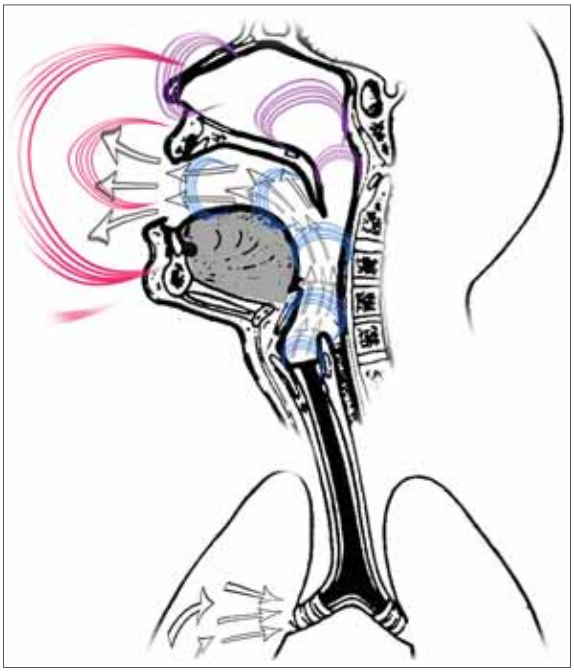
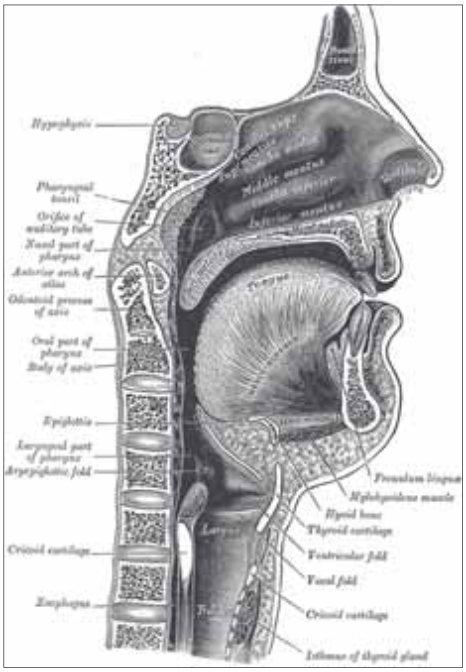
AUSTRALIAN ALMANAC Vol.2 No 22

The Extended Sensorium

The Sounds of a Cosmic Chorus

By Aaron Halevy
Part 1 of 2.





As we listen to the faint whispers which come to us from the shimmering aurorae and passing meteors, we reflect upon that possibility that humans can "hear" events extra-terrestrial.[1] Now we must ask ourselves, can we take any of our assumptions about hearing any further? Must we agree that the modern understanding of what "hearing" is and what the ear's functions are, is a closed subject? And if not, as these phenomena goad us to, then what are the implications? If recording devices can not yet record these cosmic sounds, yet living human beings can hear them, then what is possibly going on in our ears? Is sound just a frequency of vibrating air waves? Take a more complex example: what might we actually be listing to when we hear a live string quartet or a chorus of bel canto trained singers? And inversely, what could our mp3s and even vinyl records not be allowing us listen to?

We've looked into the cosmos for some new clues for our senses, we've looked at the animals and their extra-powers, now let's look back, where all good scientist must look, into ourselves. A fresh study of hearing and making music, from a standpoint less weighed down by common assumptions, could bring us closer to a more free understanding of what is actually happening in the real, unsensed universe. This investigation could bring what we call sound nearer to the domain of light and magnetism, and reveal what a galactic impression classical music can have.

Human Singing

Although not many people may have heard it, U.S. researchers in discussion with Lyndon LaRouche by the 1980s had possibly rediscovered the human singing voice in the realm of cosmic radiation.

