NRAO ONLINE 21 Pre-1950. Collaboration Cambridge-Sydney Eclipse 1947

Misunderstanding in 1946-1947 between RPL and the Cavendish over proposed eclipse expeditions to Brazil[1]

Wendt, Orchiston and Slee (2008, *Journal Astron History and Heritage*, vol 11(1), 171, "The Australian Solar Eclipse Expeditions of 1947 and 1949") have summarised the desultory interactions starting in August 1946. After extensive negotiation, neither the Cavendish of the RPL group went to Brazil in May 1947.

On 17 July 1946, Bowen wrote to the Executive Committee of CSIR in Melbourne with a suggestion that RPL might participate in an eclipse expedition to Chile in 1947 (later modified to Brazil due to more favourable conditions of the eclipse[2]) for observations of the structure of the sun at 600 and 1200 MHz and with Yagi aerials at 100 and 200 MHz. A major goal was to investigate the structure of the corona at a number of wavelengths as the moon covered the sun. The text included enthusiastic rationale:

> You are aware of the interest normally taken in eclipses by astronomers and ionospheric people. You are aware also of our own recent interest in noise from the sun and that have just communicated a paper on this subject to the Royal Society [McCready, Pawsey and Payne-Scott, 1947, based on the early 1946 data from Dover Heights, see Chapter 14.] Briefly, we have a new tool for astrophysical investigations and using it we have already performed most of the simple observations in a clear sky … [T]he occurrence of a total eclipse provides a unique opportunity for study of the corona, the region which we suspect is most active in generating radio noise.

A formal proposal was submitted to CSIR on 7 August 1946 to take the 16 by 18-foot dish from Georges Heights to Brazil in early 1947 for the May eclipse. The estimated costs were £2,500 for transport of personnel and equipment (latter would be about 3 tons, a volume of about 35 cubic metres). At this period, Bowen was in the UK and Europe. On 12 September, he wrote Pawsey from London with news that Ryle (of Ratcliffe's radio noise group) would go to Brazil in 1947 as part of the British expedition. Bowen would visit Cambridge on 21 September 1946 to give a talk on RPL radio noise research; he would begin discussions with Ratcliffe about Brazil.

[1] NAA C3830 A1/2/12B Brazil Eclipse

[2] In Chile the eclipse occurred early in the morning close to sunrise, not ideal for radio observations close to the horizon. In August 1946, more suitable locations in Brazil would be suggested in the state of Minas Gerais (south west of Salvador on the Atlantic coast). Possible sites were Curvelo, Montes Claros and Uberaba with distances from Rio de Janeiro respectively 600, 900 and 900 km. The final site (see below) was 20 km south of Bocayuva in Minas Gerais.

"We should … collaborate in every way and see that our own work is complementary or parallel …" The following week, Ratcliffe wrote Pawsey on 17 September 1946, before Bowen arrived:

> … I thought your paper [a preprint of the Royal Society publication of McCready, Pawsey and Payne-Scott of 1947] on solar noise was [admirable] . There have been so many people scratching at this subject and taking a few half-hearted measurements, and that is nice to see someone who has done it so thoroughly.
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> As you now know, we have embarked on a big programme of this kind … [There will] be a certain amount of overlap between us. I do not think there is any harm in this. The methods which we are using are in many respects very different. You gain your extra sensitivity by means of a larger aerial gain; Ryle gets it with his special integrating technique [phase switch, Chapter 19]. You do your "Michelson method for the diameter of the source" by using the reflection in the sea; Ryle does it by spacing his aerials. With the spaced aerial arrangement Ryle can find the polarisation; moreover he is not restricted to horizontal viewing [that is only at source rise or source setting]. He is not intending to concentrate on solar noise, but has ideas about ... exploring galactic noise.
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> He is intending to go to Brazil [in May 1947] to make measurements on the eclipse; I mentioned this to Bowen and he said you had begun to wonder whether you ought to make eclipse measurements as well. I think it would be a most valuable thing if you and he could meet in Brazil … I will arrange that Ryle sends you … a copy of his future programme … Including what he intends to do at the eclipse …
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> … [T]his question of the emission of radio wavelengths from the sun is such a big one that it needs several workers on it. I do not view with any more dismay the possibility of overlap here than I do in the case of ionosphere research … Now that Air Mail works so quickly (Ryle showed me your reply yesterday to his letter) we will make a special attempt to keep you fully in touch with what we are doing.

