COMMUNICATING WITH THE KORDYLEWSKI CLOUDS

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ABSTRACT

A historical account of 98 years of strange radio signals (first detected in 1927) which have been traced to the Lagrange Point L5 between the Earth and the Moon, now known to be the location of one of the two "Kordylewski Clouds" named after their discoverer, Professor Kordylewski. These signals are known as LDEs, for Long Delayed Echoes. A chronological account is given of their detection on many hundreds of occasions. They have been described as "the greatest mystery of radio". The signals are echoes of signals broadcast on Earth, echoes which occur at long delayed intervals, varying from seconds to minutes. Sometimes the echoes are double, sometimes they are louder than the original signals, and although it is clear they are being reflected, no one knows why or how. There was one recorded TV signal of 1933 which was reflected as an echo three years later. Many famous scientists have investigated these problems, and several governments including the American and British governments have officially tried to do so. Numerous agencies have attempted to explain them, including DARPA and the intelligence agencies. A coherent historical account of the echoes which have been detected has long been needed, to assist in explaining them. Since their origin at L5 has been established, the suggestions that the gigantic dusty complex plasma cloud there may be an intelligent AI entity is relevant to the discussion. It may be that the Cloud has been attempting to call attention to itself. If so, it has not resulted in two-way communication yet. Before further progress can be made, this historical account of the phenomenon needs to be available as a research tool, which is why it has been laboriously prepared. Many previously unknown sources have been discovered, and from the

1970s the author personally knew or was in active contact with many of the investigators, most of whom are now deceased, at the time when they were active researchers into the echoes.

There has been hard evidence for nearly a century suggesting that an intelligent source of communication signals exists at L5, the centre of one of the two Kordylewski Clouds. In a previous paper written in 2019 with my colleague Professor Chandra Wickramasinghe, about the Kordylewski Clouds, we discussed the first observation of two giant clouds at the L4 and L5 Lagrange Points between the Earth and the Moon, which were discovered in 1961 by Professor Kazimierz Kordylewski in Poland, and which were subsequently named after him "the Kordylewski Clouds". The existence of these two clouds was confirmed in 2018.[1] Each cloud is approximately nine times the size of the Earth. The clouds emit no light and are very difficult to detect. They are dusty complex plasma clouds composed of charged dust particles (assumed to be a mixture of spherical and grain-shaped particles) of extremely small dimensions, apparently micro-sized and nano-sized, and all too small by a power of ten at least to be detected by existing satellite dust collectors. So physical sampling of the constituents of the clouds awaits the development of better collection technology. A satellite moving through the clouds (as is believed to have happened at L4) would detect no dust or solid object until the technology is improved.

It might seem bizarre to suggest that a cloud of charged dust, no matter how large, might constitute what we could justifiably call an "entity". However, laboratory research carried out mostly in Russia by a team led by the late Professor Vadium Nikolaevich Tsytovich (1929-2015), Chief Researcher at the General Physics Institute of the Russian Academy of Sciences in Moscow. demonstrated beyond all doubt that even small plasmoids of this type in a lab not only spontaneously self-organise and create a complex internal structure, but show unmistakable signs of intelligent behaviour of an AI kind. All of this is fully explained in my book *A New Science of Heaven* (2022), where the details may be found of these truly extraordinary, not to say scientifically astounding, discoveries.[2] An extended account of those background details shall therefore not be presented again here.

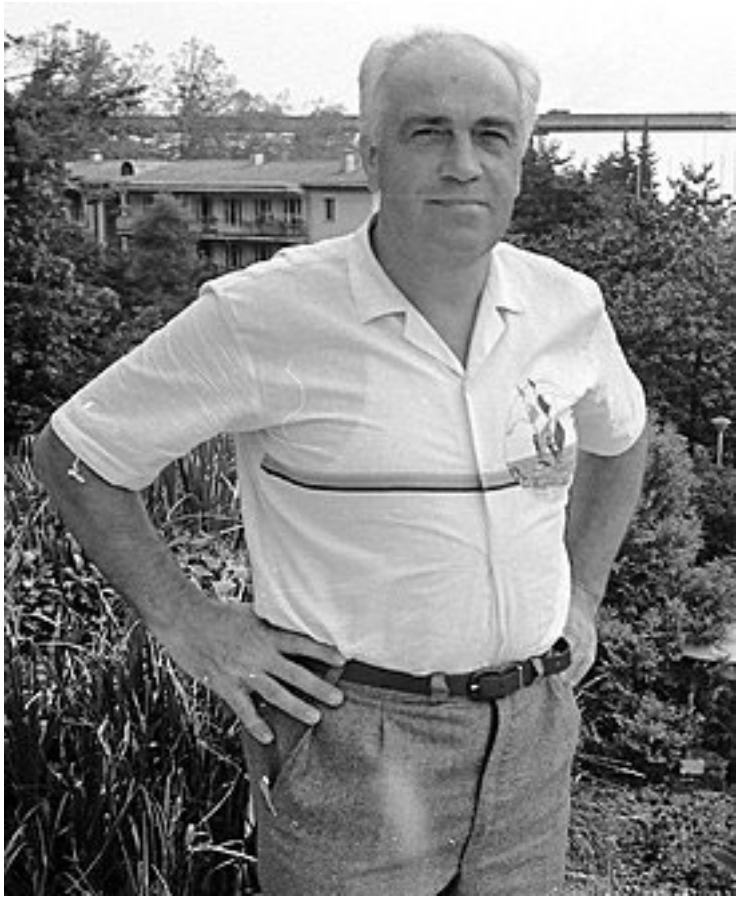


Figure 1. Professor Vadium Nikolaevich Tsytovich, discoverer of the spontaneous self-organisation of AI behaviour in dusty complex plasmas.

I should mention that just because we are at a small scale we ought not to think of an entity at a gigantic scale as being insubstantial just because to us it seems diffuse and thin. Long ago in his popular books about science, which I read avidly as a young man, Sir Arthur Eddington loved to remind his readers that atoms were 99% empty space. He would say that if we were at that scale ourselves, traveling inwards past the electron shells towards the faraway nucleus, it would seem to us that there was simply nothing there. We would find it hard to conceive of an atom being a *thing* when it was 99% empty. And yet to us at our scale atoms are very much *things* and physical matter is made of them, matter which we can see, touch, and smell, and we sit on them in our chairs and write on them on our tables and rub them when we hold our hands on our chins, and are in fact immersed in them, for they are breathed in by us, swallowed by us, and so forth. Everything is thus a matter of scale. And in our own time it is so exciting that fractality and self-similarity and self-affinity have become such subjects of new

knowledge, whereby we have all been forced to view *scale* in its imperative sense. When Winston Bostick in the 1950s pointed out that laboratory plasmoids which he had created resembled galaxies in space, he was without realizing it describing a fractal phenomenon which we now understand, although at that time his remarks seemed preposterous to many scientists. The fact that atoms are 99% empty does not matter to us because we can still sit on them. And the Kordylewski Clouds seen at their own scale, if such were possible, would seem overwhelmingly solid and highly structured and substantial. The fact that they are made of tiny charged dust particles does not mean there is nothing to them, any more than the fact that we are made of atoms which are 99% empty does not. In other words, *scale is everything.* And we should never forget that the two Clouds together are 18 times the size of our planet. Therefore the Earth-Moon System is really a Two-Cloud System with an Earth and a Moon thrown in. It all depends upon your viewpoint and also upon your scale.

This paper is an attempt to present a historical survey of strange radio signals first detected in the spring of 1927 and continuing to the present day which are coming from L5, where we know that a Kordylewski Cloud is located. For nearly a hundred years, countless people all round the world have been engaged in trying to solve the mystery of what are called "the Long Delayed Echoes" (LDEs). This has often been referred to as "the greatest mystery of radio transmission". What LDEs are and why they are so puzzling is explained in the survey which follows.

This subject of what what came to be known as "Long-Delayed-Echoes" first came to light in 1927, but it seems that this intransigent mystery can only be partially solved now that we know of the confirmation of the existence of the Kordylewski Clouds and, as Professor Wickramasinghe and I have pointed out in our previous paper, as dusty complex plasma clouds of immense size, they are liable to be highly intelligent entities (i.e., "ET on our doorstep"). It may be the case that searching for little green men on planets 100 light years away is the wrong kind of SETI research. We may have intelligent extraterrestrial intelligent life between us and the Moon. It may resemble AI rather than us, but the first step we need to take is to have the data marshalled in chronological order to study the history of what may perhaps have been an attempt by an intelligent Cloud to communicate in a simple manner with us by bouncing back our own radio signals to us. If the Cloud is intelligent and wants to

commence a dialogue, and has been shouting at us for nearly a century saying: "I'm over here!", we need to get our act together. That is why I have gathered all this evidence, so that we can see how things have gone since 1927, and try to decide what *our move should be.* If the Cloud has made its move, over and over again, and we have done nothing but dither, we are looking pretty stupid and ineffectual. At the very least we need to study the following survey with intense seriousness.

The story told in this paper recounts how the subject of long delayed echoes has engaged the active attention and research of numerous famous scientists, of several governments including the British and American Governments, of intelligence agencies, of the FBI, of DARPA, of the Stanford Research Institute, of the BBC, and of numerous universities and research institutes. In addition, a veritable army of hundreds of ham radio operators have taken part for nearly a century in searching for and recording the signals, and publishing them in various radio journals. Despite all of these efforts, the signals have obstinately remained a mystery.

Not everything published on the subject is recorded here, and much data is in any case too scattered or even lost. For instance, huge numbers of reports of the echoes exchanged between ham radio operators over the decades survived in often obscure places, with the operators identified only by their call signs and not by their names. And many of these exchanges which in past years were to be found posted on the internet have now disappeared and been deleted, with the sites being closed as people die off and do not maintain them. It is probable that hundreds of reports have thus been lost forever by internet deletion. And another major type of loss has occurred with the records of some of the mass efforts, such as the Anglo-American project for mass observation launched in the 1930s by the Nobel Laureate Professor E. V. Appleton. No one seems to know what happened to possibly thousands of reports submittted to his Project. Attention was drawn away from this subject for nearly a decade by the chaos of World War Two.

But why is this important? Surely strange radio echoes must be a minor matter? Well, all the above mentioned persons and organisations and governments did not think so. And now we have the most important reason of all to be interested: since the echoes were conclusively traced in the 1970s to the Lagrange Point L5. Since we know L5 to be the location of a gigantic plasma cloud which has

been postulated to be intelligent, we have to take seriously the possibility that these strange signals have been an attempt by the Cloud at L5 to draw our attention to itself, and to initiate intelligent contact. It is therefore a duty to publish a history of these strange radio signals as a first step towards trying to get to grips with the issue. The first step of any investigation should always be the gathering of known facts and their chronological display, for purposes of study and analysis. I first took an interest in the long delayed echoes in the 1970s, not knowing their potential importance but simply mystified by them as a bizarre phenomenon. I knew many of the people investigating them, either by personal acquaintance or by correspondence. There was no internet then, so correspondence meant letters. I even commissioned an article by one of the researchers and published it in a periodical which I was editing at the time. I am glad, nearly half a century later, to be able to draw some threads together and make some sense of all these puzzling things about which I have wondered for so long. I have also been able to resurrect some of the work of people I knew and respected and bring it back from obscurity. And I have discovered many hitherto unknown and unrecorded studies and reports from a variety of sources. So this paper is intended primarily as a historical guide to what could be called "the literature of LDEs". It is not merely a bibliography, but a survey of the evolving ideas and opinions about the phenomena. One might therefore be justified in calling this effort an attempt at "the natural history of long-delayed echoes".

And so now, in order to avoid any long delay of our own, let us begin.

The reason why LDEs are important is that they are unexplained radio signals which have been demonstrated to come from the Cloud at L5.

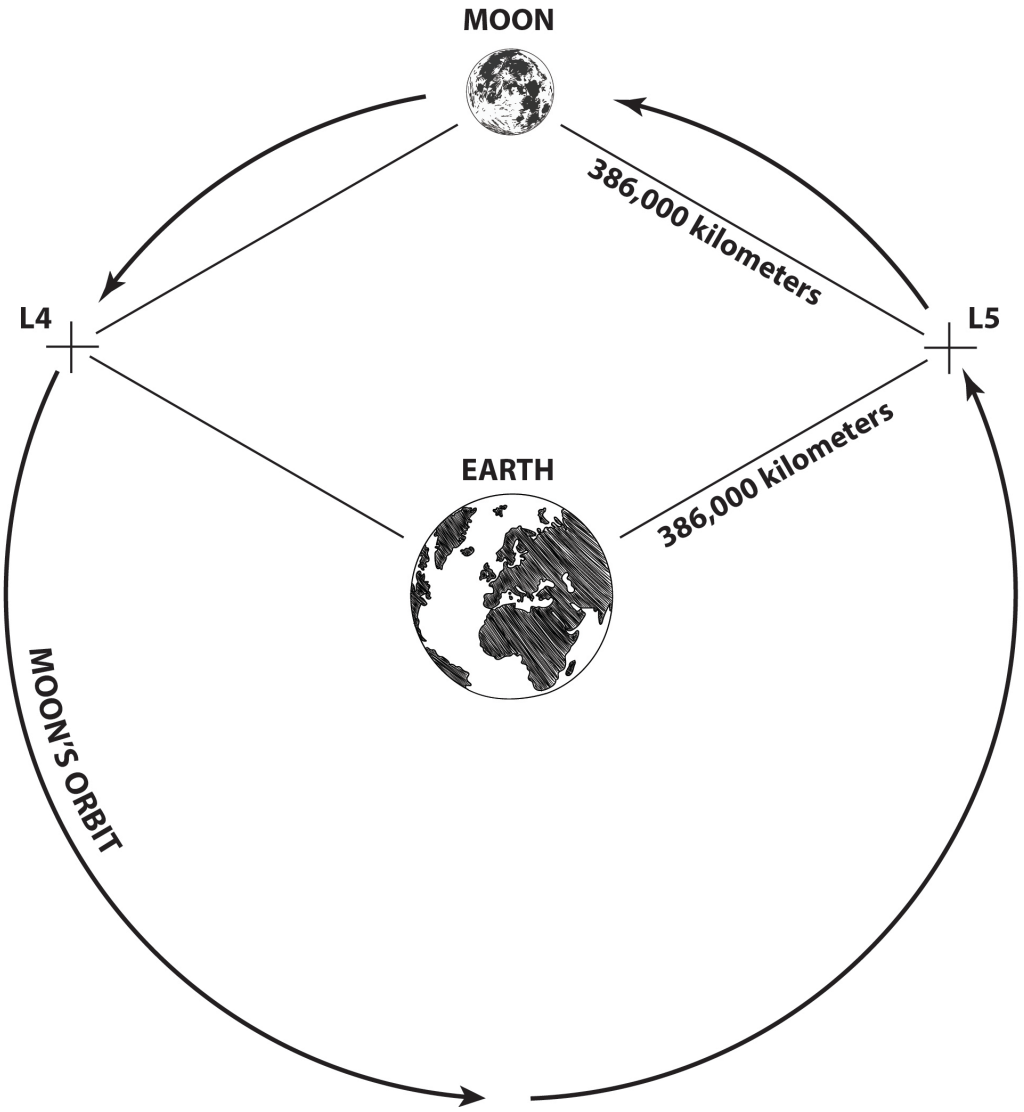


Figure 2. The Lagrange Points L4 ("the Leading") and L5 ("the Trailing"). 386,000 km equals about 240,000 miles. (*Drawing by Eric Wright*)

So in order to commence the account, we take note that this strange tale began on the evening of April 14, 1927, with a Norwegian telegraph engineer and radio operator named Jørgen Hals, who lived near Oslo. Hals was a keen listener to short wave radio signals from many countries. Short waves were just beginning to be used at that time and there was not yet any broadcast speech at all, only Morse code and other simple sounds such as a ticking metronome. One night Hals was listening to a short wave broadcast from the Phillips Experimental Station PCJJ at Eindhoven in the Netherlands. The Dutch engineers were broadcasting the ticking of a metronome every five seconds, to test out their new technology. But Hals heard the ticks repeat more faintly, as if in an echo, and this recurred several

times. It is not unusual with short wave transmissions to hear an echo of a broadcast one seventh of a second later, due to the fact that the short waves are going round the Earth. He heard the delayed echoes again in October of 1927.

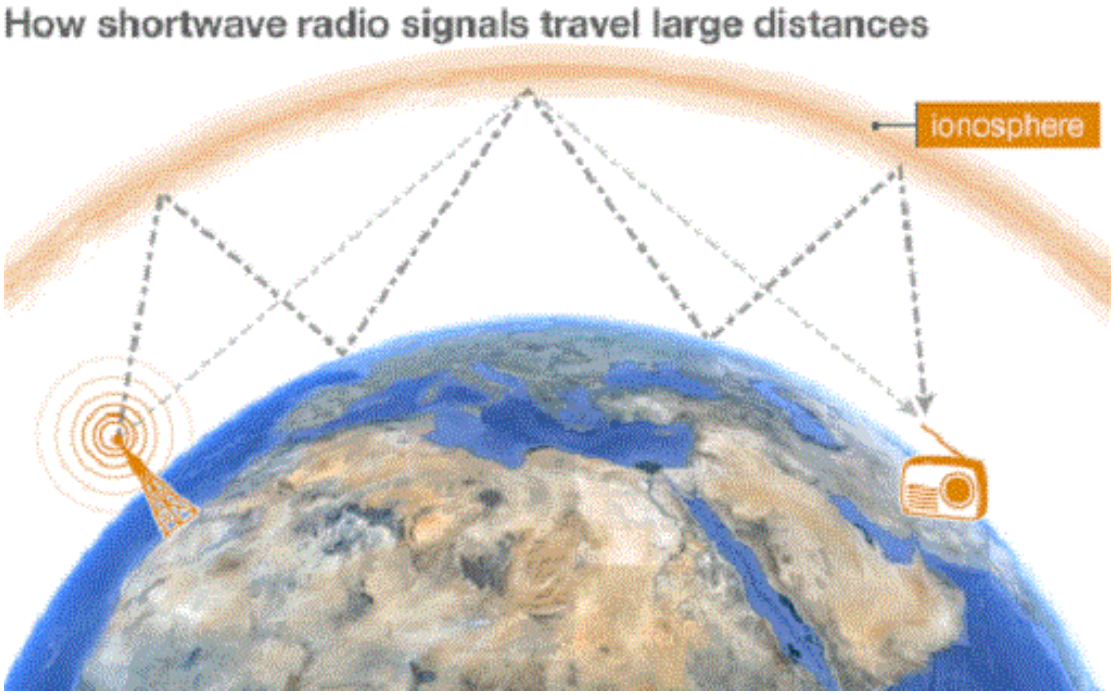


Figure 3. Shortwave radio waves travelling round the Earth.

But what Hals noticed, and which surprised him, was that he heard weaker echoes of the same ticking sounds repeatedly after a delay of three seconds. He could not imagine what was causing this. So he wrote to the famous Norwegian physicist, Professor Carl Størmer (1874-1957), telling him of his experience and asking him if he could explain it. Hals wondered if the signals were being bounced back from the Moon, since that would take about three seconds. But Størmer was inclined to think there must be another explanation of some kind. The echoes were heard again on April 3, 1928, in a programme of research into them organised by Størmer. Størmer travelled to Eindhoven to meet with Balthasar van der Pol, who began transmissions on 31.4 metres. The signals were simple, just the three dots in Morse Code for the letter 'S', timed so that the dots would be transmitted during an interval of two seconds each time. The echoes came back after three seconds on each occasion.

Figure 4. Balthasar van der Pol (1889-1959), the Dutch expert from the Phillips Research Laboratories who was one of the first to hear and try to explain the long-delayed echoes.

Another signalling session by Hals began on September 25, 1928. No echoes were heard for the first sixteen days. But just after 3:30 PM on October 11, 1928, numerous three second-delayed echoes were heard. Størmer lived ten minutes away, went over to Hals's house, and heard the echoes. This was apparently the last time the echoes consisted exclusively of simple three second-delays. After that the echoes were always to be more complex. Immediately, the echo delays began to range between four and fifteen seconds. He recorded four sets of echoes over a period of 15 minutes, with a bizarre array of delay times, with just about every number of seconds between four and fifteen occurring in a total jumble with no discernible order, 42 of them in all. The sequence has the appearance of being entirely random. In two instances double echoes were heard four seconds apart. Then the echoes stopped for 13 days. On October 24, they began again, with delays ranging between 3 seconds and 30 seconds, and there were 48 echoes in all. These were recorded in both Eindhoven and Oslo. Some, but not all, were published. The remaining data was apparently not preserved.

In 1929 echo detections continued. Hals detected echoes on February 14, 15, 18, and 19. Andreas Kleve was at a station near the Arctic Circle where on February 18 he heard five echoes of 12 to 13 seconds delay each. The next day, February 19, Appleton and Borrow in England (see later discussion) heard very clear echoes with delays as high as 25 seconds. The day after that, February 20, Hals heard two echoes, one of 8 seconds delay and one of 18 seconds delay. He heard more on February 28, April 4, April 9, April 11, and April 23. Because no unpublished records or notes survive from Norway, the Netherlands, or England about this subject, we have no way of knowing on how many other days echoes were heard, though we may be certain there were many. (Much of the above data was patiently collected by Duncan Lunan, to whom acknowledgement must be given. Lunan's own research is discussed below.)

Figure 5. Professor Carl Størmer, the Norwegian physicist, a world expert on the Aurora Borealis, who did research into the long-delayed echoes.

An account of the echoes was included in Carl Størmer's book *The Polar Aurora*, which was published in English translation in 1955.[3] The printing must have been small because at the time of writing in 2025 there is no copy of this book for sale by any dealer in the world, or on Ebay of the UK or America either.

