, Germany, have studied a rare species of ultra-dense stars, so called magnetars, to uncover an underlying law that appears to apply universally to a range of objects known as neutron stars. This law gives insight into how these sources produce radio emission and it may provide a link to the mysterious flashes of radio light, Fast Radio Bursts, that originate from the distant cosmos.

The results were published in Nature Astronomy on Nov 23, 2023.

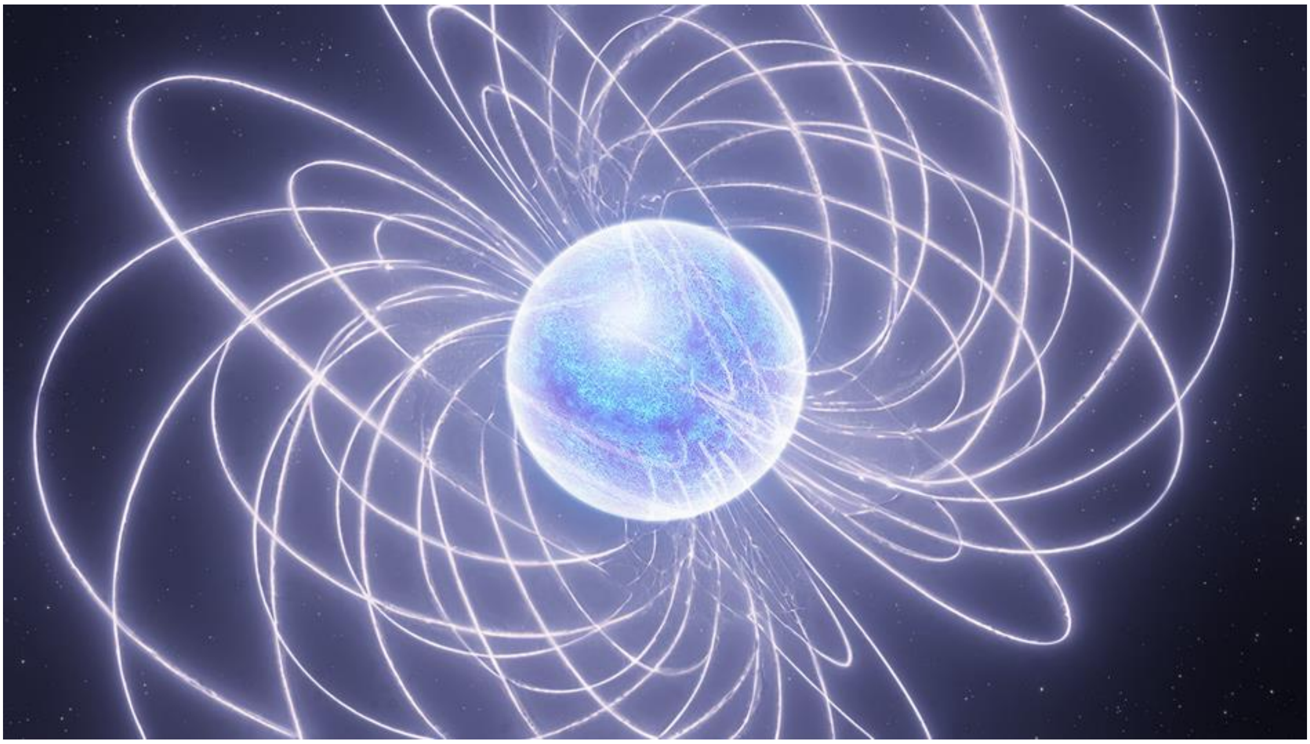


Fig. 1: Artistic impression of a magnetar, where a neutron star emits radio light powered by the energy stored in the ultra-strong magnetic field, causing outburst which are among the most powerful events observed in the Universe.

