

# Atmospherics

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*What would the sun be itself, if it were a mere blank orb of fire that did not multiply its splendours through millions of rays refracted and reflected, or if its glory were not endlessly caught, splintered, and thrown back by atmospheric repercussions?<sup>1</sup>*

Radio, or, more strictly because more broadly, wireless signalling, unleashed a dream of absolute communication and universal contact. Contemporary communications – or the material imagination which makes sense of them – still have as their ideal horizon a universe of absolute transparency and traversibility. In such a world, everywhere will be maximally accessible to everywhere else, and delay, obscurity and interference will be done away with. It will be the opposite of Hobbes’s vision of ‘war of all against all’: rather, it will be the communication of all with all. Atmospherics are the buzzing fly in that utopian ointment.

W.E. Ayrton’s evocation of this world during a lecture given at the Imperial Institute in 1897 has frequently been quoted:

there is no doubt that the day will come, maybe when you or I are forgotten, when copper wires, gutta percha covering, and iron sheathings will be relegated to the museum of antiquities. Then when a person wants to telegraph to a friend, he knows not where, he will call in an electromagnetic voice, which will be heard loud by him who has the electromagnetic ear, but will be silent to everyone else, he will call, “Where are you?” and the reply will come loud to the man with the electromagnetic ear, “I am at the bottom of the coalmine, or crossing the Andes, or in the middle of the Pacific.” Or perhaps no voice will come at all, and he may then expect the friend is dead.<sup>2</sup>

There are two features of this that are worth comment. The first is the care taken to establish that the intercourse of the electromagnetic ear and voice takes place silently and secretly; the second is the total inundation notwithstanding of the air, earth and oceans. No matter where their adventures may take these wirelessly-connected Jules Vernes, their existence

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<sup>1</sup> Thomas de Quincey, ‘On Wordsworth’s Poetry’, in *The Collected Writings of Thomas de Quincey* (Edinburgh: Adam and Charles Black, 1845), Vol XI, p. 301.

<sup>2</sup> W.E. Ayrton, ‘Sixty Years of Submarine Telegraphy’, *The Electrician*, 42 (February 19, 1897), p. 548.

will be so tied up with their ability to be in contact that failure to reply may safely be taken to mean death. We may borrow Hamm's words from Beckett's *Endgame*: 'Outside of here – [the proleptic everywhere of universal hearsay] – 'it's death.' Some of us might imagine this situation of communicative incandescence as itself lethal.

This utopia of absolute communication is frequently evoked in the early years of radio. In 1912, *The Marconigraph* reprinted a poem from the *Melbourne Punch* celebrating the recent achievement of the SS *Miltiades*, which had sailed round the Cape to Melbourne without once being out of radio contact:

There is no spot now where a man may go,  
Be it burning desert or Polar snow,  
But there the voice of a friend will come  
Bidding him hope for aid;  
There is no place now where the world is dumb,  
Or lonely, or left afraid;  
But universal are words like these,  
"Hullo! 'Miltiades!'"<sup>3</sup>

But this sociable ideal of general audibility encountered difficulties, which the following century would slowly come to suspect were intrinsic rather than accidental. The first is hinted at in Ayrton's evocation: that of secrecy. The necessity for some way to prevent spillage in a transmission system that, unchannelled by wires, would spread everywhere in all directions, was understood early, before the actual technology of radio had been developed. William Crookes saw in 1892 that signalling without wires through space would bring the possibility of eavesdropping and interference, though he was sadly optimistic about the possibility of keeping intruders out through tuning.

I assume here that the progress of discovery would give instruments capable of adjustment by turning a screw, or altering the length of a wire, so as to become receptive of waves of any preconcerted length. Thus, when adjusted to 50-yard waves, the transmitter might emit, and the receiver respond to, rays varying between 45 and 55 yards, and be silent to all others. Considering that there would be the full range of waves to choose from, varying from a few feet to several thousand miles, there would be sufficient secrecy, for the most inveterate curiosity would surely recoil from the task of passing in

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<sup>3</sup> *Marconigraph*, 2.19 (Oct 1912), p. 275.

review all the millions of possible wave-lengths on the remote chance of ultimately hitting on the particular wave-length employed by those whose correspondence it was wished to tap.<sup>4</sup>

Crookes does not anticipate a world in which electromagnetic ears will be come capable of passing in review across all frequencies much more quickly than human ears. The difficulty of eluding other electromagnetic ears was paralleled by the necessity of excluding unwanted or unexpected electromagnetic voices. For, towards the end of the nineteenth century, the air acquired a new accent. Users of telephones had for many years become inured to the annoyance of fizzing, crackling and other strange noises of electrical interference, and familiar with the haphazard of ‘bad lines’ and ‘good lines’. Even before the appearance of telephone wires, telegraph wires looped across the landscape from what are still in Britain called ‘telegraph poles’ seemed to suggest a kind of exposure to the air, and the possibility that the wires might leak sound, or the air might somehow become implicated in the messages transmitted. But the development of radio, which would be identified with the air through which it was for the most part transmitted, rather than through the sea or earth, made for a new vulnerability of transmitted sound (and, later on, television images) to the vicissitudes of the air. Where previously the air had been audible only in the relatively familiar and recognisable forms of the sougings and screeches of wind, electrification gave the air a new, more diffuse, unpredictable and illegible sonority, a new, more enigmatic, more anguished music of the spheres. Put simply, the background of sound would come increasingly into the foreground. For that to happen, it was necessary first that the background first be constituted as the channel of information – through the devising and diffusion of radiodiffusion. What came through *on* the air was the sound *of* the air, given voice by being given over to the electromagnetic carriage of voice. But, in the process, the air would become a different air.

This can be seen as part of a general widening of awareness within modernism to include the peripheral, the subliminal – what Michel Foucault has called the effort to ‘think the unthought’. Walter Benjamin called this new field of visual (in)attention ‘unconscious optics’: we may similarly designate an ‘auditory unconscious’, constituted of everything that ordinarily fell upon the ear without being recognised or registered, but that nevertheless shaped feeling and perception. More and more, listening was to be assailed, augmented or interfered with by what made itself heard.

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<sup>4</sup> William Crookes, ‘Some Possibilities of Electricity’, *Fortnightly Review*, February 1892, quoted J.J. Fahie, *A History of Wireless Telegraphy 1838-1899* (Edinburgh and London: William Blackwood and Sons, 1899), pp. 198-9.

### History of Atmospheric

The kinds of accidental interference that radiotelegraphers named, variously, 'strays', 'Xs', 'atmospherics', 'parasitic signals', 'static' and 'sturbs' had a central place in the evolution of the theory and the material basis of radio. No sooner were radio waves detected and employed than the problem of atmospheric disturbance arose. It was clear early in the history of radio that atmospheric disturbances could produce and propagate the same kind of electromagnetic waves that Hertz had demonstrated by causing a spark to be transmitted across his laboratory.

But putting atmospheric back into the centre of the picture is a difficult, even a paradoxical enterprise because the point of understanding atmospheric was in order to suppress or expel them. Oliver Lodge, who in 1897 had taken out a patent on a tuning device that would enable radio to be transmitted and received without interference, declared bluntly that atmospheric 'are of no assistance, and are a nuisance which ought to be eliminated'.<sup>5</sup>

Indeed, atmospheric had come to notice even earlier than this. Even before the development of wireless telegraphy, telephone users found that their apparatus was subject to interference too, an interference that may itself have predicted some of the forms and uses of radio itself, though the effects were usually the result of electrical induction rather than electromagnetic radiation. One Charles Rathbone who was listening on a private telephone run between his house in Albany and the Observatory heard singing, which it turned out was emanating from an experimental concert transmitted by Thomas Edison over a telegraph wire between New York and Saratoga Springs. The *New York Times* carried a report in 1873 of the strange interferences produced in telegraph equipment by an electric storms. The article explained that the 'electric wave' produced during a storm sometimes acted to block or obstruct transmissions, and sometimes augmented them. On occasion, it provided the possibility for a kind of wireless transmission of signals:

When the electric wave is of considerable duration and power, the operators have been known to let go their batteries, detach the wires, carry them to the ground, and, by means of the electric throbs,

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<sup>5</sup> Oliver Lodge, *Talks About Wireless: With Some Pioneering History and some Hints and Calculations for Wireless Amateurs* (London: Cassell, 1925), p. 45.

messages have been transmitted entirely independent of the ordinary auxiliaries.<sup>6</sup>

The electrical nature of lightning had been known since Priestley and suspected before, but it seems to have been Oliver Lodge who first proposed that lightning produced impulses of a specifically oscillatory character, just like the spark which Hertz used to show the existence of radio waves. With the telegraph or the telephone, reception and transmission had to be born together – that is, one could only receive a message that has been humanly sent, despite the fantasies of spiritualists. Radio, by contrast, revealed an excited, excitable world of radio discharges, audible evidence of the universe of overlapping oscillations and radiations revealed by nineteenth-century physics. In the very earliest days of radio, one listened to, or listened out for, atmospheric impulses, since there was little else to listen to.

