

Chanchal Uberoi



Chanchal Uberoi at the Department of Mathematics, Indian Institute of Science, Bangalore.

Chanchal Uberoi is a musician and a physicist. She was the first woman Dean of Science Faculty (1999–2001) at the Indian Institute of Science (IISc), Bangalore. She completed her Ph D from IISc (1966) in ‘Small amplitude-phenomena in conducting fluids and transport properties of plasmas’, and continued her professional career at the Institute until her retirement as Dean. Even after that, she worked on an Indo-French Mathematics Programme, as an Emeritus Scientist with the support of the University Grants Commission (UGC), and also contributed a chapter on space plasmas for the *Handbook of the Solar–Terrestrial Environment*.

Uberoi is the author of well-read books including *Earth’s Proximal Space*, *Introduction to Unmagnetized Plasma* (with Problems) and *The Alfvén Wave* (with Akira Hasegawa). For this last book, she received the Technical Communication Award in recognition of Merit in Books by East Tennessee Chapter of the Society of Technical Communication (1983). She has written many technical papers in scientific journals as well as popular articles for general readers. Her pioneering contribution is in the area of Alfvén waves. She has been conferred many honours both nationally and internationally.

Uberoi spoke to *Current Science* about her music album that connects sounds from space and traditional Indian classical music (Box 1).

How did you get the idea for the CD?

I started work on whistlers almost in 1963. It was always in the back of my mind to understand from where these sounds – which we have understood physically – are coming from. But then so many other sounds came up. Whistlers were heard on the ground. But for the other sounds, satellites or spacecraft were needed. So we had to first understand where these sounds are coming from, and whether they have any meaning with the sounds of music that human beings are singing on the Earth. I talked about it with a group of musicians when I was in Seattle, sitting idle. And they were overjoyed. They said: ‘Yes, yes, we have to make a CD’. And that is how it was made in 3 or 4 months.

Just 3 or 4 months?

You see, the whole background was in the mind, not consciously but subconsciously. Whistlers were there, sounds were there, the planets were there, and music was there. I learnt music when I was 14 or 15, very rigorously for 7 years; I learnt 50 or 60 ragas. So when you hear

the sound, you know that this raga and that sound have got some conceptual similarity. Then, you can put the background of the sound and the raga, and you find that they both match quite a bit.

You have covered only sounds from Earth, Jupiter, Saturn and Sun in the CD...

There are sounds from Uranus and Neptune also. But we wanted to make the CD short – about one hour. If we had included more sounds, it might not have been good. We also thought that we can make separate CDs for different planets, but I believe there are some 60,000 magnetic tapes with the University of Iowa, which has a project with NASA. There are many sounds, and each sound has a different kind of composition. Maybe they are not emotional...

All these sounds portray a specific kind of emotion and then you mix it with a raga of similar emotion?

They have a specific tone and melody. Then you begin to recognize that melody

Box 1. Ragas across space.

This CD contains 13 music tracks in which electromagnetic radiation from the Earth, Jupiter, Saturn and Sun (as recorded by the spacecrafts – *Polar*, *Voyagers I and II* and *Cassini*, and converted to audio) have been subjectively matched with classical Indian ragas and composed into music.

While some tracks involve a vocal rendition, others are instrumental using the rudra veena, trombone, brass didjeridu and tabla. The radiations and corresponding ragas featured include: (1) From Earth: magnetopause – raga Bhairav, auroral kilometric radiation – raga Yaman, whistlers – raga Kedar, proton whistlers – raga Marwa, saucer – raga Poorvi, hiss – raga Malkauns, chorus – raga Pratiksha. (2) From Jupiter: magnetopause – raga Malhar, electron cyclotron emission – raga Sohini. (3) From Saturn: bow shock – taal freeform, Saturn kilometric radiation – raga Durga, lightning – raga Todi and (4) From Sun: heliospheric emission – ragas Malhar and Bageshri.

The artists are Chanchal Uberoi (vocal), Daniel Shurman (rudra veena), Pran-Greg Powers (trombone), Stuart Dempster (brass didjeridu), Chaz Hastings (tabla), Arijit Mahalanabis (vocal) and Vibhavaree Gargeya (vocal).

For more information visit: <http://www.cdbaby.com/cd/ragasacrossspace>



with a raga. You see that the background of this sound and this raga seem to be matching. And that is how we begin to feel that – concept wise – they can be paired.

