The Beginnings of Radio Astronomy in England

A tribute to Stanley Hey MBE FRS (1909-2000)

by Brian Austin, G0GSF

Serendipity often plays its part in scientific discovery. One example, close to the world of radio and electronics, was the discovery that launched an entirely new branch of physics in England and expanded a much older one immeasurably. It is the science of radio astronomy.

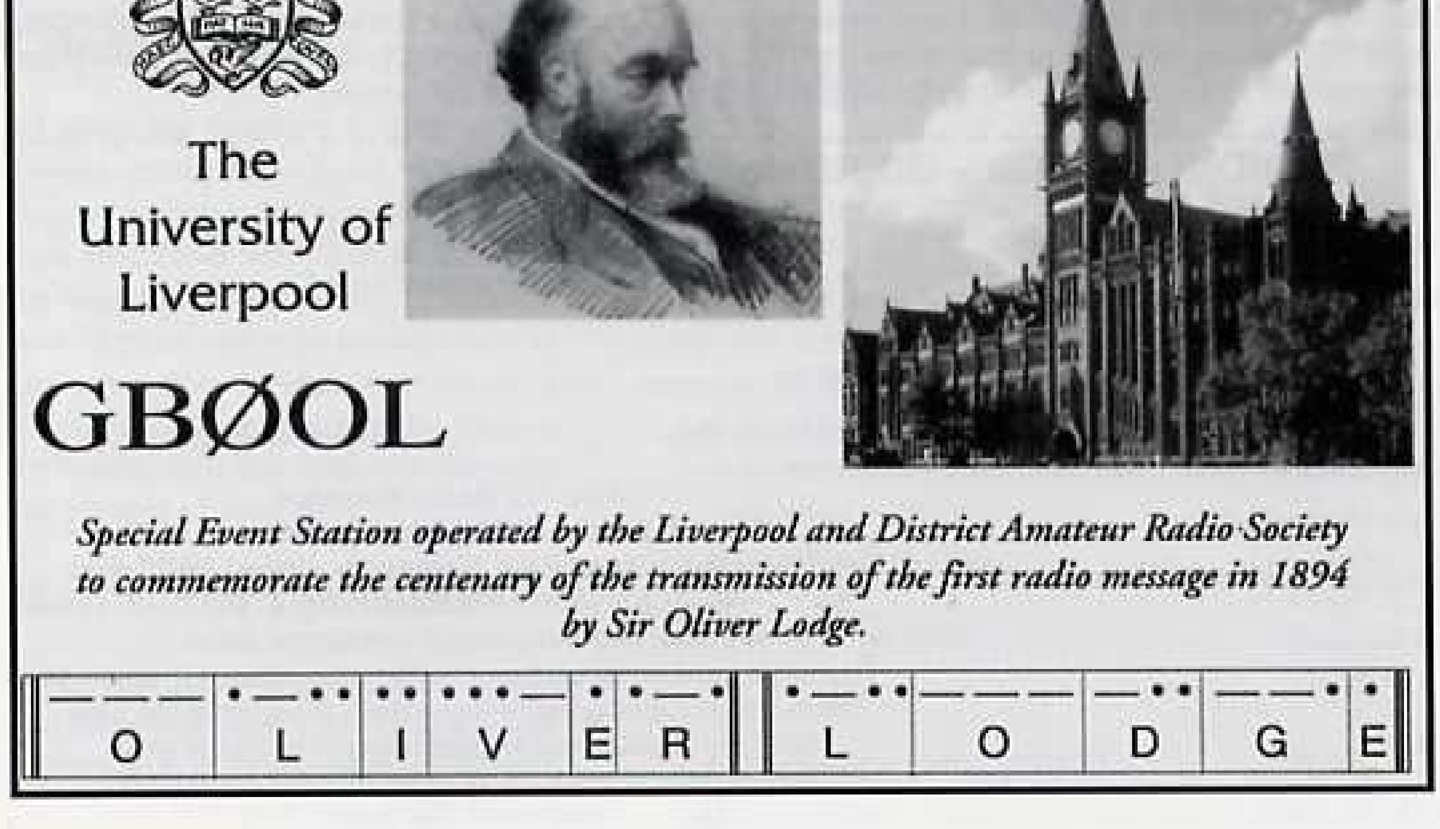
To most people radio is inseparably linked to communications. One only has to consider its multiplicity of applications involving the transmission of speech, music, images, data and text to see why. But it was not long after Heinrich Hertz turned Maxwell's equations into practical reality, and Marconi stunned the world by sending signals across the Atlantic, that a completely different application of radio was first suggested. That was in 1904 and its inventor was a German by the name of Christian Hulsmeyer. What followed thirty years later, and became the most important technological development in World War II when developed simultaneously by both sides in that conflict, was not communications at all but a form of remote sensing, to give it a modern name. We now know it by that most famous of palindromic acronyms –radar.

But there was an even older form of remote sensing by radio that had the ability to probe into the furthest reaches of the universe and it was first tested ten years before Hulsmeyer's device rang a bell when it detected a ship near the Hohenzollen Bridge near Cologne. This new science became radio astronomy and its pioneer was Oliver Lodge, Professor of Physics in the University of Liverpool. However, there was nothing serendipitous about Lodge's experiment for it followed some protracted discussions with his scientific colleagues, most notably, G. F. FitzGerald.

