= Jodrell Bank Observatory =

The Jodrell Bank Observatory (originally the Jodrell Bank Experimental Station , then the Nuffield Radio Astronomy Laboratories from 1966 to 1999 ; / ?d??dr?l /) is a British observatory that hosts a number of radio telescopes , and is part of the Jodrell Bank Centre for Astrophysics at the University of Manchester . The observatory was established in 1945 by Sir Bernard Lovell , a radio astronomer at the University of Manchester who wanted to investigate cosmic rays after his work on radar during the Second World War . It has since played an important role in the research of meteors , quasars , pulsars , masers and gravitational lenses , and was heavily involved with the tracking of space probes at the start of the Space Age . The managing director of the observatory is Professor Simon Garrington .

The main telescope at the observatory is the Lovell Telescope , which is the third largest steerable radio telescope in the world . There are three other active telescopes located at the observatory ; the Mark II , as well as 42 ft (13 m) and 7 m diameter radio telescopes . Jodrell Bank Observatory is also the base of the Multi @-@ Element Radio Linked Interferometer Network (MERLIN) , a National Facility run by the University of Manchester on behalf of the Science and Technology Facilities Council .

The site of the observatory , which includes the Jodrell Bank Visitor Centre and an arboretum , is located in the civil parish of Lower Withington (the rest being in Goostrey civil parish) , near Goostrey and Holmes Chapel , Cheshire , North West England . It is reached from the A535 . An excellent view of the telescope can be seen by travelling by train , as the main line between Manchester and Crewe passes right by the site , with Goostrey station being only a short distance away .

= = Early years = =

Jodrell Bank was first used for academic purposes in 1939 when the University of Manchester 's Department of Botany purchased three fields at the site from the Leighs . The name of the site came from a nearby ground rise called Jodrell Bank , which was named after William Jauderell and whose descendants , the Leighs , lived at the mansion that is now Terra Nova School nearby . The site was extended in 1952 by the purchase of a farm from a local farmer , George Massey . The new land included the site upon which the Lovell Telescope was sited .

The first use of the site for astrophysics was in 1945 , when Bernard Lovell wished to use some equipment left over from World War II , including a gun laying radar , to investigate cosmic rays . The equipment he was using was a GL II radar system working at a wavelength of 4 @.@ 2 m , provided by J. S. Hey . He originally intended to use the equipment in Manchester ; however , electrical interference from the trams that then ran down Oxford Road prevented him from doing so . Consequently , he moved the equipment to Jodrell Bank , 25 miles (40 km) south of the city , on 10 December 1945 . Lovell 's main topic of research at the time were transient radio echoes , which he confirmed were from ionized meteor trails by October 1946 . The first staff were Alf Dean and Frank Foden and meteors were observed by the naked eye while Lovell observed the electromagnetic signal on the equipment . Coincidentally , the first time he turned the radar on at Jodrell Bank ? 14 December 1945 ? the Geminids meteor shower was at a maximum .

Over the next few years , he accumulated more ex @-@ military radio hardware , including a portable cabin , commonly known as a " Park Royal " in the military (see Park Royal Vehicles) . The first permanent building on the site was located near to this cabin , and was named after it .

Today , Jodrell Bank is primarily used for investigating radio waves from the planets and stars .

= = Searchlight telescope = =

A searchlight was loaned to Jodrell Bank in 1946 by the Army ; a broadside array was constructed on the mount of this searchlight by J. Clegg , consisting of a number of Yagi antennas . This was first used for astronomical observations in October 1946 .

On 9 and 10 October 1946 , the telescope was used to observe the ionisation in the atmosphere caused by meteors in the Giacobinids meteor shower . When the antenna was turned by 90 degrees at the maximum of the shower , the number of detections dropped to the background level , proving that the transient signals detected by radar were indeed from meteors . Shortly after this , the telescope was used to determine the radiant points for meteors . This was possible as the echo rate is at a minimum at the radiant point , and a maximum at 90 degrees to it . The telescope , as well as other receivers on the site , was also used to study auroral streamers that were visible at the site in early August 1947 .

= = Transit Telescope = =

The Transit Telescope was a 218 ft (66 m) parabolic reflecting aerial built at Jodrell Bank in 1947 . At the time , it was the largest radio telescope in the world . It consisted of a wire mesh suspended from a ring of 24 ft (7 @.@ 3 m) scaffold poles , which focussed radio signals to a focal point 126 ft (38 m) above the ground . The telescope mainly looked directly upwards , but the direction of the beam could be changed by small amounts by tilting the mast to change the position of the focal point . The focal mast was originally going to be wood , but this was changed to a steel mast before construction was complete . The telescope was replaced by the fully steerable 250 ft (76 m) Lovell Telescope , and the Mark II telescope was subsequently built on the same location .