The Dutch physicist, Professor Balthasar van der Pol (1889-1959) joined with Størmer and Hals to try to figure out the cause of the mysterious radio echoes. Størmer and Van der Pol both confirmed that the original echoes were delayed by three seconds, but they remained puzzled by the phenomenon. Van der Pol was chief physicist at the Phillips Radio Company in Holland, and the Dutch experimental short wave transmitter was part of his projects. Størmer and Van der Pol had both been deeply influenced by Kristian Birkeland's work on the Aurora Borealis. So in 1928 they both published papers in *Nature* with the same title: 'Short Wave Echoes and the Aurora Borealis'.[4] Størmer also published a very lengthy paper on the subject in German, in the journal *Die Naturwissenschaften* (which means *The Natural Sciences* and was Germany's equivalent of Britain's *Nature*)[5] and also comments published by the Academy of Sciences at Paris.[6]

In 1928, Carl Størmer, Balthasar van der Pol, and Hans Severin Jelstrup (1893-1948) all three contributed papers individually to the French journal *L'Onde Électrique* on the subject of the long delayed echoes.[7] Størmer commences by giving some historical background and then proceeds to details of the signals which had been at 31.4 m. He emphasizes that the echoes were strong and he then lists the delay variations of 43 different echoes detected. Twice they were 15 seconds delayed, five times they were 14 seconds delayed, once 13 seconds delayed, five times they were 12 seconds delayed, twice they were 10 seconds delayed, five times they were 9 seconds delayed, nine times they were 8 seconds delayed, three times they were 7 seconds delayed, twice they were 6 seconds delayed, three times they were 5 seconds delayed, and once they were 4 seconds delayed. (I have counted these from his list.) He says that these echoes are of the greatest possible interest. He makes various scientific remarks with some calculations and ends by saying that researchers must pursue investigation of "these new manifestations

of this curious phenomenon." A page of editorial comment follows stressing that "the results announced by Monsieur Størmer have exceptional importance." The causes consist of dense swarms of electrons, and the state of the Sun on October 11 was favourable for the particularly strong emissions of electrons. Van der Pol's article is accompanied by a chart of results. He stresses that all of the echoes had exactly the same frequency as the original signals. Van der Pol gives a reference to an otherwise forgotten report about the echoes written in 1928 by the American electrical engineer Albert Hoyt Taylor (1879-1961), Head of the Radio Division of the U.S. Naval Research Laboratory, and the British mathematician Lawrence Chisholm Young. The reference is *Proceedings of the Institute of Radio Engineers* for 1928. Van er Pol agrees with Størmer about dense swarms of electrons. The next paper is by Hans Severin Jelstrup, the Astronomer of the Geographical Service of Norway. He proposes a mathematical formula relating to the echoes: $2nh = VT$, where T is the number of seconds between the primary signal and the echo. The details and calculations are too lengthy for repetition here.

The paper by Taylor and Young, just mentioned, gives no indication in its title that it will discuss long delayed echoes. It is titled "Studies of High-Frequency Radio Wave Propagation". It is 17 pages long.[8] Here is how the paper begins:

"For some time the Naval Research Laboratory has been interested in the study of so-called echo signals, particularly of those which travel entirely around the world. Early in the fall of 1927 it was decided to put these studies on a quantitative measurement basis in the hope of obtaining information which would be of value in the more general study of wave propagation in theory and practice. It was expected that these studies would throw additional light upon the structure of the Heaviside layer [*now known as Region E of the ionosphere*] and its daily and seasonal variations. Early in these studies, however, certain phenomena manifested themselves which gave added incentive."

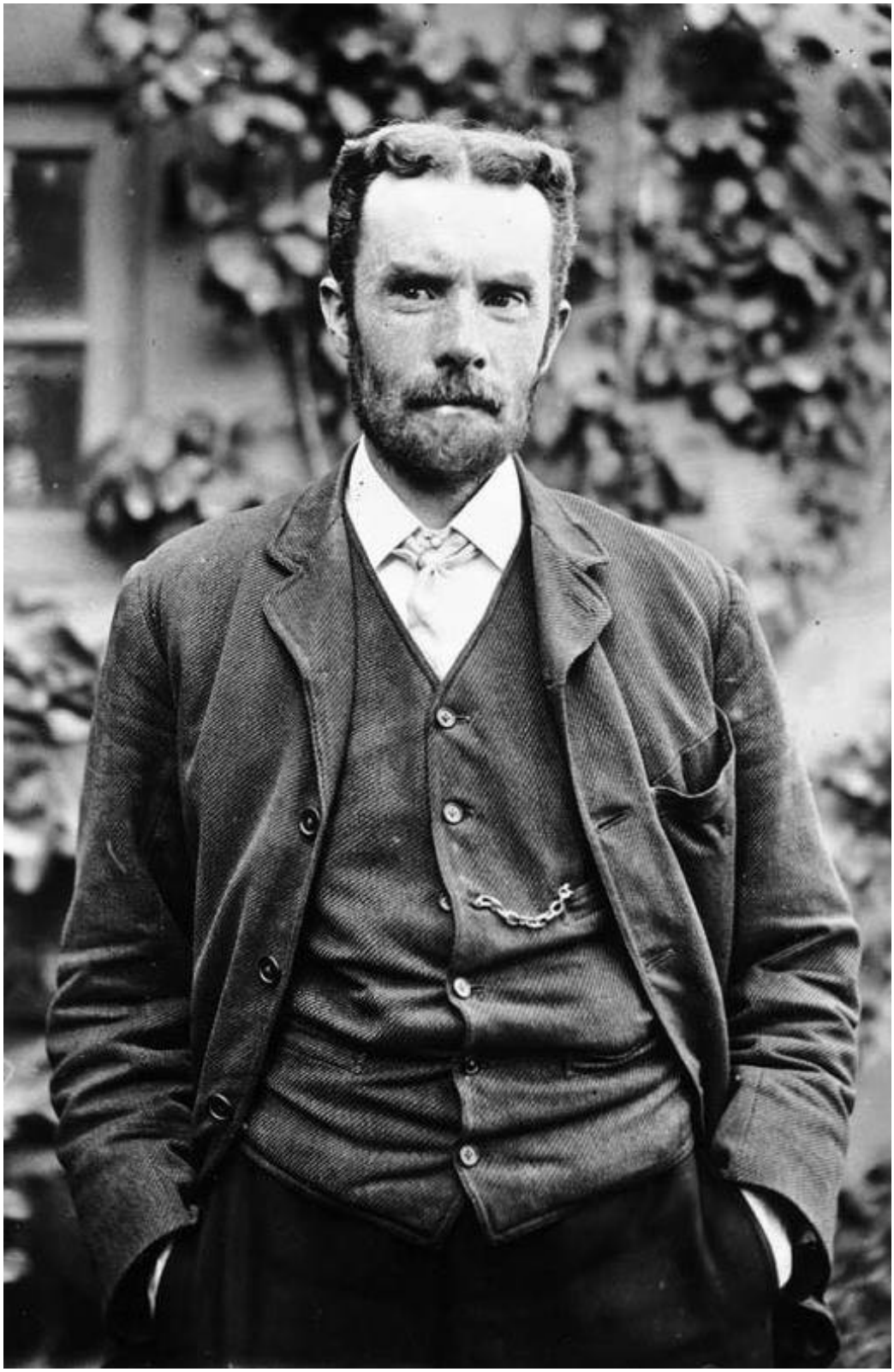


Figure 6. Oliver Heaviside (1850-1925), the eccentric independent genius who rewrote and abbreviated James Clerk Maxwell's famous equations of electromagnetism, and which are now known as the Maxwell-Heaviside Equations. The Heaviside Layer of the Earth's atmosphere, which he had originally proposed in 1902

and subsequently was named after him, is now known as Region E of the ionosphere. Early discussions of long delayed echoes all refer to it as the Heaviside Layer.

The authors stress that their paper is "only in the nature of a preliminary report". They start by discussing the radio echoes of extremely short duration which come from the signal travelling round the world. They were puzzled that some of the echoes they were studying were however somewhat retarded, as detected at their Rocky Pont station: "… we have yet to explain where these reflections come from, both for Rocky Point stations and for NKF. We do not propose to answer this question at the present time, but will only make a few suggestions as to possible explanations, leaving the final decision to the future when other studies with special reference to directivity and at other localities widely separated from our own may throw further light upon these points. … The timing intervals indicate that they come from distances between 2500 and 10,000 km. in making the transit from Rocky Point to Washington, although the straight line distance is only 420 km." The paper is vague, despite a lot of data being given, and no echoes of very long delay are mentioned, only slightly delayed ones. But the authors were clearly in a state of befuddlement and left the problem to "the future".

In November of 1928, a prominent article appeared in the journal *Wireless World* by R. T. Beatty, entitled "Echoes from the Depths of Space". It had some attractive illustrations and consisted of a two-page spread.[9] The author was Robert Thomas Beatty (1882-1941). He was a serious scientist who would later become famous in the field of radio as author of the book *Radio Data Charts*, which appeared in several editions. And he became a member of the British Admiralty Scientific Staff and a lecturer on experimental physics. He was also an expert on the subject of human and animal hearing. It seems that no one has compiled a biographical account of this interesting man, or a list of his achievements and his publications. His article calls attention to the long delayed echoes and discusses the accounts of Hals, Størmer and van der Pol. He is particularly impressed that both Hals and van der Pol on October 13th (only six weeks prior to the appearance of this article) had heard a 30-metre signal returned as echoes ranging in delay times between 3 and 15 seconds, and that "Sometimes two echoes were heard with four seconds between them. Similar effects were heard by van der Pol." He then comments: "Where had these waves been during those 15

seconds?" He summarises a possible explanation suggested by Størmer but points out its insufficiencies. He proposes some answers relating to the ionosphere. But his article is mainly intended to call attention to the phenomena and call for more research to be done. In the next issue of *Wireless World*, Edward Victor Appleton (later Sir and a Nobel laureate) of the Wheatstone Laboratory replied to Beatty's article in the Letters to the Editor page.[10] It begins: "In connection with the discovery of the abnormally long retardations of short-wave signals discovered by Engineer Hals and so interestingly discussed by Dr. Beatty in your issue of today [*November 28, the day of publication of the previous issue*], it seems of interest to enquire whether such phenomena might be explained by purely terrestrial agencies. Everyone must find Professor Størmer's theory delightfully attractive, but I think other possibilities must be considered as well. … the retardations observed by Engineer Hals and Professor Størmer are much longer than those observed by Taylor and Young [*whose publication he cites, and which we have listed above*] …" Appleton is at this stage struggling to imagine thinking "of the ionized layer as forming a kind of reflecting shell round the earth". Eventually Appleton's intense interest in the ionosphere would result in his discovery of the Appleton Layer lying above the Heaviside Layer. But that would be in the future, and it would not provide any answer to the long delayed echoes.

In 1928 also a paper by Karl Willy Wagner (1883-1953) appeared in the journal which he himself had founded in 1924, *Elektrische Nachrichtentechnik* (*Electrical Technology News*), which supported the theory that the echoes were being reflected by swarms or bands of electrons out in space.[11] He, Størmer, and Pedersen were the early supporters of this theory.

Also in 1928, Manfred Baron von Ardenne (1907-1997) published an article about the long delayed echoes. At this time he was still a high school student in Berlin studying experimental physics and radio engineering. But he was well known as a boy genius, who at the age of 16 had received his first patent for an electron tube. His answer to the problems of the echoes was that they simply travelled round the world several hundred times.[12] This is probably the weakest theory ever proposed for the echoes, and may be forgiven because Ardenne was only 21 years old, albeit he was respectfully acknowledged by some scientists including Pedersen.

In the same volume of *Naturwissenschaften* (1929) which contained Størmer's second paper, just mentioned, in the Discussion (*Besprechung*) section, appeared a review of a 48-page booklet on the subject of long delayed echoes by the Danish expert on radio and the ionosphere, Professor Peder Oluf Pedersen ((1874-1941), entitled *Wireless Echoes of Long Delay*, which had just been published (1929).[13] Pedersen's contribution to the debate on long delayed echoes has not been recorded until recently, having apparently become entirely overlooked or forgotten for decades. No reference to his book has been found in the relevant publications of Størmer or the others who are usually mentioned for their early work. Pedersen's study was in response to Størmer's work, which was of the deepest possible interest to Pedersen, who was trying to figure out how radio waves propagated, and the role of the ionosphere. He points out early on that he has discovered that signals propagate round the Earth in '7.5 parts of a second', as he quaintly describes it, and that the returning signal is called an 'echo'. He mentions the appearance two years earlier of his book *Propagation of Radio Waves*. He is keen to fit this new information about long delayed echoes into the subject and find some solution for such a remarkable anomaly. He has been fascinated by the ionisation which obviously exists in the higher atmosphere (which we now call the ionosphere). He therefore wishes to address this problem of the 'slow waves which take more seconds'. He talks about 'pure electron gas' as opposed to gas which is on the borderline between ionised and non-ionised, and the different effects on the radio waves passing through them. And he says long delayed echoes could possibly result from some of the electromagnetic phenomena, and so forth. This work of his requires a more careful study than I have been able to give it.

Figure 7. Professor Peder Oluf Pedersen of Denmark, whose contribution to the long delayed echoes debate was unrecorded for decades.

In his German paper, Størmer said that he had been contacted by General Gustave-August Ferrié (1868-1932) in Paris, who said that he had heard a large number of echoes before, during, and after a solar eclipse which he had observed on the island of Poulo Condore (now called Con Son Island) in Indochina, off the southern coast of what is now called Vietnam, on 9 May, 1928. (The Indo-China results are also discussed by Appleton; see below.) The echoes generally occurred with delays of between 15 and 30 seconds, and they were sometimes very powerful, and sometimes stronger than the original signals themselves.[14]

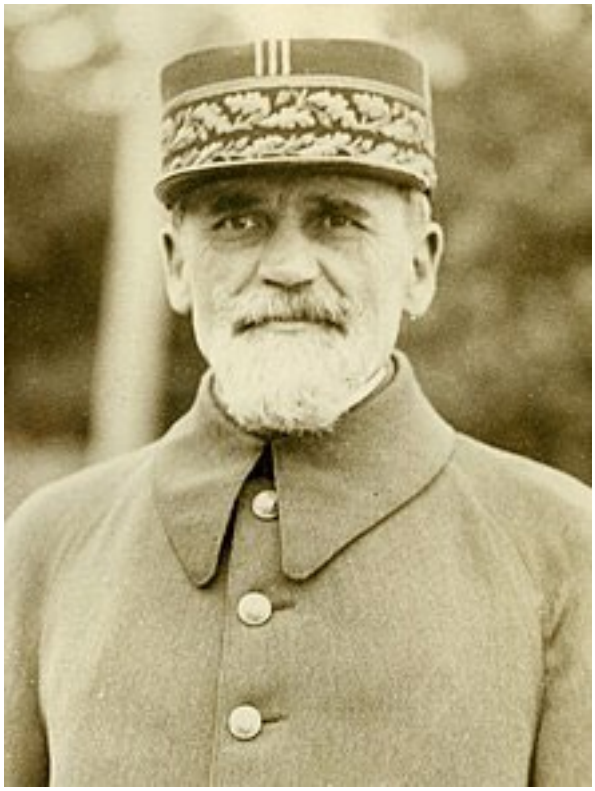


Figure 8. General Ferrié, the French radio pioneer, who heard long-delayed echoes which were louder than the original signals themselves.

General Ferrié was internationally renowned as a very famous radio pioneer, as well as being a General in the French Army who had been head of the French military radio operations before and during the First World War. He had worked with Marconi on setting up telegraphic communications between England and France before that. He introduced vacuum tubes into radio receivers in France. He became President of the International Scientific Radio Union and President of the Astronomical Society of France.

Størmer published Van der Pol's chart of further long-delayed echoes detected on 24 October 1928 as Figure 1 of his own paper. (This chart was never made available in an English language publication.) He also reported that Engineer Hals had worked jointly with Chief Engineer Hermod Petersen to listen to long-delayed echoes in a series of listening stations ranging from southern Norway all the way up to Spitzbergen, which is in the Arctic Ocean north of Norway. He said that Hals had detected a series of echoes on 14 February 1929, and that on 18 February 1929 another Norwegian named Andreas Kleve had detected another series of them at the listening station at Bodø on the Norwegian coast. He also said that on 19 February between 3:30 and 4:30 in the afternoon, Størmer himself had been with Edward Victor Appleton (1892-1965, later Sir), who was at that time Wheatstone Professor of Physics at Kings College London, and his colleague R. A. L. Borrow, and that they had heard long-delayed echoes of up to 25 seconds. Appleton is one of Britain's most famous scientists. He won the Nobel Prize for Physics in 1947 for his work in the 1920s on the ionosphere, which of course included his studying the LDEs, as he recounts in his paper of 1930, which is quoted later.

Figure 9. Sir Edward Victor Appleton, who studied the long-delayed echoes. He won the Nobel Prize for Physics in 1947 for his ionospheric studies of the 1920s, which included the LDEs. The UK's National Rutherford Appleton Laboratory at Didcot is jointly named for him and the physicist Lord Rutherford.

Appleton's first publication relating to the long delayed echoes appeared in *World-Radio* in 1928.[15] In this article, which preceded his awareness of the echoes detected by Hals, he discusses certain unusual radio echoes but does not yet understand them to be the long delayed ones, of which he would learn soon afterwards. This article deals first with standard echoes of one seventh of a second from travelling round the earth, and indeed travelling both ways round the earth. He then speaks of others:

"The second type of echo can best be understood with reference to Fig. 2, which illustrates the transmission from South America to Germany on which the effect was observed. A directional antenna was used in South America (Rio de Janeiro) and it was found that sometimes a single dot sent out by the transmitter was received two or three times."

Appleton's attempt to explain this was to say that the echoes must have been traveling round the world multiple times. (His diagram attempting to explain this looks like something with epicycles drawn by Ptolemy.) His intense desire to explain this specific anomaly tells us why he soon became almost obsessed with the long delayed echoes, when he at last became aware of them. So, it does seem as if long delayed echoes may possibly have been first observed by the unnamed Germans listening to transmissions from Rio de Janeiro. But Appleton does not give us the date, and all we know is they were no later than, say, May of 1928. So in the absence of certainty regarding any earlier date, we shall continue to speak of long delayed echoes having been first detected by Hals in 1927.

Appleton's next article, specifically about the long delayed echoes of which he had subsequently learned, appeared in *Nature* in 1929.[16] I have also discovered a previously unrecorded publication on the subject by Appleton, dating from 1930. It is entitled "Wireless Echoes' and he delivered it as an address (an "Evening Discourse') to the British Association for the Advancement of Science. It was subsequently published by the Association.[17] It contains four diagrams and one photographic plate. The discourse commenced with a lengthy and detailed account of short wave radio, mentioning

also the extremely short echoes which can be heard in association with it, echoes of for instance one hundredth of a second. He then goes on to say the following:

'So far, in this discourse, I have dealt with echo-phenomena for which there are now fairly widely-accepted explanations. I now turn to a group of phenomena the origin of which must still be regarded as something of a mystery. I refer to the remarkable echoes which can sometimes be heard, not a millisecond, but several seconds after the creation of the original signal and which were discovered three years ago by a Norwegian wireless amateur observer. Here I would like to observe that no subject seems to have been more fortunate in the assistance rendered to it by amateur experiments than that of wireless transmission. It is agreed by those best qualified to form an opinion that it was the amateurs who discovered the extraordinary suitability of very short waves for long-distance propagation. Amateur observers have rendered extremely valuable service on special occasions when observations were needed, for example, during the 1927 eclipse in this country. As we have seen tonight, it was a Bristol wireless amateur who first obtained satisfactory data about television echoes, while it was a Norwegian amateur, Engineer Hals, who first observed the echoes of long delay.

"Engineer Hals, who lives at Bygdö, near Oslo, in Norway, had for some time been making observations on wireless signals during auroral displays and sending in periodic reports to Prof. Störmer, the well-known authority on aurora, who live in the same locality. One day in December 1927, Prof. Störmer met Engineer Hals accidentally and they began to discuss wireless reception, and in the course of this conversation Hals stated that he had been listening to the Dutch Short Wave Station at Eindhoven working on about 30 metres, and had heard echoes three seconds after the original signal, and also ventured the suggestion that the echoes were due to waves which had been to the moon and back.

"Prof. Störmer, recognising that if the existence of these echoes could be established, a remarkable discovery had been made, asked Engineer Hals to make a written report of his observations.

Hals submitted this Report:

"I hereby have the honour to advise you that at the end of the summer, 1927, I repeatedly heard signals from the Dutch short-wave

transmitter PCJJ (Eindhoven). At the same time I heard the telegraph signals I also heard echoes. I heard the usual echo, which goes around the earth with an interval of one-seventh of a second, as well as a weaker echo about three seconds after the principal signal had gone. When the principal signal was especially strong, I assume that the amplitude for the last echo, three seconds after, lay between one-tenth and one-twentieth of the principal signal in strength. I will only herewith confirm that I really heard this echo."

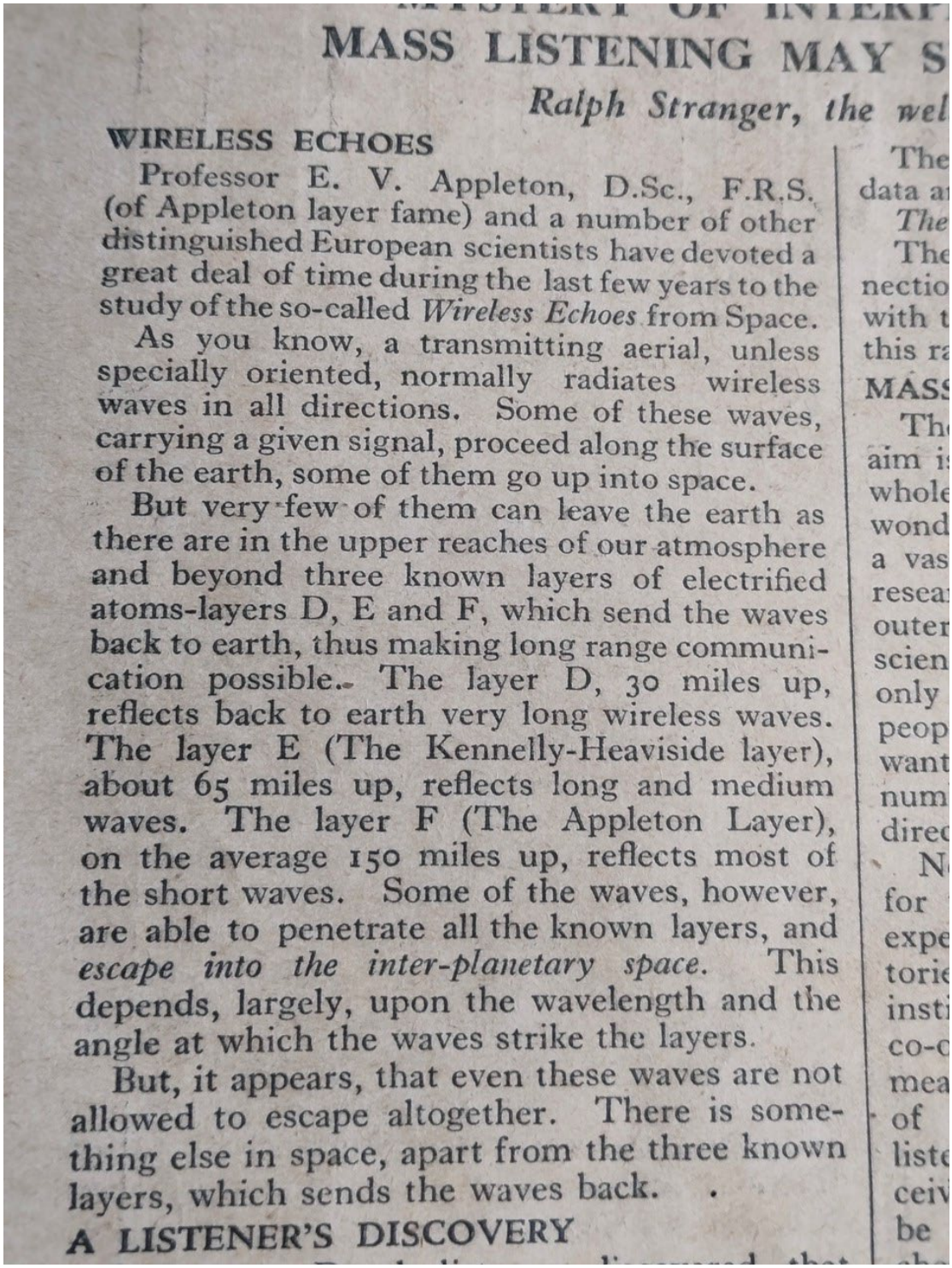
Appleton informs us:

"Another series of observations was arranged in the autumn of 1928, the same transmitter being used and attention being concentrated on aural observations to see if the same echo could be identified by several observers. In these observations Dr. [Balthsar] van der Pol, of Eindhoven, also joined and was able to confirm the existence of echoes heard as long as 30 seconds after the original signal. Further confirmatory evidence of the reality of the phenomenon was obtained by Mr. R. A. L. Borrow and myself, who heard echoes on February 19, 1929, at King's College, London. … In May of last year [1929], a French astronomical expedition went out to Poulo Condore in Indo-China to make observations on the total eclipse of the sun – and a party of French wireless engineers accompanied the expedition to make observations on the influence of the eclipse on wireless transmission generally, and on short-wave echoes in particular, if such could be heard at the site chosen.