More specific studies into the human voice around the 1950s from the communications branch of the U.S. military and from civilian communications, like telephone companies, found some new questions to the study of what seemed to be a straight forward subject. Early on in this period, researchers in vocal physiology assumed a very simple system for the production of sound from the human voice, this model is referred to as the "linear model." Essentially, the vocal chords are producing simple acoustical sound waves, that are then propagated in the air which flows, linearly through the throat and out of the mouth. Microphones measure the pressure of the speech signal to some accuracy. The futility of this model was admitted by some. One researcher from Bell Laboratories, who we will discuss more later, Dr. James Kaiser, said of this linear model: "It's totally irrelevant [to them] whether or not that model bears any resemblance to the physics of production. It only has to be a computationally efficient and adjustable model. That's it: computationally efficient and economically viable, so as to allow one to build the hardware to generate the speech signal as part of the system." [2] That is, they only cared about what happens outside of the mouth.

The questions about what the ear hears and what else could be going on in the voice are unnecessary to determine in such a model with such a goal. Why? "Because," as Dr. Kaiser said, "almost all this work on modeling was done by electrical engineers, they like to look at things as filters, as block diagrams that have 'input,' 'system,' and 'output.' The 'source,' or input is the vocal fold oscillation. The filter is represented by the cross-section area of the acoustic tube, and the 'output' is the pressure wave at the mouth. That's the filter model and its many variations. That's the approach that was used."[3] The equations were written. The models required many computers to calculate the equations, and if these models were criticized, the heartless mathematician would lurch from his table of equations to say, "these questions are not a problem, because the model works."

From this perspective with no horizon, these researchers ran into several "anomalies." Vocal *formants*, as they are studied today, are regions in the human voice, where harmonics have stronger amplitudes. The principal vocal formants are formed at generally 500, 1500, 2500, 3500 Hz and so on. When lighter gasses are introduced to vocal

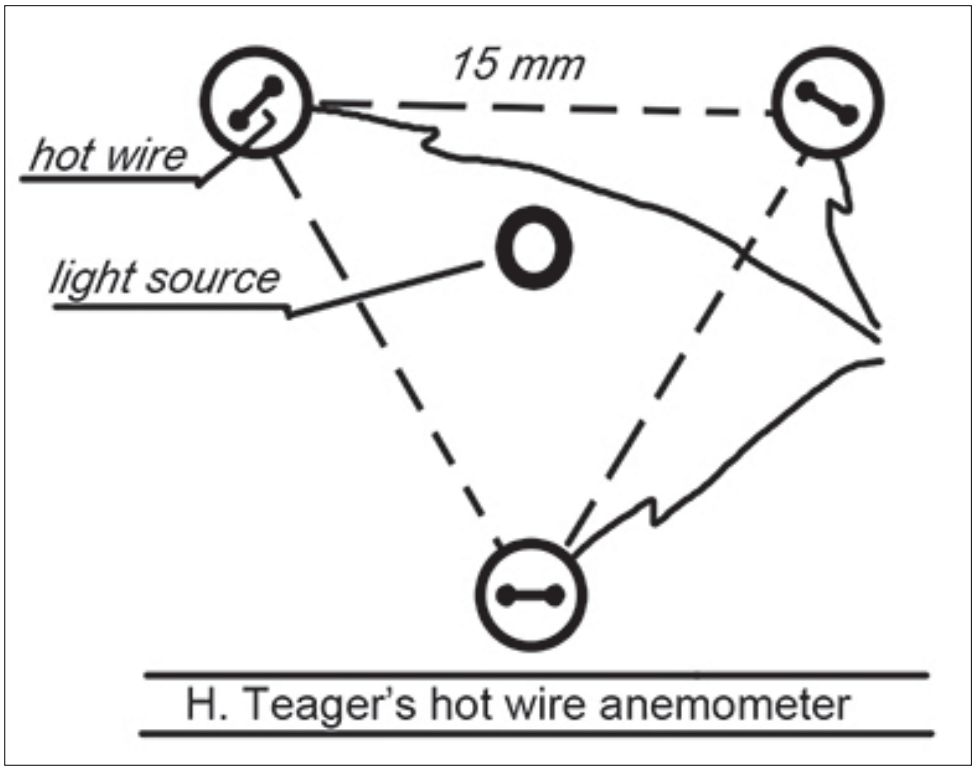
Hermann Helmholtz (1821-1894), a German scientist contemporary with Riemann, published a book in 1863 called *On the Sensations of Tone As a Physiological Basis for the Theory of Music.* We shall discuss this more later, but it is relevant here to point out that it is Helmholtz's view of sound and its laws, established in this book, which is the dominant view of today's professionals in all related fields: a real "classic." It is no surprise that when Helmhotz arrives at the conclusion in his book that Mozart's trio minuet in Don Giovanni is always sung too dissonant, "The chords," Helmholtz writes, "almost always sound a little sharp or uncertain, so that they disturb a musical hearer." He suggests that perhaps they should learn how to sing in these "perfect musical chords," to satisfy him.