On 20 September 1946, Pawsey sent a succinct outline of the plans for Brazil to Bowen, still in London. On 3 October 1946, inquiries were sent to Thomas Cook in Sydney inquiring about shipping possibilities. In retrospect, an expected arrival in Brazil in early April 1947 was quite unrealistic given the complex nature of the organisation of shipping a three-ton cargo from Australia to South America in 1947.

On 24 September 1946 after Bowen's visit to Cambridge, Ratcliffe wrote Bowen expressing misgivings about the Cavendish Brazil expedition for the following year, a process stimulated by

Bowen's visit three days earlier. His letter did make rather stringent demands on their "colonial" colleagues. Ratcliffe:

> We are very anxious to get on with our work here in Cambridge and had only considered going to the eclipse in the belief that no-one else was likely to go. Now that Pawsey is going, Ryle would much prefer not to go but to get on with his Cambridge work. [Clearly a much less risky decision.] His decision to do this would be made much even more firm if he felt that he could suggest various points to Pawsey which Pawsey would then look out for during the eclipse.
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> I am anxious to make a decision on this point at the earliest opportunity and in order to do this I should like your assurance that Pawsey will definitely go and will make observations roughly of the type you described. In addition I should like to know whether … he will be willing to incorporate a few points which Ryle might suggest.

At the bottom of the Ratcliffe letter located in the NAA (National Australian Archive), Bowen agreed. He wrote in his distinctive scrawl: "Assurance given verbally [likely on the telephone] that construction plan would proceed."

A few days later (4 October 1946), Bowen wrote Pawsey from London with the latest news of the rapid loss of interest in the upcoming eclipse by their UK colleagues at Cambridge. "I believe Ratcliffe is rather glad to be relieved of the responsibility." On 11 October 1946, Pawsey prepared a more detailed plan, "Notes on Proposed Eclipse Expedition to Brazil 20th May 1947". The plan was strikingly devoid of details of the logistics of the expedition, such as the location in Bahai state and a realistic transportation scheme for the 3-ton shipment. In the light of subsequent events, the tentative time scale seems naïve [eg preparation of equipment October to Dec 15 1946, trials and packing of equipment 15 December to 21 February 1947, voyage to Rio de Janeiro 21 February to 7 April 1947 (with no known shipping dates) and journey to the unknown site (7 to 14 April 1947), setup and observations 14 to 20 May etc].

By 15 October 1946, Pawsey informed the CSIR Executive that the Cavendish astronomers would not participate "if they can be assured that CSIR will send one. [Ratcliffe] requests a positive answer as soon as possible to make definite plans and suggests that, in the event of our [RPL] expedition going alone, he would like to propose certain observations to be taken during the eclipse." Thus, Pawsey requested a rapid decision from the CSIR about the RPL project. A few days later (24 October 1946), Bowen wrote White (Executive Officer of CSIR) from Canada on his way back to Sydney from London with concerns about funding problems for the proposed Brazil project of May 1947 [Bowen to White]:

> I gather that there is some doubt about whether the eclipse expedition will come off either for technical reasons or because of the expense involved.
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> As far as the experiments are concerned, I have already indicated what a profound impression the Australian work has made in England and the US. There is no doubt that Pawsey is doing classical work which will be referred to for many years to come. The next essential step is to measure the apparent diameter of the sun's disk on different frequencies, and the only way I can see of doing this is during a total eclipse. It would be a pity if we lost the opportunity of doing this in 1947.
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> … [W]e should go to any length to overcome [financial problems] ... or even doing a little borrowing [!]. In my recent travels I have become forcibly aware of the fact that there is far too much money in the world at the moment and not enough achievement. I don't think we ought to cut the achievement for fear of spending hard cash.