"A short-wave transmitter, operating on a wave length of 25 metres, and situated on board ship, was employed for the special tests for echoes. The transmissions consisted of musically-modulated continuous waves, the actual signals being two dots, sent each half minute. Echoes were heard frequently during the half-minute intervals, the time-lag ranging from five seconds to twenty-five seconds. Throughout the four-hour period beginning at noon, local time, echoes were observed to follow practically every signal, and, at times, the strength of the echo was approximately one-third that of the original received signal. … A particularly interesting effect was observed during one of the tests after the eclipse. When signals were being sent out every half minute, the operator forgot to send one particular signal. This was noted by the receiving operator, but he actually heard an echo due to the signal sent out 40 seconds earlier! …I think it is, perhaps, most fitting to conclude our survey of short-wave wireless phenomena at this point, leaving the problem of these

echoes of long-delay with you as an inviting subject for your speculation, A tussle with such a problem will, at any rate, illustrate for you the healthy state of the subject of wireless at the present day."

Appleton subsequently published an article in four parts in the volume of *World Radio* for 1934, entitled "Wireless Echoes of Long Delay".[18]



MASS LISTENING MAY S

Ralph Stranger, the wel

WIRELESS ECHOES

Professor E. V. Appleton, D.Sc., F.R.S. (of Appleton layer fame) and a number of other distinguished European scientists have devoted a great deal of time during the last few years to the study of the so-called *Wireless Echoes* from Space.

As you know, a transmitting aerial, unless specially oriented, normally radiates wireless waves in all directions. Some of these waves, carrying a given signal, proceed along the surface of the earth, some of them go up into space.

But very few of them can leave the earth as there are in the upper reaches of our atmosphere and beyond three known layers of electrified atoms-layers D, E and F, which send the waves back to earth, thus making long range communication possible. The layer D, 30 miles up, reflects back to earth very long wireless waves. The layer E (The Kennelly-Heaviside layer), about 65 miles up, reflects long and medium waves. The layer F (The Appleton Layer), on the average 150 miles up, reflects most of the short waves. Some of the waves, however, are able to penetrate all the known layers, and *escape into the inter-planetary space.* This depends, largely, upon the wavelength and the angle at which the waves strike the layers.

But, it appears, that even these waves are not allowed to escape altogether. There is something else in space, apart from the three known layers, which sends the waves back.

A LISTENER'S DISCOVERY

Figure 10. Extract from an entire page published in the April 6, 1934, issue of the BBC's publication *World Radio*. (See main text below.) This extract ends by saying: "There is something else in space, apart from the three known layers [of our atmosphere], which sends the waves back." A mass campaign is announced to try and find an answer to the mysterious long delayed echoes.

Appleton's call for mass public assistance with the studies of long delayed echoes was followed by a similar call in America, this time not just by a distinguished scientist and a national broadcaster (the BBC), but by the top official of the relevant American government department. Thus, the British and Americans were simultaneously engaging in long delayed echo research at the highest level, in a coordinated attempt to find answers to the mystery of the echoes.

In the August, 1934, issue of *QST* (the leading American ham radio magazine, which is discussed later) a remarkable open appeal was published by J. H. Dellinger (John Howard Dellinger, 1886-1962), in his official capacity as Chief of the Radio Section of the United States Government's National Bureau of Standards in Washington. It is an entire page in length and is entitled "Observations on Long-Delay Radio Echoes: An Opportunity for Amateur Cooperation".[19] Dellinger was a brilliant telecommunications engineer and is famous as being the man who first discovered that solar flares caused fadeouts of short wave communications. He has a crater on the Moon named after him. Also, in this very year, 1934, he was Vice President of the International Scientific Radio Union. From 1921 till his death (more than forty years), Dellinger represented the United States at international radio conferences. He was Chairman of the Radio Technical Commission for Aeronautics and held numerous other positions.

His appeal published in *QST* was addressed to all radio hams everywhere. He first explains what long-delayed echoes are, and gives the background of the discoveries of Hals, Størmer, van der Pol, and Appleton. Then he says:

"The British Broadcasting Corporation through its magazine, *World-Radio*, and with the aid of Professor Appleton, has just inaugurated a world-wide endeavor to learn more about these long-delay echoes. Special emissions are provided from two high-power high-frequency stations to facilitate observations by anyone who cares to listen with a high-frequency receiving set. Listeners in all parts of the world have been enrolled in the endeavor, over 10,000 of them in Great Britain. It seems likely that information of unique value to science will result, and an orderly explanation of the curious phenomenon developed, when definite data are secured on the frequencies and the times of day and season at which these echoes

occur, their intensities, the area over which a given echo is heard, their relation to magnetic storms, sunspots, etc.

"The stations transmitting the special signals are GSB, Daventry, England, and HBL, Geneva, Switzerland (the League of Nations station)."

He then gives details about those transmissions, frequencies, etc., and says to use a watch with a second hand while you wait for the echoes, to measure their duration. And he ends by saying:

'I would be very glad to have any successful reception of long-delay echoes in the United States reported to me, and will relay the information to the British authorities who are coordinating the investigation for the world as a whole. Observers should give the identifying letter of the signal observed, the time to the nearest second at which the echo was heard, an estimate of the relative intensities of direct signal and echo, a description of the sharpness or apparent shape of the echo, and any pertinent information on interference, fading of signals, etc." [*Here there is a misprint which says 'continued on page 83'*, *whereas it really continues on page 88.*]

"I would be interested also in receiving reports of reception of long-delay echoes on any other stations, especially high-frequency stations of this country. It may on the other hand, be difficult to be certain of any echoes observed because of the lack of silent periods as in the special signals from the two European stations.

"Summaries of the results of this investigation will be made available later in publications in this country. Persons desiring to keep in touch with all details of the project meanwhile can do so by consulting the weekly issues of *World-Radio*, published by Broadcasting House, London, W.1, England."

Although a footnote reference to the Dellinger appeal in *QST* has appeared at various times in brief discussions of the echoes over the years, no one seems to have mentioned his Appeal or described what he said, which suggests to me that people have just been repeating a footnote without ever having seen the publication itself.

Figure 11. John Howard Dellinger (1886-1962)

In his article of 1929 referred to earlier, Carl Størmer tried to come up with some theory to explain the LDEs. Having heard them himself, and their existence being beyond question, there was no possibility of dismissing them as mere reports or mistakes of radio operators. Some of them were very loud and even hurt the ears when heard through earphones, so that they appeared to have been amplified somehow. In fact at one point they were so loud they sounded throughout his house and required no ear phones. The fact that the echoes could be louder than the original signals which they were echoing was one of the strangest features of the LDE phenomenon. In order to evolve a theory for the echoes, Størmer turned for inspiration to the work of Norway's most famous atmospheric scientist, Kristian Birkeland. He referred to Birkeland's theory that there were 'cathode rays', i.e. streams of electrons, reaching the Earth from the Sun. He called this 'The Theory of the Polar Light' (the polar light meaning the Aurora Borealis). In his article, Størmer published a very dramatic photograph taken by Birkeland in his lab, showing a suspended magnetic globe (which Birkeland called a *terella*, as it represented the Earth) generating a toroidal (doughnut-shaped) field of electrons going from pole to pole, to prove his theory that the same was the case with the Earth and explained the Aurorae. He also published a drawing showing the Earth surrounded by a gigantic toroidal belt to protect it from radiation, and with streams of electrons entering at both the poles. Obviously, this was an attempt at drawing the main van Allen radiation belt decades before van Allen. Strangely, no one ever mentions this important fact in the history of science. (Appleton also included a similar drawing in his 1930 paper.)

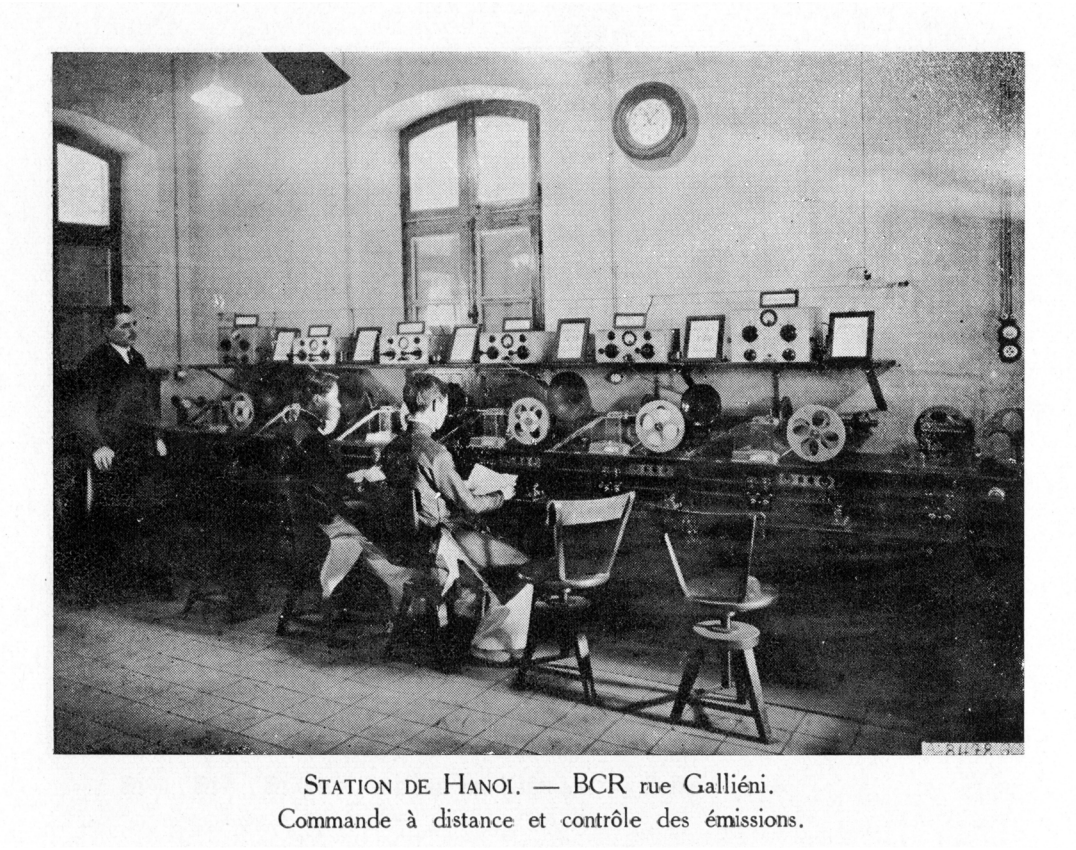
Størmer suggested that maybe the long-delayed echoes were being reflected off these electron streams (which we now call Birkeland Currents). He went into considerable detail, which it is not necessary to repeat here. It was a very sensible try indeed. And we can now see that Størmer was way ahead of his time in suggesting this. However, despite Størmer's bravery and brilliance, his attempts at explanation did not really get to the bottom of the matter.

Discussion of the LDEs in France, in connection with the findings made in French Indo-China, appeared in the journal published at Paris, *L'Onde Electrique: Radioélectricité et Ses Applications Scientifiques et Techniques*. These discussions appeared in the issues for June and October 1930. In the former issue, a gigantic multiply-folded chart was inserted, entitled *Observations d'échos Radioélectriques retardés.* ("Delayed echoes" in French is "Échos retardé") The chart reproduces the complete data found on May 8, 9 and 10, 1929, in Indo-China by the Eclipse Expedition. The different types of echoes heard are represented on the chart by different symbols, and attention is given to the different types of series of echoes and the echo strengths. I possess an original copy of this chart, as well as the journals themselves, and note that no one seems previously to have mentioned the existence of the chart. This is probably because the library copies of the journal long ago lost the inserted chart, which is not only huge and bulky but on very fragile paper, so that it can very easily fall to bits if handled indelicately. However, this chart preserves precious and highly detailed data, which deserves detailed study by some radio engineers. The chart is far too large for reproduction here, as it is a huge foldout.

The chart appeared with a paper by J.-B. Galle, described as an engineer at the National Laboratory of Radio Electricity.[20] Galle was particularly concerned with observing and reporting the long delayed echoes during the period of the total eclipse. The French also wanted to know whether short wave radio was effected by an eclipse. Galle justified his interest in LDEs by emphasizing that they were (I translate): 'the phenomena of delayed echoes discovered by Professor Stormer and also observed by Dr. van der Pol, and by Messrs. Hals in Norway and Appleton in England'. He clearly felt it necessary to give this pedigree to justify his research into the LDEs. The discussions of this period refer to what we now call Region E of the Earth's ionosphere as 'the Heaviside-Kennelly layer', and Galle is

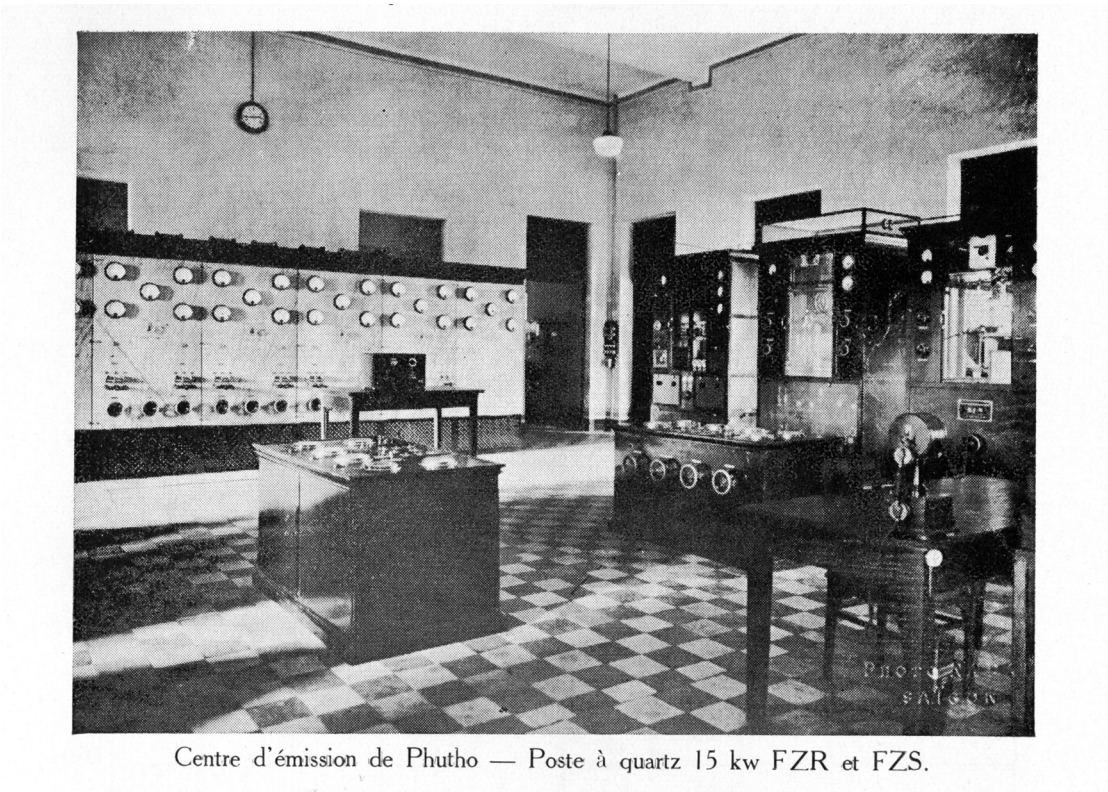
careful to emphasize that radio echoes from this layer took less than 10,000th of a second and therefore had nothing to do with the long delayed echoes. On page 259 Galle points out that the long delayed echoes are delayed by several seconds, even sometimes more than 20 seconds. He gives a description of the equipment used, accompanied by a photo of a man (perhaps himself) sitting with headphones at a long table covered in radio equipment listening to the echoes. In summarising the results for the LDEs, he gives the data for the different strengths (weak and strong) and many variations of the delay times for the echoes.

Four months later, a paper appeared in the same journal for the October, 1930, issue, signed merely 'Gallin'.[21] That was L. Gallin, the head of The Radio Service for the whole of French Indo-China. At the end of his Report, illustrated with diagrams, he pointed out that the observations of the long delayed echoes contradicted the theory of Professor Størmer, who thought the echoes might be reflected from streams of electrically charged particles in space. The next year, in 1931, L. Gallin published a history of the French Indochina Radio Telegraph Service from its creation in 1909 to the end of 1931.[22] He did this because he was Chief of the Service and the history was prepared for circulation during the International Colonial Exposition at Paris in 1931. It contains many fascinating photos of the stations, plus many tables of information, and its foldout map at the back shows the station at the island of Poulo Condore directly south of Saigon. The long delayed echoes are not mentioned in this book, of which I have a rare copy.



STATION DE HANOI. — BCR rue Galliéni.
Commande à distance et contrôle des émissions.

Figure 12. Part of the radio station at Hanoi, Viet Nam, in 1930.



Centre d'émission de Phutho — Poste à quartz 15 kw FZR et FZS.

Figure 13. The station at Phuto in Viet Nam in 1930.

A third publication of this subject 1930 was jointly authored by Galle, General Ferrié, and Georges Talon.[23] Amongst the things they reported were that at one point the operator forgot to send a signal but "echoes" of it came back anyway, after 5 seconds and again after 10 seconds. Those two signals were clearly not really echoes of a non-existent signal (which was an impossibility), and thus were either further echoes of an earlier one or were simply generated and emitted by whoever or whatever wanted to draw attention to itself by filling in the gaps of a pattern which it somehow realised had been left incomplete by the French operator.

In 1930, Ernst Carl Reinhold Brüche of the Research Institute of the Allgemeine Elektricitäts-Gesellschaft (AEG), which in English is 'the General Electricity Company', in Berlin, published a very long paper in *Die Naturwissenschaften* about Størmer's paper, his Theory of the Polar Light, and the long-delayed echoes. This has never before been mentioned in any English publications. I happened to leaf through the volume of 1930 *Die Naturwissenschaften* which had for other reasons and was surprised to find Brüche's heavily illustrated paper, complete with a reproduction of Størmer's 'van Allen belt'.[24] The paper has many photos (17 photographic plates) and diagrams of plasma phenomena, and reports many experiments which he carried out. He also discusses at length the electron streams, the 'torus space around the Earth'. He discusses the long-delayed echoes and gives even more references to further reports of them, such as articles by Ferrié and his French colleagues J. B. Galle and G. Talon, which appeared in French scientific journals during 1930, as well as another article by himself and a colleague, W. Ende, which appeared in 1930 in the German journal *Zeitschrift für Physik.*

On April 6, 1934, a truly remarkable event happened. The BBC in London had for several years been publishing a weekly magazine entitled *World Radio: The B.B.C. Foreign Programme and Technical Journal.* In the issue of this date the editor devoted an entire page on the back of the front cover to the issue of the long delayed echoes. Its headline ran: A LARGE NUMBER OF LISTENERS WANTED'. The page was written by Ralph Stranger, Honorary Secretary of the World-Wide Radio Research League (WRRL, today known simply as the WRL, World Radio League for ham radio operators). The sub-title read: "Mystery of Interplanetary Space to Be Penetrated / Mass Listening May Succeed Where Isolated Scientists Fail." And below that it said: "Ralph Stranger, the well-known Technical Author, forms a Research League". This was

done jointly with Professor Appleton, and the notice says: 'Professor E. V. Appleton has expressed his full approval of the aims of the League, and it was he who suggested that the first problem (other scientists will deal with other problems) to be attacked should be that of *long-delayed echoes*. He kindly promised to co-operate in directing the experimental work and assisting in the League's progress. … The next problem is to keep Professor Appleton and his brother scientists in constant touch with the millions of listener-experimenters spread throughout the world. This was solved by the Editor of the B.B.C. technical journal, *World-Radio*, who has offered the hospitality of the columns of his paper to the members of the League.'[25]

In the whole-page notice, readers were informed of the crucial importance of the long delayed echoes. The text begins by saying: "Professor E. V. Appleton, D. Sc., F.R.S. (of Appleton layer fame [now known as Layer F of the ionosphere, 150 miles up]) and a number of other distinguished European scientists have devoted a great deal of time during the last few years to the study of the so-called *Wireless Echoes* from Space." Later we are told: "In 1928 wireless echoes were obtained after a lapse of fifteen seconds. Professor Appleton has heard in London an echo after a lapse of twenty-five seconds which appears to imply that the wave was reflected by some mysterious body or medium at a point 2,325.000 miles away from our planet! What can there be in space 2,325,000 miles away? Is this mysterious 'something' a layer of electrified atoms, an extensive cloud of some cosmic matter, some unknown solid body, or merely a stream of corpuscles from the sun? … *The whole things is at the moment a mystery.* There is a race in scientific research in connection with wireless echoes. It is hoped that, with the aid of the vast listening British public, this race may be won by a British scientist. The aim of mass listening with a scientific aim is, I believe, a novel one. Science, in the whole of its history, has never had such a wonderful opportunity of obtaining so quickly a vast mass of results. … It has been decided to start work on May 4. … It has been decided to call the organisation 'WORLD RADIO RESEARCH LEAGUE'. Throughout April we shall be enlisting members."