production, such as helium, the calculations based on the linear model should force the pitches of all the sound, including the vocal formants to raise by a factor proportional to the difference in the velocity of the gas, yet when the tests were done, the change was far less than expected and the irregularity was even astonishing – each of the formants are unpredictably changed in different ways with the faster gas. Other questions were raised, but were not important to explain in the linear model such as: dealing with the surface of the vocal tract, its characteristic tissue was considered uninteresting; the lubrication as essential to speaking was neither here nor there in the standard model; the similarity to speech that birds can achieve[4] was not accounted for; the changes which take place in the space of the tract,[5] i.e. the tract's geometry while vocalizing was relatively simplified in the standard theory. 'Where does the voice comes from,' although a silly question to some, anyone who sings knows from experience that the voice does not emanate from the throat alone, but this too is explained away as a *passive* feeling, "nothing really going on here." Most interestingly, the energy-input measured at the glottis is only 0.1-1% of the energy which is measured in the acoustical sound waves as the end result. In other words, 99-99.9% of the energy put into use when someone is speaking or even singing is accounted for again as *passive* resonance in the linear assumptions of the vocal apparatus.

Teager discovered by the use of a hot wire anemometer, an apparatus generally used by aerodynamacists to make measurements of the amplitude of the flow, that the air flow within the vocal tract varies wildly from place to place; from the beginning of the glottis, for the same vowel at the same pitch, the air flow inside the mouth was different in every location of the readings. Dr. Teager was struck with the fact that a simple, uniform air flow in the voice was impossible.

To summarize the findings, as Teager describes in his paper, "Active Fluid Dynamic Voice Production Models, or There is a Unicorn in the Garden,"[7] after thousands of tests and a perfection of the apparatus he concluded that, the air flow is not uniform, but is more a combination of several separate jet flows at very high speeds. These jet flows utilize the walls of the vocal tract aerodynamically to constantly create nonlinear effects by means of the high speed pressure changes. These jet streams create a whole family of observable vortices along the walls and in the few cavities, even including toroidal shaped vortices formed along the volume of the tract.[8] The action of these vortices alone is surprising, in that they are found to be pulsating in and out in phase and modulating the formants of the voice.[9] As Teager wrote, "The pulsatile jet proceeds through the vocal tract and drives or excites everything downstream from it. If you think of it another way, what do you remember most about going over the Niagara Falls, the froth, or the falling water? The sound generated from the second order process is the froth; the main source of energy is the glottal jet."[10] So the sound which we mostly hear is the effect which is generated by this entire process.

It must be stated here that there was a very intense battle that Teager and Kaiser had to wage, against those who would force them to abandon their new model, and to take the advice, as it was told to Prometheus, to "kick not against the pricks." Kaiser describes Teager's frustration with the other agenda which he had to fight against in doing the research: "Look, let me get the physics right first. Then once I understand what's physically going on in this generation, then I will worry about the mathematical modeling after that, because then I will have much better guidelines as to how to do the modeling and which



Air passing around a wire cools it, changing its electrical resistance, which can be detected by the same attached wire which is electrically heating it, measuring the amount of air flow passed the apparatus.

approximations are meaningful and which ones are not meaningful." And so he worked, he wrote, and the papers were shot down, again and again. Kaiser: "I think he [Teager] had been beaten on so much by the establishment that he had just retreated into his little shell—or his big shell—and said to himself, 'Look, I'm going to solve this problem once and for all so completely and get so much evidence that there's no way these fellows are going to say, "Herb, you blew it"'… he had a tremendous amount of integrity." They both eventually left Bell Labs and in 1989 Teager died of lung cancer, and was not able to further his work.