Neutron stars are the collapsed cores of massive stars, concentrating up to twice the mass of the sun in a sphere of less than 25 km diameter. As a result, the matter there is the most densely packed one in the observable Universe, squeezing electrons and protons into neutrons, hence the name. More than 3000 neutron stars can be observed as radio pulsars, when they emit a radio beam that is visible as a pulsating signal from Earth, when the rotating pulsar shines its light towards our telescopes.

The magnetic field of pulsars is already a thousand billion times stronger than the magnetic field of the Earth, but there is a small group of neutron stars that have magnetic fields even 1000 times stronger still! These are the so called magnetars. Of the about 30 magnetars known, six have also been detected to emit radio emission, at least occasionally. Extragalactic magnetars have been suggested to be the origin of the Fast Radio Bursts (FRBs), and in order to study this link, researchers from the Max Planck Institute for Radio Astronomy (MPIfR) with help from colleagues at the University of Manchester, have inspected the individual pulses of magnetars in details and detected sub-structure in those. It turns out that similar pulse structure was also seen in pulsars, the fast-rotating millisecond pulsars, and in other neutron star sources known as Rotating Radio Transients.

To their surprise, the researchers found that the timescale of magnetars and that of the other types of neutron stars all follow the same universal relationship, scaling exactly with the rotation period. The fact that a neutron star with a rotation period of less than a few milliseconds and one with a period of nearly 100 seconds behave like magnetars suggests that the intrinsic origin of the subpulse structure must be the same for all radio-loud neutron stars. It reveals information about the plasma process responsible for the radio emission itself, and it offers a change to interpret similar structure seen in FRBs as the result of a corresponding rotational period.

“When we set out to compare magnetar emission with that of FRBs, we expected similarities,” recalls Michael Kramer, first author of the paper and Director at MPIfR. “What we didn’t expect is that all radio-loud neutron stars share this universal scaling.”

“We expect magnetars to be powered by magnetic field energy, while the others are powered by their rotational energy,” complements Kuo Liu. “Some are very old, some are very young, and yet all seem to follow this law.”

Gregory Desvignes describes the experiment: “We observed the magnetars with the 100-m radio telescope in Effelsberg and compared our result also to archival data, since magnetars do not emit radio emission all the time.” “Since magnetar radio emission is not always present, one needs to be flexible and react quickly, which is possible with telescopes like the one in Effelsberg,” confirms Ramesh Karuppusamy.

For Ben Stappers, co-author of the study, the most exciting aspect of the result is the possible connection to FRBs: “If at least some FRBs originate from magnetars, the timescale of the substructure in the burst might then tell us the rotation period of the underlying magnetar source. If we find this periodicity in the data, this would be a milestone in explaining this type of FRB as radio sources.”

“With this information, the search is on!”, concludes Michael Kramer.