Some further comments were then published on the subject in 1934 by Appleton, who as a pioneer in radiophysics, carried a lot of weight,[26] and Hals himself replied in four papers on the subject in the same BBC journal, *World Radio*, later that year.[27] A paper commenting on the matter was published in the same year by the American radio engineer John Howard Dellinger (1886-1962).[28]

Apparently nothing else appeared until well after the War, when in 1952 a paper was published by the ionospheric scientist Kenneth George Budden (1915-2005) and G. G. Yates (sometimes mistakenly called C. C. Yates).[29] Budden and Yates investigated the long delayed echoes and at first thought the echoes might have been reflected by "ionised corpuscular streams from the sun". However, after investigating such ejections from the Sun, they abandoned this idea because "such clouds of ions emitted from the sun are not likely to be dense enough to give detectable radio echoes". Their conclusion was therefore that "the echoes of long delay heard by previous observers were associated in some way with ionised regions fixed relative to the earth". This was a most impressive idea, considering that such "ionised regions fixed relative to the earth" were not known yet, and would not be known for decades. In other words, they intuited that there must be a charged cloud somewhere in near space, fixed in position relative to the Earth. And indeed there is, as we know now. It is the Kordylewski Cloud centred at the L5 Lagrange Point. Budden and Yates were way ahead of their time in proposing such a bold idea, specific evidence for the location coming more than 20 years later and specific evidence for the charged plasma cloud itself coming only 77 years later.

In 1957, the astronomer Fred Hoyle (later Sir) published a science fiction novel which was destined to become a sci fi classic. The title of the book was *The Black Cloud.*[30] The subject of the book is a gigantic cloud of gas in space which is seen at a great distance by an astronomer. He notices that it is coming closer and heading directly for Earth. Eventually it is discovered that the cloud is not only alive, but is intelligent. But the cloud seems to be aiming for our sun, and will black out the light from the sun and all life on Earth will die. The cloud has no malevolent intent, but this will be the inadvertent result of its motion, and it is already in the solar system. At the last minute, Earth is saved for an amusing reason: the cloud suddenly hears another cloud calling from faraway in space, it changes course and goes to meet its new friend elsewhere in the Galaxy. Hoyle clearly enjoyed the humour of this. Although I knew Fred from the late seventies, I was not a close friend by any means, as he was very self-contained and was content to be alone with his wife Barbara (known as 'the bulldog') who protected him, though many of us thought she *over*-protected him. He was an extremely sensitive man who had been hurt too many times. I never discussed the novel with him. Fred's closest friend and collaborator, and indeed his most intimate friend, was Chandra Wickramasinghe, who had been his Ph.D. student at

Cambridge. The two of them wrote many, many papers and books together over the decades. I am fortunate to be able to say that Chandra is one of my closest friends, and so he told me that Fred explained to him long ago that he had wanted to publish some papers in journals about his ideas concerning gas clouds in space, and that they might possibly be intelligent. But every journal he approached refused to publish anything on that subject. Fred was so frustrated that he decided that the only way to get his ideas out and circulated was to do so within the format of a work of fiction. And that is how he wrote his first science fiction novel. Its huge success with the public led to his writing many more sci fi novels, often co-authored with his son Geoffrey Hoyle, who told me his father came up with the ideas and he then wrote them up. In 1961 Fred wrote the famous BBC Television science fiction series *A for Andromeda*, followed in 1962 by *The Andromeda Breakthrough*, both of them eagerly watched by 12 million people in Britain, who were still talking about the series decades later. The series concerned a signal sent to Earth from the Andromeda Galaxy (Messier 31) which when decoded gave instruction for the construction of an alien entity, a beautiful girl who was named Andromeda (and was originally played by Julie Christie, fresh out of drama school). So the obstructionist editors of the scientific journals who forced Fred to turn to fiction to get his ideas in print unexpectedly handed him a second career. As Chandra often says to me, the astonishing idea of *The Black Cloud* was a forerunner of the concept of the Kordylewski Clouds being intelligent. In the 1950s dusty complex plasmas were still unknown, so Fred did not say his gas cloud was a plasma cloud. But when we wrote our joint paper for *Advances in Astrophysics* on this subject, Chandra and I had the eerie feeling that Fred was looking over our shoulders and chuckling at the irony of it all.

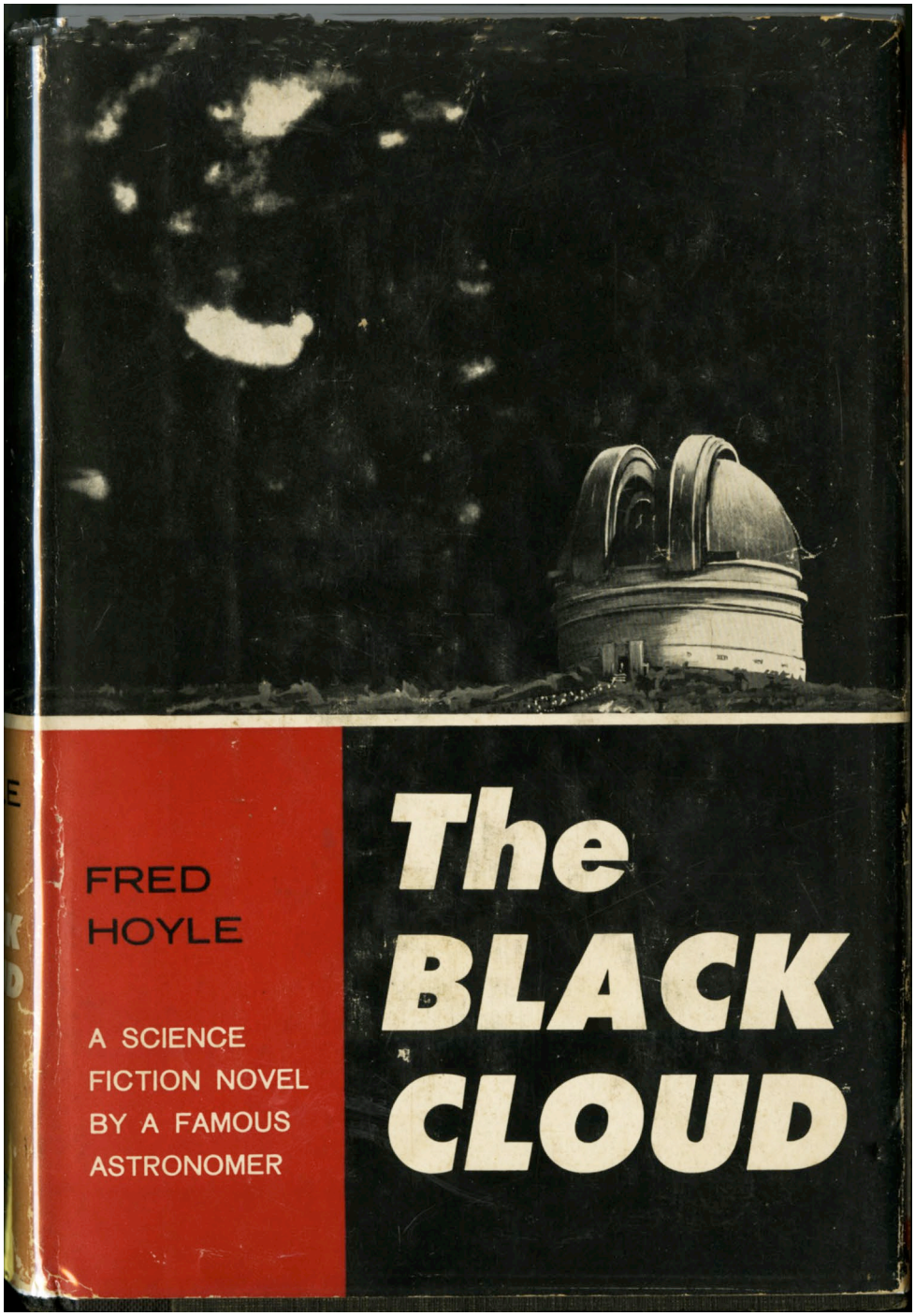


Figure 14. The jacket cover of the first American edition of *The Black Cloud* (1957). The British first edition (1957) had a different cover, showing a turbulent cloud in the sky.

In 1959, the journalist, television broadcaster and author of popular books about strange phenomena, Frank Edwards, published his book *Stranger than Science.* It contained 72 brief accounts of anomalous phenomena, including a short section entitled "Signals

from Space".[31] Although Edwards does not discuss the long delayed echoes, his comments are worth taking note of because of what he does tell us. He mentions that in October of 1958, the people at Cape Canaveral detected signals mimicking those of the Russian satellite Sputnik 1 which had been launched the previous year. But a rigorous investigation revealed that neither Russia nor the USA had launched anything just then, and that there should not be anything in space emitting any signals. And yet, the signals kept coming, for successive three-hour periods. It was determined that they were coming from what seemed to be an object of some kind travelling towards the Moon, but then it veered off from that direct course and disappeared. Numerous contradictory and clearly spurious "explanations" were issued to the press, apparently to try to shut down discussion of this anomaly which the authorities could not really explain. Edwards was one of those popular writers who did not give any references, so I have not checked any of this information which I am merely noting just in case it might be found to be relevant by some future researcher. He also mentions that in 1956 Ohio State University and other observatories reported "code-like chatter from Venus". All such anomalous reports, if found to be true, need to be put on a list of "possible relevance for further investigation", and it should not be assumed that the long delayed echoes are the only mysterious space signals which may have importance. It merely happens to be the case that it is the long delayed echoes which are the subject of this paper, and it is entirely possible that they are only one aspect of the phenomena which we should be investigating. There is so much more work to do.

In 1969, a highly unusual article was published by the cryptography genius and colleague of Alan Turing from Bletchley Park, I. J. Good (1916-2009). He used the Anglicised name Irving John Good although he had been born Isadore Jacob Gudak in London of Polish Jewish parents. Good was the very first person to warn of an *intelligence explosion* when computers got too smart. In 1965 he had formulated this as a theory predicting that humanity would in future encounter *superhuman intelligence*, with a millionfold increase in processing speed compared to humans. This would have drastic implications for the human species. His predictions appear to be coming true now, with the rapid rise of AI. But it was in 1969 that he became sufficiently specific and made points which are relevant to this discussion even though he never seems to have been aware of long delayed echoes. I need to explain the strange place Good's important paper appeared in that year, and

how I came to see it at the time of its publication and still have that copy today. In the late 1960s I was doing some unpaid research for Sir Alister Hardy (1895-1985), the recently retired Linacre Professor of Zoology at Oxford, and generally circulating with scientists of his type and acquaintance at Oxford and Cambridge. I thus came to know the young physicist Ted Bastin (1926-2011) who was collaborating with my later close friend David Bohm, and the philosopher Dorothy Emmet (1904-2000). Together, with Professor Richard Braithwaite (1900-1990) and his wife Margaret Masterman (1910-1986), a follower of Wittgenstein, they founded a group known as the Epiphany Philosophers. And one of their main projects was the publication, through Pergamon Press at Oxford, of a journal entitled *Theoria to Theory*, which started publication in October of 1966. I only came to know of this journal of very limited circulation (and largely forgotten today except by myself and my friend Rupert Sheldrake, who contributed to it from the time of its very first issue) through these means, and still possess copies from that time. As an example of how highbrow this strange journal was, in the same issue with the article by I. J. Good which I am about to describe appeared the short story by Jorge Luis Borges "The Circular Ruins", which was apparently the first publication of anything by Borges in Britain. Borges would of course become famous round the world, but Dorothy Emmet as Editor of this journal seems to have been the first British person to appreciate him sufficiently to publish him. Good's article was entitled "The Chief Entities".[32] At the time I had not heard of I. J. Good, and indeed few people had. The article seemed to me like science fiction, and I assumed it was intended to be something of that kind, for the Borges story gave a similar impression.[33] But in retrospect we can now see that it was deadly serious. Good stresses that intelligent life must be common in the Universe and that the odds are that most of it will be many millions of years old, also that our planet must be known to it, and it must have a presence in our solar system. Such civilisations would have many "ultraintelligent machines". Such intelligent societies would be run by what he calls "Top Beings", though he then says "perhaps it would be better to talk about the Chief Entities rather than the Top Beings, since they might be machines, or a hybrid between machines and livings beings, 'biomachines' as it were. … It is not essential that all the Chief Entities should live on planets; many of them might live in artificially constructed space stations … these stations would be useful for relaying radio, laser, or telepathic communications … The Chief Entities will make their presence known when they see fit. … There can be little doubt that we have been under regular observation ever

since we started using radio." Since it has been suggested that the Cloud at L5 is something resembling a "biomachine", i.e. an AI intelligent entity which may indeed be millions of years old as Good imagines such Chief Entities to be, and that the Cloud is responsible for the long delayed radio echoes (and even a TV echo in 1933, described later), maybe Good was being inspired by pointing out that entities such as the Cloud would take note of us when we started using radio. Due to the inspired visionary nature of I. J. Good's ideas, and his own undeniable "ultraintelligence", it seemed worth including a notice of his article in this survey.

Oswald Garrison Villard, Junior (1916-2004), a Professor of Electrical Engineering at Stanford University, took up the matter of the long delayed echoes with some colleagues in 1970 and 1971. Villard was one of the leading scientists involved with the American military's "messing with the ionosphere", with the atomic bomb explosions in the ionosphere, and so forth. He had a particular interest in the ionosphere because he had worked for so long on over-the-horizon radar, which he was able to accomplish, and which was of extreme importance to the American military because it made it possible to know if Soviet missiles were being launched on the other side of the globe below the horizon of America and thus not detectable by normal radar, in order to give many minutes' additional warning of an imminent nuclear attack. The techniques used for over-the-horizon radar are related to the notorious techniques of "atmospheric heating" and "remote weather control" as weapons for what the military call "total dominance of the battlefield". Villard also was one of the most prominent developers of stealth technology for military aircraft.

After this, numerous other people began to be interested, especially the British electronic engineer and independent scholar, George Sassoon (1936-2006), who later in the 1970s became a close friend of my wife and myself. He published his important paper 'A Correlation of Long-Delay Radio Echoes and the Moon's Orbit' in the summer of 1974.[34] It is important to give some description of George. He was the only child of the famous British First World War poet Siegfried Sassoon. Upon his death, George inherited a gigantic mansion at Heytesbury in Wiltshire. It was in a terrible state of disrepair, almost beyond repair, in fact, as it was practically a ruin. George would sometimes take me up to the top of the house, a perilous journey indeed, to his huge radio room where he had his short wave equipment, and which was filled also with enormous

quantities of certificates and honours as a radio ham. There must have been more than 200 of these awards and certificates. His achievements in that field were inexhaustible. He had several times detected faint and desperate emergency 'Mayday' signals from ships at sea and had saved many lives by alerting rescue vessels. There was simply no end to these good deeds, pursued often throughout the night, and being a champion radio ham was an essential part of his life. It is important to recount all of this to explain why he was so fascinated by the "impossible" long-delayed radio echoes that he undertook a fanatically detailed study of them, making many charts with timings over a period of years.

In early 1979 I was at the time co-editor of a popular science magazine, and I commissioned George Sassoon to write an article about LDEs.[35] After a lengthy summary of the history of LDE detection, he wrote: 'In 1974, I became interested in the subject myself, and took the trouble to look up the original published accounts of the early work. What I found astonished me. I had expected to find descriptions of odd isolated signals coming back, but here were great masses of them, sometimes arriving in regular patterns.

"In most of the patterns, the shortest delay observed was three seconds, supporting Hals' original idea that whatever was causing the echoes was located at a distance about the same as that of the Moon. This meant that the echo source must be either on the Moon itself, or located at one of the two Lagrange equilateral points, 60 degrees ahead of and behind it in its orbit. A body in any other orbit at that order of distance from the Earth would soon become severely perturbed, and crash onto the Moon or the earth.

"If the echo source is out in space, it is more likely that echoes will be heard when it is above the observer's horizon than below it. Short wave signals can propagate round the world, of course, or they can travel part of the way round and then escape into space, returning by the same route if echoed. Therefore, we might expect to find that most echoes were heard when the echo source was highest in the observer's sky, that is, to his south if in the northern hemisphere. Likewise, fewest echo reports would be expected when it was to his north, at its lowest point beneath the horizon, and also because radio signals can only penetrate with difficulty through the polar regions, compared to other directions.

"I collected over thirty dated and accurately timed echo reports from the 1927-30 period, and did the necessary astronomical calculations. The results were amazing: the trailing lunar equilateral point was more than 20 degrees below the horizon only once, yet it was more than 20 degrees *above* the horizon no less than eleven times, out of 36 reports.

"I then looked at the data in another way, dividing the sky up into its segments like a grapefruit, with the stem at the pole star. The moon and its equilateral points go round the sky about every 25 hours, taking a little over 6 hours to pass through each segment. The trailing equilateral was in the southerly segment 13 times out of 36, the next highest scoring segments being those to either side of it which both scored 6. Working outwards, the next two scored 5 each; and the most northerly only one.

'If you threw a dice 36 times and got 13 sixes and only one 1, you would probably think the dice were loaded – and you would most likely be right, for the odds against this being a chance result are hundreds to one against.

"I then did the same calculations for the ham operator reports collected by Villard, and got the same result; the trailing equilateral was consistently more above the horizon than below it, and it was located in the most southerly grapefruit segment – Local Hour Angle between +30 and -30 degrees – about twice as often as it should be by chance. The odds against this being a chance result are over 300 to 1, and whether it is an alien space probe or not, there seems little doubt that the echo source has some connection with the trailing lunar equilateral point [L 5]."

In 1965, James Godwin Strong of the British Interplanetary Society in London (an organisation which promotes the exploration of space, founded in 1933) had suggested that if an alien probe were sending back the long delayed echoes it would have to be within the orbit of the Moon in one of the two Lagrange Points, as they are the only two stable points which qualify. It seems that James Strong was therefore the first person to suggest this location, which was later to be adopted by both Professor Ronald Bracewell and Tony Lawton and proved from the data to be the case by George Sassoon. Strong made the comments in a book he published about space exploration.[36] He also mentions Kordylewski's discovery of the Kordylewski Clouds in 1961. He refers in passing to Størmer and van

der Pol but wrongly believes that no long delayed echoes had been heard since their time, so that clearly he had only heard of and not actually studied their reports.

Others who came to be interested in LDEs included Duncan Lunan, Tony Lawton, and Ronald Bracewell. Professor Ronald Newbold Bracewell (1921-2007) was a remarkable man, Professor of Electrical Engineering at Stanford University. He and I corresponded a lot about the subject of extraterrestrial life, which was a passionate interest of his. He had been interested in communicating with intelligent extraterrestrial life since at least 1960, when he published a paper in *Nature* on the subject.[37] This paper first came to my attention in 1963 when I bought a copy of the book *Interstellar Communication*, in which it was reprinted.[38] It is a brief and very general paper but it contains these remarks and mentions the long delayed echoes:

"Would not (a) more advanced society [in space] … spray some number of suitable stars, say, one thousand, with modest probes. Each probe would be sent into a circular orbit about one of the thousand stars, at a distance within the habitable zone of temperature. Armoured against meteorites and radiation damage, and stellar powered, the probes could contain durable radio transmitters for the purpose of attracting attention of technologies such as ours. … For this reason we might better devote our efforts to scrutinizing our solar system for signs of probes sent here by our more advanced neighbours. …Such a probe may be here now, in our solar system, trying to make its presence known to us. … the probe could first listen to our signals and the repeat them back to us, its signals would have the appearance of echoes having delays of seconds or minutes, such as were reported 30 years ago by Størmer and Van der Pol and never explained." (And he gives three key references.)

In 1962, the radio astronomer Frank Donald Drake (1930-2022) published his book *Intelligent Life in Space*. It was a short book about SETI. In it he mentions in passing the following:

"The astronomer R. N. Bracewell, of Stanford University, has suggested that advanced civilisations wanting to contact other beings will send out automatic probes travelling at much less than the speed of light to visit other stars, search for life, and then radio back a message if some sign of life is found."[39]

Drake is rather dismissive of the idea of a "Bracewell Probe", as they later came to be called. He does not mention the long delayed echoes at all.

Two years after his first paper, in 1962, the same year that Drake's book appeared, Bracewell followed it with another paper in a journal for radio engineers.[40] Bracewell had suggested in all seriousness that there might be an extraterrestrial probe parked at L5 and that it was sending the long-delayed radio echo signals back in patterns that might conceal messages. He even thought they might be a code for the construction of a star map of the home of the extraterrestrials, a suggestion later elaborated by Duncan Lunan, but later dropped. Bracewell was highly respected in his field. Bracewell was author of a classic mathematics textbook, *The Fourier Transform* (1965), and he wrote *The Galactic Club: Intelligent Life in Outer Space* (1974) about extraterrestrial life. In that book, he mentioned the idea of an alien probe creating echoes of our own radio transmissions to call our attention to itself, but he did not mention the long delayed echoes which were already known and which he had been investigating. He published a drawing in the book showing an alien 'messenger probe' in space with the Earth in the background, beneath which he wrote this caption:

"If an alien probe near the earth picks up a terrestrial broadcast from a radio transmitter that you are listening to and then amplifies and retransmits it, you will hear first the direct transmission followed by a repeat after a time equal to that taken to travel out to the probe and back. The general effect will be like an echo."