In their view this largely unobserved activity in the vocal tract, which makes up the very small action taking place (i.e. "fine structure") is responsible for much of the volume of the voice and most all of the higher frequencies, known as formants. The tract itself then becomes very *active* to say the least and not a *passive,* linear system. By this view of the vocal apparatus the anomalies listed above can become more understandable. For example, Kaiser in an interview conducted in 1997 said on the subject of the efficiency of the vocal action: "So now, let's look at this whole system from an energy point of view. For example, my speech now: I am putting maybe about a quarter of a watt into this system. Only less than one percent of that comes out as sound. So it's like I've got this tremendous reservoir of continuous energy and only a very small part of it comes out as acoustical energy. That leaves a great potential there. The opera singer stands up there on the stage at the Met singing with no microphone, with fifty or sixty pieces of orchestra in the pit, but yet that voice clearly fills that whole hall up. How do they do it with the same set of lungs and vocal chords that you and I carry around? They've learned to get that efficiency up from the order of half a percent up to seven or eight percent." Kaiser further discusses speaking and singing in what can be seen as a negentropic process, "This is a wind-driven instrument, and the energy in this system is in the moving air. And with moving air, any time you have a time-rate-of-change of flow, you have the potential for the generation of an acoustic wave."[11]

Lyndon LaRouche, a founding member of the Fusion Energy Foundation, upon hearing of the results of this research in the mid 1980's, suggested that this evidence should lead to an electrodynamic view of the human singing voice. This discussion coincided with a strong drive within the fighting part of the scientific community at that time to promote nuclear fusion research, and the discussion was how to confine the fusion process enough to create the reactions, similar as they occur in the sun. This, at the time, became related work of Phillip S. Callahan on the communication of moths, where the moths emanate a sort of double propagation: one as the "lasing" or shaping of the space, and the other as the communication (or information) wave.[12] Mr. LaRouche suggested on this and other evidence, some specific experiments to be conducted to extend the discussion of the singing apparatus in this regard.

Mr. LaRouche wrote, "The essential thing here is that the bel canto tone is an approximation of a lased tone, as distinct from the raw tone generated in the lower portions of the human apparatus."[13] "The implication is, that the state of the macro-system in this respect, relative to the induced transparency, is more comparable to the relevant physics of propagation in water, and to certain aspects of solid state physics, than any popular, 'gas theory' notion of the air medium." He goes on to define the relevant experiments to be performed to test this hypothesis: "What is implied is some form of our dyeing of the prepared air molecules in a drift-tube-centered, ultra-quiet room sort of experimental configuration. What is suggested as instrumentation, is a combination of appropriate stroboscopic and stroboscopic-like NMR observations. We wish to observe the condensation of the air molecules and the magnetic orientation in the cross sectional volumes of condensation and rarefaction."[14] Unfortunately, these tests have not yet been done, and deeper study of this phenomenon still lies beyond our grasp. The evidence already is astonishing, but much more must be done to further this work.

When thought of in the context of our more recent discussion with Mr. LaRouche on the phenomena of a space-time made of cosmic rays, one can imagine the analogy of this unseen cosmic ray space which has a mutability, which the galaxy and solar systems act on and respond to in their evolutionary development.

Now that we've broken into the discussion of what is beyond the sound waves themselves, what about ideas? How do ideas manifest in the voice and then out into this space, and into the mind of the audience? What else is at play here? Is this communicated through the ears? Or can it possibly pass to your ears through your iPod?

Registration Please …

Let's look at the human voice more in practice, not as a mechanical device, but looking at what we need it to accomplish. This reflects the same discussion of Köhler's *isomorphism*: what is the nature of matter in order to facilitate cognition, and therefore what is the nature of the voice to facilitate musical ideas – as opposed to the throat making sounds for no reason? That which is called a register shift, or *passaggio*, by singers trained in the bel canto method, has some very interesting implications which are worth touching upon, at least briefly, here.[15]

Kaiser, as a singer, knew intuitively that this discussion with Teager had implications which could help him in his own singing, "Certain things became much more clear to me about certain problems that I had (problems that had come up through my singing, which I was doing very actively)." Similarly, we find a functional understanding, albeit not in these terms, of the processes which Teager and Kaiser found, in some of the best teachers of bel canto.