Long Waves From The Sun

Early in June 1894 Lodge mentioned, almost as an aside during a public lecture at the Royal Institution in London, that he intended "to try for long wave radiation from the Sun". This was two months before he gave the first public demonstration of signalling by means of wireless waves to an audience of distinguished scientists in Oxford. Needless to say, the suggestion created no stir amongst the audience; indeed there were those who scoffed at the very idea. This was probably not too surprising for radio was unknown at the time except as electromagnetic waves – a scientific curiosity predicted by Maxwell and then discovered by Hertz – but neither had any idea of their worth to the world.

Now, more than a century later, that world usually credits Marconi with having 'invented' wireless or radio when, in fact, there would appear to be little doubt amongst historians of science that it was Oliver Lodge's demonstration in August 1894 that



Sir Oliver Lodge – radio pioneer in Liverpool turned Maxwell's mathematics and Hertz's physics into a communications tool. However, it took the entrepreneurial flare of Marconi to exploit the technology to limits that no one else had even dreamed of and that fact is also beyond doubt. Just as Watson Watt was the father of radar as we now know it, so Marconi sired radio, though neither was the inventor of the technologies that forever after have been associated with their names.

What then of Oliver Lodge's idea of receiving radiation at other than optical frequencies from the Sun? His experiments, in June 1894, were conducted in Liverpool with the apparatus housed in an iron shed that was the University's electrotechnics laboratory. Sunlight, reflected into the shed through an observation window, illuminated a coherer – the earliest of radio detectors – which was connected to a very sensitive reflecting galvanometer. Despite numerous attempts, during which the galvanometer was certainly deflected, Lodge was unable to claim that the sunlight falling on the coherer produced anything more than a thermal effect. There was no evidence of what he called a "proper Sun effect". What he meant by this is probably to be found in his correspondence at the time with George Francis FitzGerald, the Irish physicist who made some significant contributions to our understanding of electromagnetic phenomena around the turn of the nineteenth and twentieth centuries.

Solar Wind

Both Lodge and FitzGerald had realised that magnetic disturbances on the Earth were, in many ways, related to the existence of sunspots. FitzGerald went even further and postulated that a cloud of electrified particles (or corpuscles, as they were known in those days) was ejected by the Sun whenever a sunspot was present. This was a remarkable suggestion and was well ahead of its time. In fact, it would be another fifty years before the solar wind was discovered and its effects on the Earth's magnetic field were shown to be fundamentally important to the science of geomagnetism and, indeed, to our very survival on the planet.

The solar wind is no occasional breeze; it's a veritable howling gale of electrically charged particles sometimes increasing to hurricane-like proportions as it blows continually off the face of the Sun. Its impact, 93 million miles away, when it encounters the Earth's magnetic field is formidable. The field lines on the sunward side of the Earth are hugely compressed while on the opposite side they are forced out into a long tail. Trapped within what is essentially a huge magnetic bottle are those charged particles – FitzGerald's corpuscles – and from them is formed the ionosphere and other regions such as the Van Allen belt so damaging to astronauts should they linger, unprotected, within it.

Little did they realise it, but Lodge and FitzGerald displayed remarkable prescience when they suggested that the Sun was responsible for rather more than just shedding illumination and warmth upon the Earth. But then those where the days when natural philosophy (or "science" as we know it today) was really beginning to flourish and discoveries were as common as the morning paper and almost as regular. Men like Lord Rutherford and before him J.J. Thomson had begun to unravel the world in its most minute form – the atom – while, soon afterwards, others like Eddington in England and Hubble in the United States were striving to dissect the very Universe itself. As always there were far more questions than answers and the most vexing of all was how to probe into the deepest recesses of atomic structure and of the galaxy. Science and especially physics was abuzz with new ideas and the age of electronics, which would provide many of the answers, was about to be born.

But it was even earlier when Lodge attempted to detect those 'corpuscles' emanating from the Sun. Though unsuccessful, due undoubtedly to the insensitivity of his apparatus in the days long before the valve amplifier, his experiment is considered to be the beginning of what is now called radio astronomy. Others, such as Thomas Edison and Arthur Kennelly in the USA had, a few years before, suggested experiments to detect such radiation but nothing ever came of them. Then Nikola Tesla, that wayward genius, whose occasional musings or wild conjecture took him off on many different tacks – often at the same time – even tried to harness the Earth's fields with the idea of modulating them to produce wireless telegraphy. Unsurprisingly, that idea came to naught and there the quest faltered and the very idea of long wavelength radiation from the Sun was seemingly forgotten about.

GLII gun-laying radar in WW2

Jansky And Reber

Thirty years later Karl Jansky, at the famous Bell Telephone Laboratories in New Jersey, used equipment much better suited to the task but designed for a very different purpose. His intention was to determine the direction of arrival of the 'static' that interfered with trans-oceanic radio-telephone circuits operating on a frequency of about 20MHz. The investigation was successful in that he soon identified the culprits as both nearby and very distant thunderstorms. But there was also a third and more persistent noise that appeared to occur only in some directions and it was also more akin to the steady hiss produced by the receiver's own electronics than to the static crashes from thunderstorms. This was puzzling and it certainly required further study and Jansky immediately gave it all his attention.

