Sherwood Observatory

Radio Astronomy section

End of 2017 progress report

Contents

Introduction

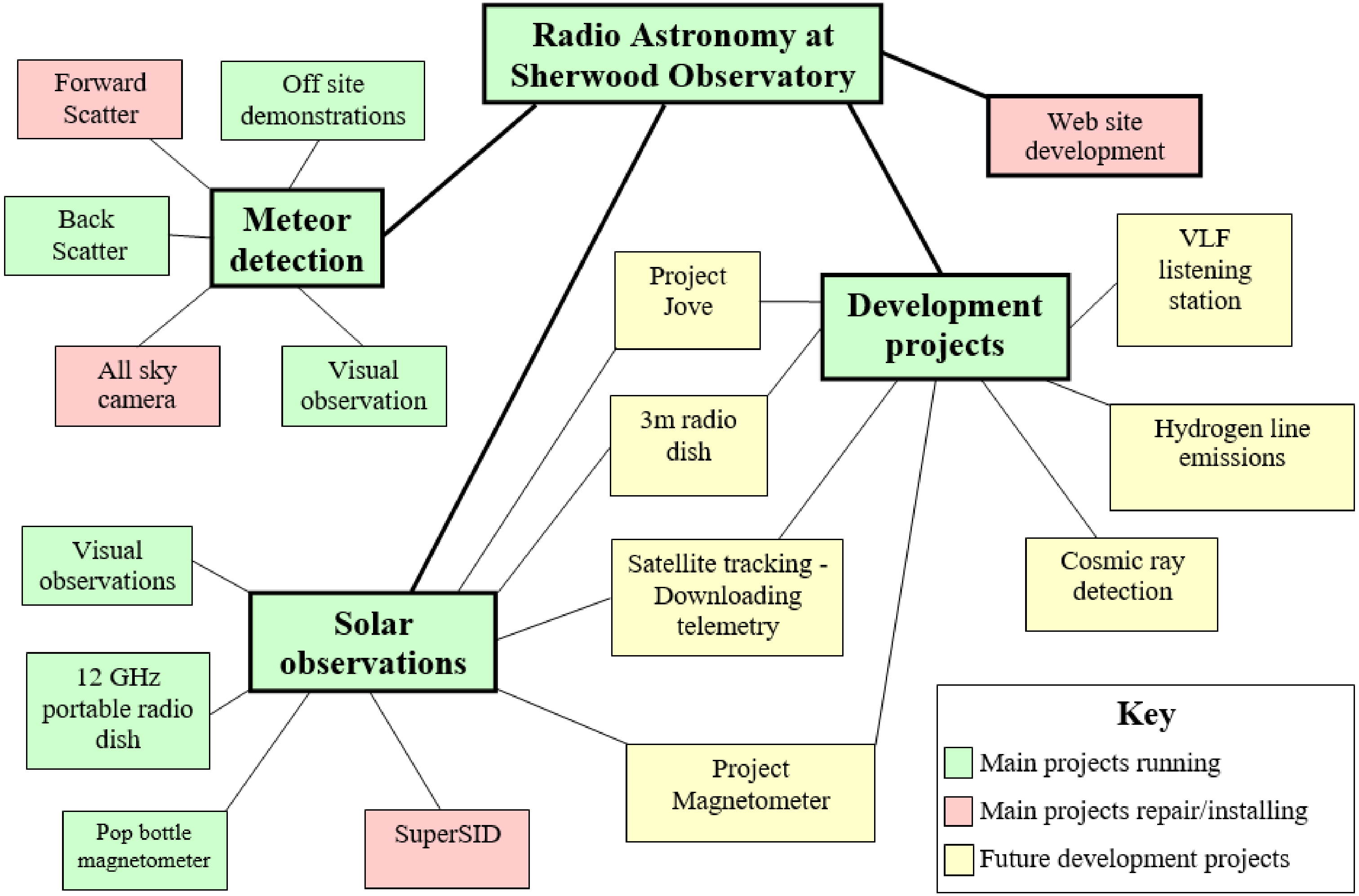
It's been a full year since I wrote the last report documenting where Radio Astronomy was at that time. Since then a lot has happened, and I think writing a yearly progress report is a good way to record these events.