The *passaggio* is described, by the best teachers, as a conscious modification of the vocal tract, by "thinking of a new shape," "shifting gears" or "going through a doorway." One can imagine this changing of the geometry of the voice, effects all the resonances and the vortices downstream. Every voice has several such shifts. In the bel canto tenor or soprano the main shift is found from the middle voice (second register) to the "head voice" (third register) and is located, at strict C=256 tuning, in the region of the F#. One can imagine that bringing the vocal apparatus into a different configuration, brings a higher efficiency of the throughput mentioned before by Kaiser, and this reconfiguration gives the singer the capacity to sing notes which otherwise would not be possible to sing before the change (a new degree of freedom). As a way to think of how this

is achieved in the mind of a singer, take Luciano Pavarotti, who wrote of the *passaggio* in his biography: "It is a little like breaking through the sound barrier. If you do it in the right way, it affects what happens on the other side."

This is very important for a singer to know, for an improper shift can throw off the ability to sing into the higher registers of the soprano and tenor voice, passed the high B, into the *do di petto,* in the "fourth register." Pavarotti again: "The *passaggio* is also very important in connection with singing the highest notes. If the shift-over from the middle to the upper register is done correctly, it opens up the top much more effectively and those high B's and C's have a better chance of being hit solidly and well." What else could be happening in going into this higher efficiency? And a similarly, what could be taking place in the Basso voice, in the shift which seems to be an *inverted* fourth register found in the lowest range of the voice species? Think then, what could be the effects of arbitrarily raising the pitch of orchestras and choruses beyond the natural, Verdi-promoted tuning of C=256, even if by "just a little bit"?

Given this delicacy of the work accomplished by this jet flow, in its negentropic action, on the whole vocal tract, which is unified by the geometry of the tract, the bel-canto register shift, has some very interesting implications in communicating subtleties in performance of music by a composer who knows how to use this higher dimensional power, such as Bach, Mozart, Beethoven or Verdi. To "play" the human voice, which every human being has been given "in the box" so to speak, the singer has the challenge of using a living process to make music, and this is what is reflected in the fluid dynamics of vocal production and the use of register shifts. Not only can the voice expand its otherwise small range by this action which exists in the bel-canto voice, but brings a higher, willful organization of the whole geometry of the action taking place, which must be thought of as received, even if "ever so slightly," by the conscious, non-sleeping members of the audience.[16]

To be continued...

Footnotes

[1]See paper on Auroral Hearing by Sky Shields within the larger report

[2]From an interview with Dr. James F. Kaiser in 1997: www.ieeeghn.org/wiki/index.php/Oral-History:James_Kaiser

[3]*ibidem*

[4]Talking Myrhy Birds: 1. www.youtube.com/watch?v=anyBbiljocA&feature=related
or see the "Einstein Bird" www.youtube.com/watch?v=gr2vt0CekKA&feature=related

[5]See this video of human singing recorded while in an x-ray machine: http://vimeo.com/12251154

[6]"The voice impresses itself though the air without displacement of air, and strikes upon the objects … " – Leonardo DaVinci (*Codex Atlanticus*, 360 r.a.)

[7]H.M Teager & S.M. Teager, "Active Fluid Dynamic Voice Production Models, or There is a Unicorn in the Garden."

[8]H.M. Teager, (1989 Presentation in France) "Evidence for Nonlinear Sound Production Mechanisms in the Vocal Tract."

[9]James F. Kaiser, (1929) "Some observations on vocal tract operation from a fluid flow point of view"

[10]H.M. Teager, "Evidence for Nonlinear Sound Production ..."

[11]This reveals the use of microphones in more and more major opera halls across the world as a fraud similar to the stupid environmentalist's protest against the use of nuclear power.

[12]Insects and the Battle of the Beams – by Phillip Callahan (FUSION magazine, 1985)

[13]Lyndon LaRouche unpublished memo.

[14]Lyndon LaRouche, 1980s memo, "Conjugate, Schroedinger-like Helices as the hypothetical form of propagation of induced transparency for electromagnetic transmission of coherent sound in the air medium."

[15]See the Schiller Institute's, "A Manual on the Rudiments of Tuning and Registration, Volume I, Introduction" (1992)

[16]Just as Dante points out, the person sitting next to you may look alive, but their soul might already be suffering in hell.