R.S.R.S.

No. 49 **Newsletter**

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SOME MEMORIES OF SIR EDWARD APPLETON

The earliest ionosphere experiments

Members of the Research Station will have been shocked to hear of the sudden death of Sir Edward Appleton so very soon after his second marriage. There will be many formal obituary notices of him. I think it will be more appropriate for me to contribute to this Newsletter some personal memories of a man I have known well for just over 40 years.

In 1924 I was in my final year as an undergraduate reading Physics at Cambridge and I found Appleton's lectures on "Electrical Oscillations and Waves" exceptionally interesting. Until then I had no particular knowledge of, or interest in, "wireless", but when I heard Appleton it seemed to me that here was a subject which embraced a very wide range of topics in physics, and I decided that if I had the opportunity to do research I would try to work with him.

When that opportunity came, in June 1924, I found that a young research student from New Zealand, Miles Barnett by name, had joined Appleton the previous April and they were studying the way in which the signals from the London Broadcasting Station fluctuated when fading set in at sunset. Along with others they already had the idea that the fading resulted from the superposition of a ground wave and a wave received after reflection from the "Heaviside Layer" which had been postulated in 1902 to account for Marconi's success in sending "wireless" waves from England to America. No-one had proved the reality of this reflected wave or indeed of the layer.

Now Appleton, like all those who learnt their physics in the Cavendish, had a good knowledge of physical optics and was steeped in the ideas of wave interference. He visualised the interference pattern which would be produced by the superposition of the ground and downcoming waves, and saw that there would be a series of interference fringes, analogous to those in an optical "Lloyd's single mirror" interferometer. He further realised that, if the wavelength of the transmitter were gradually increased, the fringes would move over the ground, and as they swept past the receiver the signal strength would vary sinusoidally. By counting the number of fringes which swept past when a known change of wavelength was made it would be possible to deduce the

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height of the reflecting layer. He also realised that the depth of the fringes would be greatest if the strengths of the two interfering waves were equal. From his knowledge of how the London signal faded he deduced that, if the two waves were to be roughly equal, reception would have to be over a greater distance. With these ideas in mind he finally decided to make the wavelength-change experiment with the B.B.C. transmitter at Bournemouth and his receiving equipment in the laboratory of E. W. B. Gill at Oxford.

The receiver in those days was a simple straight valve amplifier and rectifier feeding an ordinary milliammeter with a time constant of about one second. The wavelength had to be altered so slowly that the expected "fringes" would not be smoothed out by the time constant, and the bandwidth of the receiver had to be sufficient to accommodate the necessary wavelength change. The experiment was performed in December 1924 and was immediately successful. It confirmed the presence of the double transmission path and from the number of "fringes" observed Appleton deduced that the reflection was from a height of about 100 km.

I well remember the enthusiasm with which he and Barnett returned from Oxford, and the interest with which Rutherford received the news. He was so pleased that he referred to it in the speech which he made at the annual Cavendish Dinner a day or two later. This was a purely social occasion on which it was not usual to refer to the work of the Laboratory, the fact that Rutherford did so was an indication of the importance he attached to the new result. Appleton was always ready to tell his Oxford friends that at last he had found a use for Oxford, as a place for Cambridge men to make their discoveries.

Once the crucial experiment had been performed Appleton set to work to follow it up. He arranged with the D.S.I.R., through the newly formed Radio Research Board, that a special transmitter should be built and installed at the N.P.L. for making the wavelengths change, that a special receiving station should be set up at a disused war-time direction finding station near Peterborough, and that another research student should be added to the team. The transmitter was supervised by Dr. Smith-Rose, and operated by Hatcher and Haxton; the Peterborough station (a wooden hut in a field) was in the charge of W. C. Brown (who lived in an adjacent hut), and the extra research student was me (I had been working on Atmospherics till then). All these people were members of the Radio Division, N.P.L. or later of the Radio Research Station. The receiving equipment was improved by the use of a Eindthoven string galvonometer, with a rapid response time, instead of the slow moving milliammeter. The wavelength in use was about 400 m.

By this time Appleton had been appointed Professor at King's College, London, direct from the very junior post of Demonstrator in the Cavendish which he held when I first knew him. He, Barnett and I used to travel over to Peterborough three times a week to conduct the experiments after midnight when there was no fear of our interfering with the broadcasting service. We were in continuous telephonic contact with Hatcher and Haxton at the N.P.L.,

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when we were ready for an experiment we would ask for a change of wavelength. They would then swing the transmitter condenser back and forth while we photographed the "fringes" on a moving film. The experiment was repeated at intervals throughout the night. We could not always experiment for as long as we would have wished. Often we could not start until about 2 a.m. because a Spanish station was broadcasting dance music, and we frequently had to stop at 4 a.m. because the Germans started with physical jerks.