Initially, from its position in space as indicated by the rotary antenna's heading when the noise was at its most intense, Jansky suspected the Sun as its source but after further work he deduced that the actual source was outside the solar system and he placed it in the centre of the Galaxy near the constellation of Sagittarius. This was truly astonishing and he published a first tentative paper in 1932 presenting his findings. But the astronomical community took little or no interest while the Bell Company, satisfied that the sources of the static had been identified, put Janskey to work on another research project altogether! Such, then, was the auspicious beginning of radio astronomy.

Then, in 1937, another American by the name of Grote Reber was so inspired by Jansky's findings that he resolved to continue the research entirely in his spare time and at his own expense. Reber, a radio engineer, designed and built a 3-3GHz receiver plus a parabolic reflector antenna about 10m in diameter that he erected in his back garden in Illinois. He then attempted to carry out a systematic survey of the heavens with the intention of refining Jansky's measurements by using a much narrower beam for better resolution. However, due to the primitiveness of the microwave art in those days he found his equipment to be severely lacking in sensitivity so he reduced the frequency until finally, at about 160MHz, he obtained useful data. After considerable effort between the hours of midnight and 6 a.m. every day when local electrical disturbances were at their minimum, and often with a full day's employment ahead of him, Reber eventually produced the first radio maps of the Milky Way.

Radio astronomy had truly arrived but again there was no rush by the American astronomical community to embrace this new scientific stripling and so it was left to others, in England, to take matters further.

Beating The Jammers

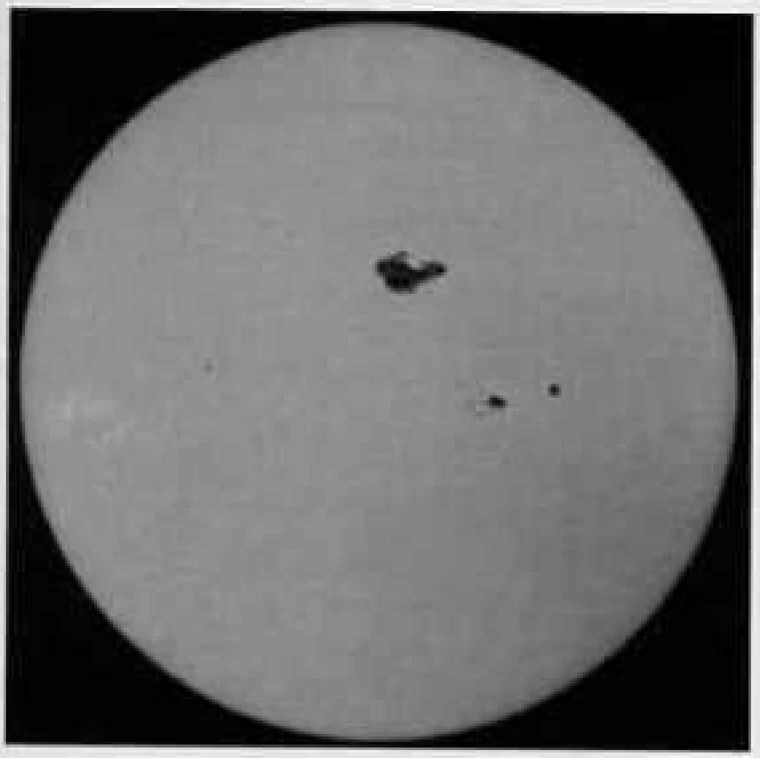
On 12 February 1942, three German warships slipped their moorings in Brest under cover of darkness and made a dash through the English Channel for the safety of their homeport of Hamburg. The battlecruisers *Scharnhorst* and *Gneisenau*, accompanied by the heavy cruiser *Prinz Eugen*, were at their most vulnerable in the Straits of Dover where they were within range of the British shore batteries and it was there, too, that they were most likely to encounter both the Royal Navy and the RAF. In addition, they had to run the gauntlet of the British coastal defence radars, concentrated there in some numbers and manned by the army. To counter them, the Germans had already begun a carefully coordinated programme of radar jamming and by late 1941 its effects were such that the British military planners were sufficiently concerned that a special effort was mounted to locate the jammers and eliminate them. The first task was given to the Army Operational Research Group (AORG) under the command of Col B.F.J. Schonland, a South African scientist in uniform and colleague of Professor John Cockcroft, one of the pioneers of British radar and general scientific factotum in the war against the Nazis.