The telescope was able to map a ± 15 @-@ degree strip around the zenith at 72 and 160 MHz , with a resolution at 160 MHz of 1 degree . It was used to discover radio noise from the Great Nebula in Andromeda ? the first definite detection of an extragalactic radio source ? and the remains of Tycho 's Supernova in the radio frequency ; at the time it had not been discovered by optical astronomy .

= = Lovell Telescope = =

The " Mark I " telescope , now known as the Lovell Telescope , was the largest steerable dish radio telescope in the world , 76 @.@ 2 metres (250 ft) in diameter , when it was completed in 1957 ; it is now the third largest , after the Green Bank telescope in West Virginia and the Effelsberg telescope in Germany . Part of the gun turret mechanisms from the battleships HMS Revenge and HMS Royal Sovereign were reused in the motor system for the telescope . The telescope became operational in mid @-@ 1957 , just in time for the launch of Sputnik 1 , the world 's first artificial satellite . The telescope was the only one in the world able to track Sputnik 's booster rocket by radar ; first locating it just before midnight on 12 October 1957 .

In the following years , the telescope was used to track a variety of space probes . Between 11 March and 12 June 1960 , it tracked the Pioneer 5 probe . The telescope was also used to send commands to the probe , including the one to separate the probe from its carrier rocket and the ones to turn on the more powerful transmitter when the probe was eight million miles away . It also received data from the probe , being the only telescope in the world capable of doing so at the time . In February 1966 , Jodrell Bank was asked by the Soviet Union to track the USSR unmanned moon lander Luna 9 and recorded on its facsimile transmission of photographs from the moon 's surface . The photos were sent to the British press and published before the Soviets themselves had made the photos public .

In 1969 , the Soviet Union 's Luna 15 was also tracked . A recording of the moment when Jodrell Bank 's scientists observed the mission was released on 3 July 2009 .

With the personal support of Sir Bernard Lovell , the telescope also tracked Russian satellites . Satellite and space probe observations were shared with the US Department of Defense satellite tracking research and development activity at Project Space Track .

Despite the publicity surrounding the telescope 's tracking of space probes , this only took up a fraction of its observing time , with the remainder used for scientific observations . These include using radar to measure the distance to the Moon and to Venus ; observations of astrophysical masers around star @-@ forming regions and giant stars ; observations of pulsars (including the

discovery of millisecond pulsars and the first pulsar in a globular cluster) ; observations of quasars and gravitational lenses (including the detection of the first gravitational lens and the first einstein ring) . The telescope has also been used for SETI observations .

= = Mark II and III telescopes = =

The Mark II is an elliptical radio telescope , with a major axis 38 @.@ 1 metres (125 ft) and a minor axis of 25 @.@ 4 metres (83 ft) . It was constructed in 1964 . Aside from operating as a standalone telescope , it has also been used as an interferometer with the Lovell Telescope , and is now primarily used as part of MERLIN (see below) .

The Mark III telescope was the same size as the Mark II , but was constructed to be transportable . However , it was never moved , and remained at its original site in Wardle , near Nantwich , where it was used as part of MERLIN . It was built in 1966 , and was decommissioned in 1996 .

= = Mark IV , V and VA telescopes = =

The Mark IV , V and VA telescopes were three proposals that were put forward in the 1960s through to the 1980s to build an even larger radio telescope than the Lovell . The Mark IV would have been a 1 @,@ 000 feet (300 m) diameter standalone telescope , built as a national project . The Mark V would have been a 400 feet (120 m) moveable telescope . The original concept of this telescope had it located on a 3 / 4 @-@ mile long railway line adjoining Jodrell Bank , however concerns about the future levels of interference meant that a site in Wales would have been used (the preferred site was near Meifod) . Several design proposals were put forward , one by Husband and Co . , the other by Freeman Fox , who had designed the Parkes Observatory telescope . The Mark VA followed on from the Mark V , but with a smaller dish of 375 feet (114 m) and a design using prestressed concrete , similar to the Mark II (the previous two designs more closely resembled the Lovell telescope) .

None of the three telescopes was constructed , although several design studies were carried out and some scale models were made . This was partly due to the changing political climate over the time (the period was from a Labour Party government under Harold Wilson to a Conservative Party one under Margaret Thatcher) , and partly to the financial constraints of astronomical research in the UK at the time . Also , at a vital time , it became necessary to upgrade the Lovell Telescope to the Mark IA , which subsequently overran in terms of cost .

= = Other single dishes = =

A 50 ft (15 m) alt @-@ azimuth dish was constructed at the observatory in 1964 . In addition to astronomical research , it was used to track the Zond 1 , Zond 2 , Ranger 6 and Ranger 7 space probes , and also Apollo 11 . The 50 ft telescope was demolished in 1982 , when it was replaced with a more accurate telescope named the " 42 ft " following an accident that irreparably damaged the 50 ft telescope 's surface . The 42 ft (12 @.@ 8 m) dish is mainly used for observations of pulsars , and is normally continually monitoring the Crab Pulsar .