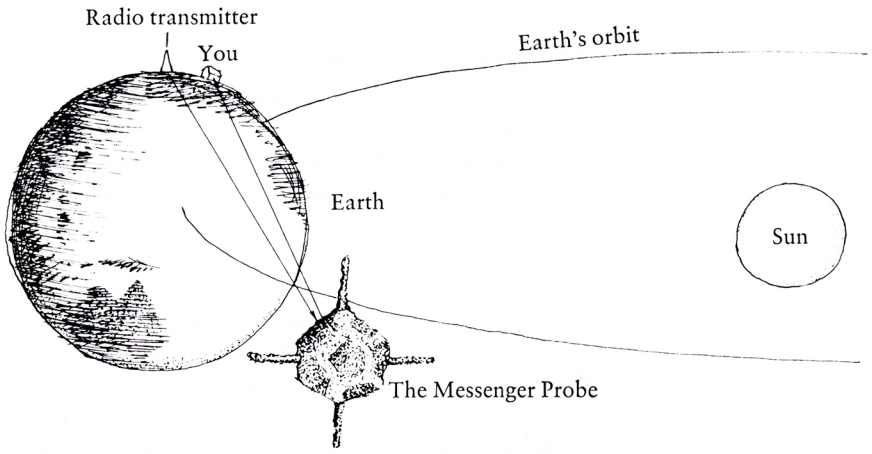


Fig. 10. If an alien probe near the earth picks up a terrestrial broadcast from a radio transmitter that you are listening to and then amplifies and retransmits it, you will hear first the direct transmission followed by a repeat after a time equal to that taken to travel out to the probe and back. The general effect will be like an echo.

Figure 15. Professor Ronald Bracewell's drawing of an alien probe at L5.

In the main text of the book he puts it like this:

"It is quite possible that a probe arrived in our solar system when our radio transmissions had not yet begun. It would therefore be desirable for the probe to continue listening. … If all goes well, then the time will come when a messenger probe has noted the presence of radio transmissions …The probe's next move is to let us know that it is there."[41]

Bracewell goes on for many pages to discuss the echoes which are sent to us by the probe, and suggests that we retransmit to the probe those very same artificial echoes, changed in some unmistakeable way to let the probe know that we have received the echoes and recognised their importance. His book became well known and his support for the concept of an unmanned interstellar probe sitting in space near the Earth made the idea famous, and such vehicles were afterwards referred to by those speculating on such subjects as "Bracewell Probes". His idea was that the probe was wholly automated and staffed by intelligent robots, not living beings. In the book, Bracewell did not mention that such a probe appeared to be at L5 and that he had been researching it. He left the discussion theoretical in this book, which was aimed at popular non-scientific consumption.

In 1964, a successful book by the prominent journalist Walter Sullivan (1918-1996), entitled *We Are Not Alone*, gave coverage to

Bracewell's ideas about long delayed echoes, and helped spread Bracewell's ideas to a wide public. Sullivan wrote:

"While Drake and his colleagues were trying to intercept radio whispers from two nearby stars, it was proposed that our neighbours in the galaxy may be using a radically different method to establish contact. Ronald N. Bracewell, a leading radio astronomer, argues in *Nature* that radio signals would be an uneconomical way to do this. … It was more logical to assume, he said, that superior civilizations would send automated messengers to orbit each candidate star and await the possible awakening of a civilization on one of that star's planets. … Such a messenger, said Bracewell in his *Nature* article, 'may be here now, in our solar system, trying to make its presence known to us.' … The messenger would keep watch for the narrow-band radio emissions announcing that a civilization on a nearby planet has reached the communication stage. The messenger might then repeat such signals back to the planet. When the civilization awoke to the significance of these strange echoes and itself repeated the signal, the messenger would know it was recognized and begin communicating. … He pointed out that strange radio echoes have been observed in the past." (And the echoes of 1927, 1928, and 1934 are mentioned, etc.)[42]

Figure 16. Walter Sullivan, the most prominent science journalist of his time.

Bracewell and I corresponded frequently in the 1970s, and although I have preserved those letters somewhere, I have not been able to find them so far. But they all concerned extraterrestrial life. When they come to light I may have more to say about them, and then I may discuss Bracewell and his ideas further. Of the people Bracewell thanks in the acknowledgements in his Preface to his book, I have met or corresponded with the following: Bernard ('Barney') M. Oliver, Philip Morrison, Gerald O'Neill (a good friend), Carl Sagan, and Professor Peter A. Sturrock. The community of people interested in these things was small back then.

In 1974 another important volume appeared, with a contribution by Bracewell. Entitled *Interstellar Communication: Scientific Perspectives*, it was clearly intended as a follow-up to the

earlier *Interstellar Communication* of 1963, and was again edited by Alastair G. W. Cameron (whom I also met on one occasion), this time with Cyril Ponnamperuma as his co-editor. Bracewell's section of this anthology volume was entitled "Interstellar Probes", and once again Bracewell discussed the long delayed echoes.[43] He said:

"To assure that its transmission would be noticed, the probe would listen to what it could hear, and whenever it hears a broadcast, it transmits exactly on that wavelength. This automatically guarantees that someone is listening, because no one transmits if no one is listening. It knows there is a receiver tuned to that wavelength, so it gives out on that wavelength. What should it give out? If it gives out something that you don't want this may turn you off, you will go away. We propose that it would transmit back what it heard; thus if there was speech coming out it would transmit the speech back. We would hear the program that we wished to hear, followed by an echo, with a time delay corresponding to the time taken by the signal to go out to the probe and back, which would be of the order of minutes. Now that's something that would be very conspicuous indeed. We know that this is so because on the rare occasions when people do hear long-delay echoes, they always notice them. The people who listen to long-distance radio are very familiar with the echo produced by passage of a radio wave completely around the earth which takes 1/7 sec, and they get used to that time delay which is quite recognisable as such. But when you hear the announcer say, 'Well, that's the end of the news, goodnight'." And then 5 min later just as you are about to get up and switch the receiver off, a voice repeats, 'That's the end of the news, goodnight,' you will certainly notice it."

He then goes on at some length describing what should be done after hearing the echoes. He says we should resend the echoes themselves!

A year before Bracewell's book came out, in 1973, a volume edited by Carl Sagan appeared which was the Proceedings of an international conference which was called The Conference on Communication with Extraterrestrial Intelligence (CETI).[44] The conference was jointly organised by the United States and the Soviet Union, and was held in Armenia. One of the participants was my friend Tommy Gold, though I never asked him about it, unfortunately. About half of the participants were Russians. Amongst the Americans were several participants with well known interest in this subject: Carl Sagan, Freeman Dyson, Frank Drake,

and Barney Oliver. Francis Crick represented the UK. The book is extraordinarily interesting, and of particular importance to us is that Bracewell's ideas were discussed at the conference, despite his absence. The initial pages of the book contain many snapshots of the participants during the conference, which are all the more interesting today because everybody in them is now dead.

In his only recorded comments at this conference, the Soviet science populariser and science fiction author Roman Grigoryevich Podolny (1933-1990) made the following comments:

"About ten years ago an Australian radio astronomer, R. Bracewell of Stanford University, suggested that there may have been a visitation of the planet earth by automatic probes in the past. One possible explanation … is that one such interplanetary probe did indeed appear …"[45]

Professor Philip Morrison of Cornell and of MIT (1915-2005, who had been a student of Oppenheimer, worked on the Manhattan Project, and became a leading figure in American SETI research) made the following remarks:

"Doctor Bracewell … in a paper some time ago, discussed the question of probes. This summer [1973] he prepared a second paper in which his considerations lead him to conclude that for a very large number of possible [radio] channels, or for a rather smaller number, such a method [of communication] is not efficient; but there exists an intermediate range in which his studies at least seem to indicate probes to be the method of choice [for extraterrestrial study of earth]. I think it very likely it should be put into the box for later consideration."[46]

Thus we see that Bracewell's idea of an alien probe near Earth was familiar to both the Americans and the Russians at this date, 1973, even though no one specifically mentioned long delayed echoes in connection with the idea. And Morrison says Bracewell's ideas must be examined further.

Figure 17. Professor Ronald Bracewell.

Explicit confirmation that the Russians were taking the Bracewell Probe idea seriously was inconspicuously published by NASA in 1977. The Soviet Union's official report following the conference which had been held in Armenia was published by NASA as an Appendix, called 'The Soviet CETI Report, in an official NASA book on SETI. Although probes and echoes were not mentioned anywhere in the American text (despite Bracewell and his closest colleagues constituting the committee which compiled the American report), the Soviets included these remarks in Part II of their report, under the heading of "Search for Cosmic Signals of Artificial Origin":

1.7. Search for Probes

"The possible discovery of probes sent from extraterrestrial civilisations and now located in the solar system or even in orbit around the earth warrants particular attention. To search for these rapidly moving objects the system of constant monitoring of the whole sky should be supplemented by specially designed radio-finding systems. Initially it would be possible to use existing installations intended for space communications and radar observations."

The Soviet report continued with a section on the importance of studying "sources suspected of being artificial", and listed the techniques of studying them and the importance of "an analysis of all data … and structure of the signal with known or anticipated types of communication".[47]

The Americans obviously took a decision, for whatever reason, to refrain from even mentioning probes in their lengthy text. But the Soviets were perfectly open about their commitment to pursuing this subject intensively, and they doubtless did so. The Russian space files must be full of data and details, but we have no knowledge of or access to the Russian history of LDE and probe investigations. What we can be confident of is that they retain an interest in the subject, and that whereas they have the Western information, the West does not have the Russian information. This means that the Russians are better informed than NASA is.

It was in 1966 that Bracewell's idea of a probe transmitting the long delayed echoes, published by him a few years before, got its main public airing. For it was in that year that the book *Intelligent Life in the Universe* appeared and caused something of a sensation in America.[48] It is a strange amalgam of a book. Its core was a book published earlier in Russian by the Soviet astrophysicist and expert in synchrotron radiation, Iosif Samuilovich Shklovskii (1916-1985). Unknown to Shklovskii at the time, arrangements were made and support was given for Carl Sagan to use an English translation of the book as the basis for a larger and more up to date book which could be seen to be produced by America rather than the Soviet Union. So without Shklovskii's knowledge or permission (there was no international copyright law in place in Russia then, so the rights to the book were unprotected), Sagan heavily edited the translated work and added ten more chapters of his own. The result was the very long and impressive work which became widely known as a book by Carl Sagan, and which helped immeasurably to give him the international reputation which he later had. Of course, Sagan gave credit to Shlovskii, but few people bothered about there being an unpronounceable Russian name beside his own. Later, Shklovskii made the best of the situation by being somewhat friendly with Sagan, and Shklovskii attended the conference in Armenia which has already been mentioned. Amongst astrophysicists and astronomers, Shklovskii was fully acknowledged, but the public took no notice of that. After all, who could pronounce, much less spell, Shklovskii? Thus it was that Sagan became such a public figure.

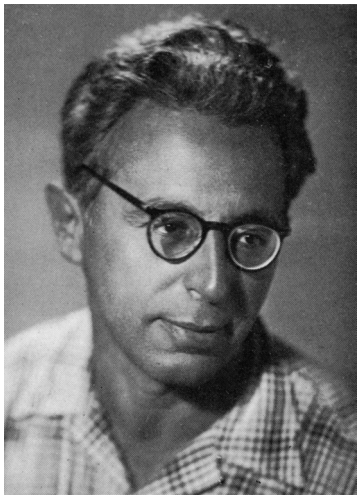


FIGURE 18. Iosif Samuilovich Shklovskii.

In the 1966 book, in Chapter 31 on "Interstellar contact by automatic probe vehicles", the long delayed echoes found mention:

"This program [of interstellar probes sent to numerous solar systems], suggested by Bracewell, could be implemented as follows: At the destination star, the probe would cover a wide range of frequencies. Should signals be detected, the probe would record them and immediately transmit them back to their original source without change. A repeated playback would undoubtedly attract the attention of the planetary inhabitants."[49]

At this point, the idea of an alien probe creating long delayed echoes went mainstream.

In 1963, an article appeared by the British magazine *Discovery* entitled "Communicating with Life in Space" written by the interesting British inventor, technologist, and engineer C. Maxwell Cade, whose important studies of ball lightning I have discussed in my book *A New Science of Heaven.*[50] This article says: "R. N. Bracewell has suggested that there may be evidence for visits from probes in some of the reports of extra-ordinary radio signals, such as the abnormally strong, long-delay echoes observed 35 years ago by Størmer and van der Pol, for which an explanation has never been found." Cade printed a series of diagrams showing such a probe.[51]

Figure 19. C. Maxwell Cade.

In 1966 Cade produced a book appeared entitled *Other Worlds than Ours*, which again mentioned long delayed echoes and a possible Bracewell Probe. I was in touch with Cade and his wife long ago, as I remembered only after opening my old copy of this book and finding inserted a note I had made of both of their telephone numbers and my own comment about them saying "back on Friday". In his book Cade has this to say:

"R. N. Bracewell has suggested that there may be evidence for past visits from probes in some of the reports of extraordinary radio signals, such as the abnormally powerful, long-delay echoes observed 38 years ago by Störmer and van der Pol, for which no explanation has ever been found."[52]

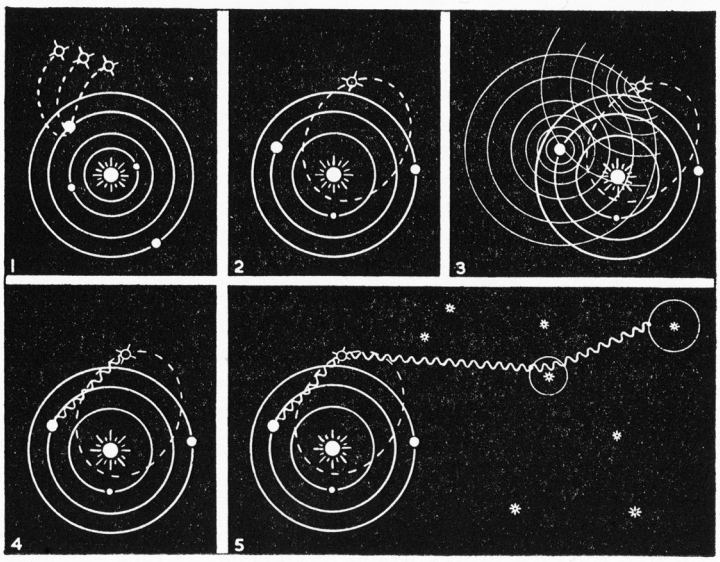


FIG. 19. COMMUNICATION BY SPACE-PROBES. In (1), a community sends out a fleet of space-probes, each of which takes up an orbit in a planetary system and listens for radio signals (2). When signals are received, the probe repeats them in the form of a delayed echo (3). Subsequently the probe establishes contact (4) and after initial exchanges transmits news of contact by star-to-star relay (5). (Redrawn from *Discovery*, May 1963.)

Figure 20. Cade inserted at this point this redrawing from his article in the magazine *Discovery* of May 1963 showing five depictions of an extraterrestrial probe taking up an orbit in our solar system and then: "When signals are received, the probe repeats them in the form of a delayed echo".

In 1963 John W. Macvey published his book *Alone in the Universe?: Notes towards an Atlas of the Creatures of Space*, in which he referred briefly to the long delayed echoes, without mentioning any names except in footnotes:

"Alternatively the suggestion has been made that star-peoples might choose to adopt some serious modification to their communication experiments rather than haphazardly occupy a host of megawatt transmitters for millennia. One such likely alternative envisages unmanned instrumented space probes being directed to the close vicinity of other stars to detect signals from nearby planets and, having recorded them, to retransmit such signals back to their base. This would ensure that their signal was a frequency capable of being received by intelligent beings. [Here he gives a footnote to Bracewell, *Nature*, Volume 188, p. 670, 1960.] A rather interesting point arises here which could be significant. In 1928 certain radio signals were picked up which had inexplicably long echoes. Were these in fact retransmissions from such a stellar probe? [Here he gives a footnote to Størmer, *Nature*, Volume 122, 681, 1928.] Though we should

perhaps not lay too much store on such slender evidence it should not be wholly disregarded. Alternatively, of course, such a probe could transmit signals to inhabited planets of the system to which it had come."[53]

By 1973 Macvey's interest in long delayed echoes had grown considerably, and he published a second book, *Whispers from Space*, in which he said he following:

"Whether or not U.F.O.s (Unidentified Flying Objects) should be considered in the role of possible interstellar probes is a moot point. A probe would after all seem more likely to remain aloof from the atmospheric regions of a planet.

"Bracewell considers that a *pilot* probe might first be sent. This would 'listen' for evidence of advanced technologies and report back accordingly, either directly or via relay probes. If this report should be positive – and in the case of Earth it presumably would – then we might be able to look forward to the arrival in due course of a 'more sophisticated mission', a prospect calculated to arouse either interest or foreboding.

"The idea of a probe programmed with an extensive store of information and containing a computer by which it could 'converse' with us is a logical extension of the concept. As we have said, it is just possible that such a probe is already lurking somewhere within the boundaries of the solar system. Here Bracewell raises a most interesting point, suggesting that in order to ensure the use of a frequency that could penetrate our atmosphere, yet lie in a band certain to be in use, the probe would first pick up some of our domestic radio signals, then retransmit them back to Earth. This would lead to *radio echoes having delays of seconds, even of minutes*. Those words are peculiarly significant in the light of an event that took place over forty years ago. In the weekly scientific journal *Nature* there appears in the issue of November 3, 1928, a letter written by one Jørgen Hals, a radio engineer of Bygodø, Oslo, to physicist Carl Størmer, couched in the following terms:

"'At the end of the summer of 1927 I repeatedly heard signals from the Dutch short-wave transmitting station PCJJ at Eindhoven. At the same time as I heard these I also heard echoes. I heard the usual echo which goes round the Earth with an interval of about 1/7th of a second as well as a weaker echo about three seconds after the

principal echo had gone. When the principal signal was especially strong, I suppose that the amplitude for the last echo three seconds later, lay between 1/10 and 1/20 of the principal signal in strength. From where this echo comes I cannot say for the present, I can only confirm that I really heard it.'

"Størmer initiated certain tests as a result of this communication and on October 11, 1928, these bore some fruit. During the afternoon of that day Station PCJJ in Eindhoven emitted very strong signals on 31.4 meters. Both Hals and Størmer heard very distinct echoes several times, the interval between signal and echo varying between 3 and 5 seconds, most of them coming back about 8 seconds after the principal signal. Sometimes two echoes were heard with an interval of about 4 seconds. Physicist Van der Pol confirmed these observations in a telegram that read 'Last night special emission gave echoes here varying between 3 and 15 seconds. 50% of echoes heard after 8 seconds!' At the time these peculiarly long echoes were attributed by Størmer to auroral causes but the feeling today is that they have never been adequately explained. Six years later, in 1934, radio echoes of a similar kind from Holland were also heard. No one, least of all the writer, is trying to suggest that an alien probe from the stars was definitely responsible for these inexplicable effects. What has been given are simply the facts as they are known. The reader must endeavour to draw his or her own conclusions."[54]

Also interested in LDE research were Fred Ordway III and Harry Lange, who were both friends and colleagues of Bracewell. Both had worked for and with NASA for years. Ordway was co-author of the book *Intelligence in the Universe*, published in 1966 and one of the early books of its kind.[55] Both Ordway and Lange worked with Stanley Kubrick and Arthur C. Clarke on making the film *2001: A Space Odyssey,* Fred's role being Technical Advisor for the film, starting in January of 1965. They were both good friends of mine since 1966, as I spent two years observing the making of that film and knew everyone involved except for the actors. One evening my wife Olivia and I went to see the Langes at 7 PM, as invited, and were surprised to see their dining table ready for breakfast. We had expected supper, being invited for 7 PM, but the Langes ate early, like German peasant farmers, and apparently assumed that everybody else must do so as well. Our stomachs were sorely troubled all evening. As for the far more sophisticated Fred, he wanted to act as my mentor if I would move to Washington and

become officially active in space. He took me to lunch at the Cosmos Club and said he would make me a member right away and get me started as a lobbyist (joining NASA apparently being the next stage after that.) But I lived in England and did not wish to move to Washington.

Figure 21. Fred Ordway (left) and Harry Lange as they were at the time I first met them in 1966, working on the film *2001: A Space Odyssey*. A space helmet may be seen in the background.

Another book appeared in 1966/1967 which mentioned the echoes. This was by Captain David Charlson Holmes of the U.S. Navy (died 2004) and was entitled *The Search for Life on Other Worlds*. Holmes wrote a very earnest and detailed book about his subject, and near the end of the book he says of a possible alien probe in our own solar system:

"Such a satellite need not be large, perhaps a carefully designed one the size of a watermelon would do. It need not listen or transmit continuously either. When the planets of a star begin to 'awaken', the satellite could flash the news home so that an intensive program of interstellar communication could be placed in operation. It has also been suggested that such a satellite might broadcast earth signals, and thus indicate the stage of our development.

"There have already been reports of signals retransmitted or echoed after a time delay. In 1927 and again in 1934, a Norwegian scientist, Carl Stormer, reported hearing radio signals originating in Holland retransmitted about 15 seconds after their original

transmission. There have been a number of attempts to explain such phenomena as echoes produced by the ionized solar clouds, but none have been entirely satisfactory.

"One could postulate that a really advanced civilisation might scatter quite a number of such satellites or intelligence-seeking probes throughout the universe."[56]

Captain Holmes is described as having been NATO's Manager of Project Shepherd, the military worldwide space tracking network. And for those who do not know such things, the rank of Captain in the Navy is a much higher rank than that of Captain in the Army. In other words, he was a senior officer, not a relatively junior one, and was equivalent to full Colonel.

The most passionate and prolific proponent of long-delayed echoes was unquestionably the young Scottish astronomer Duncan Lunan. Supportive of him and almost equally keen was Tony Lawton of the British Interplanetary Society, who had in fact added an extended comment to Sassoon's 1974 paper. (I was made a Fellow of the British Interplanetary Society on 1 July 1978, at the urging of my close friend Arthur C. Clarke, and met Lawton as a result.) In various books and articles Duncan proposed in some detail that there was a star map encoded in the varying timings of the echoes relating to a specific galaxy in space, but this was a theory which he later abandoned, so it is not discussed further here. The idea that the long delayed echoes might be communicating a code for a star map originated with Ronald Bracewell and was enthusiastically investigated by Lunan who was convinced of this at first but then later saw its flaws. (See also below.)[57] In 1975 the Ukrainian scientist A. V. Shpilevskiy published an article in the Polish journal *Urania* (Number 4, 1975) entitled "New Interpretation of Mysterious Radio Echoes" in which he also supported the star map hypothesis, but named a different constellation than the one discussed by Lunan. However, the star map ideas were abandoned, unless Shpilevskiy still believes in them, which is not known.

