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Preface

Dear Readers of this newsletter,
dear Users of the 100-m telescope,

the worldwide outbreak of the COVID-19 virus has an impact on the life of everybody.

Parts of our observatory personnel were asked to work from home because our staffs' health has the highest priority. Similarly, also the visitor’s center is currently closed until the situation improves.

Despite these restrictions, the 100m telescope itself is still operational. The observations are running as scheduled, but in remote or service mode, and with limited but efficient support by our staff.

Please, be assured that we will do our best to keep the observatory running in order to serve your scientific needs as good as we can. Therefore, don't hesitate to submit your observing requests for the coming deadline.

Let us take the opportunity to express our sincere thanks to our dedicated observatory staff for their efforts to keeping the telescope operational.

We hope to seeing you soon again in Effelsberg!

Best wishes and stay healthy,

Michael Kramer & Alex Kraus

Call for proposals – Deadline June 3, 2020, UT 15:00

by Alex Kraus

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 https://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.

Please note, that observing proposals for the new **Phased-Array-Feed** cannot be accepted yet – the system is still being commissioned.

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) (e.g. to NRAO for the VLBA).

The following deadline will be October 5, 2020, 15:00 UT.

RadioNet Transnational Access Programme

by Alex Kraus

RadioNet (http://www.radionet-org.eu) includes a coherent set of Transnational Access (TA) programs aimed at significantly improving the access of European astronomers to the major radio 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 additional aid from the Transnational Access (TA) Program of 'RadioNet'. 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.

The Transnational Access program is one of the activities of "RadioNet“, an Integrated Infrastructure Initiative (I3) funded under the ECs Framework Program Horizon2020, that has pulled together all of Europe's leading astronomy facilities to produce a focused, coherent and integrated project that will significantly enhance the quality and quantity of science performed by European astronomers.

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.

After completion of their observations, TNA supported scientists are required to submit their feedback through the TNA web pages.

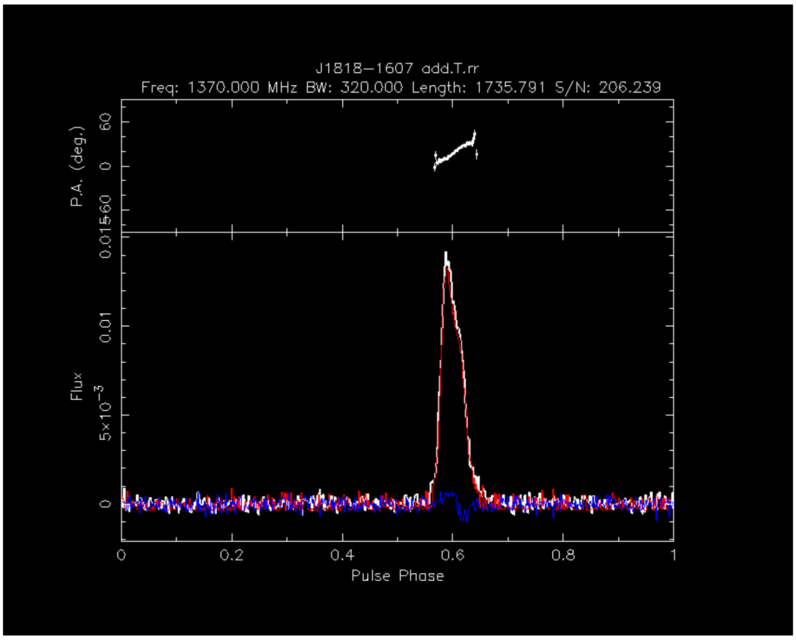
Detection of pulsed radio emission from new magnetar Swift J1818.0-1607 and measurements of its spin-down properties

by Michael Kramer

Following the Swift/BAT detection of a short burst from the new soft gamma-ray repeater (SGR) candidate, Swift J1818.0-1607, (GCN circular 27373) and detection of coherent X-ray pulsations with a spin period of 1.36 s with NICER by Enoto et al. (ATel 13551), Effelsberg was the first telescope to discover radio pulsations from this source (Karuppusamy et al., ATel 13553) less than 24h later. The observation was confirmed shortly after by the Lovell Telescope at Jodrell Bank (Rajwade et al., ATEL 13554).