On the same day (24 October 1946), Bowen wrote Pawsey with encouragement. He repeated his statement that RPL should "push ahead regardless of cost". He continued with a remarkable aside comment:

> A good reason for not going to Brazil would be if someone could think of a way of making the same measurement without using an eclipse. One way of doing this would be to construct a spaced [interferometer?] aerial on a large expanse of ground with a very narrow diagram and wide spaced lobes, but I do not know how practical this is.

As discussed in ESM_18.1.pdf, Exchange of letters, there was correspondence between Ryle and Pawsey in the period 28 October to 25 November 1946, mainly about the lobe and load switching schemes being developed by the two groups. In addition, Ryle pointed out a number of relevant details of the potential power of the future eclipse observations. A determination of the size and shape of the thermal component arising from the corona of the sun would be possible as well as the determination of the position and size of the intense, compact time variable sources associated with sunspots. Ryle called this "sunspot noise", now known to be mainly Type I bursts. The existing Cambridge data suffered from confusion if multiple sources were present. Ryle wrote on 28 October 1946:

> If there are any suitable spots at the time of the eclipse it should be possible to determine the source diameter even though it be of order [6 arc sec in size]: it is only necessary to ensure that the response time of the apparatus is sufficiently rapid. [3]
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> … I am very sorry not to be going to Brazil, especially as it would have meant meeting you [perhaps implying they had not met earlier] and your party, but I am afraid we just have not the effort to make a good show of it without stopping all our work here.

On 31 October 1946, Pawsey gave Ratcliffe at Cambridge an update on progress in Sydney. There was no news regarding approval from the CSIR but RPL were assuming that the trip would be funded. He asked that the Cavendish observe the sun from the UK on the day of the eclipse in Brazil. The eclipse observations would be enhanced:

> … [I]f records could be taken simultaneously at a place with the region of totality and at one well removed. England provides a suitable place out of the region. Would it be possible to have records taken … at suitable frequencies?
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> You mentioned to Bowen that Ryle proposed to cancel his trip if we went also that, in this event, he had some observations … [that we could make for him.] I should be very willing to collaborate … I suggest that you and Ryle make any proposals you think fit. [We will do our best to do these, even though we have a full programme during the eclipse.]

Finally on 14 November 1946, the CSRI Executive approved the project. As we will see below, the delays with finance, approvals from the Brazilian government and especially the preparation and testing of the equipment had serious and fatal consequences for the project. The RPL group was late by 2-3 months to insure a workable timescale. The Australian Legation in Rio de Janeiro had begun to warn RPL in November about their tight schedule. The Australian diplomats insisted on an accelerated schedule; for example their suggested departure time for the equipment was 6 January 1947 compared to the original planned departure on 21 February. To add contingency to the planning they suggested the departure be by late December 1946. Thomas Cook travel service remained vague concerning shipping times and routes (eg through the Panama Canal or to San Francisco). In early December 1946, RPL enlisted the assistance of Lewis Lewis and N.A. Whiffen of the Scientific Research Liaison Offices in London and

[3] During the eclipse of 1 November 1948 observed in Australia, Christiansen, Yabsley and Mills (1949) found that the typical size of the radio sources at 50 cm wavelength associated with sunspots was about one arc min size.

Washington; a new proposal was made to ship to London with one freight line and then move the cargo to another steamship service for the final transport from the UK to Rio de Janeiro.

The choice of the site for the Australian expedition was still uncertain on 5 December 1946; possible sites in Minas Gerais and even a site north of Sao Paulo (west of Rio de Janeiro) were suggested. The favoured site was at Pirapora near Montes Ciceros (170 to the southwest) in the state of Minas Gerais. The location was 780 km north of Rio de Janeiro and 900 km from the Atlantic Ocean. On 13 December 1946, the SRLO personnel in Washington had preliminary discussions with the National Geographic Society about the Australians joining them at Bocaiuva also in the state of Minas Gerais, 170 km to the east of Pirapora.