Research into atmosphericics remained patchy and sporadic during the first decades of the twentieth century. The first systematic work was undertaken by W.H. Eccles and Morris Airey, who were able to observe in an important paper on the subject of 1911 that '[t]he sum total of the work published on the whole subject is very small'.<sup>7</sup> Slowly, as experiment and report began to build up, atmosphericics started to gain a positive interest in themselves, rather than simply as a nuisance to be eradicated. A contributor to *Wireless World* wrote in 1920 that 'from the operator's point of view, these natural disturbances, called variously strays, or atmosphericics, are particularly undesirable, though to the experimenter with non-utilitarian aims they present a fascinating field of study'.<sup>8</sup>

From 1910 onwards, interest in and understanding of radio atmosphericics increased markedly. The British Association set up a Committee for Radiotelegraphic Investigation in 1913, which undertook a systematic investigation of atmosphericics. In 1918, Robert Watson-Watt began supervising research at the Aldershot Wireless Station. In 1920, the Committee for Radiotelegraphic Investigation gave way to the Radio Research Board, under the direction of the Admiral of the Fleet Henry

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<sup>6</sup> 'The Electric Wave', *New York Times*, January 12, 1873, p. 3, reproduced at <http://earlyradiohistory.us/1873wave.htm>

<sup>7</sup> W H Eccles and H Morris Airey, 'Note on The Electrical Waves Occurring in Nature', *Proceedings of the Royal Society A*, 85 (1911): [145-50], p. 146.

<sup>8</sup> 'Cantab' 'Strays and their Origin', *Wireless World*, 8.10 (August 1920), [346-7], p. 346.

Jackson. One of the four sub-committees it established was charged with the investigation of atmospheric.

A review of the subject in *Wireless World* in 1923 noted this huge increase in research, saying that '[n]ot very long ago it would have been easy to tell you in an hour's lecture – from a half-sheet of notepaper, so to speak – all that was known about atmospheric. Happily, that is not now the case'. Nevertheless, and despite the fact that, between 1906 and 1918, over a hundred patents had been lodged for anti-interference devices – or 'X-stoppers', as they were often known – it was still the case that 'the greatest unsolved problem in radiotelegraphy is that of interference by atmospheric'.<sup>9</sup> There were many false dawns. In 1919, Roy Weagant, a consultant with RCA, announced that he had discovered that the radio waves produced by atmospheric move at right angles to the waves produced by radio, and always in a vertical direction. This, he believed, would enable him to eliminate static altogether.<sup>10</sup> He was to spend 4 more years of largely fruitless research trying to use this mistaken insight to develop a foolproof means for filtering out interference. Despite the advances in understanding, there was no steady advance of clarity and corresponding retreat of atmospheric, partly because the advances in radio technology itself, such as the use of ever longer wave-lengths and more sensitive receivers, not to mention the huge growth in broadcasting itself, opened radio up to more sources of interference. A report on the Weagant 'X-stopper' in 1919 acknowledged that 'the interference due to these atmospheric impulses even in the old coherer days – bad though it then was – was almost as nothing compared with the terrific disturbances experienced in modern long-distance receiving stations'.<sup>11</sup>

### Local Habitations

The first efforts at understanding atmospheric involved trying to localise them. The assumption that guided most early research into atmospheric was that they were the result of lightning storms. In 1895, Alexander Popov connected a coherer to a lightning rod and showed that it was possible to detect approaching storms. Thereafter, others explored the possibility of weather forecasting by means of radio. In the early years of the century,

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<sup>9</sup> R A Watson Watt, 'Observations on Atmospheric', *Wireless World*, 12.18 (August 1 1923) [601-12], p. 601.

<sup>10</sup> 'Discovery In Wireless: "Atmospheric" Eliminated', *Times*, 42043 (March 8, 1919), p. 11.

<sup>11</sup> 'The Weagant "X-Stopper."' *Wireless World*, 7.75 (June 1919): 127-31 and 7:76 (July 1919): 209-11, p. 127.

Albert Turpain made detailed observations which made it possible to detect thunderstorms many hours before there was any other evidence of them.<sup>12</sup>

W.H. Eccles and H. Morris Airey devised a system for recording ‘strays’, which involved making vertical lines of different lengths to mark different intensities of sound along a horizontal line representing the passing of time. When they correlated records taken at two receiving stations in Newcastle and London, they found a very close synchronicity between the two recordings, concluding that ‘between 60 and 80 per cent. of the atmospherics audible at Newcastle and London, about 270 miles apart, are due to the same cause. This cause is probably a discharge of atmospheric electricity at places whose distances from the stations are possibly of the order of hundreds of miles’. Eccles believed that most of the interference affecting British radio reception emanated from tropical storms in West Africa.<sup>13</sup> Others thought that audible atmospherics came from disturbances thousands of miles distant.

The study of atmospherics brought meteorology and radiotelegraphy close together, as is suggested by their conjuncture in the short-lived *Weather and Wireless Magazine*, which ran from 1923-24. In its pages, J. Reginald Allinson concluded from the use of frame aerials to detect and track the progress of thunderstorms before there was visible evidence of them that ‘these stray waves have been “captured,” and made to serve a useful purpose’.<sup>14</sup>

But as atmospherics began to be more thoroughly investigated, they turned out to involve more than the weather. Radio emissions from volcanic eruptions suggested that radio would have its uses for the geologist and the vulcanologist. A.G. McAdie wrote in 1913 that

no great eruption can occur, with its development of atmospheric electricity, without a corresponding electro-magnetic wave disturbance in the ether, shown in the form of static interference on wireless receivers, and more or less pronounced interruption of communication by wireless telegraphy. The time is not far distant when by means of these various records it will be possible for the meteorologist to determine the velocity of propagation of volcanic

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<sup>12</sup> Albert Turpain, *La Prévision des orages* (Paris: Naud, 1902).

<sup>13</sup> W H Eccles and H Morris Airey, ‘Note on The Electrical Waves Occurring in Nature’, *Proceedings of the Royal Society A*, 85 (1911) [145-50], p. 150.

<sup>14</sup> J. Reginald Allison, ‘Atmospherics’, *Weather and Wireless Magazine*, 2.5 (1924), [13-14], p. 14

ash, the detonation or sound waves, the pressure or impact waves, and the duration of thunderstorms and tornadic or whirlwind effects.<sup>15</sup>

Eccles devoted much attention to the mysterious fluctuations in the amount of atmospheric and in the range of radio transmissions between day and night. His explanation was that solar radiation must cause ionisation of the upper atmosphere – in what was originally called ‘the Heaviside layer’, after the speculations of Oliver Heaviside concerning its existence, and then verified during the 1930s as the ionosphere – and that this ionisation would be reversed during the hours of darkness.

Carl Størmer reported the puzzling phenomenon of echoes of short-wave signals being heard not just ½ second after the source sound (the normal period taken for a signal to orbit the earth), but also at an interval of around 3 seconds afterwards. He speculated that the radio waves were reflected by the aurora borealis.<sup>16</sup> During this period some remarkable reports began to be received regarding the powers of the aurora borealis both to interfere with radio transmissions and, more remarkably to become audible when the aurora occasionally came down to ground level. Writing in *Nature* in 1931, S. Chapman summarised the testimonies given by J. Halvor Johnson, who had investigated low-level auroral displays in Alaska and Northern Canada.

The sounds are variously described as “a swishing or rustle like that of a silken skirt moving back and forth ... very low, but yet plainly discernible”; like those “that accompany small static discharges”; like the sound made when “a couple of slices of good fat bacon are dropped into a red-hot pan”; “they may attain a loudness comparable to that emitted by a high-tension electric current when charging a set of horn-gap lightning arresters ”; “quite audible swishing, crackling, rustling sounds”; “a crackling so fine that it resembled a hiss”; sounds “similar to escaping steam, or air escaping from a tire”; “much like the swinging of an air hose with escaping air”; “the noise of swishing similar to the lash of a whip being drawn through the air”; sounds “likened to a flock of birds flying close to one’s head”; “not musical, it was a distinct tearing, ripping sound as when thin muslin is ripped or torn apart”. One man at sea, in an open boat with four natives, on Oct. 11, 1893, heard “the most fearful whizzling and crackling

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<sup>15</sup> A.G. McAdie, ‘Volcanic Eruptions and Their Effect Upon Wireless Telegraphy’, *Marconigraph*, 2.23 (February 1913): 488-90, p. 490.

<sup>16</sup> Carl Størmer, ‘Short Wave Echoes and the Aurora Borealis’, *Nature*, 122 (1928): 681.



sounds, sounding at times as if thousands of firearms were fired within short distance”; at the time there was “no wind and no clouds”. Another writer mentions “loud reports similar to rifle cracks”, “the air was still and the aurora was just above the tops of the birches”; the few loud reports were followed by much crackling.<sup>17</sup>

Many of the radio waves emitted by the aurora occur in audible frequencies – which is not to say that they can on that account be heard, but they only require a transducer to pass across into sound, rather than any more complicated kinds of radio apparatus.

There were speculations about the possibility of picking up radio transmissions from outside the earth’s atmosphere. Oliver Lodge had attempted in vain in 1894 to detect radiation the sun, as a result of mundane interference: “There were evidently too many terrestrial sources of disturbance in a city like Liverpool to make the experiment feasible.”<sup>18</sup> During the 1920s, when the orbits of Earth and Mars came close together, and, following an injudicious hint dropped by Marconi, European and American newspapers became full of excited speculation about the possibility of picking up signals transmitted from the mysterious red planet. On April 23, Frederick Milliner and Harvey Gainer tuned in to very long wavelength transmissions in Omaha, in order to detect incoming signals from Mars. *The Times* reported the experiment rather coolly:

At first (he said) we used wave lengths of from 15,000 to 18,000 metres, and for several hours it seemed as if we heard everything that was going on in the world. We got Berlin, Mexico, and all the large stations. We got in on a thunderstorm somewhere, and the crackling lightning was like hailstones on a tin roof all around us. About 2 a.m. it cleared up and everything grew quiet.

