Information on Fiorella Terenzi's astrophysical music - acoustic astronomy

NEW SOURCES, NEW MUSIC

Electronic Musician. 1990, January, p. 55

With the current state of synths and sound modules, packed to the brim with snappy presets, it's easy to forget that what was initially so exciting about electronic instruments were the new sound possibilities and the new forms of music that would arise from those fluctuating oscillators. While many major-league acoustic hitters still pursued the 12-tone strategy of Schoenberg, many early electronic musicians found that the power of manipulation over sound waves encouraged a freedom from the concepts of pitch, form, rhythm, and timbre that had held back composers of earlier Western music.

Since the 1950s, some composers have taken this concept even further, realizing that musical inspiration can actually begin with non-musical sources. Since computers could analyze and extract all forms of data from natural resources (the topography of a particular geographic area, for instance, or the intensity and rhythmic pulse of a mountain stream), there was nothing to stop them from using these ones and zeros to create audible analyses as well. In some cases, the "composers" become translators, playing tapes of an ego-less music that begins and ends with computer-generated information; in others, the data music was used as a backdrop or grounding for human-inspired melodies played over the top.

Fiorella Terenzi has combined her passion for music (having studied piano, composition, opera, and voice in her native Italy) with a knowledge of science -- she recently received her doctorate in physics with a specialization in astrophysics from the University of Milan -- to carry these concepts yet another step. As a researcher at the Center for Music Experiment, University of California-San Diego, her composition *Music from the Galaxv* has come closer to its finale.

"Basically, what I'm doing is collecting radiation from another galaxy and turning it into sound," she says in a rich Italian accent. "The actual collecting is done by staff researchers, astronomers, and astrophysicists, who in this case are studying a galaxy called UGC 6697. They collect the radiation using a huge radio telescope, which is like a big antenna, and send the data directly into the computer at the University of California at San Diego's Center for Music Experiment. What is received are numbers representing the radiation coming from the galaxy.

"Usually in astronomy you use that data to produce an image for photos of the stars. What I want to do is say: Okay, you receive light from the sky, but you receive other kinds of radiation as well. You can receive X-rays, gamma rays, and electromagnetic radiation, which will let you hear what's going on in the universe. So I display on the computer the waveform representing the emission of the galaxy. Once I have the waveform on the screen, I have to take a big step because the radiation is received at an impossible frequency to be heard by human beings. Humans can only hear between 20 to 20,000 Hz; galactic radiation is at about 1 gigahertz (1,000,000,000 Hz). So with the computer I translate the data into the 20 to 20,000 Hertz portion of the spectrum. " Terenzi uses a sound synthesis language called "cmusic" (created by Prof. F. Richard Moore at the University of California, San Diego, Computer Audio Research Laboratory) to turn the numerical data received

from the galaxy into a class of sounds for use in her music ... The computer information is then processed through a digital-to-analog converter and,played through conventional loudspeakers.

Terenzi explains that this particular galaxy transmits a very low frequency which will make up a four-hour loop. "And at the same time there are high frequencies that appear over the low spectrum," she says. "The sound is very complex and is not regular, because the galaxy itself is an irregular astronomical object. In the future, I would like to study a pole star, which would give me a beat every second. But this galaxy is interacting with an intergalactic medium and is thus quite complex."

Having a four-hour loop of galactic sound does little by itself, of course. Terenzi composes music based on her tonal translations of the pulses. "Then I use the sound to compose galactic music. I study the sound of the galaxy and try to recognize the intonations of this sound. This galaxy seems to be tuned at about B-flat, so I use a big ground sound from the galaxy, and over the ground I play different synthesizers, or I play oriental musical instruments to compose in a style respecting the sound coming from the universe. I can break the sound of the universe into small samples as well, two to three seconds long, and then loop the galactic sound and use the galaxy as a drummer. Or I can play a melodic line using the sounds from the galaxy, choosing a particular piece of the complete sound "...