With all the delays and underestimated delivery times, it is no surprise that by the next week the RPL were forced to cancel the mission; the time scale was underestimated by 2 to 3 months. The major issue was the transport problem. Bowen Carroll of the Admiralty on 9 January 1947: "… Our equipment is in an advanced state of preparation but the transport is such that we cannot get from Australia to Brazil in sufficient time to achieve useful results." By late December 1946, it became clear that the route through London would have only worked if the equipment left Australia during December. Also, the trans-shipping in London from one company to another would likely not have been possible. Finally, they had been advised that "the depressing picture of customs and internal transport" situation in Brazil was a major problem. A solution would be that the Australians would have been forced to send an officer by air to await the arrival of the large 3-ton shipment in Brazil.

On 28 January 1947, Whiffen from the Australian Embassy in London wrote Bowen in a tone of subtle criticism:

> I wish that you had taken the hint in my cable and suggested that arrangements be made to include your party with either the American or British Expedition [which never came to Brazil due to a severe plane accident in Dakar in West Africa]. From what I have heard, the American army transport plane would have flown most of your necessary equipment from Australia, and, at same time, you would have been provided with a camp site already fitted with power supplies, drinking water, etc. In view of the other expeditions proceeding to Brazil in this connection, I do not feel that you would have been held up for any length of time for customs and internal arrangements.

The correspondence between Pawsey and colleagues at the Cavendish in Cambridge, Ratcliffe and Ryle, continued in January and February 1947. Ratcliffe wrote on 6 January:

> … I am … sorry to hear [the news of the cancelled venture] because we were looking forward to some valuable results from your expedition. Ryle has got continuous recording going on two frequencies [80 and 175 MHz] simultaneously and is getting some most interesting results.[4]

On the following day in Sydney (7 January 1947), Pawsey wrote Ryle and Vonberg, thanking them for a preprint of their *Nature* letter of 7 September 1946 ("Solar Radiation on 175 MHz", see Chapter 19 and NRAO ONLINE 20): "You will have heard from Ratcliffe that we have been obliged to cancel our proposed Brazil expedition because of transport difficulties. I sincerely hope that our change of plans after your decision to abandon your trip will not seriously put you out."

Ryle replied over a month later on 15 February 1947:

> I was sorry to hear that you had to abandon the eclipse expedition, but your decision did not worry us unduly, as I doubt very much whether we could have made a worth-while expedition in the time available. Things seem to move very slowly here, particularly at the moment when we are without power in the Laboratory. We do, at least, however, manage to get the apparatus going between 12 and 2 each day, which gives some idea of what goes on. We are getting some quite interesting information on the slow variation of solar variation which looks like showing a solar rotation period, and we hope to write some of the recent ideas up soon.

In the end the only successful radio observations of the 20 May 1947 eclipse were made at sea. The US expedition from the US Naval Laboratory by Hagen and colleagues (see Sullivan, (2009), *Cosmic Noise: A History of Early Radio Astronomy*, Cambridge University Press, Cambridge, UK, p 205 and 207, Hagen, 1949, see CN page 512 for the reference) observed at 3.2 cm from a small US Navy ship near the equator about 2500 km northeast of the coast of Brazil using an 8 foot dish.

The Soviet expedition to Brazil was also successful. Wendt et al (2008) summarised:

> The 1947 total eclipse was ultimately successfully observed at 200 MHz by a Soviet expedition that used the steamship *Griboedov* as an observing platform … Their observations confirmed that a significant proportion of the radiation at this frequency originated in the corona, something that was independently predicated by Ginzberg [a

[4] Ratcliffe also mentioned that he was looking forward to Pawsey's visit to the UK in 1948 (see Chapter 17).

member of the Soviet expedition in 1947, along with Shklovskii in 1946), but was unknown to Radiophysics staff at that time.

Sullivan (2009, CN p 205 and p217-219) provided details of the Soviet expedition with a photo of the 200 MHz dipole on the ship; the azimuth of the aerial was changed during the eclipse by raising and lowering special anchors and also adjusting lines thrown to the shore. A thorough account of the 1947 events in Brazil are presented by Salomonovich (including four photographs, "The First Steps of Soviet-Astronomy" p 269 in *The Early Years of Radio Astronomy, Reflections Fifty Years after Jansky's Discovery,* Sullivan, W. T., III. (1984) Cambridge University Press).