Before getting into the report I would like to thank all the people that have contributed in some way in making this year the success it has been. Firstly, I would like to thank to Michael Knowles for all the work done during his time as observational programmer. Because of other commitments, Michael decided to relinquish the position in April 2017, and I took over at the following AGM. I would also like to thank the volunteers who regularly help out. Although having little knowledge in the field of radio astronomy they are demonstrating an amazing willingness to learn. They are also beginning to target certain fields within this vast subject to specialise in.

The progress in radio astronomy at Sherwood Observatory has not been all sunshine and roses. Misfortune came in the shape of Storm Doris. We took that one on the chin, learned from the experience and bounced back even stronger. Some good news I would like to report is that the solar observing has come on in leaps and bounds in the form of the 12GHz radio dish. We have also built a new storage facility for the radio equipment too.

Best wishes, Sparky.

Radio Astronomy flow chart 2017



Meteor detection

Visual Observations

This has been the first full year of Meteor Watch since the inaugural meeting on the 12th Dec 2016. Throughout the year members have used a variety of methods to observe meteor showers. These include the Quadrantids in January, Lyrids in April, Perseids in August, Orionids in October, Leonids in November, and the Geminids in December. On three of the occasions members gathered at the observatory to view meteor showers visually. It is intended to continue the visual Meteor Watch program throughout 2018.

All sky camera

The “All sky camera” has been out of action throughout this year, having been sent off to America for repair. After some delays in getting it back, it was returned to Craig Bradford who then brought it up to the Obs in December. It is intended to thoroughly test it before reinstalling it this year. It will be a great asset to the observations of meteors, and is hoped to integrate these observations with the Brams forward scatter technique. This will give us a better interpretation of what we are seeing on the screen.

Issues encountered relating to the radio mast and aerials

The beginning of 2017 saw the meteor detection working well, until the 23rd of February when storm Doris hit the UK, causing the mast to collapse and damaging the aerials.

<u>Assessment of the system failure</u>

Following the storm, the damage was assessed and the cause of system failure identified. It was established that the collapse was the result of wind vibration loosening one of the turnbuckles used for tensioning a top section guy rope. Eventually, at 15.36pm, it fully unwound releasing the rope. The wind then bent the top section of the mast damaging the aerials. The Graves aerial was a write off, but the Brams aerial was salvageable, suffering only slight damage. During the inspection the top guy fixings were found to be still secure.

<u>Rectifying action taken</u>

To ensure there will not be a repeat of the above failure, one of the members - with experience of working on aircraft air frames - demonstrated a method of wiring both turnbuckles and D links so they cannot come undone. The Graves aerial was one we made ourselves, so a new one was constructed. The Brams aerial was found to be salvageable, suffering only slight damage; Chris Dakin (The Wiz) made a new part for it on his 3D printer. No other damage was sustained. The mast was repaired in April.

Back Scatter radar - Graves

Following the initial teething problems in erecting the mast, and getting the system to work, the Graves receiver has been working well. At present it forms the back bone of our meteor detection work, and has been used to successfully detect three meteor showers when members were unable to view them visually. This system uses the Back Scatter technique to pick up incoming meteors.

Forward Scatter - Brams

System issues

The masthead pre-amp for the Brams aerial was found to have burnt out, so it was removed and the coax feed wired directly into the band-pass filter. The power supply in the inner sanctum feeding the pre-amps were also burnt out. The wiring feeding power to this system was also cut through when the mast bent in half.

Rectifying action taken

The power feed wiring and the coax feed have all been replaced. The new filters and pre-amps have been purchased ready for installation this year.

Off site out-reach demonstrations -

It has been a good fruitful year for our outreach work. The portable Graves mast and aerial aerial is a system constructed by members earlier in the year, and has been used at all but the Sherwood visitor centre. When used, the system is able to give good results.