After the nearly 100% degree of linear polarisation detected by Effelsberg already supported the suggested nature of the source as a magnetar, joint Effelsberg and Jodrell timing observations confirmed this impression when they were the first to determine the spin-down rate and hence the age and magnetic field of Swift J1818.0-1607. As reported by Champion et al. (ATel 13559), the large spin-down rate of $-4.4(1)^{-11}$ s^{-2} implies a characteristic age of the magnetar of only 265 years.

With a dispersion measure of about 700 cm^{-3} pc and a rotation measure of about +1440 rad m^{-2}, the source is deep in the Galactic plane. Timing observations continue with Effelsberg and also the Nançay Radio Telescope. Together, a number of timing events have been detected which will be reported in a refereed publication soon.



Giant magnetic fields spanning across the Andromeda Galaxy

40 years of observations with the Effelsberg telescope

by Rainer Beck and Elly M. Berkhuijsen

Astronomers at MPIfR obtained the so far most comprehensive and detailed map of the magnetic fields in the Andromeda Galaxy, our Milky Way's neighbour, using the Effelsberg telescope. The magnetic fields form a broad ring with a diameter of 40,000-100,000 light years. The field orientation almost follows the ring, as was predicted by the dynamo theory of field origin. Such giant magnetic fields play an important role in the formation and development of galaxies.

The Andromeda Galaxy Messier 31 (M31 in short), at a distance of "only" 2.5 million light years, is the nearest spiral galaxy. It surpasses our Milky Way galaxy in size and total mass. M31 is visible to the naked eye in clear nights. Ancient Arabic star maps show M31 as a nebulous spot. Modern telescopes operating at many wavelengths allow us to study its stars, gas, and dust in unique detail. Warm dust and hot gas trace regions of recent star formation, while cold gas indicates where star formation will happen in future. Radio continuum waves open the view onto another, often neglected constituent of galaxies: the magnetic fields.

Galaxies are continuously forming new stars. The most massive stars may explode as supernovae. These generate shock waves that rush through the gas between the stars (the interstellar medium) and accelerate particles to almost the speed of light, which are called "cosmic rays". If an electron (or a much rarer positron) crosses a magnetic field, it spirals around the field line and emits linearly polarized radio waves, called "synchrotron radiation". The intensity of this emission allows us to calculate the field strength. The polarization angle indicates the field orientation in the plane of the sky. Additional measurement of the variation of the polarization angle with wavelength ("Faraday rotation") gives the field direction along the line of sight, so that the field structure in three dimensions can be investigated.

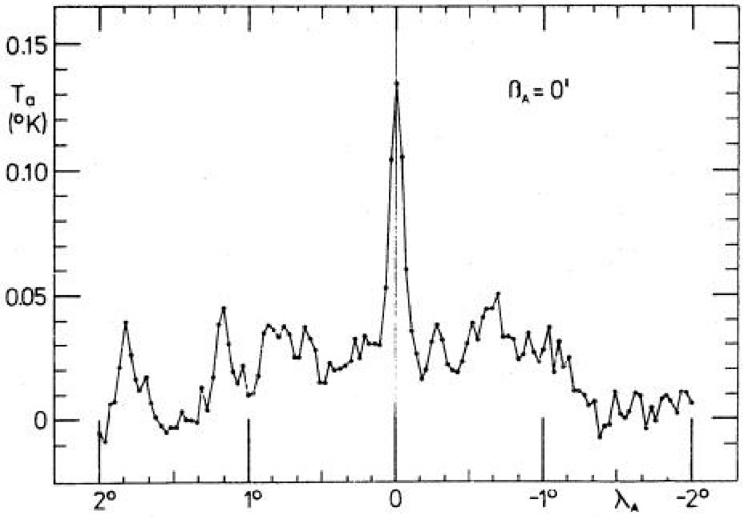


Figure 1: Scan along the major axis of M31 with the Effelsberg telescope at a wavelength of 11 cm, showing the central region and several spiral arms (from Berkhuijsen & Wielebinski, Astrophysical Letters 13, 169 (1973)).