Esoterica

RR, *Los Angeles Reader*, 1991 September 6
Dr. Fiorella Terenzi *Music From the Galaxies* (Island)

Just when you thought modem music has exhausted every possible territory, an Italian physicist has produced a unique recording from a way-out source. How way out? Well, how does 180 million light years grab you? Fiorella Terenzi, who received her Doctorate in Physics from the *Universita degli Studi, Milano*, recorded the radio frequencies from the galaxy UGC 6697 and converted them into audible sounds on this strange-but-fascinating album. In her astronomical explorations of the galaxy, the doctor discovered some interesting musical aspects: Some parts of the galactic "sounds" seem well-tuned around B-flat or D-minor. Close listening will even reveal harmonics. Most of the record is raw electronic sounds but, on the album's last track, "Cosmic Time," Terenzi arranges more traditional instrumentation around her cosmic music. It is strangely beautiful, definitely different music where no one has gone before.

GRIFFITH OBSERVATORY

2800 East Observatory Road, Los Angeles, CA
Monday, 1991 November 18

"Music from the Galaxies" by Dr. Fiorella Terenzi Lecture, Demonstration, Concert held in the planetarium theater of the Griffith Observatory.

Dr. Fiorella Terenzi, an Italian astrophysicist, has captured radio waves (a form of light) from a distant galaxy 180 million light years from earth, converted the cosmic waves into sound, and transformed the sound into music. Join us this evening for a rare adventure in "acoustic astronomy.

To quote a recent review, Dr. Terenzi's music is "eerie, moody, science-fictiony stuff, ... reminiscent... of the other worldly music on the soundtracks of such classic science fiction movies as *Forbidden Planet*. "In her illustrated talk, Dr. Terenzi will explain how radio waves are captured from distant galaxies, compare cosmic waves and musical notes, and explain how she transformed the cosmic waves into sound. She will then perform a short concert of her original "space music" live under the stars in the planetarium theater.

Dr. Terenzi has a doctorate in physics from the University of Milan with a specialization in Astrophysics and Radio Astronomy, and she is Professor of Mathematics and Physics at the *Liceo Scientifico*. She was also a visiting researcher at the Center for Music Experiment of the University of California, San Diego, where she developed computer programs for the analysis and performance of musical scores. Her first release, *Music from the Galaxies*, is available on Island Records.

Sky's the limit for astrophysicist's heavenly music

Dr. Fiorella Terenzi, an astrophysicist and musician, tunes into the sounds of the universe.

By Suzan Bibisi. *Daily News*, "L.A. Life," 1991, Friday, November 29, p. 47

An Italian astrophysicist has created far-out music from sounds that were millions of years in the making -- 180 million light years away, to be exact.

To cut her galactic grooves, Fiorella Terenzi, an astrophysicist and musician, trapped radio waves from a galaxy, funneled them into a computer program. and translated those digital bites into music. The result is a spacey new-age album, *Music from the Galaxies*, that for the first time takes sounds from gas clouds slam-dancing around Galaxy UGC 6697 in B-flat and D-flat and turns them into music, said John Mosley, program supervisor for the planetarium at the Griffith Observatory, where Terenzi recently performed before an audience of 350 people.

"It's the first attempt to take astral sounds and turn them into music," Mosley said "This is one musician who knows a star from a planet." A recent review labeled the music "eerie, moody, science-fictiony stuff. . . reminiscent. . . of the otherworldly music on the sound-tracks of such classic science fiction movies as *Forbidden Planet*."

Terenzi, a 28-year-old astrophysicist-musician, with a doctorate from the University of Milan, created the computer program to translate the electro-magnetic radiation at the University of San Diego. She captures the radio waves, created from the explosions of gas clouds colliding, in radio telescopes in New Mexico. The 27 telescopes are lined up in a, row like satellite dishes at attention.

The radio waves are translated by computer into numbers, which are fed through a synthesizer. The galaxy's whooshes and hisses are turned into meditative music. Her album contains 30 minutes of raw galaxy sound, similar to static, that is not altered by synthesizer. The balance of the album including the last cut. "Cosmic Time." is culled from harmonies found in the radio waves that are augmented with a synthesizer.

"There is a high amount of activity going on," Terenzi said, explaining why she chose Galaxy UGC 6697. "Particles, like elections, are colliding very violently. There is a definite chemical reaction going on. " Electromagnetic radiation waves now are translated into cotton candy images. Terenzi's work adds color and substance to the images that are later made into music. Her computer program, for example, would turn whispy white images into a blurry version of "Starry Night" and those images are turned into music.