We attended a total of 6 shows, including: Sherwood visitors centre on 25th Feb, Great Hucklow retreat centre in July, Pleasley Pit on 4th June, Sutton on Trent festival on 2nd Sept, 2nd Pleasley Pit visit on 10th Sept, and Duffield festival on 23rd Sept. We are expecting a similar amount of shows to visit this coming year, with the detection equipment being used at the Sherwood visitor centre this January.

During the 4th June Pleasley Pit event the meteor results took us by surprise. We recorded nearly 50 meteors, with an estimated 100+ detected. However, when we returned on the 10th Sept the results were more disappointing - with only 3 meteors detected. We were in the same location, with the same outlook, using the same equipment on the same setting. This just goes to show how much the meteor rates vary daily!

Sherwood Obs open evenings and basic astronomy course-

Radio astronomy has had a strong presence at all the open evening events, and since moving into the lecture room incoming meteor are viewed live on the lecture room TV monitor. This has been augmented with a talk on Meteors/Meteorites. We expect a similar presence at open events this coming year.

Radio astronomy is for the first time on the official agenda sharing half an evening lecture with Peter Jenkins Astrophotography in our basic astronomy course starting this January.

Solar observations

Visual Observations -

During this past year, 2 solar days were attended at the Obs with a number of equipment test days being carried out. Few sunspots were seen, which isn't surprising since the sun is heading towards solar minimum, expected during 2019/20 period.

12 GHz portable radio dish -

Equipment

- 12 GHz portable radio dish is fairly straight forward. We use a standard satellite dish mounted on a motor driven equatorial mount on a tripod. The receiver is a satellite finder powered by a flash-light plug-in charger. We did a hack on the satellite finder taking a feed off from the meter terminals. This gives us a DC output that we can feed into a data logger to record the results.

- The Data Logger is an inexpensive internal battery powered USB stick mini voltage data logger from Rapid scientific suppliers.

- A Dataq 1100 USB powered. It has 4 analogue inputs with constant input of +/- 10v, 2 dedicated digital inputs, a 12 bit resolution and up to 40 kHz sample rate.

Observing

Using the portable 12GHz radio dish worked well at Solar days, etc, where we were able to show the public evidence of electromagnetic radiation emitted from the Sun. This was achieved by the method known as "drift scan". The radio telescope is set up pointing slightly ahead of the Sun's direction of travel, but, because the mount is not driven, the Sun appears to drift through the radio telescopes beam width; or if you like its field of view.

The Data Logger did record the results, but unfortunately the scale of the recording meant that the results were at the very bottom of the graph. Too small to detect any solar bursts, which is our ultimate goal. It did however display the time for the sun to pass through the radio telescopes beam width. By extrapolating the results we were able to calculate the field of view of the LMB, that being approximately 3 degrees.

Improvements

How could we improve the recording? My initial idea was to boost the Data Logger DC voltage to around 3 times its present value. That would certainly display more sensitive results. This proved to be quite problematic so after some time trying to solve the problem it was decided to adopt a different approach.

The Dataq 1100 USB powered system is a better quality data logger, purchased to overcome the issues encountered with the above data logger. It has 4 analogue inputs with constant input of +/- 10v, 2 dedicated digital inputs, a 12 bit resolution and up to 40 kHz sample rate. Because it is programmable, we are able to set the parameters we wish to display. This was tested live on our first Obs solar day, but what we found was that because it was so sensitive it picked up a lot of interference. This proved to be coming from the mains - commonly known as 'Mains hum'. This again meant that picking up any meaningful results was impossible. We had to find a way of suppressing/eliminating the interference.

