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Rhythms of nature

The way of nature is to select frequencies that suit circumstances, says S.Ananthanarayanan.

We can easily see this in the case of musical instruments. What the musical instrument receives is a supply of energy, either by blowing into a cavity or across a reed, or by plucking or bowing a string. But the instrument, by how it is tuned or the way its strings are held, selects the frequencies of sound in which the energy supplied can express itself. Other frequencies are suppressed and only the selected frequency is heard.

The flute

Here, the player blows across a hole in a long, rigid tube. The stream of air compresses the air at the blowhole and the compression passes through the tube, till the end, where the tube is open and the air is free to expand. Once compressed like this, the air column also springs back, to reduce the pressure inside the tube, only to be forced back in by the stream of air across the blowhole. The length of the tube, and the elastic and inertial properties of air then decide the speed of this back and forth compression and rarefaction, something like a pendulum swinging, now fast at its lowest point and now coming to a stop at the highest!

The regular compression and expansion of air in the flute is then heard as a note. It is nearly the same when we blow across the opening of a bottle, something that most of us may have tried. In the flute, the difference is that there are holes along the length of the tube. If any one is open, then this opening starts behaving like the end of the tube and the note heard is as if the tube were only that long. This is the way the flautist can vary the pitch of the sound of the flute, by moving his fingers over the openings.

The violin or the sitar

It is the same with stringed instruments. The plucking or bowing action stretches the string and lets it go. The string is set vibrating and given the length and thickness of the string, there is a particular frequency at which its vibrations meet their own effects completely ‘in step’. It is at this frequency, then, that the string best utilizes the energy supplied by the plucking or bowing and that is the frequency of the sound heard.

Quantum mechanics

The laws of motion, as also those of reflection and refraction of light, were basically empirical and simply stated what was observed. But these laws are found to be violated when dealing with very small dimensions. Quantum mechanics is a new way of explaining physical things, such that it suits both very small and ordinary dimensions.

In quantum mechanics, a billiard ball striking another is permitted to rebound in all possible directions. It has a ‘probability’ of being found at all points in the vicinity of the point of impact. And these probabilities get stronger and weaker as the distance changes, in a wave-like way. It turns out that it is only in the direction of actual rebound, according to the usual laws of physics, that the probabilities all add up right. In other directions the probabilities just cancel out. But this way of looking at what is happening takes care strange behaviour at small dimensions, when the ‘canceling out’ is not complete.