Then we hitched up a long wave length, which took us into space – beyond everything that might be taking place on earth. There was a most deathly silence. We concentrated our faculties to catch the faintest sound, but there was nothing, nor was the silence broken during the entire time we had the long wave hooked on.<sup>19</sup>

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<sup>17</sup> S. Chapman, ‘The Audibility and Lowermost Altitude of the Aurora Polaris’, *Nature*, 127 (1931) [341-2], p. 342.

<sup>18</sup> Oliver Lodge, *Signalling Across Space Without Wires*, 4<sup>th</sup> edn (London: *Electrician Printing and Publishing Co.*, 1908), p. 33.

<sup>19</sup> ‘No Message From Mars: Marconigrams Into Space’, *Times*, 42393 (April 24, 1920), p. 14.

This excitement was renewed in 1926, in which year *Popular Wireless* asked ‘Is it possible that the inhabitants of Mars will send a wireless message to the earth on October the 27<sup>th</sup>? On that date, the mystery planet makes its nearest approach to earth. Can the vast space separating planet from planet be bridged by radio?’<sup>20</sup> *Popular Wireless* put together a powerful 14-valve receiver, and claimed on 6 November 1926 to have received a mysterious signal ‘Who sent the mysterious M’s that were picked up on the PW 14-valve set, when listening-in for Mars?...several expert telegraphists were among the company that actually heard the M’s, and there is no doubt whatever of their mysterious nature.’<sup>21</sup> The technical press was rather snuffy about this popular effervescence. In 1920, *Wireless World* published a picture of a Mr Frank Marshall receiving signals in the cellar of the Rose and Crown in Park Lane, which bore the sardonic caption ‘He is NOT receiving from Mars’.<sup>22</sup>

This worldliness was dispersed in 1931, when Karl Jansky, investigating the problem of atmospherics in transatlantic communications for the Bell Company, discovered that, even when one subtracted the static produced by known atmospheric disturbances, such as thunderstorms, a residual noise persisted, which underwent a periodic variation corresponding to the period of the earth’s rotation with respect to the stars.<sup>23</sup> When Grote Reber built his own bowl-aerial that he could point to different areas of the sky, he found that the radio emissions were strongest from the parts of the Milky Way in which stars were clustered.<sup>24</sup> The discovery of this ‘cosmic static’ would lead after the Second World War to the huge advances in the understanding of the universe brought by radio astronomy.

In one sense, the mapping of radio space has helped to put and keep atmospherics in their place. The audible atmosphere was an atmosphere that lost its traditional dimension of altitude: hereafter, one might be airborne, or

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<sup>20</sup> *Popular Wireless*, 23 October 1926, quoted in Ron, ‘Mars Calling Earth’, *Radio Bygones*, 74 (2001): [4-6], p. 5.

<sup>21</sup> Quoted, *ibid*, p. 4.

<sup>22</sup> *Wireless World*, 8.3 (May 1 1920), p. 101.

<sup>23</sup> Karl G. Jansky, ‘Electrical Disturbances Apparently of Extraterrestrial Origin’, *Proceedings of the Institute of Radio Engineers*, 21 (1933): 1387-98.

<sup>24</sup> Bernard Lovell, *Voice of the Universe: Building the Jodrell Bank Telescope* (New York, Westport, Conn. and London: Praeger, 1987), p. 21

in midair, communicating with the air by communicating through it, without actually having to be aloft. A celebration of the life of Marconi in the inaugurating number of *Wireless World* said that ‘he found the bridle which controlled this Pegasus of the air, and as a result our second Prometheus brought down to earth “radiotelegraphy”’.<sup>25</sup> But, as radio has been steadily spatialised, so space has been radiolised – that is to say, reconfigured to accord with a world in which what matters are not points, nodes, orientations and distances, but velocities, frequencies, connections, transmissions and syntopies. Radio space could come as close to the surface of earth as the ground-level aurora borealis, and extend further into space than optical telescopes could reach. Radio allowed the experience of the far-here, or the far-hear: that which was unimaginably distant could also have the immediacy and importunity of that which sounded in your ears.

### **And a Name**

One of the odd symptoms of early attention to atmosphericics was a desire to formalise them in a descriptive and expressive language. The noises which interrupted and sometimes swamped communications were not merely random, but had their own acoustic profiles. A phonology, and then a phonetics of the atmosphere began to be devised, as the mouth and tongue assisted the ear in picking out, naming and echoing back in language the different kinds of interference. Observing that the electro-magnetic atmosphere ‘had a language of its own’, J.J. Fahie wrote that the sound of lightning discharges registering on telephone lines was ‘very characteristic – something like the quenching of a drop of molten metal in water, or the sound of a distant rocket’.<sup>26</sup> As early as In 1913, Eccles proposed a distribution of radio atmosphericics into ‘clicks’, ‘grinders’ and ‘hisses’ (or ‘fizzles’). A writer for the journal *Wireless World* in 1919 explained that ‘[h]issing noises are due to actual static discharges from the aerial to earth caused by electrostatic induction by charged clouds or winds’, while clicks and grinders emanated from lightning discharges, and were most common in transatlantic communication.<sup>27</sup> An article in *The Times* in 1925 added a couple more terms to this taxonomy: ‘crashes’, ‘which may last as long as five seconds and appear to result from local temperature changes and squally weather’, and the ‘fizzly’, ‘quite a distinct kind of atmospheric which often accompanies rain and hail squalls. It causes a continuous hissing

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<sup>25</sup> ‘Commendatore G. Marconi’, *Wireless World*, 1 (1913), p. 3.

<sup>26</sup> *Ibid.*

<sup>27</sup> ‘The Weagant “X-Stopper.”’ *Wireless World*, 7.75 (1919): [127-31], p. 129.

sound in the receiver, and only occurs when showers of rain or hail having charged particles are near or actually in contact with the aerial'.<sup>28</sup>

Some researchers developed specialities among the forms of atmospheric disturbance. Heinrich Barkhausen reported in 1919 on his work on long whistling tones. He explained that, during the years when radio operators employed enhanced amplifiers in order to try to intercept transmissions from the enemy, they would regularly hear on their headphones

a quite remarkable whistling tone. At the front, it was said that one heard 'the grenades flying'. As far as it is possible to represent it in letters, the tone sounded somewhat like *pion*...beginning with the highest audible tones and then running through the whole scale of tones and finishing with the lowest audible tones. On many days these whistling tones were so strong and frequent that they sometimes made listening impossible.<sup>29</sup>

Barkhausen originally thought that these tones must originate from the earth, since the radio apparatus on which they were detected was often deep underground, but, when he returned to the subject a decade or so later, he revised this opinion, ascribing the whistler to multiple reflections from the ionosphere.<sup>30</sup>

The coming of broadcasting in 1922, and the subsequent crowding of the airwaves meant that many more listeners became familiar with the effects of interference, and new sounds began to be distinguished. A feature article in *The Times* described 'radiation from oscillating aerials, which is generally known as "howling" ' and also two kinds of interference from Morse signals – ' "mush," a welter of vague unreadable dots and dashes, and rustling noises, whistles, and chirps, produced by the harmonics of continuous-wave stations'.<sup>31</sup> Specialised terms like 'heterodyning', to describe the effects of combined frequencies of different kinds of receivers started to pass into

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<sup>28</sup> 'Atmospherics. Wireless Forecasts Of Thunderstorms', *Times*, 43984 (June 10, 1925), p. 8.

<sup>29</sup> Heinrich Barkhausen, 'Pfeiftöne aus der Erde', *Physikalische Zeitschrift* 20 (1919), [402-3], pp. 402-3

<sup>30</sup> Heinrich Barkhausen, 'Whistling Tones From the Earth', *Proceedings of the Institute of Radio Engineers*, 18 (July, 1930): 1155-9

<sup>31</sup> 'Morse Signals: A Growing Source Of Interference', *Times*, 44306 (24 June, 1926), p. 28.

ordinary use. Describing observations and experiments with different kinds of interference picked up by submarine cables, E.T. Burton and E.M. Boardman carefully distinguished two new varieties of musical atmospheric – the ‘tweek’, a ‘damped oscillation trailing a static impulse’ and the ‘swish’, which has a sound such as is made ‘by thin whips when lashed through the air’.<sup>32</sup>

More recently, groups of radio researchers have taken to listening out for VLF or Very Low Frequency signals from nature, the particular fascination of such materials being that they are often in the audio range of frequencies, and require only a transducer to be rendered as sound. This has spawned an exotic zoology of sonorous sub-species, including ‘hooks’, ‘risers’, ‘pure-note whistlers’, ‘2-hop whistlers’, ‘whistler echo-chains’ and ‘dawn-choruses’. Perhaps the suggestion here is that atmospheric enact a kind of incipient self-naming, seeming almost to speak themselves, as though a voice were emerging out of the fog of noise (as a *noice*, a *voise*).