Many of us know that night work can be very tiring, but when Appleton was there, there was never a dull moment. In between times he would either be telling us about his latest theories, entertaining us from his inexhaustible fund of stories, or drinking the very strong tea which Brown and Barnett as New Zealanders, Appleton and I as North country Englishmen, all enjoyed. During those nights it was a wonderful experience to see a very active intelligence rapidly appreciating the immense potentialities of the new experimental methods.

J. A. Ratcliffe

A Tale of Two Lasers

/The story so far: BE-B, a foreign satellite, circles the earth and a team of intrepid British scientists on Winkfield Plain man a laser-equipped searchlight mirror intent on ascertaining the range of the orbiting object by obtaining laser echoes from it. Their motto is 'shoot at sight!', enough to terrorize the neighbourhood and immobilize London Airport. But disturbing news reaches them from across the Channel, and as clouds gather over England a member of the team takes up the tale. Now read on:-/

In February I told you about some of our activities and ventured to voice some of our hopes and aspirations - not to mention 'aims'. It is in a somewhat chastened mood that I must admit to a conspicuous lack of success. Our target, Explorer 22, should have been faintly visible in reflected sunlight during the second half of March, and no doubt it was, but, alas, only from beyond the clouds. One night the sky cleared and we had a perfect view of - the full moon and nothing else. So without being glimpsed by us BE-B went back into eclipse, and the weather improved immediately.

Our 10" telescope and tracking mount had just arrived - too late but better than never - and was awaiting installation, as good a time as any for me to go on leave. French scientists announced early in February that about ten days after our own tentative successes they had obtained echoes enabling them to calculate the satellite distance to be 1571.994 km $\pm$ 8 m. What elaborate and powerful equipment did these doubtlessly numerous scientists and technicians use somewhere in S.E. France under admittedly much better weather conditions to achieve results superior to those claimed by the Americans - I was determined to find out there and then.

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So, on 6th April, while my wife and the Queen Mother spent the day at Aix-en-Provence, I took the train to Manosque on the single-track line linking Marseilles to Grenoble. At the station I was met by a French scientist, Mr. Bivas and his assistant who turned out to be Mrs. Bivas. Up a winding road we travelled for many miles through the wild and lonely hills of the Basses Alpes towards a distant wooded slope dotted with eight domes - the Observatory of Upper Provence, the largest in Western Europe, with its big reflecting telescope (driven by British machinery) under a huge cupola at the centre of the site. The nearby village now calls itself proudly Saint-Michel l'Observatoire (just think: 'Datchet of the R.S.R.S.'). In the grounds a concrete building about 40 feet long by 15 feet wide, with sliding roof, houses the laser and its ancillary plant. As for the large team of workers, this does not exist - Mr. and Mrs. Bivas are on their own. They live at the Observatory and the awkward hours satellites choose to pass overhead present no problem to them. The predictions having been worked out, Mrs. Bivas will take her seat on the tracker which carries both the laser and the 36-cm receiving mirror with the photomultiplier system. The hydraulic drive ensures a very smooth and rapid action under the control of a single joystick as she keeps the satellite aligned with the crosswires of her binocular sighting telescope. She fires the laser by pressing a foot-switch while, in the adjoining room, her husband looks after the timing equipment. The outgoing laser pulse starts the timing process, and an echo signal above a preset level and received after an approximately predicted delay stops it. The time interval is printed out to tens of nanoseconds on paper tape. French industry built the whole installation to detailed specifications, and probably at great expense, but once the considerable teething troubles had been overcome the results achieved were remarkable.

The very efficient laser is cooled by a refrigerant (there is a miniature power station and pumping plant next door) and can transmit 0.5 joules in the form of a 30 ns pulse every two seconds. During the last days of March, while we were still scanning the clouds, they, at Saint-Michel, had on successive nights been able to register up to a dozen echoes on each transit, and to calculate the range to within $\pm$ 3 m; since then they have improved the accuracy limits to $\pm$ 2 m, in any case partly accounted for by uncertainties regarding the velocity of light. This is, of course, just what will be needed for the purposes of geodesy - Mr. Bivas' ultimate interest in using this powerful new tool. Not only their fine equipment but also their devoted partnership which raised the experiment to such a high level of perfection had impressed me greatly as I left the Observatory for a hair- and dust-raising switchback journey to catch the train with few nanoseconds to spare. British Rail at least give you a sporting chance but French trains are excessively on time.

On the 29th April BE-C (Explorer 27) was launched into an orbit of little use to us at Winkfield but quite suitable for Saint-Michel, where, at the first possible opportunity, they scored several hits on the new satellite and

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accurately confirmed its range. Apart from its laser light reflecting corner-cube array BE-C is also equipped with a photo-detector system that produces a telemetry signal whenever it encounters a laser beam. Our hopes that we might perhaps detect via telemetry at Winkfield when their laser and, eventually, ours had hit BE-C were dashed by the news that monitoring of the channel concerned would only be possible in the U.S.A. Nevertheless we hope to hear direct from France about their results obtained with present and future satellites.