It was a unique concept, but a lot can be done further. Videos can be made, Uranus and Neptune can be included... this is just a beginning.

How do plasma waves sing?

In nature, most of the matter is in plasma state, which is a collection of charged particles. It is a dielectric medium. Unlike a neutral gas, which can support only pressure waves, by which we can hear the sound when we are talking to each other, a plasma can support a variety of electrostatic and electromagnetic waves. The interactions of plasmas with planetary electric and magnetic fields are generally in the radiofrequency range. This is also noted from spacecraft and satellite observations. Just like in a car radio, an electromagnetic wave can be converted to radio waves. This is how our conversation can be heard through a radio receiver. Radio receiver conversion was first done by J. C. Bose, an Indian; he was an out-of-the-world person. Of course, Marconi patented it; so his name is there. But it was Bose who first produced a sound and received it without any cable.

So just like this wireless communication in radio, we can convert these electromagnetic waves of plasma into radio or sound. Spectrum analysers, converters and radio receivers are available. A spacecraft with plasma wave receivers and different types of antennae picks up these electromagnetic waves which are in the radiofrequency range and these get converted into sound. It is actually through the ears of the spacecraft that we hear these sounds.

And then you try to match them with known sounds?

If you listen to the sounds of waves like whistlers – ‘oui, oui, oui’ or a howling sound or a snake-like sound, then you begin to wonder whether you can produce such natural sounds in your

own raga system; whether you can pinpoint some ragas that match these sounds.

The CD was meant for educational programmes – that students will get interested if you tell them that these plasma processes are happening. You can tell them how a hissing sound or a proton whistler or a saucer is produced, and then tell them that these are like ragas. But now it has become more philosophical. People think that it reminds you that there is nature outside which is keeping you alive – which is true. The existence of life on Earth requires all the electricity and magnetism which is happening around us, without which all the outer radiations from the Sun and galaxies will kill us. The electromagnetic radiations interact with the magnetic field of the Earth and form a kind of protective body – *Laxman rekha* type – a magnetosphere around us.

People are interested in the origin of life. I always tell them ‘Why are you going so far? Just see how maintenance is taking so much effort from nature.’ We are surrounded by powers in the range of megawatts; Aurora goes to 10^{10} megawatts. If we could harness that energy, we could have lighted the whole Earth; but it is not possible to do so. There is a wind current around the Earth, which is ~0.1 ampere; it is there all the time. Aurora is there, wind current is there, magnetic storms take place just like our ordinary storms – all these help to stabilize things within the Earth; otherwise we would not have survived.

My aim was only education – to make people understand processes, what maintenance of life on Earth means, what are electromagnetic effects, what are electricity and magnetism; but now it has become more spiritual. People are taking interest – how do some sounds in nature come about? Is it really music? Did ancient sages hear these sounds in their minds while doing yoga? I don’t know; maybe they sensed these things. It may be that instead of my singing with the planets, the planets are singing with me. It could have happened that we learnt the music from them. Rather than we putting raga into space, space has put ragas into us.

We learn so much from nature...

Some people have used bird sounds. The Western people have used sounds made by whistlers and merged them into their music. When I first heard Western music, I thought that I could actually produce these sounds (almost) through our ragas. That made the difference. If you use ghazals and qawwalis, nothing will happen; only the serious, authentic music matches. All the pieces featured in the CD are in Dhrupad style.

If I look back, the interaction during those 3–4 months was highly intellectual and a delightful experience. It happened because I learnt music and I learnt science; both were in my mind together. That is why I want students to learn more profound things like classical music. Most important is that ragas have personalities. Each raga is associated with one emotion like romance, love, mercy, bravery, disgust; the *nava rasas* come in. This helps in finding out the appropriate raga; for example, ‘This sound is really frightening; so, it should be with that raga’. Even in dance forms, they use *talas* for producing different kinds of *rasas*. Ragas are not permutations or combinations of *swaras*, and also they are by artists from ancient times. How did the art match the sound? It is very interesting to me that satellites and spacecraft have found all these sounds. I am sure a lot can be done if people put their mind into it. This is just the beginning.

What are you working on now?

My interest in space weather has led me into a very interesting problem of understanding the effect of solar variability and climate change especially during the period of prolonged solar minima, lasting for nearly three centuries from 1450 to 1750. The historical events and socio-economic effects due to climate change during this period are well studied in the context of European history, but no study has been ever made about happenings in Indian history. I am trying to link the anomalous solar activity to historical events in India.

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