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Blue skies, elephant calls and superconductors.

by S.Ananthanarayanan

Russian scientists working under a post-cold war collaboration with the US have found a superconductor that could detect down to single photons at wavelengths of 3 - 10 microns, in the infra red region. Whew! What on earth is that good for?

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Blue skies

Many of us may know that the sky is blue because it’s the blue part of sunlight that gets scattered the most, and lights up all parts of the sky on the blue side. And at dawn, or at sunset, when we can look at the sun, it’s the red light, which has not been scattered, that we see!

Yes, that's it, the shorter wavelengths get scattered the most and the longer waves are able to plod on!

Animal calls

This is true about sound waves as well. While long waves can pass obstacles and move long distances, short waves are efficiently reflected and can give sharp 'echo images'. Bats seem to understand this much of acoustics, and they use a very sharp cry, outside the human range of hearing, to navigate as they fly! We also know that dogs and cats can hear these high pitched sounds and it is these higher pitched sounds that help them locate just where the slightest sound came from.

Elephants do another thing

Elephants also use sounds outside the human range of hearing. They use cries at a *lower* pitch to communicate when the herd itself is scattered over kilometers of grazing. The low pitched sounds are perfectly suited, because they do not scatter and carry long distances.

These lower pitched sounds are also what giraffes, hippos and the Finback whale use to communicate, and in the case of whales, scientists say these signals border on speech!

Distant stars

You would have guessed by now what kind of radiation manages to reach us from the most distant stars. The visible light is scattered and far too faint, it’s the radio wave part, which has wavelengths in metres, that gets here strong enough to detect.

The giant metre-wave radio-telescope (GMRT) near Pune is geared up to detect just these waves.

GMRT
(giant metre-wave radio telescope)

Ootacamund radio telescope

In contrast with radio waves, television signals, which propagate along the 'line of sight', have wavelengths in centimetres, microwave signals, used in long distance telephony, have wavelengths a hundred times smaller and visible light a thousandth of that! X Rays and gamma rays, with even shorter wavelengths, can barely reach the fringes of the upper atmosphere, and a good thing too!

But there is special interest in signals in the infra red region which lies between microwaves and visible light. These signals, although less hardy than radio waves, are important in long-range astronomy as they are more effective to make out details of distant bodies. They are also important in telecommunications, as this range is best to bounce off a satellite. The trouble has been to find a way to detect and measure these waves. In metre-wave astronomy, it is possible to use arrays of antennas spread over kilometers. In the microwave region too, a number of methods are available. But in the far infra-red, scientists have sorely missed a detector of reasonable cost and sensitivity.

Superconductors

Superconductor-based devices seem to meet just this need. Superconductors are dream materials with zero resistance to electric currents and hold out the promise of loss-free energy transmission, magnetic levitation, electromagnets of fantastic strength and the like. The trouble is that these qualities usually show themselves only at very low temperatures, below -200°C. But this is the feature that is now proving useful!

At such low temperatures, if a photon strikes such a material, it agitates the electrons in the material, creating the effect of a rise in temperature, and the superconductivity disappears! This is a change that can readily be detected and counted, etc. And as the energy imparted is in fact so low, the material also snaps back to being a superconductor almost instantly!

Russians' discovery

Scientists at the Moscow State Pedagogical University have developed a new superconducting material, niobium nitride, which is so sensitive that it is capable of detecting just a single photon, and it can recognize changes in light signals as fast as 25 billion times each second (25 gigahertz).

"Detecting single photons is amazing, and ours is one of a few detectors that can do so," says electrical engineer Roman Sobolewski. "But what really distinguishes our device is its speed -- 25 gigahertz is very fast for an infrared detector." Sobolewski says conventional infrared detectors are typically either much less sensitive or slower.

Apart from being of promise in astronomy and telecommunications, this material is a possible component of a new type of computer known as a superconducting computer
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