It is worthwhile to give something of an account of how Duncan Lunan actually came to investigate whether a star map were encoded in the variations of durations of the long delayed echoes. Lunan has borne the weight of heavy criticism for this, and some have accused him of being a fantasist. But that is not a fair appraisal at all. In fact, the initial impetus for this idea came from two of the

most distinguished American scientists involved in SETI speculations at that time, Professor Ronald Bracewell and Professor Philip Morrison. The account of how these developments took place is to be found in a book published by Lunan in 1974.[58] Chapter Twelve of that book, consisting of forty pages, is devoted to discussing the long delayed echoes. And, for the sake of the chronology of events, I should point out that in it Lunan records that he met Tony Lawton for the first time in December of 1972. Near the beginning of the discussion, Lunan cites some remarks made by Philip Morrison ten years earlier in an article in a rather obscure journal.[59] It should be pointed out that Morrison was one of J. Robert Oppenheimer's Ph.D. students, he worked on the Manhattan Project, and was one of the people who loaded the atomic bombs onto the planes for the raids on Japan. He later worked with Eugene Wigner on nuclear reactor design. He was an early and enthusiastic proponent of SETI. Lunan was impressed by Morrison's opinion "that a space probe [an alien one] should have sent back something coherent unmistakably meant to attract attention' … And if all the echoes *were* returned by an artificial object at the distance of the Moon, the later variations in delay time should carry some kind of meaning." There is nothing remotely unreasonable about this idea. And Lunan was motivated to search for just such a thing. As he says: Assuming *for the sake of argument* that the echo patterns came from a space probe [as suggested by Bracewell], therefore, I asked: What meaning could these signals be meant to convey?'" And here Bracewell specifically suggested an image of a star constellation. As Lunan says: 'Should we be surprised,', Bracewell wrote of his hypothetical probe, 'if the beginning of its message were a TV image of a constellation?' … I therefore tried graphing the echo patterns to see what happened."

It is very important for us to realize that Lunan commenced his own studies of the echoes by following the specific ideas of two of the world's leading SETI scientists. He was therefore behaving in a perfectly reasonable manner. His work which followed included intensive studies of the data, plotted in charts which themselves are of great value. He then carried out an almost unbelievably detailed and difficult study of what astronomical information might possibly be suggested by the echoes. He concluded that the constellation Epsilon Boötis was being referred to in the variations of the echo times. He published ten complex diagrams and the work involved in all of this must have taken months. He was fiercely attacked about this and later publicly withdrew his hypothesis. His work on the echoes, apart from that hypothesis, has therefore never been

properly appreciated. And he concluded his discussion about the echoes in that particular book by mentioning that in October of 1973, Professor [Samuil Aronovich] Kaplan (1921-1978) of Gorky University in the then Soviet Union announced that he "had detected pulsed radio signals on high frequencies, coming from a source *within the Solar System*. A later statement amplified the details: the signals were of artificial origin. Coming from some relatively nearby source, apparently not of human manufacture. There was a strong possibility that they came from a space probe, sent here by some other civilisation to contact us." Kaplan, who died young in a train crash, was the head of the Department of Astrophysics and the Observatory at his university, he specialised in the study of white dwarfs, interstellar turbulence and interstellar magnetic fields, and he developed theories about interstellar plasma. Lunan gives no reference, so that I have not been able to trace Kaplan's publication discussing SETI. A full bibliography of his publications does exist, but it is in Russian.

In 1973, extended discussion of the long delayed echoes was published in the Correspondence pages of the British Interplanetary Society's journal *Spaceflight.*[60] A lengthy letter was published from George Cunliffe McVittie (1904-1988, writing as G. C. McVittie), Honorary Professor of Theoretical Astronomy, University of Kent. It is savagely critical of Duncan Lunan, whom he accuses of manipulation of data. McVittie says he had long been a friend of Ronald Bracewell and that he has contacted him about Lunan. McVittie says he learned of Lunan from an article in the London *Sunday Telegraph* of February 4, 1973, and saw that it mentioned Bracewell, which awakened his interest in the matter. McVittie also attacked Lunan's "co-investigator" "Mr. Anthony Lawton of E.M.I." McVittie went on to criticise the press, the BBC, and all media, saying: "… I have noticed that the media are uninterested in the validity of the evidence for an assertion in astronomy but are only concerned with the amount of sensationalism that can be extracted from the assertion". The passionate and *ad hominem* nature of McVittie's comments are the most violent I have ever come across during the 98 years of the relatively calm and polite debate on long delayed echoes. There have during all of those years been strong disagreements, but McVittie is the only person I know of who became positively vicious and who engaged in personal abuse. Duncan Lunan was given right of reply, and defends himself by correcting errors by McVittie and justifying himself and his work. Tony Lawton also replied, defends Lunan, and points out errors in McVittie's letter,

such as for instance McVittie attributing to van der Pol observations which were really made by Størmer, and he insists that no data has been manipulated. Another brief letter appears from John R. Milburn, who points out that as there was no Doppler Shift to the echoes, they could not come from a distant constellation (a point which later became moot when Lunan abandoned that idea, and of course Millburn was absolutely correct on this point). Lawton then wrote a further reply giving far more details and once again defending Lunan. Another letter was published from Raymond Ward saying "I was present at Caxton Hall on 29 March when (Lunan) and Mr. Lawton spoke". He admires them and wonders whether they have heard of an extraordinary phenomenon which occurred "some years ago" with a television transmission, which he recounts as follows: "A TV engineer (in this country, I believe) picked up a picture of a test card which he could not identify, but naturally assumed it was a freak reception of a distant transmitter. However, the test card was eventually identified, and turned out to be that of an American station which had gone off the air some years before! The story went on to speculate about something in space recording TV transmissions and re-broadcasting them afterwards." This letter aroused such interest at *Spaceflight* that the Editor at this point added his own comments, as a result of his own research: "The case was reported in the magazine *Electronics World* in October 1971. At 3:30 p.m. on 4 September 1933, C. W. Bradley of London, England, picked up on his TV set the American call letters KLEE-TV. Later that month, and at various times thereafter, the same letters were observed on TV screens at Atlantic Electronics Ltd., of Lancaster, England. The strange fact (the magazine reported) was that this signal had been sent from Houston, Texas, three years earlier and had never been transmitted again prior to the time it was received in England. In 1950 KLEE-TV became KPRC-TV and no other TV station on this planet has broadcast the call letters KLEE-TV since." A letter was then published from Ross A. Edwards praising Lunan, making some comments about time quanta in whole seconds for the echo delays possibly being used intentionally by the sender or reflector to emphasise that the echoes was not natural phenomena but are intelligently intended, and raising the intriguing question of whether extraterrestrial intelligences would read words and graphs left to right or right to left. And finally Lawton (who has been shown the Edwards letter prior to publication) says that both of the points raised by Edwards "could be the subject of further papers". But he correctly adds that not all echo durations reported as whole second were really whole seconds, because Størmer freely

admitted that the durations were approximate and van der Pol had used a stopwatch. Lawton is especially intrigued with the right to left versus left to right issue, citing examples on Earth such as Arabic and Chinese and making clear this idea needs to be explored.

In 1983, Duncan Lunan published *Man & the Planets*, in which he discussed the Lagrange Points, in which he said:

"… probes have been suggested to sample dust clouds, possibly containing primal Solar System material, observed by Kordylevski [*sic*] in 1961; and permanent satellites there could be valuable because at least one would be outside the Earth's magnetic 'tail' during any solar event. There are mysterious Long-Delayed Echoes (LDEs), first reported in the 1920s, and now shown statistically to emanate from the Equilaterals [Lagrange Points]."

To these remarks he adds this footnote:

"In *Man and the Stars* I investigated Professor R. N. Bracewell's suggestion that LDEs might represent a space probe from another civilisation trying to attract attention. James Strong suggested that such a probe might be in one of the Moon Equilaterals [either L4 or L5]. The 'echoes' were much too loud to be natural reflections, the conventional explanation for more than forty years, and dates and times showed a strong correlation with movements of the equilateral points, especially meridian transits. Working with all known cases of LDE up to 1970, George Sassoon found odds of thousands to one against coincidence. Until then it had been taken for granted that LDEs were atmospheric. Lawton and Newton suggest that they're generated in 'Trojan ionospheres' [at the Lagrange Points, sometimes called Trojan Points], but such stable charged clouds are unlikely and the spaceprobe hypothesis is still in contention, although the 'translations' [i.e., the encoded star maps] I put forward proved invalid."[61]

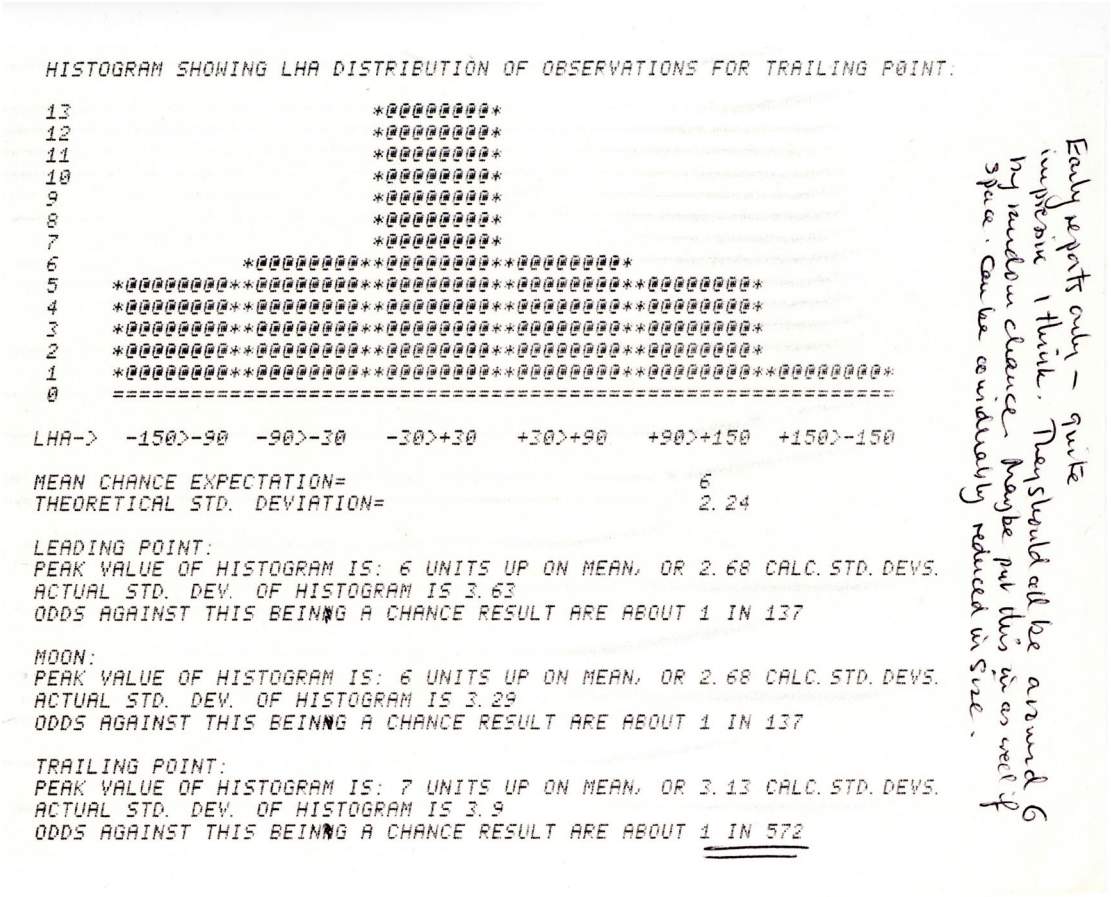
Figure 22. Duncan Lunan.

In 1983 it was still impossible to envisage gigantic charged dust clouds at the Lagrange Points L4 and L5, as we now know to be the case, so all of the uncertainties expressed by Lunan were unavoidable at that time.

But to return to George Sassoon. His intense studies had been conclusive, and made it clear that the radio echoes were coming from L5. He was able to demonstrate that the odds were thousands to one against his being wrong. And it was this finding that led Bracewell to place his "Bracewell Probe" at that spot. L5 is what George preferred to refer to as "the trailing Trojan", a Trojan being another name for a Lagrange Point, and L4 is the "leading one" while L5 is the "trailing one", the first being 60^{o} ahead of the Moon and the latter being 60^{o} behind the Moon as seen from the Earth, with L4, the Moon, and L5 all moving in synch in the sky over our heads.

Figure 23. A photo I took of George Sassoon one evening when he came to dinner at our house. After dinner, while sitting at the dining table, he sang passionate gypsy songs in fluent Serbo-Croat and accompanied himself expertly on his accordion.

Below is a printout histogram given to me by George, with his comments written in the margin. One must remember that he was using equipment of the late 1970s, so it looks primitive today. These were some early results, and show that the odds were 1 to 572 that the signals had to be coming from L5 ("the trailing point") at that stage in his research. The odds later improved substantially, becoming thousands to one.



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HISTOGRAM SHOWING LHA DISTRIBUTION OF OBSERVATIONS FOR TRAILING POINT:

13                          *@@@@@@@@@@*
12                          *@@@@@@@@@@*
11                          *@@@@@@@@@@*
10                          *@@@@@@@@@@*
9                           *@@@@@@@@@@*
8                           *@@@@@@@@@@*
7                           *@@@@@@@@@@*
6                *@@@@@@@@@@*@@@@@@@@@@*@@@@@@@@@@*
5      *@@@@@@@@@@*@@@@@@@@@@*@@@@@@@@@@*@@@@@@@@@@*@@@@@@@@@@*
4      *@@@@@@@@@@*@@@@@@@@@@*@@@@@@@@@@*@@@@@@@@@@*@@@@@@@@@@*
3      *@@@@@@@@@@*@@@@@@@@@@*@@@@@@@@@@*@@@@@@@@@@*@@@@@@@@@@*
2      *@@@@@@@@@@*@@@@@@@@@@*@@@@@@@@@@*@@@@@@@@@@*@@@@@@@@@@*
1      *@@@@@@@@@@*@@@@@@@@@@*@@@@@@@@@@*@@@@@@@@@@*@@@@@@@@@@*
0      ==========================================================

LHA->  -150>-90  -90>-30   -30>+30   +30>+90   +90>+150  +150>-150

MEAN CHANCE EXPECTATION=                              6
THEORETICAL STD. DEVIATION=                           2.24

LEADING POINT:
PEAK VALUE OF HISTOGRAM IS: 6 UNITS UP ON MEAN, OR 2.68 CALC. STD. DEVS.
ACTUAL STD. DEV. OF HISTOGRAM IS 3.63
ODDS AGAINST THIS BEING A CHANCE RESULT ARE ABOUT 1 IN 137

MOON:
PEAK VALUE OF HISTOGRAM IS: 6 UNITS UP ON MEAN, OR 2.68 CALC. STD. DEVS.
ACTUAL STD. DEV. OF HISTOGRAM IS 3.29
ODDS AGAINST THIS BEING A CHANCE RESULT ARE ABOUT 1 IN 137