Terenzi said her inspiration came from research, not media influences. Although Dr. Fred Brockman, a fictional character in the Kurt Vonnegut short story "The Euphio Question, " (from *Welcome to the Monkey House*) discovered radio waves through his radio telescope, he never turned those signals into music.

"The idea for the album came from studying music and physics together," she said "I compared musical notes and radiation, measuring the intensity and frequency." Terenzi said she hopes her project can be put to practical use. Perhaps she will not be able to communicate with extraterrestrial beings as aliens did with humans in the movie *Close Encounters of the Third Kind*, but she hopes to better describe an invisible universe, she said The most visible star from Earth is Sirius, which is eight light minutes away. Terenzi hopes to detect more celestial bodies that are millions of light years away.

She [...performed] another little night of music at Santa Monica College on 1991 Dec. 7 in the school's planetarium...

Let's Get Astrophysical, with Doctor Fiorella Terenzi

In Conversation with Jas. Morgan, Bart Nagel and Gracie & Zarkov. *Mondo 2000*. #5, (1992) pp. 97-100

Northern Italy has long been famous for beautiful music and beautiful women. Fiorella Terenzi is a strikingly beautiful woman who studies music composition and operatic singing at Milan's Conservatorio di Musia Giuseppe Verdi. *She is also a professor of mathematics and physics at* Licio Scientifico *in Milan. The magnificently endowed Dr. Terenzi received her doctorate in physics, with a concentration in astrophysics from the* Universita Degli Studi *in Milan.*

Her extraordinary first album, Music from the Galaxies, on Island Records. combines her twin passions for music and astrophysics. She was recently visiting researcher at the Center for Music Experiment of the University of California. San Diego and will be performing lecture/concerts at Griffith Observatory, Los Angeles, in November and December.

Dr. Terenzi discussed. in her charming Itnlianate inflection, hard-core astrophysics, computer music, opera and signal processing. What they have in common is the subject of our interview. -Gracie & Zarkov

ASTRONOMY DOMINE

MONDO 2000: How many albums do you have out?

DR. FIOREILA TERENZ: *Music From The Galaxies* is my first one. It's galactic music. It's the first experiment in transforming radiation from celestial objects into sound

M2: How did you invent your *Music from the Galaxies*?

FT: I started to look at the sky with my grandmother-going out to the country when I was a baby. When I was 4 or 5 years old, my grandmother would take me out into the *campagna*, and she would look for the right places, as dark as possible, to look for meteors. Later, at the *Università di Milano* I was taking astrophysics and astronomy, so I was studying the whole sky, the radio sky and the visable sky. At night, at the Conservatory (*Milano Conservatorio di Musica Verdi*), I was taking composition, opera and piano. I began to study music theory and how music can be specified as frequency and intensity. So if I had frequency and intensity from a celestial object, and musical notes are frequency and intensity, there must be a way to make music from the data. That was my first intuition.

M2: So that's when you had your basic conceptual leap?

FT: No, I didn't really make the connection until I took a course in radio astronomy. I was also working on radio astronomical classification -- determining the time intensity and frequency for a particular galaxy.

The data was in the Fourier transforms on the computer. I was looking at the frequency of hydrogen (the 21 cm line), and molecular lines. *[The hydrogen and molecular line data yields information on how stars form from interstellar gas. This signal also yields data on whether the universe is open or closed by looking for the "missing mass. "-Z.]* This was a raw data count, looking for any kind of structure. I was cleaning up data, removing the background contribution of the sky from around the major peak, checking out the calibration of data. and removing ground noise. *[Data reduction is the necessary drudgery of Big Science and the inexorable fate of all graduate students.-Z. J]*

M2: When did the data stream become music?

FT: I realized that radio waves coming from a celestial object were very similar to musical notes. Both have an intensity that gives you loud or soft sound. They also both have a frequency that give you high or low pitch. So I went to my professor and said, "Instead of looking for an image of the universe, instead of looking at photos of stars, I want to try to play the universe. I want to hear the sound of radiation coming from a celestial object." So I went to the Center for Music Experiment and I did it as an experiment using their big VAX work station. I believe that sound is a powerful tool to investigate the cosmos because it reflects the chemical and physical properties of celestial objects.