Suppression/elimination procedures

To help suppress/eliminate the mains hum a new battery pack was used to supply the equatorial mount. By installing several plug-in sockets it could also supply the satellite finder as well, thus eliminating 2 sources of mains hum. The third source of mains hum was from the power supply for the laptop. We disconnected the supply and to our dismay we found the battery in the laptop was not holding power, so a new battery was purchased. Once fitted, the system was again tested out and was found to be almost noiseless. Some slight interference from the lecture room lighting etc, was noted, but it is not expected to be a problem outside at solar days etc. The new battery power supply is certainly powerful enough to run the equipment all-day, but the battery in the laptop is not. It would be nice to have the laptop running on mains for the day, but we need to find a way of filtering out mains hum. Any ideas?

Locating the Sun in cloudy conditions

Another issue identified was aiming the satellite dish at the Sun on days when there are blanket cloud conditions. We toyed with a number of ideas to overcome this, but one idea proposed was to construct a holder for a smart phone out of non-magnetic material. The phone would run a program like Stellarium, and, when properly set up, the Sun should be in the centre of the radio telescopes field of view when shown in the centre of the phones screen. This would be an immense help on cloudy days since the radiation we are picking up from the sun is mainly unaffected by cloud cover. We are now on generation three of the construction, and fair/good results are being achieved. Fine tweaking still needs to be done, but the results are promising. We hope to have a fully functional system running for the summer.

Pop bottle magnetometer -

The magnetometer was built some time ago now. It is still working but needs a little TLC to bring it up to its former glory. It is mainly used as a demonstration to show how the Sun can affect the Earths magnetosphere and is used at Solar days and out reach events.

SuperSID -

This system was working well up until we upgraded the RA computers to Windows 10. This proved to be a problem since then we cannot get SuperSID working. Chris D has been trying to solve the problem with a work around from a third party with limited success. I have contacted the Stanford Solar centre, from where we brought the receiver, requesting either a Windows 10 patch or a link to a new downloadable program. I am still waiting for a response. The equipment, aerial and receiver are still in good condition. If all else fails, then we will have to revert back to using Windows 7.

Future development projects

Space weather -

What does the term mean?
We have heard a lot of the term “Space Weather” used recently, but what does it mean? Wikipedia define Space Weather as “a branch of space physics and aeronomy concerned with the time varying conditions within the Solar System, including the solar wind, emphasizing the space surrounding the Earth, including conditions in the magnetosphere, ionosphere and thermosphere”. The term Space Weather was first used in the 1950s and came into common usage in the 1990s. Its focus in the main part is on the Sun and how it is affecting us, both in space and here on the earth. Other contributing factor to Space Weather is the extent of inbound Galactic Cosmic Rays ("GCR").

Detrimental effects of Space Weather on artificial satellites.
As we populate the space that surrounds us with satellites, the effect of Space Weather becomes more acute. For example, 46 of the 70 spacecraft failures reported in 2003 occurred during the October 2003 geomagnetic storm. The two most common adverse Space Weather effects on spacecraft are radiation damage and spacecraft charging. Higher UV emitted radiation given off during solar disturbances e.g. coronal mass ejections (CME) heat the earth’s atmosphere causing it to expand. The orbits of spacecraft in low Earth orbit (LEO) decay to lower and lower altitudes due to the resistance from the friction between the spacecraft's surface (*i.e.*, drag) and the outer layer of the Earth's atmosphere. Eventually, an LEO spacecraft falls out of orbit and towards the Earth's surface. Many spacecraft launched in the past couple of decades have the ability to fire a small rocket to manage their orbits. Other issues identified are scintillation of satellite-to-ground radio signals and long-range radar signals.

Positive effects of Space Weather on artificial satellites.
As stated above, the Earth’s upper atmosphere can be heated and puffed up by ultraviolet radiation from the sun. Satellites in low Earth orbit experience friction as they skim through the outskirts of our atmosphere. This friction creates drag, causing satellites to lose speed over time and eventually fall back to Earth. Drag is a good thing, as it helps keep low Earth orbit clear of debris, both natural and man-made. But during solar minimum, this natural heating mechanism subsides. Earth’s upper atmosphere cools, and to some degree, can collapse. Without a normal amount of drag, space junk tends to hang around.