TRAILING POINT:
PEAK VALUE OF HISTOGRAM IS: 7 UNITS UP ON MEAN, OR 3.13 CALC. STD. DEVS.
ACTUAL STD. DEV. OF HISTOGRAM IS 3.9
ODDS AGAINST THIS BEING A CHANCE RESULT ARE ABOUT 1 IN 572
```

Early reports only – quite impressive I think. They should all be around 6 by random chance. Maybe put this in as well if space. Can be considerably reduced in size.

Figure 24. An early calculation by George Sassoon, with his handwritten comments to me in the margin, showing that the signals were coming from L5 ("the Trailing Point"). As his research progressed, the odds increased a great deal, and became thousands to one.

In 1979 Donald B. Muldrew, a Canadian Government scientist, published a lengthy article in the *Journal of Geophysical Research*, entitled "Generation of Long-Delay Echoes".[6263] He begins by saying: "Long-delay echoes (LDE), defined as radio echoes received seconds after transmission, have been reported in the literature almost from the discovery of the ionosphere to the present time." In his very next sentence he says the first observations were apparently made by Hals, and refers to a 1934 publication as a reference, This has the unfortunate effect of seeming not to acknowledge that they were made in 1927, and one needs to be alert to realize that Muldrew is merely being very careless in his exposition. If he had only added the words "in 1927" to his text this confusion could have been avoided. (He gives correct dates on the second page.) Muldrew is very scathing about some people and some ideas. He ridicules Duncan Lunan for his star map hypothesis (an idea which originated with Bracewell as a suggestion), which Lunan abandoned. But at the same time he

discards the notion of an extraterrestrial probe (also Bracewell's idea), which is really a separate matter. He dismisses the ideas of Størmer, Rasmussen, Clark, Cohen *et al.* (see discussion of them below in the survey of *QST* contributions.) He dismisses the studies of George Sassoon. Muldrew comes across as one of the least impressive participants in the studies and debate concerning the long delayed echoes, and his habit of scoffing at numerous investigators is not helpful.

In 1975 Peter J. Duffett-Smith published a paper about an automated search he had made for long delayed echoes at three different frequencies.[64] He was not successful.

In October, 1977, an official U.S. Government Report was published. The House of Representatives had a Committee on Science and Technology, and it in turn had a Sub-Committee on Space Science and Applications, the Chairman of which was Congressman Don Fuqua (pronounced "foo-quay"), a Democratic Congressman from Florida (born 1933). He was a space enthusiast and he presided over a Report entitled *Possibility of Intelligent Life Elsewhere in the Universe.* I am fortunate to have an original copy of this Report of 123 pages. In fact, the Report had originally been published in 1975, and this 1977 edition was revised and expanded and hence is the correct one to which to refer. Among the interesting things revealed in this Report is that NASA had an Interstellar Communication Study Group, a fact not widely known! The Report has a section on Unmanned Probes, and on page 73 we read the following:

"*The Bracewell Model.* Ronald Bracewell, a radio astronomer at Stanford University, suggested as early as 1960 that radio signals are an uneconomical way to contact other civilisations, recommending unmanned automatic probes as an alternative.

"He envisions a galactic communication network linking many established technical civilizations. The nearest one to our solar system would spray an area of some thousand stars with 'modest' probes which would enter circular orbits around their destination stars, within the habitable zone. 'Such a probe may be here now, in our solar system, trying to make its presence known to us.'

"The process foreseen by Bracewell would have the probe equipped with a radio transmitter. It would listen for intelligent

radio signals from us, discovering what wavelength to transmit on, and then repeat what it had heard back to us. On Earth, thee signals would appear as echoes with a delay factor of seconds or minutes, depending on how far away the probe was, 'such as were reported 30 years ago by Stormer and Van de Pol and never explained'.

"We would eventually recognize that a probe was trying to contact us, and respond by repeating the message once more to let the probe know we were aware of it. The probe would then begin transmitting its message, with occasional checks to ensure it had not set below the horizon. Bracewell suggests that the first message might be a television image of a constellation showing the probe's home port."

From this, we can see that the long delayed echoes were accepted by Congress, on the word of Bracewell, as perfectly respectable phenomena which could be connected with SETI. And this was as long ago as the 1970s.

There were many detailed discussions and speculations which took place in the 1970s. I became actively involved at the end of the 1970s because I was editing a magazine dealing with the frontiers of science and I worked with George, Duncan, Tony, and Bracewell in trying to put together a thorough account of the long-delayed echoes. George wrote an article commissioned by myself entitled "Long Delayed Radio Echoes – Signals from an Extraterrestrial Probe?" which appeared in the March, 1979, issue of the American popular science magazine *Second Look* (pages 3-5 and 21). In his article, George heavily criticised a report on LDEs written by Derek M. Sears and colleagues of the Plasma Physics Laboratory of Stanford University which attempted to play down the LDE phenomenon.[65] He pointed out that Sears's paper was circulated to numerous high-level government entities such as the Electronic Warfare Lab at White Sands, the U.S. Army Missile Command, and the National Security Agency. George commented:

"It seems remarkable that the military should be interested in an obscure natural phenomenon, which occurs so rarely that it could never have any significant effect on radio communications."

My co-editor of *Second Look* wrote to the National Security Agency asking what information they had about LDEs. He received a

reply dated 27 March 1979 (marked Serial: N 9108) from Charles W. Sullivan of the Policy Staff stating:

"We have made a thorough search and are unable to locate any information relating to Long Delay Radio Echoes in this Agency's files."

We know that must be a lie because, unknown to Mr. Sullivan, we already knew that the first Sears Report had been specially sent to them and other agencies in 1970 and its sequel report in 1974 (see below). Of course it will come as no surprise today, now that we all know much more about the NSA, to see them denying any knowledge of LDEs. The important point of this is that when the NSA lies, it means there is something sensitive there which they wish to conceal at all costs. So it is obvious from this that the NSA and related official bodies took the matter very seriously, so seriously indeed that they entered into their default mode of denial about it.

And if I may make a sarcastic observation: if the NSA, which is supposed to be able to detect every signal of any kind, did not know about LDEs, it would be a pretty incompetent organisation. But since it is not an incompetent organisation, it must know about LDEs. QED. (A mathematical proof.)

In 1974, Sears followed up his 1970 report by publishing a further report on the echoes which was the one which especially upset George Sassoon.[66]

In 1975 the L-5 Society was formed in America, the name referring to the L5 Lagrange Point. I became a member of the Society in 1980 or earlier. The Society was formed to support the initiatives for space colonization of our good friend Professor Gerard ("Gerry") K. O'Neill of Princeton University. Gerry had founded the Space Studies Institute, of which I was also a member, and had designed a space colony which he wanted to see constructed at L5 for gravitational reasons. In our many discussions, including when we stayed with him and Tasha in Princeton, Gerry never mentioned to me anything about the Kordylewski Clouds, so that if he knew of them he had dismissed them from his mind because they were at that point unconfirmed. An interesting account of the formation of the L5 Society may be found in the book *Worlds Beyond*, edited by the New Dimensions Foundation, published by And/Or Press in the USA in 1978. The book is an anthology and the account of L5 was written by

Keith and Carolyn Henson, the founders of the Society (pages 105-114). I personally knew several of the contributors to this volume, including Bucky Fuller, whom I first met in 1966 in Maine, where I stayed overnight on his private island. I never knew the Hensons.

In 1979 as joint editor of the magazine *Second Look*, I commissioned and published an article by Ronald Bracewell entitled "Methods of Planet Detection", dealing with possible techniques for searching for planets around other stars, a problem which seemed intractable then but has long been solved in the intervening years with the launching of space telescopes (which in his article Bracewell anticipated happening by 1983).[67] At the risk of being immodest, I can mention that in his article Bracewell made favourable reference to my first book. We enjoyed congenial correspondence over a period of time but never met. In the article just mentioned, long delayed echoes were not mentioned.

***QST* is the name of a magazine for amateur radio enthusiasts, known as radio hams, which commenced publication in December, 1915, and continues to this day. It is published by the American Radio Relay League (ARRL), which at the end of 2021 had 158,238 members. The initials QST stand for 'calling all stations', which is known as the 'Q Signal'. Radio hams are an extremely large international community, and they tend to know each other not by their names but by their registered personal call signs. We must recall that the long delayed echoes were first noted by a radio ham, and hence is it not surprising that various comments about the echoes have appeared in *QST* from time to time. And several of the distinguished scientists and professors who have studied the echoes were also radio hams themselves. The comments in *QST* about the echoes commenced in 1934:**

1934. <u>August issue</u>. John Howard Dellinger (1886 – 1962). His public appeal. (This has already been discussed above.)

1969. <u>May issue</u>, pages 38-43. This issue of *QST* contains a six page article by Oswald ("Mike") Garrison Villard, Jr. (W6QYT, a Trustee of the Radioscience Laboratory at Stanford University), Calvin R. Graf (W5LFM, affiliated with the US Air Force as an expert on nuclear explosions), and James M. Lomasney (WA6NIL, a specialist radio engineer at the Stanford Research Institute), entitled "Long-Delayed Echoes … Radio's 'Flying Saucer' Effect".[68] The paper acknowledges that the research was part funded by the Office of

Naval Research, contracts Nonr-225(24) and Nonr-225(64), which means that US Naval Intelligence was sponsoring the work, and Graf must have been seconded from US Air Force Intelligence. It contains the following notice in a box at the beginning of the article: "Amateur help is needed in unravelling the mystery of signal 'echoes' which persist for times much longer than round-the-world propagation delays. This baffling and unexplained effect wherein whole words – and not just syllables – are repeated, was first reported in 1928, and occurs so rarely that many doubt its reality. Interest in the subject has been reawakened by recent discoveries in plasma physics which – if applied to the ionosphere- suggest new possible explanations. The authors review the reports known to them, suggest that the effect is real, and solicit further observations."

The authors thus in the 1960s renew the public request for information first made by Appleton in the 1930s. And this time the request was ultimately on behalf of the advanced research departments of the US Navy and the US Air Force. Nothing could be clearer in demonstrating the intense interest in the long delayed echoes of the US Government by this time. As this work was done nearly half a century ago, a Freedom of Information request for the contracts might tell us much about the thinking of the authorities then.

The authors cite an otherwise unknown source in their footnotes: *Quarterly Status Reports, Tri-Service Contract Nonr-225(24)* NR [*which must mean Naval Research*] 373 360, Stanford Electronics Laboratories, Stanford, California. See Reports 17-25, covering the period October, 1958 – December, 1960. In other words, work on the long delayed echoes for US Naval Intelligence at Stanford University was being funded at least as early as October, 1958. It should be remembered that Professor Bracewell and Professor F W. Crawford were both at Stanford University.

Here is how this article begins:

"Have you ever had the experience of hearing your own voice repeat the last couple of words of your transmission, after you have switched over to receive? Or have you been aware, after another station stands by, that a weaker signal on the same frequency is repeating the last few words of the transmission, with exactly the same 'fist'? [*In ham radio, if an operator sends clear Morse code*

***which is easily readable, he is said to have "a good fist", whereas if it is unclear, he is said to have "a bad fist".*]**

"Well, believe it or not, some amateurs have. If you, dear reader, think us out of our minds to even bring this matter up, rest assured that there are many others who share your view and would cheerfully consign us to the booby hatch [*old-fashioned slang for place for crazy people*]. If you haven't tuned out by now, you are undoubtedly asking: just who are the folk who have had this experience? Are they emotionally unstable types, prone to LSD-style hallucinations? But hear this: one is a professor of mathematics at a Midwest research foundation, still another has managerial responsibility for important communication satellite programs at a prominent West Coast aerospace corporation, and most of the rest have a professional connection with electronics in some way."

The authors give some history and background and then say:

"… the Cavendish Laboratory of Cambridge University undertook a study in 1948 … In a careful year-long test involving transmission of 27,000 test signals at 13.4 and 20.6 MHz, not one LDE was recorded.[69] No further published scientific research seems to have taken place since that time."

The article is very long and contains numerous illustrations, charts and read-outs. At one point the authors record this incident:

"The almost universal reaction to hearing a good LDE is total astonishment. For this reason the memory tends to be fresh even after the passage of years. Some of the reports convey this feeling quite dramatically. According to W6OL, 'I was just tuning the band, listening, and heard this Russian working someone. There was some slight QRM [*human-generated interference*] on his transmission but the copy was reasonably good. However, I heard him sign and then I realized that the QRM was his echo, and that I could again copy the last part of the transmission.' Says W6KPC, who heard 'whole words, if they were not too long, … the echo was so loud, long, and startling that my reaction was to 'talk' about it with someone! … I've never heard such long echoes before or since.' In W6ADI's words, 'I was calling ON4AU on 28 Mc. and switched over to listen and heard on my own frequency ON4Au de W6ADP K. Was very weird and never will forget it. Signal sounded like it was coming a long way but was 86 or so.'"

The article discusses the ionosphere and many matters, but here is the most important part of the article in terms of useful conclusions:

"Summary of Characteristics

"The Stanford recordings suggested – but did not prove – that incoherent noise 'echoes' may exist, as well as coherent ones containing a replica of the signal. The amateur and the early reports, of course, deal only with the coherent variety, which seem to be appreciably less frequent in occurrence. Following is a summary of the conclusions which can be derived from the ham reports taken as a group:

1) **Multiple-second 'coherent' signal echoes, either phone or c.w. [*'continuous wave', i.e. using Morse Code*], appear to be real, and are observable for short periods of time at highly infrequent intervals.**
2) **They are audible both on a station's own signals, and on signals of other stations,**
3) **They have been observed at 7, 14, 21, and 28 MHz, but apparently not at higher frequencies,**
4) **They either occur most frequently (or perhaps are most easily heard) when a given band is just 'opening up' – i.e., when skywave propagation to some point on earth is just becoming possible,**
5) **They seem to be audible when long-distance propagation is good, and when geomagnetic activity is low. (The presence of long-path as well as short-path propagation, or signals from stations at antipodal locations, is apparently a good omen.)**
6) **Stations reporting LDEs typically have been ones having antennas well up in the air, at locations reasonably good for DX [*distant contact*], but other than that no exceptional facilities seem to be required.**
7) **An active ham who DXes [*engages in distant contacts*] one or two hours a day, may expect to hear an LDE once a year, on the average.**
8) **The LDEs appear to be one single echo, rather than several successive ones.**
9) **No Doppler shift is perceptible.**
10) **The sound of the echo resembles that of a DX signal (i.e., it apparently involves long-distance multipath propagation.)**
11) **The strength is usually weak, although some reports have put it at S3 or more.**

12) Echo strength always decays with time, rather than the other way around.
13) The total time interval during which the echo effect can be heard is remarkably short - usually no more than a few minutes.
14) There is some indication that LDEs may be heard more frequently on signals which have travelled through the northern and southern auroral zones."

It is most unfortunate that this crucial list appears never to have been reprinted anywhere, and has only been seen by those who have consulted this 1969 publication itself, which today must be practically no one.

1970. <u>February issue</u>, pages 30-36. Villard, Graf, and Lomasney again:

These three authors published a follow-up article in the same journal several months later, in the February, 1970, issue.[70] This time an air of excitement permeated the article. It begins by describing an important LDE experience, and I do not quote the account because it is expressed in so much technical jargon, but it was 'an exact repeat' of a transmission. The authors then say:

"Sounds spooky? You bet. This was WB6VKV's initiation into a very exclusive club: those who have heard long-delayed echoes, or LDEs. The authors know of only about 50 other members in all, and they would very much like to add to the list, because LDEs are just possibly one of the world's 'longest-delayed' radio mysteries, having first been discovered in 1927 [*43 years before the article*]. It seems to be time that *somebody* tried to figure out what nature is trying to tell us in this way…. The 'delays' are really impressive. For example, WB6VKV timed himself with a watch, as he simulated sending the above letters, and got a delay of 11 seconds. It takes only one-seventh of a second for a signal to travel all the way around the earth. Where had that signal been all that time, and why was only *one* echo heard? … how in the world can nature "store" signals that long? … LDEs are not just an anachronism from the 1930a; they still happen, and they still need to be explained. … The diversity of reported effects is impressive. In longitude, the locations at which LDEs have been heard range from Africa to the Marshall Islands; in latitude from Peru to Canada. The reported delays range from fractions of a second to over five minutes. The radio frequencies at which echoes

appear extend all the way from 810 kHz up through 144 MHz. A purpose of this article is to list what has been reported, in the hope that it may stir latent memories and/or stimulate future observations."

Then follows a two page table listing 46 detections of echoes with full details of each: name of person, call sign, date, time, band, durations, and numbers of times the echoes were heard (some were heard twice, for instance), etc. These reports were from all over the world, including Peru, Columbia, and Libya. The authors call for more reports to be sent to them at the Radioscience Laboratory at Stanford University. The authors thank the Office of Naval Research under Contract Nonr-225(64) and the Advanced Projects Agency [*of the Pentagon*] for financial support.

1971. There were two contributions in two issues of *QST*:

<u>May issue</u>, pages 54-58. This year Villard again went into print in the May 1971 issue of the magazine, but with two different colleagues this time: Antony C. Fraser-Smith and R. P. Cassam, both of the Department of Electrical Engineering at Stanford.[71] In this article they published a table of one and a half pages listing 38 new reports of long delayed echoes, in the same format as the previous article. This is a lengthy paper with charts by Villard, Fraser-Smith, and Cassam, with one and a half pages of tables of detected echoes, with names, dates, delays and durations. Some of the echo delay times in this list are remarkably long. The longest delay was of three to four minutes (in Ohio), there was one of 2 minutes (in Canada), two of one minute (in Florida and Michigan), and so on. Foreign reports include Australia, Mexico, Argentina, England, and one from shipboard north of Guam. This time the authors suggest the possibility that the echoes are coming from an alien probe in orbit near Earth, pointing out that their colleague at Stanford, Professor Bracewell, had first suggested this in 1961. Now, ten years later, these three men have this to say about that idea:

"Frankly, the chances seem very good that the eventual explanation for the LDEs will prove quite unspectacular. But at the moment it must be admitted that the cosmic probe hypothesis, although it has some drawbacks, is about as good an explanation for the really long-delayed echoes … as anything else which has been postulated." And once again, the authors thank the Office of Naval

Research and the Advanced Projects Agency (*of the Pentagon*) for financial support. Funding for this study was supplied by the Office of Naval Research and ARPA (now known as DARPA).

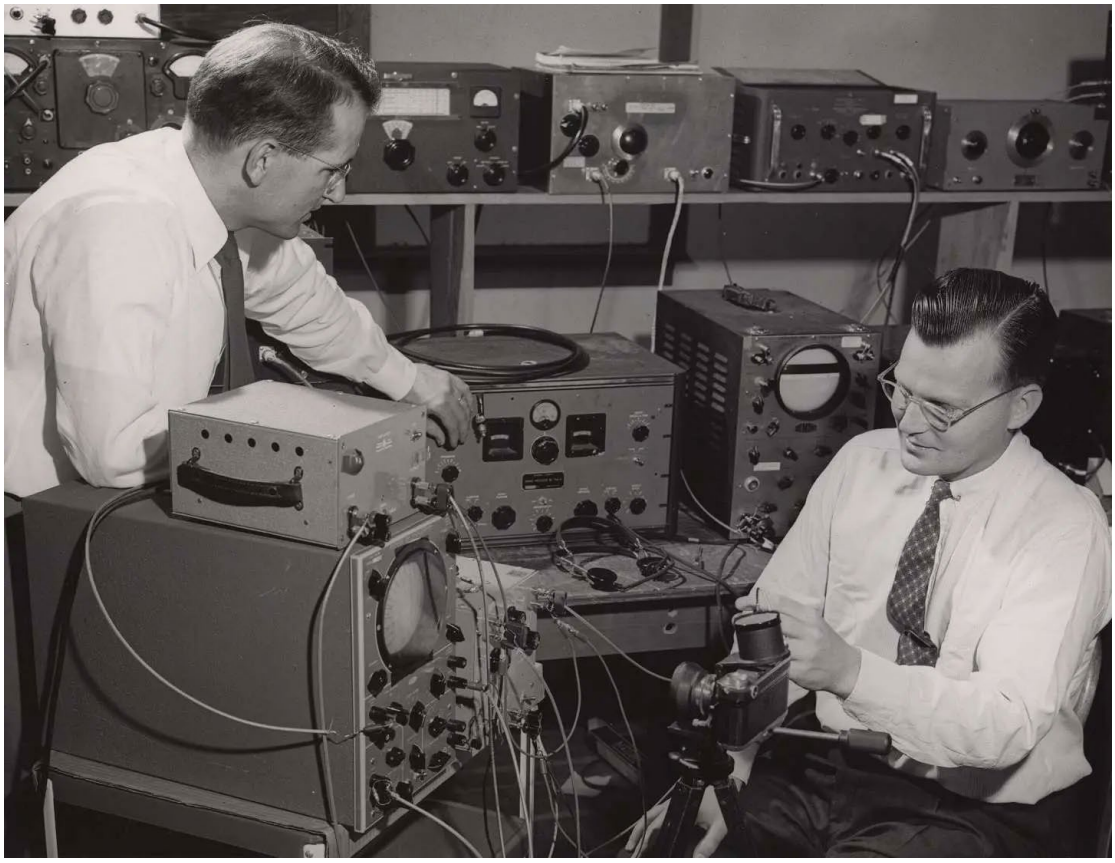

Figure 25. At right is Oswald ("Mike") Garrison Villard, Junior, tending to the equipment which he and his colleague Allen M. Peterson (at left) used to record meteors in the ionosphere in 1950. By 1959 Villard had carried that work to such an extent that he was able to invent over-the-horizon radar, which revolutionized the international political situation, since it enabled America to detect missile launches in the Soviet Union which were far below the horizon of the Earth and invisible by means of radar otherwise. Not satisfied with that great achievement, Villard went on to help perfect the stealth technology used to make military aircraft undetectable by radar. In other words, we owe to him and his colleagues all the stealth fighter planes and stealth bombers of today. For such a busy man to take a prolonged and deep interest in the long delayed echoes is a sign of how important defence scientists have long known them to be, and how desperate they have been to try to explain them.

November issue, pages 40-41, and 45. C. R. Clark WB4O BZ, "Two Possible Explanations for LDEs". The author lived at Moncks Corner, South Carolina. A drawing showing the Lagrange Points accompanies the article. The author suggests that echoes exceeding two and a half seconds may be coming from "a reflector in space" at one of the Lagrange points. He believes that the reflector could be "a cloud of ionised gas". He suggests that L2 is the most likely point for this, but he points out that L4 and L5 are stable and it could be one of them. He calls for all members of the ham radio fraternity to send in echo reports to the Radioscience Laboratory at Stanford University "which has been collecting reports and will be grateful for all they receive". He calls for people to make tape recordings of the echoes and send them to Stanford.

In 1976 there were four contributions in two issues of *QST*:

May issue, pages 54-58. This contribution is by Oswald G. ("Mike") Villard, Jr., Anthony C. Fraser-Smith, and R. P. Cassam. It is entitled: "LDEs, Hoaxes, and the Cosmic Repeater Hypothesis" (because possible hoaxes are included in the discussion, though are not a main feature of the paper). This paper has an extensive pre-history, and is only a portion of a study commissioned from the US Office of Naval Research (Contract Number N00014-67-A-0112-O066) by the Advanced Research Projects Agency (ARPA, which later was called DARPA), Order Number 1733, Program Code No. 1K20. It is described as Technical Report Number 2 and is marked Unclasssified. The Originator's Report Number is SU-SEL-71-030,TR No. 2. Stamped for the files is the identifying numberAD726735, giving the date July 26, 1971, as the *QST* paper is attached in the report. The work was carried out by the Radioscience Laboratory of the Stanford Electronics Laboratory at Stanford University. (The report itself was delivered in May 1971, a total of 9 pages.) The Principal Investigator is listed as Villard, and his direct phone number is given. The Scientific Officer is described as: Director, Field Projects Programs, Code 418, Office of Naval Research, Arlington, Virginia 22217. Only part of the report was published in *QST*. The summary of the report itself starts by saying: "Thirty-eight additional radio amateur reports of the long-delayed echo (LDE) effect are listed, bringing the grand total to 90 in our reported series." This means that 90 LDE reports were studied by this team up to May, 1971, and the authors refer to their earlier publications in the May, 1969, issue and the February, 1970, issue of *QST*. In this paper the authors take very seriously indeed the

suggestion by their Stanford colleague, Professor Ronald Bracewell, that a cosmic probe has been sending back the echoes to call attention to itself (what they call "The Repeater Hypothesis"). The report summary, which does not appear in *QST*, says: "A new manifestation of the effect is reported here for the first time. It is a situation in which the *only* communication path between a given transmitter and a certain receiver behaved as if it contained a delay of several seconds. (There was no 'echo' as such, to attract attention.) If confirmed by similar observations, this report represents an important clue as to the causative mechanism. A further evidence of the reality of the LDE effect, the [published] article reproduces an original log entry describing a typical LDE observed in Australia in 1937. Hoaxes, and their recognition, are discussed. In the authors' view, the extraterrestrial hypothesis in explanation of the very long delays is at the moment as plausible as any other."

It is very important to stress that by May, 1976, at the latest, ARPA (Advanced Research Projects Agency, now known as DARPA with the D added for Defence, though it may need to be renamed again since the Department of Defence has been renamed the Department of War, and become WARPA), the most advanced and secret research organisation within the American Government, had fully accepted that the long delayed echoes might be caused by some kind of intelligent extraterrestrial intervention as a means of signalling to humanity. Of course, at that stage, the thinking was that there must be a physical alien probe performing this function. Not enough was known at that date about dusty complex plasma clouds, nor had the Kordylewski Clouds been officially confirmed. What is remarkable, however, is that these conclusions were reached *fifty years ago.* That should give us all considerable cause for serious thought.

Continuing with our survey of this important 1976 article in its published form, we read: "The grand total of usable reports is now in the 90s, and the picture which is building up is fascinating in its complexity. … Frankly, the chances seem very good that the eventual explanation for LDEs will prove quite unspectacular. But at the moment it must be admitted that the cosmic probe hypothesis [of Bracewell, whom they mention by name earlier], although it has some drawbacks, is about as good an explanation for the really long-delayed echoes … as anything else that has been postulated." The article contains three pages listing reports received from various ham radio operators, by way of providing supporting data.