Think about the universe. Often you have a binary system of stars spinning together. The frequency of these stars is almost the same -- not quite equal -- so the two stars generate beats. This is the same phenomenon you have when you tune an instrument. You are tuning your bass to a 440 A., and let's say your string is tuned at 445 Hertz. If you play them together you generate beats. The beats stop when you tune your strings precisely. But you can't see beats. You can't see how the two fragments collided with your eyes. The graphic representation doesn't show you. But if you play the binary system of stars, you're able to hear beats. So this is a powerful way to investigate the cosmos.

M2: What's your method for translating radio telescope information into sound?

FT: First you collect radiation from stars and galaxies using radio telescope astronomy facilities. I was using the one at Socorro, a Very Large Array (VLA) radio telescope in New Mexico. And we were using the Kitt Peak National Observatory in Arizona, and the European Southern conservatory in Germany. All of these astronomers were working on a galaxy called UGC 6697. Once you collect the radiation coming from a celestial object, you can save it on a tape or send it by cable to any computer in the world.

MAN, THAT NEBULA COULD BLOW

M2: Why did you choose this particular galaxy?

FT: UGC 6697 is very complex. It's a spiral galaxy. *[We live in the arm of another Spiral Galaxy, The Milky Way.-Z.]* It's really powerful. It has a strong emission and it's really far away -- one hundred eighty million light years. There's a small satellite companion galaxy spinning around it. The two galaxies collided, and that created the complexity you hear in its sound. I chose it for this complexity. Also because the data was available. At the beginning I was thinking of using a pulsar. A pulsar is a star that pulses every second or maybe every millisecond. It sends a precise signal in time. Next time I'll use a pulsar because I want a cosmic drummer for my composition. *[Pulsars are believed to be rapidly rotating neutron stars that emit a highly collimated signal in the shape of a searchlight beam usually about once per second. The precision is to six or seven digits.-Z.]*

SHE BLINDED ME WITH SCIENCE

M2 How did you choose a scale and transform the radio digital data into musical scales?

FT: Let's consider data from one galaxy, from one single profile of that galaxy. The signal profile has a wide frequency range where the most important peak represents the characteristics of the galaxy. For example, if you look at that waveform, you recognize certain chemical elements. *[The study of line emission from interstellar molecules helped discover the spiral structure of the Milky Way.-Z.]* The first thing that you realize is that the waveform -- every kind of radiation -- comes to a billion Hertz: 0.4-1.5 gigaHertz (GHz). So the first thing is just to shift the waveform into the human hearing range, 20-20,000 kiloHertz (KHz), without altering anything.

M2 Do you pick a distinct source -- like a molecular line?

FT: No. It's not a narrow range; each profile can cover a broad range of three octaves.

M2 So you simply divide by 10^6-10^8?

FT: Exactly. Sometimes a radio telescope is picking up something else, so that the broad range is much, much wider than three octaves. When the signal is shifted then I lose data below 20 Hz and above 20 kHz.

M2: Are you picking multiple signals for the music?

FI': It's a software program, with an electronic music oscillator, to apply the frequency and intensity. Choosing which harmonics you associate with the oscillator in the software, you develop a different timbre, and different texture. You say to the oscillator, "read the wavefonn"-- that is, the waveform coming from the galaxy with all its frequencies, all the harmonics in a Fourier representation. The oscillator performs exactly the number representing the frequency and harmonics coming from the galaxy.

M2: So you divided the frequency and directly triggered the oscillator as if it had been a digitized acoustic waveform, and it comes out as music.

FT: Exactly. *Perfetto!* After this initial process there is the creative composing process that depends a little on what I want to do. I might want to stay in the electronic domain or go to the classical. Maybe, why not opera and experiment with the voice?

M2 What are your favorite operas?

FT: I like Puccini: *Tosca*, and *Turandot*.

SPACE JAM

M2: Do you perform your music live?

FT: Yes. I did the Greenpeace Music Nature Festival in Milan with Paul Winter and Montreux. I performed the galaxy using a synthesizer, a sampler and an oscilloscope to show the wave form of the vibrations. I was playing the raw data of the galaxy on the synthesizer. On the second part I had a musician playing shells, stones, coconuts and flute. I associated the galaxy with primitive musical instruments because the sounds are one hundred and eighty million years old. And then I got to the future. The galaxy was performed with harp, bass, saxophone, drummer, congas and piano -- with everyone following a score.