### **Tapping, Tuning, Jamming**

But, increasingly, there was another, endogenous form of interference, that had a less celestial origin, and came from the inside of radio communications. The multiplication of different kinds of electrical appliance, including radio appliances themselves, brought about forms of human atmospheric. The ‘Amateur Notes’ column of *Wireless World* in 1913 sardonically reported the concern of established radio users at ‘interference caused by the learners at these schools [wireless schools in London] transmitting too diligently – and, what is more, using magnetic receivers.

We rather gather that the frame of mind of those correspondents who are protesting against the conduct of these schools is this: “If I, by careful adjustment, can receive signals on my chalcopyrite-molybdenite crystal – quite five times out of ten – without missing more than a few words now and then when my crystal goes out of adjustment, where should there be any need for anyone else to use the magnetic detector, which is undoubtedly less sensitive, and therefore requires stronger signals which interfere with my experimenting?”<sup>33</sup>

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<sup>32</sup> E.T. Burton and E.M. Boardman, ‘Audio-Frequency Atmospheric’, *Proceedings of the Institute of Radio Engineers*, 21 (1933) [1476-96], pp. 1481, 1487.

<sup>33</sup> *Wireless World*, 1.9 (1913), p. 587.

As the airwaves began to become congested, the human atmosphere began to provide new sources of involuntary or accidental interference. C.G. Blake complained that 'I have very great difficulty in my own station, because there is a butcher's shop very close where they work a sausage machine, and when it is going it is absolutely impossible to receive signals at all'.<sup>34</sup> 'B.C.L.' wrote from Colchester to *The Times* with his speculations about the origin of the persistent atmospheric which affected radio reception in snowy or frosty weather, suggesting that they were caused when the wheels of collectors of local trams no longer made good contact with cables or rails, and therefore sparked.<sup>35</sup>

Neighbours using different kinds of equipment could easily interfere with each other's reception, as *The Times* carefully explained in 1926:

The crystal set is regarded by many as being entirely incapable of giving rise to any kind of interfering noises. Actually a crystal set may be even more annoying to a neighbour than a valve receiver, should the respective aerials be close together and run parallel with one another; for whilst one is searching for a sensitive spot with the point of a catwhisker, one's neighbour may be pulling his set to pieces in the hope of discovering the cause of a baffling series of crackles, crashes, and grinding noises. The two aerials are tuned to the same wavelength. When the catwhisker is raised from the crystal the path to earth from the aerial of the set of which it forms part is broken, to be made again directly contact is re-established. As the catwhisker is moved over the surface of the crystal contacts of varying resistance are made. Once again the carrier wave is slightly modulated, with the result that the valve user next door hears a succession of weird parasitic sounds. If when the sensitive spot has at last been found the crystal user lays his telephones on the table for a moment and gives verbal expression to his joy, it is quite possible for his words to be heard by his neighbour, since the diaphragms of the telephones vibrate under the influence of the sound waves and the carrier-wave is once more modulated.<sup>36</sup>

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<sup>34</sup> E.W. Marchant, 'Methods of Reducing Interference in Wireless Receiving Sets', *Wireless World*, 12.13 (June 30, 1923): 426-31; discussion, *Wireless World*, 12.14 (July 7<sup>th</sup>, 1923): 463-65, p. 465.

<sup>35</sup> B.C.L., 'Wireless Freaks', *Times*, 44173 (January 19, 1926), p. 17.

<sup>36</sup> 'Strange Causes of Interference: Unsuspected Crystals', *Times*, 4441 (October 26, 1926), p. 24.

Sometimes, the human atmosphere seemed to be displacing the natural. Philip Augsburg published in 1927 a collection of stories on the theme of radio in which he evoked the human turbulence encountered by the northwest wind:

now even a plain nor'wester can't howl a bit without getting tangled in a most amazing assortment of saxophone blues, stock quotations, tenor grace notes, hints on how to hold a husband, and what to do when your partner bids three hearts – all pushing relentlessly to keep a rendezvous with the peepul.

Nor are these the sum of strange things that the plain nor'wester encounters. Sometimes it runs into a play being broadcast over the radio. A voice cries, "Stand back, you bully!" and the nor'wester, amazed, asks, "Who-oo-ooo?"<sup>37</sup>

Not all of these forms of interference were accidental. There are two kinds of distortion possible of the perfect transmission. The first is an implied diminution of the signal, through appropriation or tapping. This may make the signal intelligible, but imperfectly transmitted. The second is an unwanted augmentation of the signal, by extra sounds that may make the signal fully transmissible but imperfectly intelligible. These alternatives of diminution and augmentation quickly became known as tapping and jamming.

Jamming began early in the history of radio, especially where rival systems or commercial interests were at work. The first congestion was experienced at sea, and this contemporary account describes some of the effects of interference and means used to combat it:

The spark sets of those days – "rock-crushers," they were humorously called because of the deafening noise they made – had so broad a band of action and made so terrific a clamor that two fellows chatting thus practically blanketed any other vessel within fifty miles that might want to use the air.

The only way to choke them off – and it was frequently used by some other operator waiting for a chance to send – was to "drop a book on the key"; that is, lay a book or some other weight on the transmitting key, setting up such a continuous roar of interference that nobody within range could send or hear a word – rendering confusion worse confounded. These and the many other inevitable

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<sup>37</sup> Paul Deresco Augsburg, 'The Leading Man', *On The Air* (New York: D. Appleton and Co., 1927) [1-14], p. 4

interferences when everybody was operating at will on the same wave length naturally led to wireless quarrels and feuds, the filling the air at times with curses, aspersions and choice obscenities.<sup>38</sup>

One of the earliest and most highly-publicised episodes of deliberate jamming occurred in 1903, during a demonstration of Marconi's system of transmission at the Royal Institution. Maskelyne set out to show that Marconi's system of tuning or syntony was neither as secure or as immune from interference as he claimed. Using an untuned transmitter at the Egyptian Theatre, which transmitted 'dirty waves' across a wide spectrum, Maskelyne transmitted the word 'rats' repeatedly to the technicians who had their equipment set up to show the Morse receptions on the platform, followed by a limerick beginning 'There was a young fellow of Italy/Who diddled the public quite prettily'.<sup>39</sup> J.A. Fleming, who gave the lecture, wrote to Marconi the following day, alluding to the 'dastardly attempt to jamb [sic] us', and then, still steaming a few days later, to *The Times* to protest at this 'scientific hooliganism'. This brought a defiantly self-justifying reply from Maskelyne, who claimed that he had undertaken the exercise as a scientific demonstration: 'We have been led to believe that Marconi messages are proof against interference...But when we come to actual fact, we find that a simple untuned radiator upsets the "tuned" Marconi radiators'.<sup>40</sup>

Such episodes became more and more common. When, in 1904, the US navy set up tests of an interference preventer that had been devised by Reginald Fessenden, he discovered that the rival De Forest Wireless Company had hired an operator to disrupt its transmissions. The ensuing events are described by a witness:

In an endeavour to hold off this interference the DeForest operator was kept under the influence of strong liquids during the tests, but in an unguarded moment he slipped away from his guards, got back into the radio station and started up a powerful transmitter, placing a brick on the key. In a few moments there was a knock at the door of the

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<sup>38</sup> Alvin F. Harlow, *Old Wires and New Waves: The History of the Telegraph, Telephone, and Wireless* (New York and London: D. Appleton and Co., 1936), p. 449.

<sup>39</sup> Sungook Hong, *Wireless: From Marconi's Black-Box to the Audion* (Cambridge, Mass. and London: MIT Press, 2001), pp. 107-12.

<sup>40</sup> John Ambrose Fleming, 'Wireless Telegraphy at the Royal Institution', *Times*, 37104 (11 June 1903), p. 4; Nevil Maskelyne, 'Wireless Telegraphy', *Times*, 37106 (13 June 1903), p. 9.



Navy Wireless station and there appeared Mr Dan Collins, the DeForest operator, who demanded that food and drink be supplied forthwith, or he would refuse to take the brick off the key...it was not till Mr Collins was finally induced, thru the supply of food and drink to withdraw the brick, that the Navy texts proceeded.<sup>41</sup>

The First World War saw systematic attempts at jamming and intercepting transmissions. One of the earliest appearances in fiction of the word ‘jamming’ to mean deliberate blocking of wireless signals occurs in ‘The Vindication of Binsted, Ex-P.O’, a sea story by Patrick Vaux of 1914. The story deals with the detection of a spy who has stolen information which enables him to jam the signals of the navy in the North Sea from an airship.

“Humberstone waves blocked again,” said the C.O in surprise to Kelsale as he stepped from starboard on his bleak, high bridge, where the molecules of fog bleared the eye and made everything wet and clammy. “Oh, damn this fog coming down again. Ouch! We’ll stop this jamming, wherever it’s coming from. It almost seems as if some folks have got inside our new transmitters.”<sup>42</sup>

Here, the word clearly refers to the efforts of unknown human agencies, but the association of this with the clammily rhyming conditions of fog which seem to exemplify the state of radio isolation perhaps suggests an interference of means. For indeed,, the transitive use of the word ‘jamming’ to signify the deliberate blocking or confusion of signals by human interference coexisted until well into the 1920s and perhaps beyond, with another usage which referred to accidental atmospherics. W.E. Collinson’s record of his own language use includes ‘jamming’ among the words most widespread among non-technical people in 1925: most such people, he writes, ‘will have some inkling of the mysteries of *tuning in* and *tuning out* and the trouble caused by *jams*, *atmospherics* and *howlings*’.<sup>43</sup> Here the word ‘jamming’ means ‘becoming jammed’, rather than the action of jamming another transmission. When Reginald Allinson referred in 1924 to the efforts being made to rid wireless reception of “‘Nature’s jammings” ’, the

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<sup>41</sup> Quoted in Helen M. Fessenden, *Fessenden: Builder of Tomorrows* (New York: Coward-McCann, 1940), p. 121.