Stanley Hey as a young man before the war

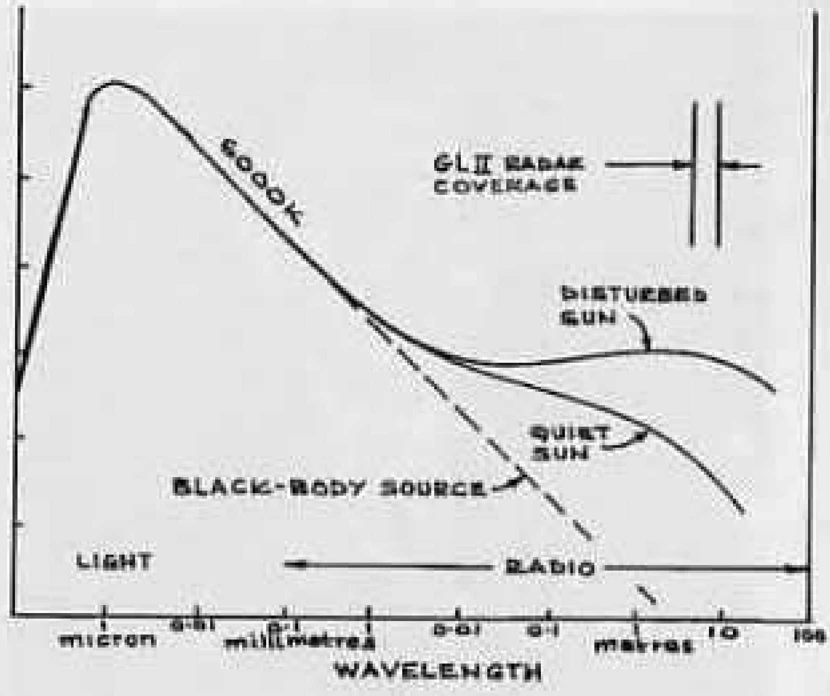
The fact that the three vessels made it back to Hamburg almost unscathed was testament not only to some remarkable seamanship but also to the effectiveness of the German's radar countermeasures from transmitters near Boulogne and Cap Gris-Nez. Following a stormy inter-Service meeting in London, called to find out what had gone wrong, control of all radio and radar jamming investigations was passed from the Air Ministry to the War Office, thus placing the matter under Army control. Schonland's AORG was given the task and he immediately set up what was called the J Watch equipped with J vans containing the necessary monitoring and recording equipment.

The man Schonland selected to coordinate this effort and to analyse the results was J.S. Hey, a civilian scientist who, but a few months before, had joined the AORG as a competent X-ray crytallographer but with no knowledge at all of either radio or radar. However, in wartime things move quickly and after an intensive course on the subjects delivered by J.A. Ratcliffe, formerly of the Cavendish Laboratory in Cambridge and now on secondment from the Telecommunications Research Establishment (or TRE), the home of British radar, Hey and his young physicist colleagues were sent as scientific observers to the radar-equipped gun sites around the coast. The radars were the GLII whose purpose was gun-laying: the process of locating a target and bringing the weapon to bear on it and, ultimately, of tracking it automatically. And it was those GLIIs at their operating wavelengths of about 4 to 6m that were now suffering severe interference from the German jammers.

Hey took on the task without much enthusiasm for it seemed like a laborious exercise of little or no scientific merit. However, he could not have been more wrong. On 26th February, one after another the GLII radars around the coast reported intense interference. The reports soon reached Hey who plotted the antenna headings at which the jamming was

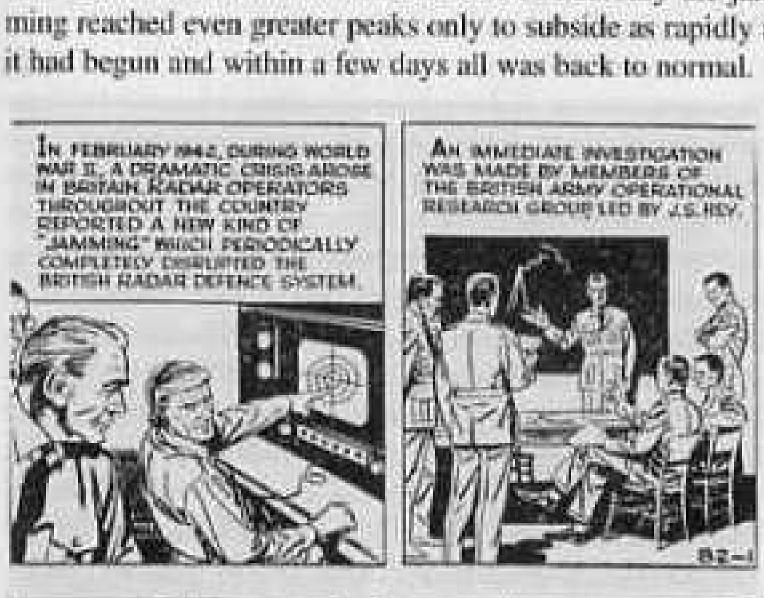


The Sun with a group of large sunspots



Graph of solar radiation relative to wavelength showing the effects of sunspots on radiated noise

most intense and logged the times of occurrence. In every case the source of the interference appeared to be moving and this seemed to confirm the War Office's worst fears that the Germans had developed, and had now deployed, an airborne jammer. This possibility had long been a dreaded threat that would clearly pose very serious problems to Britain's defensive radar screen. However, no massive air raid or bombardment followed and then, as night fell, all jamming ceased. The following day the pattern repeated itself and, if anything, it was even worse. And then on the 28th of February the jamming reached even greater peaks only to subside as rapidly as it had begun and within a few days all was back to normal.



The jamming of the radars: a cartoon from the 1960s with acknowledgement to the Daily Herald

To the military, who were expecting military action of massive proportions to accompany the jamming, this sequence of events was most puzzling; to Hey, however, the facts suggested another explanation entirely.