At the same time as the 42 ft was installed , a smaller dish called the " 7 m " (actually 6 @.@ 4 m , or 21 ft , in diameter) was installed and is now used for undergraduate teaching . Both the 42 ft and 7 m telescopes were originally used at the Woomera Rocket Testing Range in Australia . The 7 m was originally constructed in 1970 by Marconi Company .

A Polar Axis telescope was built at Jodrell Bank in 1962 . This had a circular 50 ft (15 @.@ 2 m) dish on a polar mount , and was mostly used for moon radar experiments . It has since been decommissioned . There has also been an optical telescope at the observatory ; an 18 @-@ inch (460 mm) reflecting optical telescope was donated to the observatory in 1951 . However , this telescope was not used much , and was in turn donated to the Salford Astronomical Society around 1971 .

= = MERLIN = =

The Multi @-@ Element Radio Linked Interferometer Network (MERLIN) is an array of radio telescopes spread across England and the Welsh borders . The array is run from Jodrell Bank on behalf of the Science and Technology Facilities Council as a National Facility . The array consists of up to seven radio telescopes and includes the Lovell Telescope , Mark II , Cambridge , Defford , Knockin , Darnhall , and Pickmere (previously known as Tabley) . The longest baseline is therefore 217 kilometres (135 mi) and MERLIN can operate at frequencies between 151 MHz and 24 GHz . At a wavelength of 6 cm (5 GHz frequency) , MERLIN has a resolution of 50 milliarcseconds which is comparable to that of the HST at optical wavelengths .

= = Very Long Baseline Interferometry = =

Jodrell Bank has been involved with Very Long Baseline Interferometry (VLBI) since the late 1960s ; the Lovell telescope took part in the first transatlantic interferometer experiment in 1968 , with other telescopes being those at Algonquin and Penticton in Canada . The Lovell Telescope and the Mark II telescopes are regularly used for VLBI with telescopes across Europe (the European VLBI Network) , giving a resolution of around 0 @.@ 001 arcseconds .

= = Square Kilometre Array = =

In April 2011 , Jodrell Bank was named as the location of the control centre for the planned Square Kilometre Array , or SKA Project Office (SPO) . The SKA is being planned by a collaboration of 20 countries and when completed it is intended to be the most powerful radio telescope ever built . In April 2015 it was further announced that Jodrell Bank would be the permanent home of the SKA headquarters for the period of operation expected for the telescope (over 50 years) .

= = Research = =

The Jodrell Bank Centre for Astrophysics , of which the Observatory is a part , is one of the largest astrophysics research groups in the UK . About half of the research of the group is in the area of radio astronomy ? including research into pulsars , the Cosmic Microwave Background Radiation , gravitational lenses , active galaxies and astrophysical masers . The group also carries out research at different wavelengths , looking into star formation and evolution , planetary nebulae and astrochemistry .

The first director of Jodrell Bank was Bernard Lovell , who established the observatory in 1945 . He was succeeded in 1980 by Sir Francis Graham @-@ Smith , followed by Professor Rod Davies around 1990 and Professor Andrew Lyne in 1999 . Professor Phil Diamond took over the role on 1 October 2006 , at the time when the Jodrell Bank Centre for Astrophysics was formed . Prof Ralph Spencer was Acting Director during 2009 and 2010 . In October 2010 , Prof. Albert Zijlstra became Director of the Jodrell Bank Centre for Astrophysics . Professor Lucio Piccirillo was the Director of the Observatory from Oct 2010 to Oct 2011 when Prof Simon Garrington became its managing director .

There is an active development programme researching and constructing telescope receivers and instrumentation . The observatory has been involved in the construction of several Cosmic Microwave Background experiments , including the Tenerife Experiment , which ran from the 1980s to 2000 , and the amplifiers and cryostats for the Very Small Array . It has also constructed the front @-@ end modules of the 30 and 44 GHz receivers for the Planck spacecraft . Receivers were also designed at Jodrell Bank for the Parkes Telescope in Australia .

= = Visitor facilities , and events = =

The original visitors ' centre , opened on 19 April 1971 by the Duke of Devonshire , attracted around

120 @,@ 000 visitors per year . It covered the history of Jodrell Bank and had a 3D theatre hosting simulated trips to Mars .

Due to an asbestos @-@ related concern for the safety of the buildings , that visitor 's centre (including the planetarium) was mostly demolished in 2003 leaving a remnant of its far end ; a large marquee was set up in its grounds . A new science centre was being planned at the time . Those rebuilding plans were shelved when Victoria University of Manchester and UMIST merged to become the University of Manchester in 2004 , leaving the interim centre , which received around 70 @,@ 000 visitors a year .