Thanks to its enormous angular extent of about two degrees on the northern sky, M31 is an ideal target for observations with the Effelsberg telescope. Disproving the Program Committee's skepticism, radio continuum waves from M31 could be detected already in 1972 (Figure 1), shortly after the telecope's opening, by Richard Wielebinski, director at MPIfR from 1969 to 2004, and Elly M. Berkhuijsen, working at MPIfR since 1970. "M31 accompanied my whole scientific life. Once M31, always M31", says Elly, remembering a forecast by Gerard de Vaucouleurs made to her around that time. The first complete radio continuum survey of M31 at 11.1cm wavelength was conducted by Elly and Richard in 1972-1973 and published in 1974 (Figure 2), followed by further surveys at 21 cm and 6.2 cm.

In 1977, PhD student Rainer Beck discovered high degrees of linear polarization of the 11.1 cm radio emission from M31 as part of his doctoral thesis, supervised by Richard and Elly. This showed that the magnetic fields in M31 are highly ordered, which came as a surprise in view of the turbulent interstellar gas. Obviously, some process is able to generate order out of chaos.

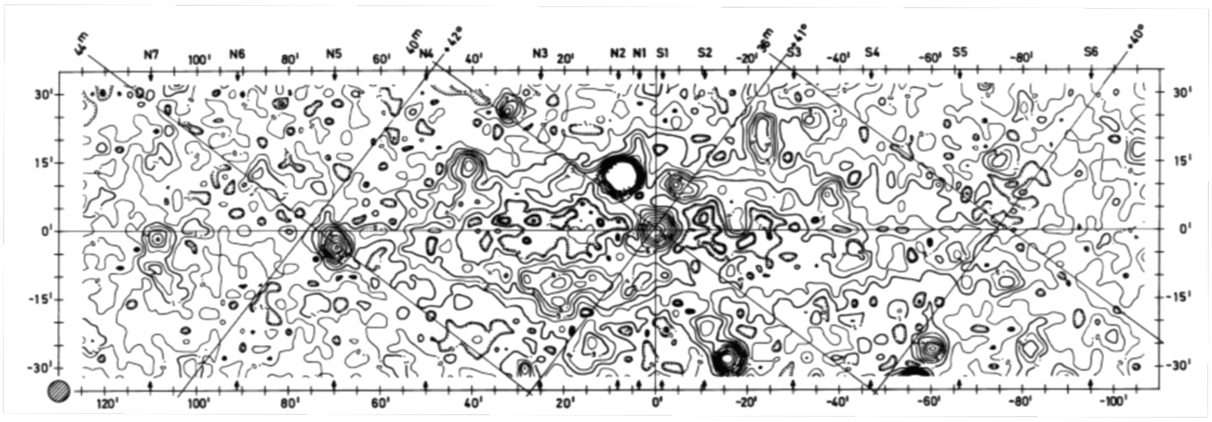


Figure 2: Total radio continuum emission from M31, observed with the Effelsberg telescope at a wavelength of 11.1 cm telescope at an angular resolution of 4.8 arcminutes, scanned parallel to the major axis of M31. The extent is about 3.9° x 1.1°. The arrows at the top edge of the plot mark the positions where the optical spiral arms cross the major axis (from Berkhuijsen & Wielebinski, Astronomy & Astrophysics 34, 173 (1974)).

In the following decades the receiving systems of the Effelsberg telescope were continuously improved. Between 2001 and 2012, two students at MPIfR, René Gießübel and David Mulcahy, supervised by Rainer Beck and Elly M. Berkhuijsen, conducted mapping of the total and linearly polarized emission of M31 at three radio wavelengths (3.6 cm, 6.2 cm, and 11.3 cm). The galaxy was scanned in strips many times to increase the sensitivity, which took more than 300 hours of observation in total. Worldwide, only the Effelsberg radio telescope is suited for such a mammoth task. The radio maps were first presented in René Gießübel's PhD Thesis and in David Mulcahy's Master Thesis. The detailed evaluation took several more years of work. The results were published in Astronomy & Astrophysics 633, A5 (2020) (https://www.aanda.org/articles/aa/pdf/2020/01/aa36481-19.pdf).

Figure 3 shows the intensity of the radio emission at 3.6 cm wavelength in colour and the orientation of the magnetic fields as white lines. The intensity is concentrated in a broad ring that is seen almost edge-on (inclined by about 75°) and extends between about 20,000 and 50,000 light years distance from the centre. With a ring thickness of only about 1,500 light years, the shape is that of a playing quoit. The field lines follow the ring almost everywhere, though slightly twisted with a systematic pitch angle of about 20°. If M31 would be seen face-on, its magnetic field would appear as a tightly wound spiral. According to Figure 3, the region close to the center hosts its own spiral field, but with a more open winding than that of the ring.