<sup>42</sup> Patrick Vaux, ‘The Vindication of Binsted, Ex-P.O’, *Sea-Salt and Cordite* (London, New York and Toronto: Hodder and Stoughton, 1914) [39-52], p. 47.

<sup>43</sup> W.E. Collinson, *Contemporary English: A Personal Speech Record* (Leipzig and Berlin: B.G. Tuebner, 1927), p. 113.

phrase seems nicely poised between accident and intent.<sup>44</sup> The use of the term ‘jamming’ in jazz, to mean spontaneous improvisation of two or more musicians together, seems to have been established by the early 1930s, and perhaps before. It is one of the many ways in which the idea of atmospherics begins to move from the distorting outside of music to its inside.

Probably the narrowing or focussing of the meaning of jamming came about after the Second World War. This was the first major conflict in which radio was not a mere psychological or technical accessory, in which not only did radio become a means of waging warfare, but sound and the study of conditions of transmission, audibility and intelligibility became an important area of research, as attested to by a review article on wartime research that appeared in 1948. The 135 items in the bibliography appended to the article include studies with titles such as *The Design of Jamming Signals for Use Against Voice Communications*, *Speech Transmission Through Six Military Gas Masks*, *Experiments With Earplugs: Their Effect on the Intelligibility of Speech*, *A Modified Tank Crash-Helmet for Use With a Separate Telephone Headset*, *Physiological Effects of Exposure to Certain Sounds*, *Methods of Training Telephone Talkers*, *Speech in Noise: A Study of the Factors Determining Its Intelligibility*, *Transmission and Reception of Sound Under Combat Conditions*, *The Effects of Noise and Vibration on Psychomotor Efficiency*, *Effects of High Altitude on the Human Voice*, *The Development of Ear Wardens*, *An Electronic Device to Simulate Atmospheric Static*.<sup>45</sup> It was out of this general effort to distinguish the conditions under which signals could be distinguishable from noise that Claude Shannon’s mathematical theory of information would arise.

The great generative problem for twentieth century communications, which is repeated in accelerated forms in the contemporary race to extend bandwidth and computing speeds, is the problem of how both to propagate and to regulate the space of communications. Every attempt to extend range, power and sensitivity – to open up new radio space – brought with it the possibility of new forms of interference. Every attempt to extend, diffuse and amplify the body beyond its limits brought exposure to the corrupting or complicating body of noise in the channel. As Hugh G.J. Aitken has argued, the rhythm of radio, that great rider of the vehicle of oscillating impulses, is itself an oscillation between the opening up of a new dimension, ‘whose nature and dimensions could be grasped only by the

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<sup>44</sup> J. Reginald Allinson, ‘Tracking Thunderstorms With a Frame Aerial’, *Weather and Wireless Magazine*, 2.8 (1924) [50-1], p. 50.

<sup>45</sup> Mark R. Rosenzweig and Geraldine Stone, ‘Wartime Research in Psycho-Acoustics’, *Review of Educational Research*, 18 (1948): 642-54.

scientifically trained intellect, one in which there were no familiar landmarks or units of measurement, one where place, occupancy, and possession had to be given meanings different from any they had had before’, and crises of overcrowding and trespass in the new ‘electromagnetic continent’, that had to be met by struggle or international regulation – or large-scale interference and tuning effects.<sup>46</sup>

### **The Time of the Air**

In his 1933 manifesto ‘La Radia’, Filippo Marinetti predicted that radio would not only do away with distance, it would also abolish temporal divisions, as the whole world participated in a perpetual, dynamic ‘now’ of radio-time, ‘without time or space without yesterday or tomorrow.’<sup>47</sup> The movements of the atmosphere give rise to the weather that is time. In a certain sense, the atmosphere is time itself. As we have seen, early measurements suggested that the atmosphere was an arena of previously undreamt of instantaneity. We should bear in mind that one of the most important early uses of wireless telegraphy was to broadcast accurate time signals, such as those which were transmitted from the Eiffel tower. In response to a lecture on the history of the chronometer, in 1920, a discussant identified only as ‘the Hydrographer’ pointed out that

It is possible now, each day, for all those who have these instruments and receiving apparatus and are within range – by means of the Vernier time signals sent out from the Eiffel Tower – to accurately determine errors easily within one-hundredth second of time, by this delicate method, which I have no doubt many here are familiar with. By means of a chronograph and a relay you can reduce that error to something very much less, and the difficulties of interference such as atmospheric and jamming are largely surmounted.<sup>48</sup>

This seems odd – though it is easy to understand how atmospheric could obscure a time signal, the suggestion here seems to be that atmospheric and jamming might themselves introduce a kind of temporal error. The investigations of atmospheric seemed to give the lie to this vision. If radio

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<sup>46</sup> Hugh G.J. Aitken, *Syntony and Spark: The Origins of Radio* (New York, London, Sydney and Toronto: Wiley and Sons, 1976), pp. 33, 37.

<sup>47</sup> F.T. Marinetti and Pino Masnata, “La Radia,” in *Wireless Imagination: Sound, Radio, and the Avant-Garde*, ed. Douglas Kahn and Gregory Whitehead (Cambridge, Mass. and London: MIT Press, 1992) [266-8], p. 267.

<sup>48</sup> Rupert T. Gould, ‘The History of the Chronometer’, *Geographical Review*, 57 (1921) [253-70], p. 269

could be used to synchronise the world, it was also subject to more unpredictable fluctuations in electromagnetic weather. W.H. Eccles led the way in investigating the patterns of intensification and abatement in atmospherics. He was curious about why radio reception was better at night than during the day, and why atmospherics should exhibit the kind of fluctuations he described in 1909:

Starting to listen at about a quarter of an hour before sunset the strays heard in the telephone are few and feeble, as they have been all day. Then, at five minutes after sunset, a change sets in, the strays slowly get rather fewer and feebler, till at 10 minutes after sunset a sudden distinct lull occurs and lasts perhaps a minute. Occasionally at this period there is a complete and impressive silence. Then the strays begin to come again. They quickly gain in number and force, and in the course of a few minutes they settle down into the steady stream of strong strays proper to the night.<sup>49</sup>

Part of Eccles's explanation was that when the rotation of the earth carried a portion of the atmosphere out of the sunlight, it formed a region in which the ions caused by solar radiation began to recombine. Endlessly revolving round the globe, this twilight belt was 'the seat of perpetual electrical discharges'.<sup>50</sup>

What was heard in atmospherics was the fracture and fluctuation of time; atmospherics suggested a time out of joint. As broadcast radio became more established, atmospherics often took the form of an infuriating fringe of Morse signals, which seemed more and more to intervene, not just from a different frequency, but from a different epoch of communicative time.

When Leon Theremin toured his electronic instrument around Europe, it seemed both the sign of a future of complete gratification, in which will and desire would be free of the limits of the body, so that bodily wants, like money cocktails and cigarettes, could be conjured out of ether-stuff, and the long-vanished past. Recalling the nineteenth-century belief that the ether was a kind of limbo or aerial graveyard of lost sounds, the *Daily Chronicle* proposed that 'the eloquence of Cicero and Demosthenes may be recaptured for all to hear'. Emile Vuillermoz similarly spoke of the instrument's power to evoke 'the great pathetic cry of the subjugated

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<sup>49</sup> W.H. Eccles, *Atmospheric Telegraphy and Telephony: A Handbook of Formulae, Data and Information*, 2<sup>nd</sup> edn. (London: Benn Brothers Ltd, 1918), p. 177.

<sup>50</sup> *Ibid*, p. 164.

wave'.<sup>51</sup> Siegfried Sassoon tuned in to the common fantasy that the ether, and especially the regions of it inhabited by radio static, might provide a carrier wave for the voices of the long-dead – in his particular case, the person of the eighth-century 'wild and warring' Queen Mathilda:

Did voices walk the air, released from death,  
Hers might be heard when, very late at night,  
I turn the wireless on and catch no sound  
But atmospheric cracklings, moans, and thuds.  
Hers might be heard, associate with this ground  
Whereon her house once stood.<sup>52</sup>

Sassoon picks up the language of picking up and tuning in, offering a strangely apt prepositional invention in his use of the phrase 'on the dark', in place of the more familiar or expected 'in' or 'through', and therefore suggesting that the dark was not so much a medium as a programme or broadcasting station

...If on the dark  
I heard shrill Norman French and stood between  
That utterance and eternity! If, so  
Attuned, I could watch Queen Matilda go  
Hunched on her horse across the crunching snow!<sup>53</sup>

### **Breakthrough**

It could only be a matter of time before spiritualists and supernaturalists, who had kept a close eye on electronic communications from the beginning, would see the opportunity that lay in atmospherics. In the 1950s, Friedrich Jürgenson thought he heard anomalous voices on recordings of birdsong. In 1964, the Latvian parapsychologist Konstantin Raudive read of Jürgenson's claims and began working with him to try to detect and record Electronic Voice Phenomena, the voices of the dead, often by tuning a radio to the static between broadcast frequencies, or recording from an untuned diode.