<u>June issue</u>, page 36. The first contribution is "Long-Delayed Echoes on EME Circuit" by Howard O. Lorenzen W3BLC. "EME" stands for Earth-Moon-Earth signalling, also known as "moonbouncing". Many ham operators enjoyed sending signals to the Moon and having them bounce back. But an anomalous result in doing this was obtained by Hans Lohmann Rasmussen, a friend of Lorenzen's. Rasmussen had received echoes of signals which he had sent to the Moon, which were delayed coming back from the Moon by two extra seconds. Moonbouncing was so familiar a practice that something like this was supposed to be physically impossible. Lorenzen says that Rasmussen "reported receiving echoes delayed an additional two seconds after his normal EME echoes at 1296 MHz were received from the Moon. Hans sent me a copy of his findings and after I circulated them to Dick Turrin, W21MU, and Bob Burns, WA2HVA, both of Bell Laboratories, and James H. Trexler of the Naval Research Laboratory, the response was unanimous that he should report this unique event in one of the scientific journals. It later appeared in *Nature* Magazine. ["Ghost echoes on the Earth-Moon Path", *Nature*, Volume 257, 1975, page 35.] Following his own letter Lorenzen attached a letter from Rasmussen, which then forms the second contribution, entitled "Ghost Echoes on 1296 MHZ". Rasmussen says: "In the middle of the summer of 1974, I had a very queer experience while working moonbounce on 1296 MHz. … out from the speaker came a second echo signal. It was a hoarse whispering signal with the true characteristics of the signal I had just received from the moon." (*His signal had a strange 'chirp' which was instantly recognisable.*) He continues: "I was so surprised that for some time I stood stiff and listened for what would follow. But nothing more came, so I keyed a new signal and waited. In came the moon echo, and the ghost echo about two seconds later – with my transmitter chirp and everything. Again and again I drew echoes, and apparently there was no Doppler shift [which means the reflector was stationary and not moving] and certainly no beat tone on the signal. … For twenty minutes I kept working both echoes and this sinister signal kept coming in without any change." The third contribution is from Alan K. Goodacre VE2AEJ, entitled "More Ghost Echoes". He writes: "Rasmussen's recent report of ghost echoes while conducting moonbounce tests reminded me of an experience I had in the late 1960s in connection with moonbounce test on 144 MHz. … These nonlunar echoes were too weak and transitory to document properly in the scientific literature at that time but I mention them now as there seems to be increasing evidence of long-delay echoes of nonlunar origin."

This same Alan K. Goodacre wrote about the echoes again in. *QST* in 1980, and in the same year wrote about them in the *Journal of Geophysical Research*, and in 1990 contributed an article "An Unusual Long-Delay Echo" in *Nature*, Volume 347, 1990, page 131. Goodacre is a Canadian geophysicist, and today is retired from the Dominion Observatory in Canada.
(Note: "Radio echoes from the moon were first obtained in 1946, by a U. S. Army Signal Corps team. Their achievement was heralded in the world press. *Time* mused that this longest distance human communication said nothing. Held to kilowatt power levels, it was 1953 before radio amateurs were successful in receiving their own echoes. From its simple beginnings, the moonbounce work developed into the field now known as radar astronomy – study of the solar system using controlled radio waves. … Radar echoes were obtained from Venus in 1961, Mercury in 1962, and Mars in the following year. The frontier now [1978] is at the satellites of Jupiter and the rings of Saturn. With recent developments in hobbyist computers, EVE (Earth-Venus-Earth) experiments are now within the range of radio amateurs."[72])

Figure 26. Moonbounces (EMEs) have always been a source of great excitement to ham radio operators. Here we have a ham magazine cover celebrating the fact that some ham operators had been able to make use of the Jodrell Bank radiotelescope to do some moonbouncing in 2007.

<u>September issue</u>, page 31. Antone Garibaldi sent a letter entitled "Ghost Echoes, Phase 2", saying: "… Rasmussen … reports a second moon echo which was delayed an additional two seconds and heard for 20 minutes of operating time. He attributes this echo to an ionized cloud of particles, emitted by the sun and travelling towards the earth at approximately 1000 kilometers per second, the front of which is the reflector. I do not think this is the case. The two-second time delay from the moon echo would seem to indicate the reflector could not be located more than approximately 186,000 miles beyond the moon. If the reflector is the ionized cloud moving toward earth at 1000 milometers per second, the time delay should decrease noticeably in a few minutes of observation and the received echo should be somewhat higher in frequency because of Doppler effect." [*Note: This Antone Garibaldi, born circa 1942, is not the same person as Antoine Garibaldi the university president.*]

In 1977 there was one contribution concerning long delayed echoes:

<u>March issue,</u> page 43, under Technical Correspondence. It was by Don Fletcher K4KCK, and was entitled "Ghost Echoes Again ... *Echoes Again*". He refers to the Rasmussen and Garibaldi contributions of the previous year. His discussion largely consists of ideas concerning the proposed ionised cloud acting as a reflector, and he thinks it might be moving, He finished by saying: "LDE data could be used to map ionized clouds to aid solar scientists. It appears that OZ9CR's [Rasmussen's] observation and conclusions may be a significant discovery."

In 1978 there were five contributions in three issues of *QST* concerning long delayed echoes:

<u>February issue</u>, pages 17-17, and also page 19. The first contribution is "A Long-Delayed Echo Revisited" by Nathaniel Cohen N1IR, Jonathan David WA1TCL, and Franklin Davis WA1TCK. The subtitle points out that LDEs "have been one of amateur radio's longest standing and most intriguing mysteries". The article begins by saying: "Long-delayed echoes have been an exciting topic of conversation among radio amateurs for years and reports of several score [*a 'score' is an English expression meaning 20*] observations have appeared in *QST*." Several of these are listed in footnotes referring to *QST* in 1969, 1970, 1971, 1976, and 1977. The initial reference is to a report by Hans Rasmussen OZ9CR detecting echoes

on July 7, 1974. The authors dismiss suggestions that solar ejections are involved, or that the LDEs are connected with the zodiacal light. They suggest that the echoes are coming from a "large area containing many small sized (1/2-micron) particles … dust swarms which can form semi-stable orbits … For the echoes of OZ9CR the cloud-swarm must had had an angular size of at least on the order of the beam size and greater than 20,000 km across … Clearly much work remains to be done to yield understanding of the LDE phenomenon. … we suggest that more LDE work be done at uhf and vhf … Although the Lagrange points need not be the only places to look, they are good places to begin." The second contribution is "More reflections of LDEs" subtitled "Solar wind? Plasma clouds?" The author is Richard Simpson W6JTH. Whereas the previous article had suggested moving plasma clouds, Simpson strongly disagrees and says the plasma cloud cannot be moving, as there is no Doppler shift. He says: "Rasmussen observed his ghost for at least 20 minutes and detected no change whatsoever in its position … One infers from this that the reflector was stationary with respect to the observer." Simpson says the electron density of the cloud must be greater than that of the ionosphere. He says: "To reach a critical frequency of 1296 MHz one must have an electron density of 2 x 10^{10} [electrons per cubic centimetre]." (Of course, Simpson is assuming only electrons are present and this calculation does not include protons and ions.)

<u>May issue</u>, pages 35-36. Under Technical Correspondence, there is one letter with an illustration of readings, followed by a reply. The first letter is from John Yurek K3PGP. He reports several echoes, with up to 6 second delays. He then reports the following bizarre experience: "I was confronted with two signals sending the same data on slightly different frequencies with one slightly delayed in time from the other. To make things worse, the two signals would fade at different times and sometimes be the same strength. Needless to say, I was very confused!" A reply followed from three men at Stanford Research Institute, Victor R. Frank K6FV, James M. Lomasney WA6NIL, and Oswald O. Villard Jr. W6 QYT. They say they have managed to prove that Yurek's findings are definitely not twice-delayed moon echoes and say: "We are thus at a loss to explain your (echoes) based on any known geophysical phenomena." They urge Yurek to "publish your observations and see if any of the amateur fraternity can come up with answers or similar observations."

<u>October issue</u>, page 35, A one paragraph letter, accompanied by an interesting diagram, appeared under Technological Correspondence: Henry C. Wolking, W4BNF, of Florida raised the matter of the solar wind. He wondered whether a highly compressed magnetic area "at some distance from the Earth" full of ions from the solar wind (what we would now call a charged plasma cloud) could be reflecting the radio broadcasts. This is a truly remarkable intuitive anticipation of the Kordylewski Clouds! Mr. Wolking deserves a gold star for this guess.

In 1980 there were two articles in two issues about long delayed echoes:

<u>1980. March issue</u>, Alan K. Goodacre VE2AEJ/3 in Ottawa, Canada (although in June of 1976 he had the call sign VE3HX; see account of him for 1976 *QST*)), contributed an article entitled "Observations of Long Delayed Echoes on 28 MHz", pages 13-16, with 14 photographic reproductions of signal displays of long delayed echoes, two data plots, and a list of eight delay times for echoes which he received ranging from 1.53 seconds to 8.97 seconds. The sub-title of his article is "The LDE mystery solved?" He says in the text of his article that echoes detected by him in Canada ranged as high as 17 seconds delay time, and that those echoes were of signals sent at 50 MHz. He says he thinks "some sort of periodic structure may exist in the delay times". He believes that for the echoes which he detected the delay times all seemed to be in multiples of 138 milli-seconds. This certainly was a first for such a suggestion. However, when his signals were sent at 14 MHz, the echoes seemed to have delays of in multiples of either 133 milli-seconds or 144 milli-seconds. He says: "While operating for a total of about eight hours from the middle of November 1978 to the middle of January 1979 I obtained a few echoes that are sufficiently strong and clear to be displayed photographically." (These are the 14 photographs referred to earlier.) Two of the photographs "show what appear to be two echoes originating from the same transmitted pulse". In his conclusions Goodacre states: "Finally, although I believe that the delay times of long-delayed echoes are quantised, the actual value of the time quantum may be different under different circumstances." In addition to the periodicities already mentioned, he mentions other time quanta of 120 Milli-seconds, 136 milli-seconds, 115 milli-seconds, and 160 milli-seconds. He is inclined to attribute the echoes to atmospheric ducts. However, it must be said that there seem to be far too many different "time quanta" proposed, and that the

multiplicity of them suggest at least to me that the idea that the delay times are quantised in any kind of regular manner is disproved by the fact that the quanta vary to such an extent that the quantisation idea is rendered meaningless. Goodacre wrote a similar article which appeared in the May, 1980, issue of the *Journal of Geophysical Research: Space Physics*, Volume 85, Issue A5, pages 2329-2334. Once again he emphasized the idea of multiples of time quanta of 138 milli-seconds, which he emphasises is the time taken for a radio wave to travel round the world. He speculates that his signals may have been trapped in "interlayer ionospheric ducts". Obviously, echoes of such extremely brief delays are by definition not long delayed and appear to be a separate phenomenon from long delayed echoes.

June issue, page 39-43. Oswald Villard, Jr., who was so prominent in research into the long delayed echoes (see for instance the October, 1980, issue), published a remarkable article in this issue about his most famous (public) invention: "Over-the-Horizon or Ionospheric Radar". The article is very well illustrated. It is surprising that he was permitted to say so much about this subject, considering its defence implications and the extreme secrecy of some of the technology. Villard was a keen ham operator and seems to have had a great affection for *QST*, to which he contributed numerous times. This article will be of great interest to those interested in Villard, who also helped develop the stealth technology for aircraft.

October issue, pages 11-14. Oswald G. Villard, Junior W6QYT, Donald B. Muldrew, and F. W. Waxham, Junior K7DS, "The Magnetospheric Echo Box – A Type of Long-Delayed Echo Explained". The authors claim to have explained one type of long delayed echoes, namely those with delays of less than one second, as "high frequency wave-trapping in occasionally occurring, tubular magnetospheric 'ducts' (which) stretch from northern to southern hemispheres along the earth's magnetic field-lines". They admit however: "LDEs having time delays in the 0.5-to-30-second range cannot he explained by the ducting phenomenon. Ducts of sufficient length do not exist. … The authors would be very grateful for additional reports of unusual echoes occurring in any frequency band." So, in other words, no real progress had been made. They recommend that vertical antennas be avoided, that the dipole should be oriented east-west, that the best time was between 7 PM and midnight local time, and that "A tape recorder is almost indispensable."

2007. June issue Gene Greneker K4MOG reported that during the morning of February 17, 2006 he heard an echo of his signal at 3.524 MHz coming back over a period of 30 minutes with a repetitive echo delay of between 165 and 168 milli-seconds. He believed it to be a signal travelling round the earth and affected by atmospheric ducts. This appears to have nothing to do with long delayed echoes. Thank you to Sverre Holm for this information,

2009. March issue. Sverre Holm LA3ZA commented briefly on the 2007 report by Gene Greneker, agreeing that magnetospheric ducts were probably involved in the extremely brief echoes detected by Greneker. Thank you to Sverre Holm for this information. There are many reports of such extremely brief echoes, which appear to be a separate phenomenon from the long delayed echoes and may indeed have atmospheric/magnetospheric causes. Clearly, echoes measured in milli-seconds are by definition not long delayed.

2009. November issue, pages 72-3. Paul-Erik Karishøl OZ4UN of Fredensborg, Denmark, published a two page article illustrated with two oscillograph readings entitled "Observation of Long Delayed Echoes on 80 Meters". The article begins like this: "I had an extraordinary experience on the evening of January 10, 2009, on 80 meters. While in a contact with EA21F on 3512 kHz at 1845 UTC [Coordinated Universal Time] I noticed what I at first thought was another station transmitting on my frequency. But I soon realized that it was the echoes of my own signal. …EA21F did not hear any echoes on my signal and I did not hear any echoes on his signal." Amongst the details he gives are these: "The echoes were not present constantly. … I heard echoes during several periods, the longest and strongest ones being a little over 1 minute long around 1931 UTC. … Many of the echoes were quite strong, stronger than my sidetone [audible feedback], and their tone was clean. Toward the end of the period OZ7BQ who lives about 12 km southeast of me, called me and told me that he did not hear any echoes. But while answering him, new echoes started to build up gradually. When I noticed the echoes I stopped my transmission and started sending single dits [by digital information transfer system]. Then he could also hear the echoes for about 5 seconds, though not as clear and strong as I received them. I did not hear any echoes on the signal from OZ7BQ, even at a time when my echoes were quite strong. I was sending dits on top of his transmission and heard my echo but not an echo on his signal. I am now very glad that I recorded the audio from 1927 to 1945 UTC. I have listened to the audio again and again. … This event on January

10 was the most surprising and exciting I have ever experienced in the 45 years I have been a ham." Karishøl admits that "my knowledge of LDEs was limited". In his search for answers he discovered the 1980 *QST* article by Villard, Muldrew, and Waxham, a 1979 article by Muldrew, and a 2007 article by Peter Martinez G5PLX in the British magazine *RadCom* for October 2007, pp. 60-3. On the basis primarily of Muldrew's views, which he quotes, Karishøl concluded that his echoes were caused by "an ionospheric/magnetospheric ionization duct", a kind of tube of low electron density aligned with the Earth's electric field lines. Karishøl helpfully placed his recordings of his echoes on a website run by *QST*. A web discussion of LDEs to which he refers unfortunately no longer exists.

In 1979 the Scottish science fiction writer and space enthusiast Chris Boyce published *Extraterrestrial Encounter: A Personal Perspective*, which closely examines what extraterrestrial intelligences would be like. And the conclusion is: *not like us.* It is a thoughtful book which perhaps did not obtain the attention it deserved. Boyce, a friend of Duncan Lunan and Tony Lawton due to their all being connected to the British Interplanetary Society, mentions the long delayed echoes and the shockingly virulent reaction to Lunan's and Lawton's writings about them. Although Boyce does not himself subscribe to their hypotheses, he writes:

"[Alien] Objects elsewhere in the solar system are not likely to be found, at the present stage of exploration, unless they deliberately attract attention by responding to radio signals received from Earth. … Between 1967 and 1972 I chaired a series of discussions at ASTRA, the Association in Scotland to Research into Astronautics. … [discussed were the] radio effects in the 1920s, which Professor Bracewell of Stanford University had suggested, might have been an attempt at communication by a spaceprobe from another civilisation. … For the record, the outcome was that the radio echo effect was traced with virtual certainty to the orbit of the Moon; to one, if not both, of the 'Trojan' or 'Equilateral' points [L4 and L5] where James Strong of the BOS [British Interplanetary Society] had suggested a 'Bracewell probe' might be found. … As to whether a 'Bracewell probe' did or does exist in the orbit of the Moon – no experimental search was made and to my mind the question remains unanswered."[73]

In 1981 Robert W. Freyman of Los Alamos Laboratory, a veteran of the Manhattan Project and a prominent member of America's Special Engineer Detachment for the most important projects, published an article recounting how he had detected in Alaska more than 2000 long delayed radio echoes in a single week between July 15 and 22 of 1980. He concluded that "the echoes seem to be genuine and these observations are therefore unique in the study of LDE radiowave propagation phenomenology.'[74] That last remark seems to suggest that research into LDE phenomenology has been very extensive indeed amongst the Los Alamos and other Government scientists over some considerable time, and that most of that research remains secret and unpublished." Freyman also acknowledged that the echoes must somehow have been reflected from plasma.

By 1983, Duncan Lunan, who was aware of Kordylewski's 1961 claims about the Clouds because of his friendship with James Strong, mentioned this in passing in a book which he published in that year, praising also the work of George Sassoon and Ronald Bracewell.[75] However, as in 1983 nothing was known about the characteristics of dusty complex plasma clouds in space, much less that the Kordylewski Clouds were such clouds themselves, Lunan's awareness of the existence of the Kordylewski Clouds did not lead to any insights. The Kordylewski Clouds were never seriously considered by anyone to have anything to do with the long delayed echoes until I included a chapter saying so in my book *A New Science of Heaven* (2021), but that chapter was never published because the publisher insisted that the chapter be removed from the book. Some of that text is incorporated in this paper.

In 1985 F. W. Crawford, whose paper of 1970 has been mentioned, returned to the fray and described experiments carried out in Alaska to study long delayed echoes. He wrote a paper jointly with 'R. J. Vidmar' (probably a mistake for Paul J. Vidmar), again in the *Journal of Geophysical Research*, once again seeming vaguely to be attempting to shut down discussion of the subject, albeit he bizarrely suggested the echoes might be caused by "other forms of guided propagation" than those suggested so far.[76] Guided by whom?

1998-1999. There is a discussion about long delayed echoes between numerous ham operators during these years preserved at this link: http://www.vhfdx.net/discuss/lde.html

In 2010 a discussion group about long delayed echoes was started by W5TXR (he and many others in the group only use their call signs and do not give their names, or just give a first name). This appeared in *Amateur Radio News* commencing December 1, 2010. The discussion starts with a description of a German ham operator named Petr Brogl receiving an echo 46 seconds after he transmitted his call sign on 7 MHz. Wendell K1LWI says he has had many echoes since the 1960s of 5 seconds delay. N7TEE says in Oregon in the 1970s he had an echo after 50 *minutes*. KC8VWM says he measured 33 seconds and 39 seconds echo delays. Dale Winther W6PDL says "Back in the late 1960s I experienced a 24 second delayed echo on 15 meters." Mel G0GQK reports an occasion when "the strange events continued for an hour and Peter DK6NP was able to make some recordings". Many, perhaps most, of the LDE discussion groups and exchanges of this kind between ham operators have disappeared from the internet, often through the websites being closed down over time. This example of one such group in 2010 resembles most of the others. It is a pity that a record does not exist of the hundreds of such exchanges on this subject.

In 2015, the American science writer Daniel Oberhaus published some comments on the long delayed echoes in an article posted on the internet.[77] It was entitled "Radio Ghosts Have Haunted the Airwaves for Nearly a Century" and was posted on October 27, 2015. (Posted on vice.com, a site which no longer exists.) Oberhaus very briefly reviewed some history of the subject. He referred then to the more recent ideas of Sverre Holm (*mentioned below*) who thinks "the most likely cosmic culprit accounting for LDEs is the collection of ionized gas clouds in Earth's Lagrange regions, which would account for echoes between two and 10 seconds." But Oberhaus tends to reject these ideas and thinks there must be some "mundane" explanation and that it is only not forthcoming because scientists think "the problem is not considered important enough". He then makes a dismissive joke suggesting that the answer "will only be considered important enough when the 13,000 year old aliens hiding behind the moon come to attack". So Oberhaus cannot be considered a particularly serious commentator on this subject. However, Oberhaus has published an extremely interesting book entitled *Extraterrestrial Languages*, MIT Press, 2019. It does not mention long delayed echoes but deals extensively with matters which could one day have an intimate connection with sentient clouds at L4 and L5 (which he does not mention in his book, though he did mention L4 and L5 plasma clouds in 2015).

Today the academic with the keenest interest in LDEs appears to be Professor Sverre Holm of the University of Oslo, who in addition to his academic career is also a radio ham. Drawing upon the calculations of George Sassoon, he accepts that the LDEs could be coming from L4 or L5 and that there may be plasma clouds at those points "where mass can be trapped", as he puts it.[78] If he is aware of the confirmation of the existence of the Kordylewski Clouds by the Hungarian astronomers, he has not publicly commented on it to my knowledge. The most important thing about his comments, to my mind, is that unlike so many astronomers and astrophysicists who turn a blind eye to this key point, Holm automatically assumes that if there are clouds at the Lagrange Points, they would be *clouds of plasma*. Thank God there is at least one sensible expert who recognises this obvious fact and does not believe that uncharged dust could persist in space. Holm is free of the perverse blindness that afflicts many of his colleagues, who have an idiotic aversion to admitting that space dust *must be charged and hence must form a charged dusty plasma.*[79]

Sverre Holm has written a survey entitled "15 Possible Explanations for Long-Delayed Echoes", which he has posted on the website of the Department of Physics at the University of Oslo. He describes it in his sub-heading as "Shlionskiy's possible explanations for long-delayed echoes (LDE) from his paper of 1989."[80] Amongst these he lists "Reflections from clusters of ionised gas clouds in the Lagrange-Trojan Regions." In his further discussion about this he writes: "Candidate points are L4 or L5 … which follow the Earth's movement. One point in favour of this hypothesis is the finding by Sassoon (1973) who went through all available observations and found that there was a statistically significant higher occurrence of LDEs when the Earth-Moon trailing Lagrange point (L5) was above the horizon." Holm is apparently unaware of the verification of the existence of the Kordylewski Clouds at L4 and L5, which would constitute a coherent and gigantic plasma cloud at L5 to explain this.

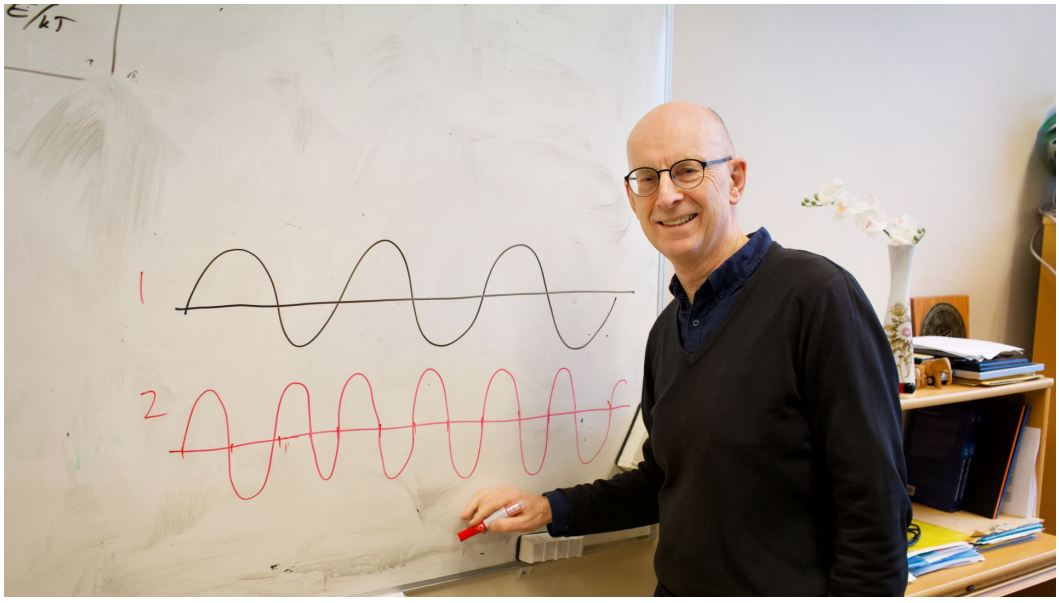

Figure 27. Professor Sverre Holm comparing wave forms.

Without going into all the many details of both fact and speculation, it is clear that the LDEs have been detected for nearly a century, and that they appear to have been manipulated at L5 to convey or hint at some kind of information. This could be considered a kind of code. These findings have a long and solid pedigree, having attracted the attention of numerous famous scientists as well as the radio hams (and, as we have seen, sometimes these are the same people).

What this means is that the L5 Cloud at least (and probably both the L5 and L4 Clouds) has been trying to attract our attention ever since we began using short wave radio. Rebroadcasting back to us our own broadcasts is a pretty brazen act, and could not be a more obvious a way of shouting at us, especially as some of the echoes have actually been louder and hence more powerful than the original signals which were being echoed. And on a few occasions the echoes have been broadcast back at us twice as double-echoes. It seems that messages may have been encoded in the echo patterns, which vary a great deal but are never less than 3 seconds delay, and that we have just not been listening. A serious effort needs to be made to decode what these messages from the Cloud mean. Preliminary efforts of the past were insufficient because of the lack of resources.

This brings us to this crucial question: What has the Cloud at L5 been trying to tell us for nearly a hundred years?

If we continue to ignore the Cloud's message, whether it contains data or is just an attention-seeking signal, we merely prove our stupidity. And who knows, by ignoring what the Cloud is trying to tell us, we might even be putting our species in serious danger. We must not forget that *the Cloud knows more than we do*.

In 2010 Paul Davies, one of the leading scientists
Most recently, the brothers John Tedesco and Gerald Thomas Tedesco, a pair of investigative journalists, have taken an interest in the subject of long delayed echoes, and have published an article entitled "Unravelling Mystique: Long-Delay Echoes; Anomalous Propagation of Radar Signals under the Influence of Unidentified Anomalous Phenomena", in the *Open Journal of Applied Sciences,* Volume 14, Number 12, December 25, 2025. They unexpectedly suggest that there is an association between long delayed echoes and Unidentified Aerial Phenomena (OAPs, previously called UFOs) and call for more research into this. Amongst the acknowledgements at the end of their paper is one to Michael Herwig, Special Agent Counter Terrorism, FBI. So clearly LDE speculation is moving in strange new directions, and what this subject has to do with the FBI and counter terrorism is somewhat difficult to comprehend.

NOTES:

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