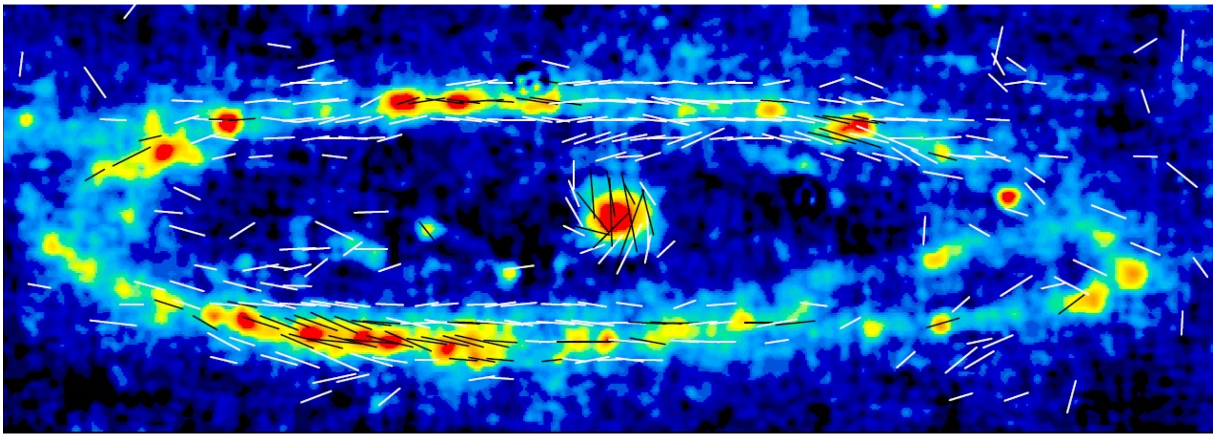


Figure 3: Total and linearly polarized radio continuum emission from M31 at 3.6 cm wavelength, observed with the Effelsberg telescope at an angular resolution of 1.5 arcminutes, scanned parallel to the major axis of M31. The extent is about 1.8° x 0.6°. Colour: intensity of the radio emission; white lines: orientation of the magnetic fields.

The comparison of the polarization angles between the three wavelengths shows a clockwise rotation (positive Faraday rotation) in the left part but a counter-clockwise rotation (negative Faraday rotation) in the right part of the image (Figure 4). This means that the magnetic field points away from us on the left and towards us on right, confirming that the field follows the inclined ring.

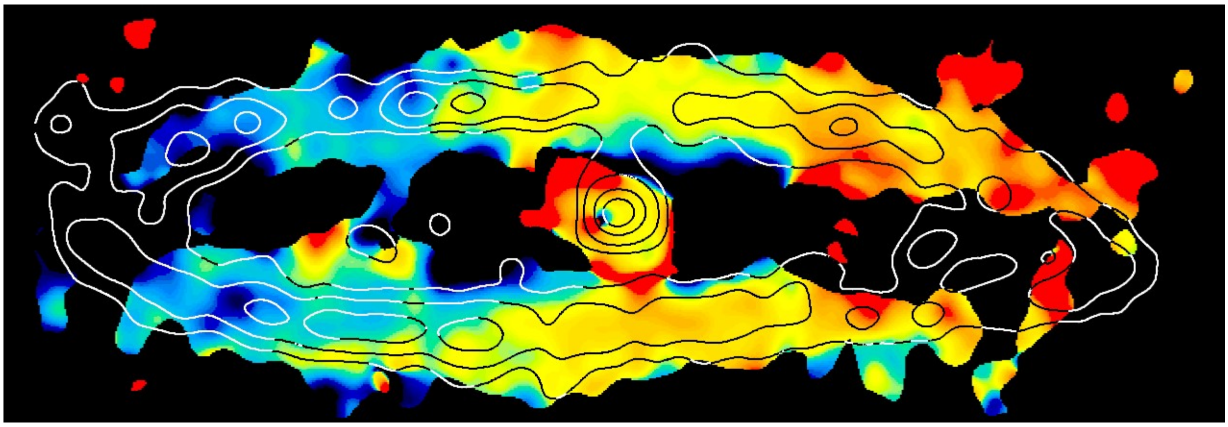


Figure 4: Magnetic field directions in M31, derived from the Faraday rotation of the polarization orientations between 3.6 cm and 6.2cm wavelengths at an angular resolution of 3 arcminutes. **Blue:** clockwise rotation - the field points away from us; **red:** counter-clockwise rotation - the field points towards us.