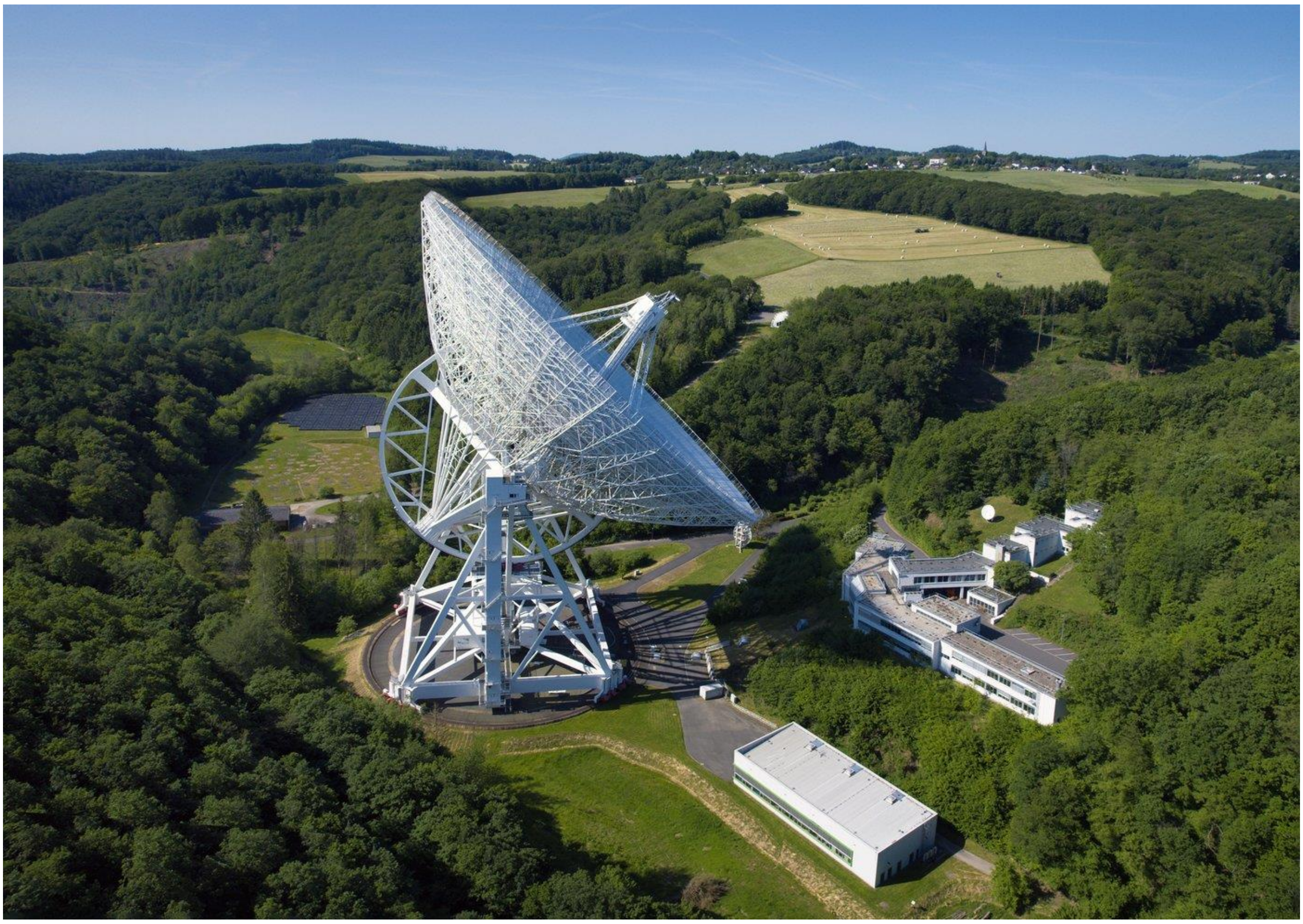
World Radiocommunication Conference puts radio astronomy on the agenda

New studies to improve the protection of radio astronomy measurements from satellite systems

Thousands of delegates from member states of the International Telecommunication Union and representatives from industry and science met for four weeks in Dubai. The World Radiocommunication Conference set the course for new applications for radio communication. The focus was also on protecting radio astronomy, in particular from the effects of new satellite constellations. Radio astronomers, including those from the Max Planck Institute for Radio Astronomy in Bonn, Germany, have been active in spectrum management for many years. They are calling for the International Telecommunication Union to update its rules and processes in order to keep pace with the changing situation. Studies are now to be carried out before the next world radio conference in 2027. The aim is to identify improved technical or regulatory measures so that the exploration of the secrets of the universe can be continued in the future.

"Considering that radio astronomy is a pivotal scientific discipline that plays a crucial role in unraveling the mysteries of the cosmos" - these are the opening words of a new resolution of the International Telecommunication Union (ITU), which was adopted last Friday at the World Radiocommunication Conference in Dubai. "This finally acknowledges a problem that radio astronomy has faced due to the extreme increase in the number of satellites in near-Earth space," says Benjamin Winkel from the Max Planck Institute for Radio Astronomy (MPIfR). He and his colleagues have been working for years to ensure that the rules and processes at the International Telecommunication Union are updated to keep pace with the changed situation.