M2: What are you planning to do at Griffith Observatory?

FT: My Griffith performance will be a lecture-demonstration concert. I will talk a little bit about the radio astronomy waves and how I process the musical notes. Then I will perform the music. I'm

going to process the galaxy in 3D. Because of the round planetarium hall, I can produce a galaxy moving in space.

M2: Is your music recorded digitally or analog?

FT: Digitally. I processed the data at the Center for Music Experiment at UC San Diego. The first thing I did was to display all the numbers on my computer. The numbers represent the radiation coming from UGC 6697 with intensity and frequency. The radiation is coming at a billion Hertz, and the human ear can only hear sound between twenty and twenty thousand Hertz. So you have to reduce the frequency. Then you have numbers that represent the wave form, and you send this information to an oscilloscope which is able to synthesize the sound. If you send information representing a violin to an oscilloscope, it will play a violin. If you send a harp, it will play a harp. I sent galactic data. It took eight months to hear a little bit of the sound of the universe. For each second of sound on the CD, it takes eight or nine hours of work on the computer. After eight months I had four hours of sound from the galaxy. Then I pressed "execute" and the data flowed directly from the computer to a loudspeaker using a digital-to-analog converter.

GIMME A U, MAESTRO

M2: With the synthesizers, do you use even-tempered tunning or do you experiment with just tuning?

FT: With my synthesizer I'm only controlling the galaxy. What I'm also doing is breaking the galaxy into small fragments in order to play a melody or harmony. If I use the library of sound from my synthesizer, I pay a lot of attention to the timbre quality. Because if I use too much electronics it doesn't fit well with the galaxy. The raw data of the galaxy is a strong digital signal. Yon can recognize a strong electromagnetic signal. So I don't want to overload the composition. For that reason I'm using harp. saxophone, piano, and -- soon-- voice.

ELECTROMUSE -- COURTESY OF MA BELL

M2: The galactic sounds on your album are remarkably similar to some of the space Sound tracks I've heard in the past. Did you notice any similarity?

FT: Of course. Another similarity I noticed is when you're tuning your FM radio, you get a wah-wah sound. You're shifting between electromagnetic waves, so it's very similar to the sound of the galaxy. Also, for the first synthesizer -- the Moog -- they were able to use a frequency modulation with that wah-wah sound with potentiometers. So you can modify your signal. But I think it's the inspirational nature of electromagnetic signal -- the noise of the electricity and the wire, the noise present during phone communication. Sometimes when you call overseas you catch a little bit of ground noise generated by the atmosphere of the earth. This is a strong signal.

M2 You said earlier that our galaxy was a strong radio emitter...

FT: Well, yes, Karl Jowsky was the first person to demonstrate that back in 1931. He was working for Bell Laboratories on communication from one ocean to another. Every time he worked he heard a big background hiss. He was wondering why. So he pointed the antennae to look for its source. He soon realized that there was a ghost radio station moving all around the horizon in synchronization with spring, summer... with the year. He knew that no one could cause that kind of registration -- moving in circles around the horizon. So be realized that the signal was coming from the nucleus of our own Milky Way. And he was the first one to catch a little bit of this background noise. Unfortunately, radio ...astronomy moved into another direction. Radio waves became an image, a graph. *[Cosmic background radiation fills the entire sky and is the black body radiation of the "Big-Bang" expanded and cooled to 3° K.-Z.]*

M2: So you suggest using sound to identify celestial phenomena?

FT: Yes, some researchers are skeptical, but I believe it is possible to have a sound classification of stars and galaxies. Ten years ago it wasn't because there weren't computers or computer music software. Astronomers know their work but they don't know about computers or computer music. Think about the Doppler Effect. When you hear a car running down the road you hear it from low frequency to high frequency. The sound changes. The same with the earth and stars. Some stars are moving away, some are getting closer. Let's say a comet is passing through -- that's the Doppler Effect. Another example is hydrogen. It has a special frequency -- 1420 megaHertz. Every time you tune your radio telescope to that frequency you have the distribution of the hydrogen in the galaxy. So, by using sound classification of chemical elements, in the future you'll be able to recognize the chemical composition of celestial objects -- *based on their sound!*

CLASSIC ROCK

M2: How about Kepler's work? He posited the music of the planets. Did his theories influence you?