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<sup>51</sup> 'The Music of the Spheres', *Daily Chronicle*, December 10, 1927, Emile Vuillermoz, 'Music and the Ether Waves', *Christian Science Monitor*, January 21, 1928, both quoted in Albert Glinsky, *Theremin: Ether Music and Espionage* (Urbana and Chicago: University of Illinois Press, 2000), p. 71.

<sup>52</sup> Siegfried Sassoon, 'A Remembered Queen', *Collected Poems 1908-1956* (London: Faber and Faber, 1984), p. 238.

<sup>53</sup> *Ibid*, pp. 238-9.

The voices, who were often those of recognisable media celebrities, spoke in a polyglot jabberwocky, their preferred mode of address being the gnomish yelp or bark: ‘Mark you make believe my dear yes’, was Winston Churchill’s puzzling admonition. The breakthrough, and the breaking through of the voices, was announced in a book of that name in 1971.<sup>54</sup>

The atmosphere has often made its moods and powers known through sound – in wind, and rain and thunderclap. But the sound of the atmosphere is no mere accompaniment or correlative, in the manner of an animal’s cry. The atmosphere sounds in the mode of irruption, or intemperate exclamation, as though in agony, prodigy or augury. Something that is ordinarily mute and impersonal suddenly seems to ‘sound’, to give voice — or be given to it. The voice of the atmosphere is not something that it has as a resource or property, lying, as it were, ready to hand for it. For the atmosphere to sound is for it *to break into* sound, to pass across some inhibiting boundary, overcome some blockage.

Radio represented the universal trumping of gas by electricity. Gas was organic, approximate and aleatory. Electricity was instant, mathematical, absolute. Radio waves were thought of as penetrating. The atmosphere constituted a distance to be traversed or an obstruction to be pierced. In July 1909, *Technical World Magazine* carried a report about the work of a French inventor named Maurice Dibos, who claimed to have invented a device that would clear the air of fog by broadcasting radio waves in combination with hot air.<sup>55</sup> There is in fact nothing wrong in principle with this idea, though it does not work in the way that it seemed to. Dibos may even have known of Oliver Lodge’s early work with electrostatic precipitation, which showed that electrical fields could clear regions of the air of particles of matter, which could be charged and then attracted to plates from which they could be mechanically cleared. Lodge had experimented with fog dispersal aerials in Birmingham in 1903, and his work

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<sup>54</sup> Friedrich Jürgenson, *Radio- och mikrofonkontakt med de döda* (Uppsala: Nybloms, 1968); Konstantin Raudive, *Breakthrough: An Amazing Experiment in Electronic Communication with the Dead*, trans. Nadia Fowler, ed. Joyce Morton (Gerrards Cross: Colin Smythe, 1971).

<sup>55</sup> Edfrid A. Bingham and John Parslow, ‘Fighting Fog With Hertzian Waves’, *Technical World Magazine* (July 1909): 520-3, reproduced at <<http://earlyradiohistory.us/1909fog.htm>>

was sufficiently advanced for him to form the Lodge Fume Deposit Co. Ltd in 1913.<sup>56</sup>

The atmosphere emerges as a medium to be traversed and therefore a resistance to be overcome. But the obstruction of the atmosphere is not like obstructions to light, which result in a visible subtraction or diminution. The absence of sound is not a dimming but an augmentation and a complication. The shadow that falls across radio-sound is made of radio-sound itself. Because the nuisance will always assume the form of a noise, the accidents and infiltrations of the atmosphere can always come to constitute the signal.

When the atmosphere itself broke into radio, it was an inversion of the usual pattern. The obstruction had penetrated the penetrating medium. In its mildest forms, atmospheric sound is mere distraction or nuisance; in its major forms, it is often associated with crisis, catastrophe, even annunciation. The event of sound is never a completed arrival or coming to rest. Sound is never complete or definitive. Sound is always interrogative, asking, or prompting the question – ‘what am I?’ No serious examination of atmospheric sound could be done by ear alone, since the ear never captures aural events; rather it is exposed to and taken by them.

And yet there was a strong impulse to bring atmospheric sound into a condition of what might be called aural presence, as though to hear these phenomena was to be in their vicinity in a way that transcribing their traces could never provide. It was not that one could wholly capture these sounds: but one could organise and orchestrate one’s exposure to them. Thomas Edison’s assistant wrote in 1890 to Professor Holden, the Principal of Lick Observatory in California, of their ideas for detecting the electromagnetic radiation of the sun: ‘Along with the magnetic disturbances we receive from the sun which, of course, you know we recognise as light and heat...it is not unreasonable to suppose that there will be disturbances of much greater wavelength. If so, we might translate them into sound.’<sup>57</sup> But why?

Edison and Kennelly anticipate more recent attempts to realise electromagnetic perturbations as sound. Perhaps there is an implicit understanding here that sound is always a matter of what breaks out from a

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<sup>56</sup> J. Patrick Wilson, ‘The Technological Heritage of Oliver Lodge’, in *Oliver Lodge and the Invention of Radio*, ed. Peter Rowlands and J. Patrick Wilson (Liverpool: PD Publications, 1994) [173-92], pp. 189-90.

<sup>57</sup> A.L. Kennelly, letter to Professor Holden, Principal of Lick Observatory in California, 2 November 1890, quoted, F. Graham Smith, *Radio Astronomy*, 4<sup>th</sup> edn. (Harmondsworth: Penguin, 1974), p. 18.

background. This anticipates radio astronomy, which, far from allowing us to hear the eternal and unchanging music of spheres, gives us the sounds of violent catastrophe. As F. Graham Smith points out,

Radio waves pick out the variable objects; these are often exploding violently, sometimes as individual stars but more usually as the central cores of galaxies. This violence manifests itself in radio emission, since radio comes naturally from the not ionized gas surrounding exploding objects; furthermore this gas, and the radio waves it emits, can change much faster than the more condensed objects which radiate most of the starlight. The radio sun is extremely variable: at times it can burst out with dazzling brightness on the longer radio wavelengths.<sup>58</sup>

There were benign forms of this breakthrough. Since sound was thought of as a kind of spontaneous spilling or overflow, it could also be the warrant of a personal presence, a kind of authenticating parasite. Radio would supply those tones of voice which were not seemingly not available in the encoded forms of signalling which characterised the telegraph. But even the telegraph had developed a complex kind of interference of its own, an interference that did not inundate or impede the message, but was rather conveyed with it, as a timbral aura or noisy ‘voice’, giving expressiveness and character even to Morse transmissions. ‘Nothing could be simpler than its alphabet of dots and dashes’, wrote L.C. Hall, in 1902, ‘Yet it has come to pass that out of the manner of rendering this simple code has been evolved a means of communicating thought and feeling rivaling in flexibility and scope the human voice. .. A telegrapher's Morse, then, is as distinctive as his face, his tones, or his handwriting and as difficult to counterfeit as his voice or writing’.<sup>59</sup> Hall tells a story of an acquaintance of his, whom he had known only by his call-sign of C.G., but whose character and disposition had been conveyed in the manner of his Morse. He reports that, when C.G. lay dying in a hospital, all his efforts were to get a message through to him. The alternation between internal speech and attempted communication was expressed in an alternation of different voices: ‘While he tapped out his messages he spoke in a tense half whisper, like one trying to project his voice through space. Between times, however, in communing with himself, he spoke in his natural tones.’

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<sup>58</sup> Ibid, p. 29.

<sup>59</sup> L.C. Hall, ‘Telegraph Talk and Talkers: Human Character and Emotions an Old Telegrapher Reads on the Wire’, *McClure's Magazine*, January, 1902, pages 227-231. at [http://www.telegraph-office.com/pages/Telegraph\\_Talk-McClure-1902.html](http://www.telegraph-office.com/pages/Telegraph_Talk-McClure-1902.html)



The indefinable personal qualities that are conveyed in the rhythms of the Morse are also themselves subject to noise and obnubilation. The accepted patois and abbreviations of Morse, directly equivalent to the 'txt-talk' of contemporary text-messaging and chat-lines, could throw up interference if they were transcribed exactly as they sounded, especially if in the kind of 'hog-Morse' transmitted by an inexpert or clumsy operator. The literal sound of the Morse could also generate interference, an interference that then becomes the characteristic sign of certain personalities:

The mere sound of the styles of some transmitters is irresistibly comic. One of these natural humorists may be transmitting nothing more than a string of figures, and still make you chuckle at the grotesqueness of his Morse. It is an every-day thing to hear senders characterized as Miss Nancys, rattle-brains, swell-heads, or cranks, or "jays," simply because the sound of their dots and dashes suggests the epithets.<sup>60</sup>

### **The Work of Listening**

The breakthroughs of atmospheric consistently construe listening and the forming of sound as an ordeal – in strong contrast to the evocations of effortless overcoming of distance. Early radio constituted an arduous, attentive, inventive labour of listening. If atmospheric forced themselves into audibility, then the early radio listener was all the time exerting his own reciprocal pressure to grasp at the fugitive sounds he sought. Listening was a work of eye and hands as well as of the ear, in which there is not much that looks or sounds like passive 'reception'. The work of listening was an active interception. The hams, amateurs and hobbyists who took radio forward in the teens of the century, filling the technical journals with the excited buzz of their witness, discovery and speculation, constituted a laborious manual imagining of the immateriality of a culture constituted of wave-forms. Radio equipment was cumbrous, mysterious, frustrating, fascinating – the coils, wires, batteries, crystals, chokes, condensers, capacitors, coherers, diodes and triodes, and all the manifold ways in which they could be configured and conjugated. Apparatus had to be designed, assembled, tested, adjusted, reworked, for radio to be developed. Listening in was itself a kind of R and D. Later, as radio transmission was taken over by official agencies, especially, during the First World War, the armed forces, and, from the 1920s onwards, broadcasting companies, amateurs came to constitute a kind of fringe phenomenon, a form of interference themselves.