Detrimental effects of Space Weather on the natural world.
Other effects include the energisation of the Van Allen radiation belts, Ionospheric disturbances, aurora and geomagnetically induced currents at the earth’s surface. Space Weather phenomena can cause damaging surges in long distance transmission lines and expose passengers and crew of aircraft travel to radiation, especially on polar routes. An example of this was the magnetic storm of March 1989. It caused the complete collapse of the Hydro-Québec electric-power grid in Canada, temporarily leaving nine million people without electricity.

The current situation
We are at present heading towards solar minimum in 2019/20. While intense activity such as sunspots and solar flares subside during solar minimum, that doesn’t mean the sun becomes dull. Solar activity simply changes form. For instance during solar minimum we can see the development of long-lived coronal holes.

Coronal holes are vast regions in the sun's atmosphere where the sun's magnetic field opens up and allows streams of solar particles to escape the sun as the fast solar wind. We see these holes throughout the solar cycle, but during solar minimum, they can last for a long time - six months or more. Streams of solar wind flowing from coronal holes can cause Space Weather effects near Earth when they hit Earth's magnetic field.

Unique Space Weather effects during solar minimum.

Solar minimum brings about many changes to our Sun, but less solar activity doesn't make the sun and our space environment is any less interesting. To give an example, there are unique Space Weather effects that get *stronger* during solar minimum, such as the number of Galactic Cosmic Rays reaching the Earth's upper atmosphere increases during solar minimum. Galactic Cosmic Rays are high energy particles accelerated toward the solar system by distant supernovae and other violent events in the galaxy. During solar minimum, the Sun's magnetic field weakens and provides less shielding from these cosmic rays. This can pose an increased threat to astronauts travelling through space.

Space Weather and Sherwood Observatory.

So, whether we like it or not, Space Weather is here to stay. In recent times there has become a growing interest in radio astronomy at Sherwood Observatory. As you may imagine, the field of radio astronomy covers a wide range of possible areas of observational opportunities. One such interesting area is the observation of the sun and aeronomy under that banner. As stated previously we have taken the first steps towards this goal

Future projects at Sherwood Observatory.

There are four possible future projects would help us to achieve this and improve the ability in tracking our Sun's "Vital signs" and to help to promote understanding among the public at large.

Project Jove

The Radio Jove project was conceived by NASA in 1998 as a hands-on inquiry-based educational project. It enables interested students, teachers and members of the general public to purchase their inexpensive, non-profit radio telescope kits, and learn about radio astronomy by building, testing and operating a radio telescope. According to NASA, since its launch more than 1100 teams of students have done this. The equipment is aimed at monitoring the storms of Jupiter, solar activity and the galactic background radiation.

Another option is to use remote radio telescopes through the Internet. Participants also collaborate with each other through interactions and sharing of data on the network. There is a "terrific" user group we can join and contribute our findings too. For Sherwood Observatory this would contribute to our observations of the sun, and would allow us to start to venture out into deeper space.

3m radio dish

The 3-metre radio telescope is a dish of 3 meters in diameter, and is about the smallest useful size for picking up deep space radio emissions such as the detection and mapping of the distribution of synchrotron and atomic hydrogen in the Milky Way. Pulsars my also be detected.

By changing the detector, different frequencies, and therefore different targets may be detected. These frequencies are in the microwave group. This ranges from 300 MHz to 300 GHz. The bands usually used are the L band, 1-2 GHz, the C band, 4-8 GHz and the Ku band, 12-18 GHz. The L band covers the Hydrogen line spectral frequencies of 1.42GHz, the other two are mainly used for solar observing.

With this sort of telescope, the higher the frequency, the more accurate required to finish of the disk. Typically +/- 2mm for 23GHz. This type of telescope can be used for On-the-fly mapping (OTF) of the Milky Way and its HL emissions and major radio sources such as Cygnus A, Virgo A, and solar observations.
These telescopes can be purchased "off the peg" or can be built using tried and trusted plans. One such set of plans are available from the Internet, our old friend Dr David Morgan.