A regular magnetic field of such giant dimension seems to be at odds with the disorder in the galaxy's gas motions. Just one theory is able to explain this amazing observation. Fritz Krause and Karl-Heinz Rädler (both Potsdam, Germany), Eugene Parker (Chicago), and Anvar Shukurov and Dmitry Sokoloff (both Moscow) developed the theory of the "galactic dynamo" in the 1960s and 1970s, claiming that within a few billion years, small-scale "seed fields" in the star-forming gas of a galaxy’s disk would combine and form a large-scale field in the disk with help of the galaxy’s general rotation. This field is described by “modes” with respect to their symmetry. The observations of M31 allow us to identify two modes, a strong axisymmetric one plus a weaker bisymmetric one. This is why the new Effelsberg maps of M31 give the so far most impressive support of this theory, making M31 a prototypical case. Magnetic fields in planets and stars are probably also generated by dynamos, but are much more difficult to investigate because those bodies are not transparent to radio waves.

Several other spiral galaxies show dynamo-generated magnetic fields as well, though with more complex structures. Another exceptional property of M31 is the lack of a detectable radio halo. Halos observed around most spiral galaxies seen in almost edge-on view are thought to be generated by “galactic winds” that transport gas, magnetic fields, and cosmic ray particles from the disk into the halo. The wind in M31 is weak or may be lacking at all, which is at odds with the idea that outflows support the action of the dynamo in the disk.

We also found disordered (turbulent) magnetic fields in M31 via the unpolarized radio emission, but these are weaker than in most other spiral galaxies. Turbulent fields are produced by turbulent gas motions energized by supernova remnants and stellar winds. The weakness of turbulent fields in M31 is in line with the low rate of star formation.

Magnetic fields in spiral galaxies are sufficiently strong to affect gas motions, the formation of new stars, and the shaping of spiral arms. There is increasing evidence that magnetic fields also play a role for the formation of galaxies. Numerical models of galaxy evolution are being developed, e.g. with the powerful supercomputers at the astrophysical institutes in Potsdam and Garching.

A Walk in the Woods

Stations of the Effelsberg Galaxy Walk in Spring 2020

by Norbert Junkes

The Galaxy Walk is one of three differently scaled astronomy walks in the neighborhood of the Effelsberg radio telescope. It complements the two other walks, the Planetary Walk and the Milky Way Walk, to a really large scale of 5 x 10^{22}, corresponding to 5 million light years per meter.

The Galaxy Walk consists of a total of 14 stations (see Table 1), leading from our galaxy, the Milky Way, almost to the edge of the Universe. The most distant station, galaxy J1148+5251, is in a (light traveling) distance of almost 13 billion light years, leading back to a time less than one billion years after the beginning of the Universe.

1)	(0.0) m	Milky Way: Start of the Galaxy Walk
2)	(0.5 m)	Andromeda Galaxy M31: 2,5 million light years
3)	(2.4 m)	Galaxy M82: 12 million light years
4)	(10 m)	Virgo A (M87): 50 million light years
5)	(50 m)	Perseus A (NGC 1275): 250 million light years
6)	(150 m)	Cygnus A: 750 million light years
7)	(450 m)	Quasar 3C 273: 2.2 billion light years
8)	(800 m)	Quasar 3C 48: 4.0 billion light years
9)	(950 m)	Quasar 3C 295: 4.75 billion light years
10)	(1200 m)	Galaxy B0218+367: 6.0 billion light years
11)	(1420 m)	Quasar 3C 286: 7.1 billion light years
12)	(1840 m)	Galaxy 0917+62: 9.2 billion light years
13)	(2260 m)	Galaxy MG J0414+0534: 11.3 billion light years
14)	(2570 m)	Galaxy J1148+5251: 12.85 billion light years

Table 1: 14 Stations of the Galaxy Walk at the Radio Telescope Effelsberg

The course of the Galaxy Walk is described in these web pages:
(https://www.mpifr-bonn.mpg.de/effelsberg/visitors/galaxywalk)
Galaxienweg - Wanderparadies Sahrbachtal, outdooractive.com, Mai 2020

The photos of a number of stations on the Galaxy Walk shown here were taken in spring 2020. The Galaxy Walk is marked with a blue radio telescope sign (see Figure 1).