A Solar Noise Source

At two of the radar sites the operators had managed to obtain both bearing and elevation readings on the source of the interference and, when plotted, they were seen to be pointing directly at the Sun – an observation readily confirmed by the radar operators themselves. This crucial information, coupled with the total disappearance of 'jamming' at night, could lead to only one conclusion: the Sun, not the German military, was the culprit. But before making any announcement Hey telephoned the Royal Observatory in Greenwich to find out whether anything peculiar was happening on the Sun at the time and he was told that a very large sunspot group with associated flares was crossing the solar disc and that it lay right on the central meridian on the 28th, the very day that the GLII radars had experienced their most severe interference.

To a competent physicist recently introduced to electronics Hey was aware that the magnetron valve generated very short radio waves by the interaction between magnetic fields and electrons in motion. He knew, too, that sunspots were regions of greatly increased magnetic fields within a sea of charged particles and so the source of this radio interference seemed obvious, at least to him, and he reported it to Schonland who smiled and said, "Is that so, Hey? How interesting. Did you know that Jansky of Bell Telephone Labs in the USA discovered radio noise coming from the Milky Way?" Hey did not and so Schonland then told him of Jansky's 1932 paper on the subject.

Scepticism

Others within the AORG, once word was out, were less easily convinced. Accepted wisdom amongst the radio experts had it that the Sun behaved, by and large, like a

Sir Edward Appleton – Nobel Laureate for his discovery of the ionosphere

perfectly predictable thermal source at a temperature of 6000°K and therefore it must radiate as such. It was, in the words of the physicists, a "black-body" source. Essentially what this means is that any object at a temperature greater than absolute zero will radiate energy in the form of electromagnetic waves of which both heat and light are examples. If the Sun is observed at optical wavelengths it behaves exactly as predicted by this black-body physics and so, on that basis, it would clearly generate an insignificant amount of energy in the radio frequency part of the spectrum. Not surprisingly, therefore, Hey's announcement that the Sun was jamming the GLII radars was greeted with much scepticism even though his evidence looked pretty watertight.

What perturbed some of Hey's critics even more though was that he was a virtual novice in the field of radio and radar and yet here he was claiming to have made a quite remarkable discovery with undeniably profound implications. Reputations amongst scientists were fiercely guarded and rivalries were intense, even in wartime, and no young scientific interloper could suddenly be allowed to claim the limelight. But in 1942 pride had to take a temporary backseat because there were bigger issues at stake and so the matter was left there. Hey's report was classified secret because of its sensitivity in regard to radio jamming and it was only circulated to those with an immediate need to know about such matters. Soon, new methods and procedures were introduced to acquaint the radar operators with the problem and steps were taken to train them in the use of appropriate countermeasures.

Intriguingly, an American physicist by the name of Southworth (also from Bell Labs) set out at almost the same time that Hey was in pursuit of the radar jammer to measure the microwave radiation from the Sun by using a very sensitive receiver. Though Southworth also believed that the Sun behaved as a black-body radiator he wondered whether it would also generate sufficient energy within the microwave spectrum which his apparatus might detect. And sure enough, it did! But his report, too, was restricted, so neither Hey nor Southworth knew of the other's work and science for science's sake was no beneficiary at that critical stage of the worldwide conflict.

The Rush To Publish

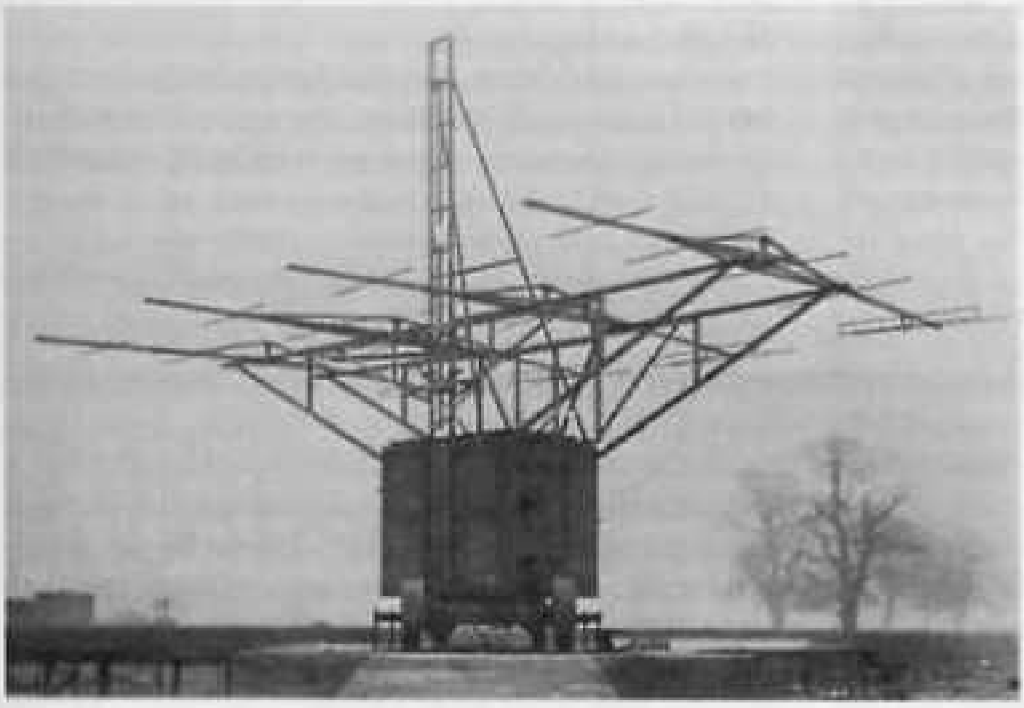
The man most directly (but belatedly) affected by Stanley Hey's finding that the Sun was a powerful source of radio emissions was Edward Appleton, soon to be knighted and awarded the Nobel Prize for his discovery of the ionosphere in 1924. Appleton was, undeniably, the father-figure when the subject of radio and all its ramifications reared its head. During the war he was Secretary of the Department of Scientific and Industrial Research and was very much 'in the know' as far as all scientific matters and their effects on the waging of war were concerned. However, it seems that news of Hey's serendipitous discovery in 1942 had not reached him as Hey himself found out when, at a meeting in 1945 attended by Appleton, he mentioned that he was contemplating publishing his discovery in a scientific journal. Appleton was astonished but, with some ground to make up, he was not lost for words.