Satellite tracking -

There has been a recent increase in interest of satellite tracking, and the downloading directly of imagery and data. With the development of low cost SDR (Software-defined radio) receivers in the form of dongles, a vast frequency band is detectable, typically 10 kHz - 9 GHz. This allows them to be used for numerous operations. For tracking and downloading pictures and data directly from satellites all you need is a computer, SDR dongle and an aerial. 2 out of 3 we have already, we just need to build an aerial. From what I have seen on You Tube, very good results are achievable. The images are pulled down from the NOAA 15, 18, 19 satellites in black and white; and from the Meteor M2 weather satellite in full colour. It is also possible to pull down telemetry data regarding the conditions in space around the satellite. An aid to our Space Weather project.

At some stage in the future we may also be able to pick up the UK's one and only self launched satellite, yes its still up there, the Prospero satellite, also known as the X-3. It is not due for re-entry till 2070 so we have some time yet.

Electronic magnetometer -

Magnetic fields

All of us are probably aware that the magnets create magnetic fields; the Earth has a magnetic field; current flowing in a wire also generate magnetic fields. But have we ever realized that the fields are generated also by our heart and brain? However, what differs between the magnetic field generated by a magnet and that generated by brain and heart is the magnitude of magnetic field. We all are surrounded by magnetic fields. Magnetic fields are generated by flowing electrical current in various electrical/electronic appliances; TV, computers, power transmission lines, etc.

The Earth's magnetic field

The Earth also has its own magnetic field, though relatively small. Earth's magnetic field is largest at the poles (~ 60 000 nT) and smallest as the equator (~ 30 000 nT). The earth's magnetic field strength is proportional to $1/r^3$ (until the influence from the solar wind gets noticeable. To be able to monitor changes in the earth's magnetic field and relate these changes to solar events such as flares, it has now become possible with the availability of inexpensive and sensitive Hall-effect sensors that easily interface to home computers, to make more quantitative measurements of changes in the geomagnetic field due to solar wind. By monitoring changes in the geomagnetic field, aurora and related effects can be forecast and studied.

Building a fully functional electronic magnetometer

The design and build of a fully functional electronic magnetometer has already been carried out by the UK Radio Astronomy Association (UKRAA), the business arm of the British Astronomical Association (BAA). The equipment is available to order over the internet along with the leads for connecting to a monitoring computer. Details of how to install the unit comes with the kit.

Another design is also available from AuroraWatch UK. They have a free service offering alerts of when the aurora might be visible from the UK. It is run by scientists in the Space and Planetary Physics group at Lancaster University's Department of Physics. They don't have a kit but the hardware design is open source (Creative-Commons Attribution Share-Alike 3.0) and the software is released under the GNU Public License v2.

Magnetometer operation

To work correctly the sensor unit must be located outside away from human disturbance. The original battery-powered version is easy to install, data is transmitted by a radio link back to a Raspberry Pi computer located indoors. They have a newer design which uses Power-over-Ethernet. It is much more sensitive and stable but requires a wired connection from the sensor unit to the Raspberry Pi or to our network. The manual can be downloaded from http://aurorawatch.lancs.ac.uk/manual.pdf. They suggest contacting them before starting to order components just to check for the latest information. They sometimes have spare printed circuit boards.

Data contribution

Data can be contributed to AuroraWatch UK automatically and will be combined with other magnetometer data for the purpose of generating AuroraWatch UK or other auroral-related alerts. The alerts data will be made available via a public API under the Creative Commons AttributionNonCommercial-ShareAlike 4.0 license. Ideally we will also license the magnetometer data under the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 license; we also need to define our own attribution requirements.

VLF listening station -

What does ELF/VLF stand for?

ELF/VLF stands for Extremely Low Frequency and Very Low Frequency, and refers to the range 300 Hz to 30 kHz. We're talking about radio waves, like the AM/FM signals you get, just at an even lower frequency. On our planet, the most potent source of ELF/VLF waves is lightning, so a lot of research is about studying lightning and its various impacts on our Earth's environment.