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<sup>60</sup> Ibid.

But there was a secondary work which was effected on this work. Just as the transformation of the phonograph into the gramophone turned what had been a kind of alternating current, in which production and reception repeatedly changed places, into a direct current, in which the production was concentrated at one end of the process, and reception at the listening (and purchasing) end, so the roles of transmission and reception were increasingly polarised in the experience of radio.

This resulted and was expressed in some striking modifications of receiving apparatus. Where early radio apparatus had been ungainly and distributed, involving a number of different components, radio sets from the 1920s onwards tended to take a more and more integrated form. Radio apparatus came indoors from the sheds, basements and workshops, into living rooms, where the radio set was disguised as furniture. (The word ‘set’ changed its meaning – no longer a collection of components that needed to be carefully set up, the set had settled into a single, bounded form.) Much of this work of removing the work of listening involved the simplification of tuning. Tuning to a particular wavelength is achieved by varying either or both of the inductance or capacitance of a circuit. Tuning in early wireless set-ups was a complex and delicate affair, usually requiring three separate knobs to be turned until a signal or station was heard. The station would then be fixed with small adjustments of all three knobs, and their positions recorded – though a change in the position of aerials or the replacement of components could mean that that the settings would have to be recalibrated. The first device to allow tuning with a single switch or knob was patented in 1925, and thereafter was quickly established.<sup>61</sup> Pre-tuned push button controls appeared in the 1930s. The control of the wayward emissions of radio led to the development of radio as a method for remote control. At the Radiolympia show in 1933, Marconi exhibited a radio that would automatically tune into a desired station when its name was called out.<sup>62</sup>

The defeat of interference and the growing regulation and regularisation of the airwaves was accompanied and symbolised by the appearance of the tuning dial. Although newspapers and specialist radio magazines carried details of the location of stations and their schedules during the 1920s, there were usually no names of radio stations inscribed on the apparatus itself; instead there was usually a strip calibrated at 100-metre wavelength intervals. After the international agreements of the early 1930s had more or less

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<sup>61</sup> Arthur P. Harrison Jr., ‘Single-control Tuning: An Analysis of An Innovation’, *Technology and Culture*, 20 (1979): 296-321.

<sup>62</sup> Jonathan Hill, *The Cat’s Whisker: 50 Years of Radio Design* (London: Oresko Books, 1978), p. 77.

stabilised the positions of different stations, dials began to take a circular form, with stations arranged in a kind of zodiac, as in the famous Ekco AD 65.<sup>63</sup>

Where previously the radio listener was in the midst of the circuit, radio developed a face, and listening began to be a face-to-face activity, with the listeners placed in front of the source of sound, a principle that seems to have been grasped early on in the design of the German ‘People’s Radio’, or Volksempfänger VE 301, of 1933. This too reinforced the sense that radio had a finite itinerary, with the broadcasting source at one end of the process, and the listener at the other end, as the destination of the sound. This was the period in which listeners clustered round the radio to look at it, as though radio were already turning into television.

All this time, atmospherics were apparently being slowly squeezed out of the system of radio, which became ever cleaner, more efficient and more tuned. But atmospherics did not thereby simply recede from notice. Instead, having been removed from the medium, atmospherics returned as part of the message: atmosphere came into the foreground. One way of defeating atmospherics was to exclude them from awareness: the other was to bring them to attention.

Atmospherics began to be thematised. The Irish writer Lord Dunsany published a radio play called ‘Atmospherics’ in 1937, in which a train passenger finds himself alone in a compartment with an escaped lunatic who believes he is receiving radio transmissions telling him to murder his travelling companion. He buys time by persuading him to wait until the order has been repeated three times: “‘Are you quite sure that wireless brain of yours is in good order this morning? What I mean is, are you sure it’s not atmospherics? You know the very best sets do sometimes.’”<sup>64</sup> Eventually, the passenger escapes by pretending to be the lunatic himself so that he is taken off the train. We assume that the crossed wires will be sorted out, though the sketch ends with the transmission being swamped in intradiegetic noise: *The rest of the conversation is drowned in the triumphant exultation of a train leaving a platform.*<sup>65</sup> Another Dunsany radio play takes us into the dream of a delirious composer who has a conversation with Beethoven, Shelley, Keats who urge him to leave earth behind. He has

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<sup>63</sup> Ibid, pp. 73-9.

<sup>64</sup> Lord Dunsany, ‘Atmospherics’, *Plays For Earth and Air* (London and Toronto: William Heinemann, 1937) [147-63], p. 155.

<sup>65</sup> Ibid, p. 163.

arranged with his landlady to be woken by a scheduled broadcast of Beethoven's Seventh Symphony, but is plucked back from eternity by a mistuning, which plays a raucous jazz programme – a kind of human static – which breaks into and wakes him from his etherial ecstasy:

I can barely hear Earth now. How rich are the colours of sleep. That's not the Seventh Symphony! What's that? I'm waking! Oh, I'm waking. All the colours are fading. Masters, I don't want to go! They're waking me up with the world's noises; with all the clatter of earth.<sup>66</sup>

Radio places the sublime and the debased adjacent to, of just the click of a switch away from each other. The atmospherics now break in, not from outside the transmission, but from within it, as part of the spectrum of radio frequencies.

When the reviewing of broadcast music became an established part of musical journalism, complaints about the degradation of music by the hit-and-miss conditions of radio reception were common. 'We have all', complained one reviewer, 'at times had to lay aside the head-phones in disgust or in despair, because of the hoots and shrieks, groanings, hisses, and gurglings that proceeded from them.'<sup>67</sup> During this period 'the word 'atmospherics' was sometimes carried across from the material context into the content of the music being transmitted. In his inaugural column for the *Musical Times* in 1929, the radio reviewer 'Auribus' reported that a broadcast of chamber music he had recently heard 'was comparatively free from atmospherics, although the principal composer was Schönberg and the others were two of his pupils'.<sup>68</sup> He maintained the blurring of medium and musical form to the end of his review: 'We seemed to be spending our time on the verge of suicide or the end of the world, listening in suspense while throttled words were wrung from a sibylline voice to the accompaniment of apparently idle successions of notes and chords. I give up Schönberg, weakly, if you like, to people who can more easily get his wave-length'.<sup>69</sup> Siegfried Sassoon wrote similarly, in a poem about a performance of

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<sup>66</sup> Ibid, p. 110.

<sup>67</sup> Arthur L. Salmon, 'Is Broadcasting a Disaster?' *Musical Times*, 66.991 (September 1, 1925) [796-7], p. 796

<sup>68</sup> 'Auribus', 'Wireless Notes', *Musical Times*, 70.1042 (December 1<sup>st</sup>, 1929) [1092-95], p. 1095.

<sup>69</sup> Ibid.

Stravinsky's *Rite of Spring*, of 'vibro-atmospheric copulations/With mezzo-forte mysteries of noise'.<sup>70</sup>

### **Etherphonics**

From the 1930s onwards, there are growing efforts to control atmospherics, not by expelling them, but by incorporating them. It was during the 1930s that film and radio technicians began the practice of capturing and manipulating 'room-tone' and environmental backgrounds, using what became known as 'atmosphere microphones' in order to gather these bottled atmospherics. A number of composers literally did begin to try to harness and orchestrate the sounds of the atmosphere, and to develop methods and musical languages in which atmosphere was integrated into the foreground form of the music. One of the most notable of these was Edgard Varèse, the title of whose *Ionisation* of 1929-31, scored for percussion instruments alone, hinted at a radio context. In his attempts to widen the scope both of music production and forms of listening, Varèse incorporated music for an instrument which dramatises the entire spectrum of attitudes towards the idea of auditory interference and atmospherics: the theremin.

Lev, later Leon Theremin, was a Russian radio scientist, who was working on devices that would automatically sense human bodies, when he discovered that, by introducing his hand into a tuned circuit involving a gas, he could induce a change in the capacity of the circuit, which altered the pitch of the tone that the circuit delivered. From this was born the idea for an instrument that could be played by hand movements in the air alone. Soon he had added a second circuit, a horizontal loop to be manipulated by the left hand, which controlled volume. By 1920, he had completed the first working version of an instrument he called the 'etherphone'. He quickly became a celebrity in his native Russia, at that period still enthusiastically encouraging technological invention. In 1927, Theremin set out to demonstrate his instrument in a series of concerts and performances in Europe and the UK.