World Radiocommunication Conferences take place every 3 to 4 years. Thousands of delegates from countries, in particular the telecommunications authorities (in Germany: Bundesnetzagentur), as well as other interest groups from industry, business and science meet for 4 weeks to work on the so-called radio regulations. This is an international set of agreements designed to regulate the smooth interaction of all radio services. If, for example, new mobile radio frequencies are to be made usable, dozens of technical studies have to be carried out beforehand to ensure that existing applications are not disrupted. The frequencies that are "made available" by nature - the radio spectrum - are already in full use. Certain frequency ranges have also been reserved for radio astronomy in order to protect particularly important observation frequencies. "However, these frequencies are far too few for modern radio astronomy," reports Gyula Józsa, also from the MPIfR."The problem of human-made interference which can impact the sensitive radio astronomical receivers was already known over 50 years ago. This was actually the reason why the 100-m radio telescope, which is operated by the MPIfR, was built in a valley in the Eifel and not in the middle of the city of Bonn. Its location ensures a certain degree of natural shielding." Of course, the new satellite systems, such as SpaceX/Starlink, OneWeb or Amazon/Kuiper, cannot be avoided in this way. After all, the aim of these companies is to provide Internet access everywhere on Earth.



The 100-m telescope is located in a picturesque Eifel valley which provides good protection from terrestrial man-made radio transmissions for decades. However, the increased use of broadband communication via large satellite constellations is causing more and more headaches for astronomers, as satellites are high in the sky all over the world.

From a European perspective, this applies in particular to the two international flagship projects, ALMA (with telescopes in Chile) and SKAO (with telescopes in South Africa & Australia). Astronomical institutes and organizations worldwide are investing billions in these ob-servatories. For South Africa and Chile, however, these ventures also play a strategic role in the nations' development. They are infrastructure measures, educational institutions and places of international cooperation all in one. Busang Sethole from the South African Radio Astronomy Observatory (SARAO) is determined that these projects, of all things, should not be jeopardized. "Reflecting on our collective efforts, I recognize room for improvement. Developing nations only started participating in the ITU after the GE06 conference, which stands in stark contrast to the institutional knowledge amassed by developed countries over 156 years. This wealth of experience should ideally facilitate, not inhibit, the needs of developing nations," said Sethole during the conference.

The fact that the needs of astronomers were addressed at all at the World Radiocommunication Conference was only possible because two important regional organizations had declared the topic a top priority in the run-up to the conference. One was the European Conference of Postal and Telecommunication Administrations (CEPT), which wanted to see the already existing protection criteria for radio astronomy better enforced. The second was the African Telecommunications Union (ATU), which has brought the issue of special radio quiet zones to the international stage. These zones are areas in which terrestrial radio equipment is restricted in the vicinity of observatories in order to create better observation conditions. However, these are purely national regulatory interventions and cannot influence satellite systems, which are subject to international rules.

The World Radiocommunication Conference in Dubai decided to combine both proposals and called on the member states to develop possible technical and regulatory solutions by the next conference in 2027. "This is still a lot of work for the radio astronomers involved," says Gyula Józsa, who led the working group on this topic in Dubai. Benjamin Winkel adds: "Nevertheless, we are very confident, because we have already done a lot of the necessary preparatory work with our European spectrum management organization, CRAF, and our colleagues from SKAO."

The Committee on Radio Astronomy Frequencies (CRAF) of the European Science Foundation coordinates activities to keep the frequency bands used by radio astronomy and space sciences free from interference on behalf of European radio astronomers. The science of radio astronomy plays a key role in increasing our understanding of the environment and the universe in which we live. By its nature it is a passive service, so it never causes interference to other users of radio, but unfortunately it is becoming increasingly difficult to protect radio astronomy operations from radio interference as use of the spectrum increases for both terrestrial and space-borne communications.