What, in turn, are we going to do with our laser at Winkfield? As soon as the clouds break, as break they must one night, we shall continue with our investigations of atmospheric scatter by firing vertically upwards, hoping to extend our present range of about 50 km and ultimately to receive photon returns from heights of 100 km or so. At the same time we will attempt, at long last, to fire 'blind' at BE-B, and even at the more distant BE-C. Some interesting experiments are planned for our Laser Laboratory, such as halving the ruby laser wavelength (turning red to ultra-violet), and the use of other laser materials; this may prove valuable in our atmospheric work. New Q-switching (i.e. laser pulse-shaping) techniques and reflecting cavities will be tried out with the aim of achieving higher peak powers, and the successful development of a calorimeter for energy measurements should lead to interesting tests and comparisons.

So perhaps it will not be long before I may continue the tale by reporting about our own achievements for a change.

W. S. Newman

STAFF NEWS

Congratulations to:-

Mr. and Mrs. Bruce (Lerwick) on the birth of their daughter, Ingrid, on 12th April.

Mr. and Mrs. Clifford Hale on the birth of their son, Mark Peter, on 24th March.

Mr. John Gaynor on his engagement to Miss Judith Gledhill on 15th April.

Mr. C. V. D. Strange on his promotion to Clerical Officer (P.U.)

Miss Anthea Arman on her 1st class pass in the Typing Proficiency Examination.

/Welcome

Welcome to:-

Visitors

Mr. Chang Chia-Chen from Wuhan University, Wupei, Central China.

Mr. Chen Kuo-Jui from the N. Western Technical Institute at Sian, Shangsi, N. West China.

Both are to be at R.S.R.S. for one year and will be in England for two years.

New Staff

Mr. A. J. Chipperfield	College Based Sandwich Course Student
Mr. R. P. Harrison	College Based Sandwich Course Student
Mr. R. J. Knight	T./A.E.O.

Resignations

Mr. D. A. Hannaford	E.O.
Mrs. P. A. Galindo	T./A.E.O.

Other Changes

Mr. G. C. Anderson commenced industrial training at N.P.L.

R.S.R.S. SPORTS AND SOCIAL CLUB

The A.G.M. of the Sports Club was held on Thursday, 29th April; sixteen members attended.

The main business was the acceptance of the Treasurer's and Secretary's Reports, but time was found to formally change the name to the Radio and Space Research Station Sports and Social Club.

The new committee members and officers are as follows:-

Chairman:	P. Bradley
Vice-Chairman:	P. Hall
Hon. Treasurer:	Miss V. Lovell
Hon. Secretary:	J. Juleff
Minutes Secretary:	A. Lowe

Committee members looking after the bar, J. Hancock and M. Edwards.

Miss Jones is going to look after the confectionery cupboard again this year.

An up-to-date list of members to contact for information on the various activities will appear on the notice board in a short time.

J. Juleff.

Tennis

The hard tennis court is available for play and members of the tennis club are urged to make full use of it and arrange matches using the booking sheets on the notice board.

The usual club evening on Wednesday will be continued this year to which all members are invited.

P. A. Smith

/Bridge Club

Bridge Club

The last two matches in the N.P.L. Inter-divisional League were played on 13th April and 11th May. Dr. Bramley and Mr. Zavody and Mr. and Mrs. Gordon-Smith were placed first on 13th April, and Dr. and Mrs. Fooks and Mr. and Mrs. Gordon-Smith were placed fourth on 11th May. Our overall placing was second out of the seven divisions taking part in the League; our regular attendance gained us several bonus points. I should like to thank all the people who played for R.S.R.S., particularly Mr. and Mrs. Gordon-Smith who played in every match. The new Bridge season will start in the autumn and there will be no more fixtures until then.

Jean Fooks

LETTER TO THE OUTSTATIONS

Dear Colleagues,

You will have seen the Director's interesting account of the early days of ionospheric research, in which such an important part was played by Sir Edward Appleton, who died recently. Few of those concerned with the work of those exciting days now remain at Slough; but all who met Appleton agree in their recollection of a man of great gifts and pleasing personality who could associate happily with his fellow workers at all levels.

The transition from the old to the new regime continues smoothly enough - or so it seems. There are no comets seen, and the earth on which State House stands is shaken only by passing traffic. Meanwhile, back at the farm, the cattle crop the grass which is now the property of a Research Council.

Pleasant news of a former member of the staff. Dr. Pressey, who will be remembered by many of you, has been promoted to S.P.S.O. and appointed head of the Space Research Management Unit. He has congratulations and best wishes from us all not least from,

Yours sincerely,

The Editor