Figure 1: *Sign of the Galaxy Walk, marked with a blue radio telescope, showing the direction to the final destination "Martinshütte". The Galaxy Walk also connects to the longer "Sahrbacher Höhenweg", leading all the way to river Ahr.*

Figure 2: *Display panel at the start of the Effelsberg Galaxy Walk, showing the positions of all 14 stations. At the right side of the panel: station no. 4 (galaxy M87) with a part of the 100-m radio telescope in the background.*

The starting point of the Galaxy Walk is in the forest behind the 100-m radio telescope. It can be reached from the visitors' pavilion in the following way. A short zig-zag path leads from the pavilion downwards to a viewing spot immediately in front of the big dish. Turning right, the starting station of the Milky Way Walk, labeled "Galactic Centre", becomes visible. The Milky Way Walk includes a total of 18 stations or 40,000 light years from the Galactic Centre outwards along the sun to the star forming region IC 410. The walking path here is marked with a red radio telescope sign, the label for the "Milky Way Walk". It continues through the forest to a wooden fence, covering the antennas of the Effelsberg LOFAR station. To the left, the antennas of the low-band part of LOFAR can be seen directly behind the fence. To the right, the path encircles the area of the Effelsberg Radio Observatory.

At the other side of the observatory area, the Galaxy Walk disconnects from the Milky Way Walk. It starts with a display panel showing all 14 stations of the Galaxy walk on an aerial view (Figure 2). The first four stations of the walk are in close neighborhood of the panel, with stations no. 1-3 left of the panel (Figure 3) and station no. 4 (galaxy M87) directly right of it.

Figure 3: *Stations no. 1-3 of the Effelsberg Galaxy Walk: Milky Way, Andromeda Galaxy M31 and M82, a galaxy in Ursa Mayor at a distance of 12 million light years. The high-band part of the LOFAR station Effelsberg shows up behind the trees.*

Galaxienweg
am Radioobservatorium Effelsberg

Der Galaxienweg vom Radioteleskop Effelsberg bis zur Martinshütte (Kirchsahr) zeigt die Entfernungen verschiedener Himmelskörper im Maßstab 1 : 5 x 10^{22} (1 : 50 Trilliarden), das sind 5 Milliarden Lichtjahre pro Kilometer oder eine Million Lichtjahre auf 20 cm. Über knapp 2,6 km (2570 m) sind es insgesamt 14 Informationstafeln, die eine Reise von der Erde bis zu Objekten am "Rand des Universums" ermöglichen, deren Strahlung uns über eine Laufzeit von mehr als 13 Milliarden Jahren erreicht.

Radiogalaxie Cygnus A

Die Radiogalaxie Cygnus A (3C 405) ist eine der stärksten Radioquellen am Himmel. Sie liegt in Richtung des Sternbilds Schwan (Cygnus). Radiobilder mit hoher Auflösung zeigen eine Kernquelle, aus der Material in zwei energiereichen Materiestrahlen oder Jets herausgeschossen wird. Vom Start aus haben wir jetzt 750 Millionen Lichtjahre (150 m) zurückgelegt; es bleiben noch 12,1 Milliarden Lichtjahre (2420 m) bis zum Ziel.

Figure 4: *Station no. 6 of the Galaxy Walk: radio galaxy Cygnus A at a distance of 750 million light years, corresponding to 150 m from the start.*

The first five stations, from the Milky Way to the galaxy NGC 1275 (Perseus A), the central galaxy of the Perseus cluster in a distance of 250 million light years, have rather bright counterparts in the optical and are accessible also for amateur astronomers with smaller telescopes. Starting with no. 6, Cygnus A (see Figure 4), the radio emission of the target sources becomes dominant. The radio emission of the active galactic nucleus of Cygnus A in a distance of 750 million light years makes it the second brightest deep-sky radio source (after the supernova remnant Cassiopeia A) whereas its optical counterpart is an inconspicuous object of 16th magnitude only.