His immediate reaction was to inform those present about reports that had reached him before the war about a strange "hiss phenomenon" heard over a range of frequencies from 10 to 40MHz and even higher. These reports had come from radio amateurs and had been published in *The T&R Bulletin*, the official journal of the Radio Society of Great Britain (RSGB) in 1936. Others, too, such as engineers from Cable and Wireless, had commented at about the same time on the "fizzlies" that interfered with radio communications while H.W. Newton, an astronomer at the Royal Greenwich Observatory, was also aware of them but not of their source. It was one of those amateurs, Dennis Heightman G6DH, who came closest to the real explanation when, in 1938, he wrote that the loud hissing sound heard on a radio receiver was "presumably caused by the arrival of charged particles from the Sun on the aerial". The corpuscles of FitzGerald?

Appleton lost no time in getting into print himself. In November 1945 he published a paper in the world's leading scientific journal, *Nature*, that made no reference to Hey but it did discuss the findings of Jansky, Reber and Southworth. That none of them had detected any significant radio noise from the Sun he attributed to the fact that their experiments were conducted during periods of minimal solar activity in 1931, 1942 and 1944. By contrast, Heightman's 1936 and 1938 reports of the hiss phenomenon, as well as similar reports from other radio amateurs at about the same time, coincided with a period of greatly increased sunspot count. But, for all that, neither Appleton nor any other scientist well versed in the field of radio had connected those effects with solar radiation at metre wavelengths.

However, following Hey's announcement at that secret meeting, Appleton now had a reputation to protect and he chose to portray things rather differently. In his 1945 paper, after mentioning Heightman's suggestion of a solar source, he went on: "Other amateur observers sent me further excellent reports from which I concluded that the noise was due to the emission of *electromagnetic* (his emphasis) radiation from active areas on the sun". However to claim, as he now seemed to be doing, that he reached that conclusion before the war is surely stretching credibility rather more than somewhat. Had he done so then why had he not published it? And if he was already aware of the phenomenon then Hey's announcement in 1945 would surely have come as little surprise to him. But it certainly did and Appleton was determined not to allow outsiders easy passage through what he considered to be his domain. So he had to get his paper in first in order to reclaim lost ground.

The world therefore first knew that the Sun was indisputably a radio source not from the Hey, who made the discovery, but from Appleton who chose to steal his thunder. Whilst staking his rather dubious claim Appleton coined a new term when he described how the solar disk could be examined by means of radio waves and a *radio-telescope*. At last the means to delve even deeper into the secrets of the heavens had arrived and astronomy was poised to take another giant leap forwards. Radio astronomy in England was born in 1945 though it was probably conceived a long time before that in 1894. This drawn-out gestation period was necessary because technology had to make enormous strides from the days of Lodge's coherer to the sophistication of radar. And it took a war to do that. Then, with peace restored and a whole generation of scientists returning to their laboratories, radio astronomy flared into life and nowhere with more vigour than in England. The man they had to thank for that was Stanley Hey.



GLII fitted with an array of four Yagi antennas

In Appleton's shadow

Hey's paper only appeared in *Nature* in January 1946. It reported the sequence of events leading to his discovery in 1942 and described how he had pinpointed the Sun as the source of the radio interference. In addition, it stated that the level of that solar noise, which covered the whole tuning range of the GLII radar receiver from 50 to 75MHz, was about 50dB stronger than would have occurred had the Sun behaved solely as a black-body radiator. Clearly it didn't and the paper concluded by suggesting that the actual source on the solar disk appeared "to have been associated with the occurrence of a big solar flare reported to be in a central position on February 28, 1942".

This was a remarkable discovery and that solar outburst was clearly the crucial event. It was the sunspot and its associated flares which produced the intense radiation that blocked the radars, whereas the quiet Sun behaved almost like the black-body everyone else had assumed it to be and so it had avoided detection by all others before Hey. Confirmation that the Sun was indeed in a state of some turmoil at the very time the GLIIs experienced the 'jamming' came from F.J.M. Stratton of the Solar Physics Laboratory at Cambridge. His letter to *Nature*, published in the same issue immediately following Hey's, provided the evidence by way of a sprectroheliogram plus a table of tumultuous solar events recorded at the observatory in Meudon, France, between 27 February and 1 March 1942.