Uses for ELF/VLF waves

ELF/VLF waves are useful scientifically because they largely reflect at the D region of the Earth's ionosphere (60-90 km altitude), and are thus efficiently guided in the Earth-ionosphere waveguide to global distances. For instance, if you set up a radio receiver just about anywhere on Earth, you can pick up short bits of radiation from lightning strikes literally halfway around the world. These are called radio atmospherics, or Sferics. ELF/VLF waves also penetrate into seawater, which has led to their use over the past several decades for communication with submerged submarines at long distances.

From a scientific perspective, though, the reflectivity of the D region at these frequencies make ELF/VLF a unique tool for remote sensing of the D region, which responds to a variety of inputs like solar activity (this is the basis of the technique that our SuperSID uses), lightning energy, electron precipitation from the radiation belts, cosmic gamma-rays, and earthquakes. Measurements of properties of the D region are extremely difficult, since those altitudes are too high for balloons, yet too low for satellites, so this is a useful ability.

Analysis of ELF/VLF waves

A number of different sounds can be heard in the receiver; these include Sferics, Tweeks, and Whistlers. They describe the type of sounds heard depending on how far the signals have travelled. Sferics are relatively close lightning strikes, Tweeks have travelled half way around the world, and Whistlers have travelled far out into space following the magnetic flux lines in the Magnetosphere. During times of high geomagnetic activity you can actually hear the Northern Lights (even if it's cloudy or the skies are too bright!). Therefore, the best time to tune in is night time. You can hear lightning striking the planet almost 24/7.

Hydrogen line emissions -

Hydrogen emits energies at 21cm wavelengths or if you prefer 1.42GHz frequency. One of the ways to detect this radiation is to use a low-cost 21 cm horn-antenna radio telescope. These can be purchased "off the shelf" or to make one yourself. This type of telescope can be simply fixed mounted and simply left to "drift scan" the sky using the On-the-fly mapping (OTF) of the Milky Way and its HL emissions and major radio sources such as Cygnus A, Virgo A. This can be turned into a picture and can be displayed with the background stars superimposed on it.

Cosmic ray detection -

What are cosmic rays?

Although commonly called cosmic rays, the term "ray" is a misnomer, as cosmic particles arrive individually as a primary particle, not as a ray or beams of particles. 90% are Protons, 9% helium nuclei, and the remainder electrons or other particles.

Interactions of cosmic rays

When these primary particles hit, they do so with such tremendous energy they rip their way into our atmosphere with atom smashing power. These interactions produce an exotic zoo of high-energy particles and anti-particles high in the earth's atmosphere. The resulting flux of particles at ground level consists mainly of muons and electrons/positrons still with energies greater than 4GeV travelling at near the speed of light ~0.998c.

Interaction of Muons

As muons have little mass and travel at nearly the speed of light, they do not interact efficiently with other matter. This means they can travel through substantial lengths of matter before being stopped. Consequently, muons are all around us, passing through just about everything. Unfortunately, a muon created as a result of Cosmic Rays is not easily seen, but their after-effects when passing through is a little more easier, typically most forms of radiation detectors will do the job. The oldest and most famous example of this is the Cloud Chamber. We have one at the Obs but it has not been demonstrated yet as it requires solid dry ice to operate it. This is being organised for a future demonstration.

Other equipment used to detect cosmic rays

Other radiation detectors can be used like Geiger Counters, Spark Chambers, Resistive Plate Chambers and materials called Scintillators which give off light when an ionizing particle passes through them.

The problem using a radiation detector for a cosmic ray observation is that there are larger amounts of terrestrial radiation as much 73% of background radiation is due to the natural decay of matter. Although in small quantities it is sufficient to make it difficult to discriminate between a terrestrial or cosmic source. Consequently, at least two detectors are needed placed one above the other, feed into electronics that can monitor coincidence between the two detectors quickly, thus potentially filtering out most terrestrial radiation. There are proven designs available over the Internet.