The next stations, namely no. 7 to 9 and 11, include a number of well-known quasars, point-like sources in the optical, but with strong radio emission from the active galactic nuclei of these distant galaxies. The names 3C 273 (Figure 5), 3C 48 (Figure 6), 3C 295 (Figure 7) and 3C 286 (Figure 8) are all catalog entries from the famous Third Cambridge Catalog of Radio Sources, first published in the year 1959. They mark the course of the Galaxy Walk with distances between 2.2 and 7 billion light years (or 450 to 1420 meters from the start).

For observers at the Effelsberg radio telescope, all of these sources are well-known as primary calibration sources for pointing as well as flux or focus calibration.

Galaxienweg
am Radioobservatorium Effelsberg

Der Galaxienweg vom Radioteleskop Effelsberg bis zur Martinshütte (Kirchsahr) zeigt die Entfernungen verschiedener Himmelskörper im Maßstab 1 : 5 x 10^{22} (1 : 50 Trilliarden), das sind 5 Milliarden Lichtjahre pro Kilometer oder eine Million Lichtjahre auf 20 cm. Über knapp 2,6 km (2570 m) sind es insgesamt 14 Informationstafeln, die eine Reise von der Erde bis zu Objekten am "Rand des Universums" ermöglichen, deren Strahlung uns über eine Laufzeit von mehr als 13 Milliarden Jahren erreicht.

Quasar 3C 273

Der Quasar 3C 273 liegt im Sternbild Jungfrau (Virgo) und ist die hellste dieser sogenannten "quasistellaren Radioquellen". Die scheinbare Helligkeit der 13. Größenklasse entspricht der des Zwergplaneten Pluto, aber hier haben wir ein ungleich weiter entferntes Objekt, das 300mal so hell strahlt wie die Milchstraße.
Vom Start aus haben wir jetzt 2,2 Milliarden Lichtjahre (450 m) zurückgelegt;
es bleiben noch 10,65 Milliarden Lichtjahre (2120 m) bis zum Ziel.

Max-Planck-Institut für Radioastronomie

Figure 5: *Station no. 7 of the Galaxy Walk: quasar 3C 273 at a distance of 2.2 billion light years, corresponding to 450 m from the start.*

Galaxienweg
am Radioobservatorium Effelsberg

Der Galaxienweg vom Radioteleskop Effelsberg bis zur Martinshütte (Kirchsahr) zeigt die Entfernungen verschiedener Himmelskörper im Maßstab 1 : 5 x 10^{22} (1 : 50 Trilliarden), das sind 5 Milliarden Lichtjahre pro Kilometer oder eine Million Lichtjahre auf 20 cm. Über knapp 2,6 km (2570 m) sind es insgesamt 14 Informationstafeln, die eine Reise von der Erde bis zu Objekten am "Rand des Universums" ermöglichen, deren Strahlung uns über eine Laufzeit von mehr als 13 Milliarden Jahren erreicht.

Quasar 3C 48

Auch 3C 48 in Richtung des Sternbilds Dreieck (Triangulum) gehört zu den Quasaren; es handelt sich hier sogar um die erste Quelle dieser Art, die im Jahr 1960 identifiziert werden konnte. Die Rotverschiebung der Spektrallinien beträgt hier 0,367, das entspricht einer Lichtlaufzeit von vier Milliarden Jahren.
Vom Start aus haben wir jetzt 4,0 Milliarden Lichtjahre (800 m) zurückgelegt;
es bleiben noch 8,85 Milliarden Lichtjahre (1770 m) bis zum Ziel.

Max-Planck-Institut für Radioastronomie

Figure 6: *Station no. 8 of the Galaxy Walk: quasar 3C 48 at a distance of 4 billion light years, corresponding to 800 m from the start.*

Galaxienweg
am Radioobservatorium Effelsberg

Der Galaxienweg vom Radioteleskop Effelsberg bis zur Martinshütte (Kirchsahr) zeigt die Entfernungen verschiedener Himmelskörper im Maßstab 1 : 5 x 10^{22} (1 : 50 Trilliarden), das sind 5 Milliarden Lichtjahre pro Kilometer oder eine Million Lichtjahre auf 20 cm. Über knapp 2,6 km (2570 m) sind es insgesamt 14 Informationstafeln, die eine Reise von der Erde bis zu Objekten am "Rand des Universums" ermöglichen, deren Strahlung uns über eine Laufzeit von mehr als 13 Milliarden Jahren erreicht.