But Appleton was not to be outdone and he now seized every opportunity he could to be involved in this exciting new field of research. As his was essentially an administrative post without access to research facilities or even junior colleagues to carry out work at his bidding he sought to collaborate closely with Hey. What followed were, in Hey's generous words, "many friendly and informative discussions", exchanged during many telephone calls made by Appleton to Hey's home in the evenings. Only once, though, did Appleton actually visit Hey at his AORG research site where the first postwar observations of the Sun were under way. A couple of jointly written research papers followed soon afterwards but it became clear to Hey that his AORG colleagues rather resented Appleton's incursion into their research work and so he took steps to bring the liaison to an end.

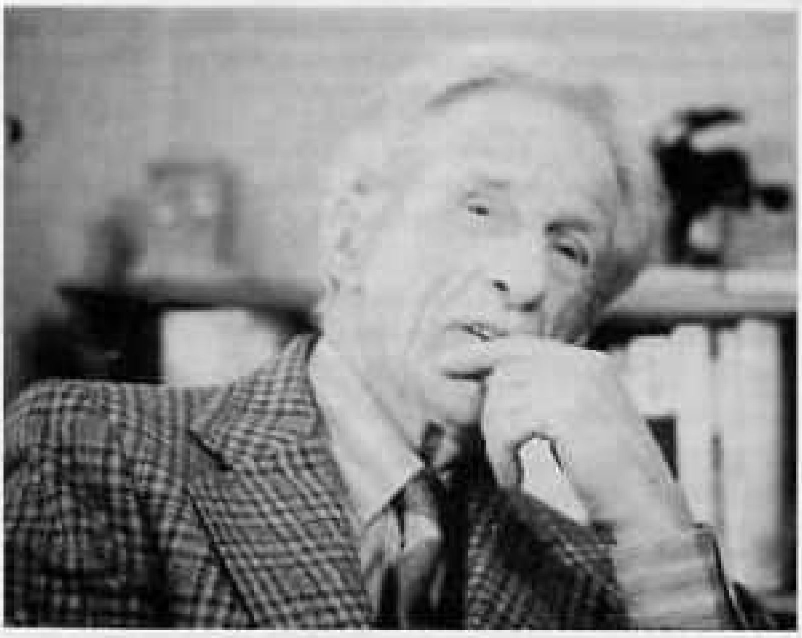
Missiles, Meteors And Cygnus A

In the closing months of the war when London came under attack from the V1 and V2, the so-called flying bomb and the first guided missile, Hey was very much involved in using the GL radars to detect and track these fearsome weapons. His modification of the GLII radar enabled it to obtain the V2 rocket's trajectory thereby providing about 70 seconds warning before impact. That the Government decided not to issue any warning for fear of causing panic worried him for years afterwards in view of the loss of life the V2 had caused. Any warning, he believed, would have been better than none at all. By now his expertise had been recognised both within and beyond the confines of the AORG and by 1949 he had become its Superintendent. But before that he made two other discoveries of great importance in the field of radio astronomy and the first of these was a direct consequence of the V2 work.

Occasionally, echoes of short duration from about 90km above the earth obscured the radar plots and were regarded as a particular nuisance by the operators who were attempting to track the rockets. On examining the offending traces on the display Hey guessed that they were reflections from the ionised trails produced by meteors entering the atmosphere and sure enough, on further investigation, that is what they turned out to be. By using three appropriately sited radars he was able to detect and track them, just as he done with the V2, and so could fix their direction of arrival. This was the first time that meteors had been detected other than by their appearance at night as 'shooting stars' and it was the precursor of great things to come.

Hey's next discovery, made in 1946, was the most significant of all. His intention was to produce a radio map of the heavens and he used the technique first adopted by Reber in the United States, but at a frequency of about 60MHz. Once again the equipment was based on the GLII radar but with its receiver front-end modified to reduce the overall noise figure as much as possible. In addition, the antenna now consisted of an array of four Yagis mounted horizontally above a large reflecting earth mat to improve its low angle performance. Within a short time of commencing the survey a remarkable, and repeatable, signal was detected that varied in intensity and this was most puzzling. It was found to lie in the direction of the constellation of Cygnus and had all the features of a discrete or localised radio source rather than being distributed across a region of space such as the Milky Way. Once again the signals were, in many ways, similar to the radio emissions from the Sun. However, their position and strength suggested a much more powerful emitter at a considerably greater distance from the Earth.

Hey now lost no time in publishing this finding and his paper immediately stimulated a group of researchers in Australia to make their own observations using their wartime radar equipment that they'd turned into a peacetime research tool. Within a remarkably short period they too confirmed the existence of an unknown radio source near the coordinates indicated by Hey and, after further work, pin-pointed it even more accurately. This galactic lighthouse became known as Cygnus A, one of the most powerful radio sources ever detected and, at 600 million light-years away, one of the most distant. This discovery was indeed a landmark and was the launch pad that took Australian scientists into the new field of radio astronomy. Their contribution to the state of knowledge was soon to be of the very highest order, ranking alongside that of their English colleagues and well ahead of any American effort for years to come.



Stanley Hey in his twilight years

Hey's Legacy ...

Many young British scientists too who, six years before, had had to abandon their careers for reasons of the greatest urgency were now returning to their universities and were casting around for new, exciting areas of research. Amongst them were two young men whose names would, in time, become synonymous with radio astronomy and both were soon made aware of Stanley Hey's discoveries. They were Bernard Lovell and Martin Ryle – both to become knights of the realm in recognition of their scientific achievements.