Ancillary Projects

Since its official opening in 1986 by the then Astronomer Royal Professor Sir Francis Graham-Smith (1982 - 1990), Sherwood Observatory has always lacked suitable storage space. When the disused Victorian reservoir next to the Observatory was purchased by ourselves in September 2014, and an opening made in the side of it to allow for safe foot access; it became clear that it would make a good storage area for non-perishable items.

So in 2017 we started on the sorting out of the Obs, open events shed and the tool shed. A tent affair was constructed situated on pallets inside the Res and non-perishable items moved into it resulting in the tool shed being completely empty. Work then started in converting it into something suitable to store sensitive radio equipment, aerials, and paperwork. We now have a waterproofed, fully insulated, decorated and carpeted store room lovingly nicknamed “The Radio Shack” by our treasurer Phil R, who incidentally helped me build it. All that is left to do is to bring power into it for heating and lighting. This we hope to do shortly.

Once that is completed we will be able to populate it with the radio equipment making things a lot more accessible for open days, off-site events, group visits and general research work. It will also clear a lot of things out of the Inner Sanctum where all of our receivers and computers live making it a much more pleasant in which to work.

Website development

Since joining the project in 2015 with little or no knowledge of Radio Astronomy and then in 2017 becoming head of the section due to Michael's retirement from that position I have had to learn a lot in the principles. I have spent a great deal of time researching the internet every week to find out just the basic information to allow this project to develop to the stage it is now. I can't take credit for it in is entirety since a lot of people have contributed a good deal of their time physically helping construct masts etc. Since I have only basic knowledge of computers it's with great thanks for the input of Chris D and Scott C for their continuing support in that area.

But it is the principles and experience that I had thought about, that I concluded that if I had difficulty in finding information out, than it must also be true other people find it difficult too.

With that in mind I propose developing a Radio Astronomy section to our website documenting our history, our failures and successes, a 'how to' section (from our own experience) this done in word, pictures and videos.

I would like to develop sections on displaying our results from our currently running projects and to be able to access data from them over the internet. We have already done some work down this avenue this past year with some success, but we have identified some issues that we face in trying to achieve these goals in their entirety. A possible work around may have been found for some of these, but more work needs to be done this coming year if we are to achieve these goals.

Conclusion

The Radio Astronomy section of Sherwood Observatory this past year has continued to develop bringing an understanding of this science to visitors and members alike with special regard to Meteors, Space Weather and in particular our Sun. This was agreed by the committee when we set up Radio Astronomy.
So it is recommended that we continue down this avenue of development in the following ways:-

- To finish repairing the Brams aerial system
- To reinstall the “All sky” camera
- To upgrade the SuperSID software and recalibrate it.
- To bring SuperSID on-line feeding our data automatically into the Stamford Solar Centres observational data base
- To finish off the “Radio shack” and populate it
- To continue to investigate possible new projects and to evaluate them
- To develop a greater understanding of Space Weather in the membership
- To continue to support Open days, Group visits and Outreach presentations promoting our particular blend of radio astronomy
- To re-establish communications with people in this field that we have already contacted and to develop a deeper rapport with them
- To investigate the ability of transferring our data to other interested organisations databases
- To investigate whether it is possible to become corporate members of groups associated with radio astronomy allowing us the ability to access information that will help in our sections development

With regard to the development of our Radio Astronomy section in the Observatories website:-

- To develop a structural map of its layout
- To document RA’s history in word and pictures
- To develop a “How to” section telling of our experiences in building equipment etc, in word pictures and videos
- A Blog page
- Face book, Twitter etc?
- To be able to display program results in real time
- To have parts of the site that are interactive over the web
- To have links to useful other RA sites
- To be able to display other organisations results e.g. AuroraWatchUK
- To have a visit counter
- To have a high ranking in search engines for Amateur Radio Astronomy