Quasar 3C 295

3C 295 in Richtung des Sternbilds Bärenhüter (Bootes) ist ein Quasar, eine Radiogalaxie mit einer sehr leuchtkräftigen Kernquelle. Das Objekt wird am Radioteleskop Effelsberg häufig als Kalibrationsquelle vermessen, um Ausrichtung des Teleskops und Signalstärke des Empfängers zu überprüfen.
Wir haben inzwischen 4,75 Milliarden Lichtjahre (950 m) erreicht
und es sind noch 8,1 Milliarden Lichtjahre (1620 m) bis zum Ziel.

Max-Planck-Institut für Radioastronomie

Figure 7: *Station no. 9 of the Galaxy Walk: quasar 3C 295 at a distance of 4.75 billion light years, corresponding to 950 m from the start.*

Galaxienweg
am Radioobservatorium Effelsberg

Der Galaxienweg vom Radioteleskop Effelsberg bis zur Martinshütte (Kirchsahr) zeigt die Entfernungen verschiedener Himmelskörper im Maßstab 1 : 5 x 10^{22} (1 : 50 Trilliarden), das sind 5 Milliarden Lichtjahre pro Kilometer oder eine Million Lichtjahre auf 20 cm. Über knapp 2,6 km (2570 m) sind es insgesamt 14 Informationstafeln, die eine Reise von der Erde bis zu Objekten am "Rand des Universums" ermöglichen, deren Strahlung uns über eine Laufzeit von mehr als 13 Milliarden Jahren erreicht.

Quasar 3C 286

Der Quasar 3C 286 steht in Richtung des Sternbilds Jagdhunde (Canes Venatici). Er stellt eine der wichtigsten Kalibrations- oder Eichquellen für die Messungen mit dem Radioteleskop Effelsberg dar. Wir haben jetzt 7,1 Milliarden Lichtjahre (1420 m) zurückgelegt;
es bleiben noch 5,75 Milliarden Lichtjahre (1150 m) bis zum Ziel.

Max-Planck-Institut für Radioastronomie

Figure 8: *Station no. 11 of the Galaxy Walk: quasar 3C 286 at a distance of 7.1 billion light years, corresponding to 1420 m from the start.*

Figure 9: *Station no. 14 of the Galaxy Walk: radio galaxy J1148+5251 at a distance of 12.85 billion light years, corresponding to 2570 m from the start.*

Figure 10: *Martinshütte: the "Hut at the Edge of the Universe" provides the final destination of the Galaxy Walk after a total of 2.7 kilometers.*

The Galaxy Walk comprises a total of 14 stations. At a distance of 1420 m from start, 3C 286 is a bit more than halfway through. There are three more stations; the final one is radio galaxy J1148+5251 in a light travel distance of almost 13 billion years or 2.6 km from the start (Figure 9).

From there, it is just a short additional trip to the end of the Galaxy Walk, marked by the “Martinshütte”, the “Hut at the Edge of the Universe” (Figure 10). Walking back in time, it stands for the Big Bang or the beginning of the Universe.

There are two possible ways back. The longer one would go from the Martinshütte along a ridge (the “Martinssteig”) down to the village “Binzenbach” and from there backwards along the stations of the “Milky Way Walk” (from supernova remnant S147 to the Centre of the Milky Way).

The course of the Milky Way Walk is described in these web pages:
(https://www.mpifr-bonn.mpg.de/effelsberg/visitors/milkywaywalk)
Milchstraßenweg - Wanderparadies Sahrbachtal, outdooractive.com, Mai 2020

A shortcut leads from the second last station of the Galaxy Walk (MG J0414+0534) down in the valley and with a right turn and a short walk from there back to the start of the Galaxy Walk.

The 14 stations of the Galaxy Walk require about one hour. With the access walk from the visitors’ pavilion and the full way back via Binzenbach it might take 2.5 to 3 hours.

Photo Credits: *Norbert Junkes, MPIfR (March 18, 2020).*