In September 1945 Lovell, who had played such an important part in developing the famous H2S radar used in the RAF's bomber and pathfinder aircraft, paid Hey a visit at the AORG HQ in Byfleet. Lovell had recently returned to the University of Manchester from the TRE and wanted to resume his pre-war research on cosmic rays. He was therefore most eager to talk to the one man who might be able to help him. He had heard of Hey's discovery that meteors were detectable by radar and wondered whether the same might be true of the cosmic rays that bombarded the Earth from sources as yet unknown. It was soon arranged that a GLII radar would be delivered to the university and set up there under Hey's guidance. However, it transpired that the electrical noise level within the city centre made observation impossible and Lovell arranged for the GLII to be moved to the university's botanical site some miles south of the city where the open fields and lack of urbanisation meant that electrical noise would not be a problem. Again Hey supervised the erection of the equipment on its new site and instructed Lovell in its use. Observations began almost immediately and Bernard Lovell thus became a radio astronomer. The place where the gun laying radar became a radio telescope was called Jodrell Bank.

Cambridge

In Cambridge Jack Ratcliffe, too, was picking up the pieces after his return from the TRE. With him were a number of young colleagues whose academic careers had been summarily interrupted in 1939 and getting them back into research became Ratcliffe's prime responsibility. His own speciality before the war had been the ionosphere but now there were many other fascinating problems that had come to light as a result of the explosion of electronics into warfare, so research topics abounded. And one that had fired Ratcliffe's imagination was Hey's discovery of the radio emissions from the Sun. The man he set to work on this was Martin Ryle who, before the war, had been a keen amateur radio operator with the callsign G3CY. Over the past six years Ryle, too, had become an expert in the field of radar and so was well equipped to use the technology for a rather different purpose.

Just as in Manchester, radio astronomy began in a small way in Cambridge with one researcher and a collection of war surplus equipment. It soon became a major research activity. In no time at all Ryle reported that the Sun was indeed a source of radio energy; in fact, it was now highly active because the 11-year sunspot cycle was approaching its peak and Ryle soon confirmed that the sunspots that were the source of the intense radiation. Studying them in great detail became the challenge and to do this Ryle developed a technique that, in years to come, would see him sharing the Nobel Prize for physics with his colleague Antony Hewish, yet another of the remarkable men who spent their years of wartime service at the TRE.

By the 1950s radio astronomy had assumed its rightful place alongside its optical kinsman and together they moved into an era of almost exponential growth, both in terms of discovery and technology. The irony in all this was that the most powerful optical source in the sky had, for years, avoided detection by radio but once discovered it became the catalyst that opened up the heavens. Though some credit must go to Oliver Lodge for being the first to try there is no doubt that the greatest praise must go to Stanley Hey – that most reclusive and unsung of astronomical heroes – for succeeding when all around him doubters reigned, almost, supreme.

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Feedback . . .

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SWB Transmitters

I was interested to read a letter by Alan Davies about SWB transmitters (*RB95*). As an Admiralty trainee engineer in 1944 I first met the various SWB's in the Transmitter Test Department at Marconi, Chelmsford. I had previously spent some time in the equivalent department of STC at New Southgate, and was struck by the contrast between the massive MWT Co product and the 'lightweight' construction of the STC designs, no doubt influenced by the American connections of STC.

As Alan Davies notes they were well-established pre-WW2 designs, and were ordered in large numbers for the armed forces, particularly by the naval service. The Admiralty had a farsighted plan for quickly restoring damaged shore W/T stations or constructing new ones after the cessation of hostilities. This involved the pre-ordering of a considerable number of SWB-8s and 11s and many other items to form complete installations. In the event, only a limited number of these 'assemblies' were deployed so no doubt the redundant SWBs were diverted for civilian use.

In 1945 I was involved with one of these installations, replacing the demolished pre-war station at Suara in Singapore. As well as the SWB CW units, we installed an RCA R/T transmitter, and the design and construction of the SWBs compared with the American set was even more marked.

We also had one Marconi TFS 31, which was a bandswitched version of the SWB-8 and had a similar separate power unit. The chore of re-setting the copper straps of the PA coils was eliminated, but the Franklin master oscillator and the individually adjusted 807 multipliers were retained.

I thought at the time that the triodes in the oscillator were the ceramic-based ML6s as used in the RAF T1154, but I note that Vyse and Jessop list them as DET5s.

SWBs were built to last, and this they certainly did. Some of the original SWBs which we installed in 1945, were still in use in the rebuilt station some twenty years later.

I think Michael O'Beirne is a little unkind to these venerable "heavy beasts" (*RB92*). Our Radio Mechanics were highly adept at working on them, smart frequency changes at the request of the remote opertors being a speciality! And I don't think we ever had any casualties! The fact that our RMs had previously assembled and aligned all these transmitters and sorted the bugs out was probably an advantage.

There are pictures of the Suara station, including SWBs being assembled in the 1945 operation, on a website operated by Randal McDowell who was on the staff of the station in the 1960s. It can be found at http://home.no.net/yerman /index.html. Comments and memories from anyone who worked there are welcome.

The station site was cleared some years ago. Whatever happened to those magnificent beasts?

John Goldberg, G3ETH
Chester