FT: I found out about Kepler and Pythagoras after my degree. Kepler had the intuition that planets moving around the stars emit a note like a musical note, and that the intonation is related to the distance of the planet from the sun. So, in theory, our solar system could "perform" a scale. A wonderful theory.

Also, Pythagoras -- who built the first documented musical instrument -- believed that numbers are perfect, and therefore only numbers could reflect the cosmic and universal harmony.

Socrates thought that the movement of celestial bodies generated music. But even though man is born with the music of the spheres in his hearing. man doesn't hear this music anymore. Since we grew up with this kind of music, we are unable to hear it.

M2: So when the universe sings, what is it singing about?

FT: It's singing harmony. It's singing *Prego, ascolta le armonie cosmiche de stelle e galassie*!

Zarkov explains it all for you:

The Fourier transform can take any analog signal and represent it as a stream of numbers, that is, digitize it When digitized, the audible frequency range of 20Hz to 20,000Hz (20KHz) can store music on a CD. Signals from the astrophysical sources of radio emissions have frequency ranges of 1,000,000,000 to 1,000,000,000,000 Hz (1-1,000gigaHz). When digitized, the signals are usually analyzed to study the structure and chemistry of far distant galaxies.

The brilliant conceptual leap of Dr. Fiorella Terenzi was to see the essential similarity of the two signals; that is, both are specified by intensity and frequency. By interpreting the radio telescope data through the Cmusic software language the intensity and frequency of the signal can be formed into the same format that represents "sound" on a CD. This technique could be extended by an enterprising electronic musician to other waveforms including digitized photos or videos, creating electronic "synaesthesia." The early electronic music composers such as Varese, Berio, Moderna, and Stockhausen accepted great technical limitations which the advent of inexpensive computer power has removed. However, the challenge to create interesting signals and wave forms remains. Without interesting waveforms an electronic composition sounds like outtakes from a bad 50's Sci Fi movie.

Dr. Terenzi's invention of "acoustic astronomy" gives her a completely novel source of waveforms. By selecting and arranging the various signals on her album *Music from the Galaxies*, Dr. Terenzi creates moody, eerie and *interesting* music that is truly "from the hearts of space."

LISTENING TO THE SONGS OF THE UNIVERSE

A scientist succeeds in translating radio waves from stars and galaxies into audible music.
Fiorella Terenzi, *Edges*, 1992, July-September, v. 5, # I, pp. 10-11

> Dr. Fiorella Terenzi received her doctorate specializing in astrophysics from the University of Milan (*Università Degli Studi*) She also studied music, opera and composition at the *Conservatorio di Musica Giuseppe Verdi* in Milan. Text synthesis of this article is by David Reisner, president of *David Reisner Consulting*. *Music from the Galaxies*, in CD or cassette, can be found at well-stocked record stores.

At night, we look up at the sky. We watch the stars, we observe the Universe. I believe we can also listen. I believe we can hear the stars and the cosmos in the same way we see-reaching out into the night sky with our ears, to hear the everlasting songs of the Universe.

Through the centuries, we have listened, on occasion. Pythagoras believed that the motion of the planets and the corresponding numbers represented the perfect universal harmony and that that harmony was represented by and contained all sound and music. During the Middle Ages, Kepler was inspired to elaborate musical scales by mapping the distances of the planets. And Holst and many others have composed music based on their feelings about the objects in the sky. But all these attempts presented human interpretations or representations of the actions of the stars.

I wanted to listen directly.

My first experimental subject was a galaxy invisible to our eyes. It hides in the darkness far away in the direction of Coma Berenices, between Vugo and Leo, under the handle of the Big Dipper. Galaxies we cannot see rarely earn beautiful names, and so this one is known simply as radio galaxy UGC 6697.

The natural radio waves from stars and galaxies are produced by the chaotic motion of high energy electrons: countless "particle collisions and accelerations." After it had traveled 180 million light-years. the radiation from UGC 6697 was collected in huge radio and optic telescopes by staffs of researchers and astrophysicists at sites around the world.