In October 2010 , the old visitor centre closed and work on a new visitor centre started . The new Jodrell Bank Discovery Centre opened on Monday 11 April 2011 . It includes a new entrance building , the Planet Pavilion , a new Space Pavilion for exhibitions and events , and a glass @-@ walled cafe with a view of the Lovell Telescope and an outdoor dining area , an education space , and landscaping of the gardens including a new Galaxy Maze . A large orrery was installed in 2013 .

As well as being open to the public every day , the discovery centre also organises various public outreach events , including public lectures , star parties , and " ask an astronomer " sessions .

There is a path (not a whole circle) around the Lovell telescope , approximately 20 m from the telescope 's outer railway . Along the path are some information boards explaining how the telescope works and the research that is done with it .

The 35 acres (140 @,@ 000 m2) Jodrell Bank Arboretum , created in 1972 , houses the UK 's national collections of crab apple Malus and mountain ash Sorbus species , and the Heather Society 's Calluna collection . The arboretum also features a small scale model of the solar system , the scale being approximately 1 : 5 @,@ 000 @,@ 000 @,@ 000 . As part of the SpacedOut project , at Jodrell Bank is also the Sun in a 1 : 15 @,@ 000 @,@ 000 scale model of the solar system covering Britain .

On 7 July 2010 , it was announced that the observatory was being considered as an applicant for the 2011 United Kingdom Tentative List for World Heritage Site status . It was announced on 22 March 2011 that it was on the shortlist to be put forward by the UK government .

In July 2011 the visitor centre and observatory hosted " Jodrell Bank Live " ? a rock concert with bands including The Flaming Lips , British Sea Power , Wave Machines , OK GO and Alice Gold .

On 23 July 2012 Elbow performed live at the Observatory and filmed a documentary of the event and the facility which was released as a live CD / DVD of the concert .

On 31 August 2013 Jodrell Bank hosted a concert performed by the Halle Orchestra to commemorate what would have been Lovell 's 100th birthday . As well as a number of operatic performances during the day , the evening Halle performance saw numbers such as themes from Star Trek , Star Wars and Doctor Who amongst others . The main Lovell telescope was rotated to face the onlooking crowd and used as a huge projection screen showing various animated planetary effects . During the interval the ' screen ' was used to show a history of Lovell 's work and Jodrell Bank itself .

There is an astronomy podcast from the observatory , named The Jodcast . The BBC television programme Stargazing Live is hosted in the control room of the observatory . The programme has had four series , in January 2011 , 2012 , 2013 and 2014 .

= = Threat of closure = =

On 3 March 2008 , it was reported that Britain 's Science and Technology Facilities Council (STFC) , faced with an £ 80 million shortfall in its budget , was considering withdrawing its planned £ 2 @.@ 7 million annual funding of Jodrell Bank 's e @-@ MERLIN project . The project , which aims to replace the microwave links between Jodrell Bank and a number of other radio telescopes with high @-@ bandwidth fibre @-@ optic cables , greatly increasing the sensitivity of observations , is seen as critical to the survival of the establishment in its present form . Sir Bernard Lovell was quoted as saying " It will be a disaster ? The fate of the Jodrell Bank telescope is bound up with the fate of e @-@ MERLIN . I don 't think the establishment can survive if the e @-@ MERLIN funding

is cut " .

On Monday 14 April 2008 , Cheshire 's 106 @.@ 9 Silk FM unveiled to its listeners their own campaign song to save Jodrell Bank , entitled " The Jodrell Bank Song " and sung by a group dubbed " The Astronomers " . Along with the song , the Silk FM team also produced a music video filmed in front of the iconic Lovell telescope . Silk FM released the song for download from Monday 21 April 2008 . All proceeds went towards saving Jodrell Bank .

On 9 July 2008 , it was reported that , following an independent review , the STFC had reversed its initial position and would after all guarantee funding of £ 2 @.@ 5 million annually for three years .

= = Fictional references = =

Jodrell Bank has been mentioned in several popular works of fiction , including Doctor Who (Remembrance of the Daleks , The Poison Sky , The Eleventh Hour) . It was intended to be a filming location for Logopolis (Tom Baker 's final Doctor Who serial) but budget restrictions prevented this and another location with a superimposed model of a radio telescope was used instead . It was also mentioned in The Hitchhiker 's Guide to the Galaxy (as well as The Hitchhiker 's Guide to the Galaxy film) , The Creeping Terror and Meteor . Jodrell Bank also featured heavily in the music video to Electric Light Orchestra 's 1983 single Secret Messages . The Prefab Sprout song Technique (from debut album Swoon) opens with the line " Her husband works at Jodrell Bank / He 's home late in the morning " .

The Observatory is the site of several episodes in the novel Boneland , by Alan Garner (2012) , and the central character , Colin Whisterfield , is an astrophysicist on its staff .

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