The instrument caused rapture and suspicion in equal measure. Some saw in the new instrument an actualisation of the desire to escape the fixed pitches and intervals bequeathed by the Western musical tradition. With an instrument like the theremin, as it was now increasingly known, it was possible to play between established pitches and colours. It was an instrument of inbetweenness, the musical equivalent of tuning between stations, in a kind of free, as yet unpopulated and uncharted radiomusical

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<sup>70</sup> Siegfried Sassoon, 'Le Sacré du Printemps', *Collected Poems* [158-9], p. 158

space. In a sense it was pure atmospheric, promising a world where there would be no necessity for instruments at all. Later in his life, Theremin would experiment with instruments that could be played simply by movements of the eyes, or even by thoughts alone. Such fantasies had already been encouraged by early experiments in wireless telegraphy, which suggested that, if electrical impulses could travel through thin air without the need for any intervening medium, perhaps the body could also be removed from the circuit. Henry Highton, who experimented with his brother Edward on wireless telegraphy in the 1860s reported in 1872 on an apparatus that employed a thermophile, which created current from variable heat: ‘You may judge of its delicacy when I show you that the warmth of the hand, or even a look, by means of the warmth of the face turned towards a thermophile, can transmit an appreciable signal through a resistance equal to that of the Atlantic cable’.<sup>71</sup>

And yet, the music which the theremin produced was a product not of removing the body from the circuit, but of introducing the body into it. In a sense, it was all interference. The report of Theremin’s Paris performance that appeared in *The Times* emphasised this, explaining the workings of the instrument by referring to the experience of ‘users of valve sets [who] are familiar with the phenomenon of “howling” which occurs as the result of electrical oscillations under certain conditions’.<sup>72</sup> Early audiences were frequently reminded that the sensitivity of the instrument made it apt to produce alarmingly grotesque noises. Reporting on Theremin’s lecture-performance in the Albert Hall in December 1927, the *Birmingham Post* was struck by the ‘examples of mere noise...highly suggestive of the range of tones obtainable from the “taming” of the wireless “howl”’.<sup>73</sup> On the one hand, the theremin was capable of tones of an ethereal purity that was hard to achieve with any other instrument; on the other hand, the ‘cracklings and buzzings’ and the ‘stray bleats and wheezes’ (Glinsky 60, 251) were only a twitch of the fingers away. *Time* magazine would later describe Theremin as ‘the Russian who makes music out of radio static’, while Samuel Hoffman, one of the later exponents of the theremin, himself described his technique as ‘controlled static’ (quoted Glinsky 146, 279). The musical

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<sup>71</sup> Henry Highton, paper on ‘Telegraphy Without Insulation’, read before the Society of Arts, May 1, 1872, quoted Fahie, *History of Wireless Telegraphy*, pp. 42-3.

<sup>72</sup> ‘“Wireless Music”: A Novel Invention’, *Times*, 44759 (December 8, 1927), p. 15.

<sup>73</sup> ‘Drawing Music From the Ether: Demonstration of Russian Professor’s Invention’, *Birmingham Post* (December 12, 1927), quoted in Albert Glinsky, *Theremin: Ether Music and Espionage* (Urbana and Chicago: University of Illinois Press, 2000), p. 66. References in the text hereafter.

interest in controlling, and unleashing feedback that has been a feature especially of rock music, from the 1970s onwards is in a direct line from the theremin.

As Albert Glinsky suggests, the real importance of the theremin may have been the fact that it seemed to make the matter of sound available to be manipulated in an infinite number of ways: ‘the raw materials of sound were now exposed and could be molded in every dimension’ (Glinsky 67). The theremin intimated a world in which music could be anything – and anything could be music. And yet, despite Theremin’s own large ambitions for the instrument and the support of pioneers like Varèse, the theremin itself gradually came to be quarantined in a tiny portion of the musical spectrum – its use in films like Hitchcock’s *Spellbound* meaning that it was stuck with signifying weirdness, psychic or psychological, and then, from the 1950s onwards, with otherworldliness and extraterrestrial forces. The sleeve-notes to *Music for Heavenly Bodies*, an album of theremin music issued in 1958, promised listeners that it would give them ‘the awe-inspiring feeling of asteroids and comets... of falling off into the whistling world of infinite space’ (quoted, Glinsky 290). The theremin arose during a period in which music was opening up to the intrigues and enigmas of unearthly sound; but it played a large part in bringing them down to earth.

### Sonification

Radio did not just amplify or enhance, as the microphone or telephone did. Radio belonged to a new, mixed sense, and sense of the mixed, in which oscillations of any kind could be rendered as sound. If one side of this fantasy of interconvertibility was the sonification of matter, the other side was the prospect of the manipulability and transformability of sound itself, which became a kind of ideal, maximally mutable matter. One of Leon Theremin’s more Carrollian competitors claimed that the theremin was an inferior version of a much more powerful instrument of his own invention, which was ‘capable not only of producing music... but odors and light beams – and conversely, capable of annihilating sound, absorbing it, transforming it into silence’.<sup>74</sup>

Digital technology has accelerated the involvement of sound in this kind of intermediality. Everywhere, sound artists are dreaming up ways of using non-sonorous actions, conditions and events to generate sound. In a project entitled *Atmospherics/Weatherworks*, for example, Andrea Polli has developed

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<sup>74</sup> ‘Asserts Device Produces Odors’, *Philadelphia Public Ledger*, March 2, 1928, quoted Glinsky, *Theremin*, p. 83.

software that will sonify the data representing storms, cyclones and other dramatic meteorological events.<sup>75</sup> One of the odd things about this project is the idea of replacing or supplementing the natural sounds of hurricanes and cyclones, which one might have thought were more than adequately furnished with sound, with sonified data deriving from windspeeds. In part, this is in order to satisfy a desire to hear what can never otherwise be heard (the sound of winds at 50,000 feet). Radio allows one the experience of proximal distance, of being in the presence – the very eye, or ear of the hurricane – of what is physically inaccessible.

Everywhere, it seems, there is the desire to expand the reach of the ear, both in terms of what can be brought to its notice – whether the microscopic munchings of snails, or the howlings of supernovae – and in efforts to integrate into listening the backgrounds and atmospheres that ordinarily remain unnoticed. The contemporary fascination with sonorous immersion and ambience, in atmospheres and soundscapes, which has been so assiduously traced by David Toop, belongs to this ambition to open one's ears to the infra and ultra-sonic atmospheres that surround sound itself, 'to introduce space and air, chance and memory into an otherwise claustrophobic world'.<sup>76</sup>

But the more we enlarge our tolerance of noise, the more we process noise into signal, and therefore make it over into our terms. The sonification of the world is not so much a Cageian tuning into the sounds of things as a modulation of things into our frequency-range. For when atmospherics become constructed atmospheres, they are a kind of autistic insulation, as much a way of keeping out as letting in. The rhetoric of the atmospheric enjoins vigilance, exposure, a permission given to the unpredictable; but the more we enlarge our tolerance of noise, our apprehension of the atmospheric, the more it becomes an atmosphere *for us*. If the work of contemporary composers and sound artists seems aimed at finding sonorous correlatives for that which lies beyond or beneath our sensory notice, allowing it to break in upon us as sound, this is accompanied by a denaturing of sound itself. Rather than the spontaneous overflow of meaning and being, sound is just one processing outcome, just one of the many forms into which data can be translated. The press, the presence, the intractable

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<sup>75</sup> Andrea Polli, 'Modelling Storms in Sound: The Atmospherics/Weather Works Project', *Organised Sound*, 9 (2004): 175-80 and 'Atmospherics/Weather Works: A Spatialized Meteorological Data Sonification Project', *Leonardo*, 38.1 (February 2005): 31-36. See too <http://www.andreapolli.com/studio/atmospherics/>

<sup>76</sup> David Toop, *Haunted Weather: Music, Silence and Memory* (London: Serpent's Tail, 2004), p. 100.



demand on us of sound is being diminished, as the realm of the inhuman has been contracted to the human.

And yet uncertainty, the hum or hiss of background noise, remains, and not just at the edge of the system, but in its midst. At its extreme limit, total information is indistinguishable from total noise. It may be that the alternation between meaning and chaos is constitutive of the kind of intelligence we possess and represent. Aristides, writing probably in the probably in the late third or early fourth century, offers a musical allegory of creation, in which the body of man is created when the soul descends from the realm of the empyrean, where it is composed of pure geometrical lines and planes, into a condition of materiality. Its materiality is a kind of atmospheric, brought about by the increasing humidity and adulteration of the air through which it falls. As it approaches the airy and humid region of the moon, which makes 'much and vehement whistling because of its natural motion', the soul precipitates a body from wet breath.<sup>77</sup> Here, rather than being the ultimate destination, the resting point or *ne plus ultra* of sound, man is, like the early radio operators, is always in the middle of listening. As such, he can come to rest neither securely on the side of information nor of noise, neither of signals nor atmospheric, but is a transformer, who repeatedly recreates the difference between the two, and is thus himself the precipitate of crossed lines, of interference, of atmospheric.

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<sup>77</sup> Aristides Quintilianus, *On Music: In Three Books*, ed and trans. Thomas J. Mathiesen (New Haven and London: Yale University Press, 1983), p. 152.