As part of my doctoral research in physics, I developed a way to transform galactic radiation into sound. Working at the University of California (at San Diego's Center for Music Experiment) and at the University of Milan, I used very powerful computer sound synthesis software called "cmusic" to translate the stream of numbers representing the celestial radiation into sound. I shifted the very high frequency vibrations of the cosmic data down into human hearing range -- from billions or thousands of billions of cycles per second down to 20 to 20,000 cycles per second. This elaborate acoustic description could only have been realized in the last few years.

After this transformation, the sound derived from the galaxy can be played through conventional loudspeakers or recorded onto digital tape or compact disk. I translated about four hours of galactic sound -- the sound of UGC 6697 from 180 million light-years away -- to create for the first time a Sonorous Universe. The sound of this galaxy is very complex. Low and dark frequencies loop for the entire duration of the sample.

Upon this background, high and light frequencies appear, simulating a circular sound dynamic. There are some interesting musical aspects to the galactic sounds. Some parts seem to be well tuned around B flat or D minor, and new harmonies, linked together following their special sidereal rules, can be recognized. The galactic sound can be relaxing and ethereal, but can also provoke deep sensations, sometimes affecting us even when we do not consciously hear them. During performances of the galactic music, people were taken into a deep state of trance by the sound, especially when played in association with sitar and tambura.

In future, I hope to develop a new way to study celestial radiation to be used in addition to present techniques. I want to apply this method to other stars and galaxies, to explore the way in which sound represents the Universe around us to identify stars and galaxies based on their sonic signature.

The Dissonance of Today is the Consonance of Tomorrow; Music of the Spheres

Don G. Campbell. *The Quest*. 1995. Winter. V. 5. # 4, p. 85

Don Campbell is author of Quest's release *Music and Miracles*, a recording artist, and presently director of the Institute for Music, Health and Education in Boulder, Colorado.

When Claude Debussy was twelve years old, the secretary of the Conservatory of Music in Paris came to him and said, "Have you finished poisoning the ears of your friends with all this dissonance?" Debussy answered. Oh, Mr. Secretary. Dissonance is today. Consonance is tomorrow."

Years later, when Debussy heard the remarkable sounds of the Balinese gamelan orchestra while walking in the *Bois de Boulogne* park in Paris, he had a radical transformation. He entered into a world that opened new space, new energy, and new light into music. Yet many of his contemporaries thought the new music to be quite disorganized, dissonant, and even "illegitimate." How strange it is for us to think of "Claire de Lune." "The Maid with the Flaxen Hair." and "The Sunken Cathedral" as radical, progressive, and ugly.

Recently, John Cage died. I had the privilege of speaking with him a number of times about his radical forms of composition (throwing a fish across the stage to the piano, four minutes and forty-four seconds of uninterrupted "Silence" at the piano, and layers of natural and mechanical sounds. for examples). He was not trained in theory and harmony, yet was able to make dynamic, sensitive statements through his music. They were not dissonant like Debussy because he used an entirely different language of sound.

Subjectively. each listener has taste and choice for what kinds of music are deepening, inspiring, and meaningful. Performers, composers, and music listeners will always have standpoints that defend the emotional and intellectual aesthetics in music. Yet there is a wisdom place of listening that takes us out of the personal and subjective into the historical and objective.

The new trends in music today defy most all rules in classical composition. These new emerging patterns of sound are found in harmonic singing, film scoring, religious music, and popular styles, as well as in the schools of music around the country. With electronic instruments, new sounds that our ears have never heard before are being created. Naturally we are curious with the new, and are sometimes startled by their lack of familiarity. What may seem trite, dissonant, or simply awkward may be the awareness of these new musical vocabularies still in their infancy.

One of the most fascinating mixes of new sounds and familiar pop styles has been created by Dr. Fiorella Terenzi, an astrophysicist As part of her doctoral research at the University of Milan in Italy and the University of California in San Diego. she developed a way to transform galactic radiation into sound through a computer music system. You may contact Dr. Terenzi at P.O. Box 34182. Los Angeles. CA 90034.

Translating galactic sounds that originated 180 million years ago into electronic sounds may be dissonant to our classical, folk, or new age ears, but it may be part of the next step in being able to listen to the Music of the Spheres.