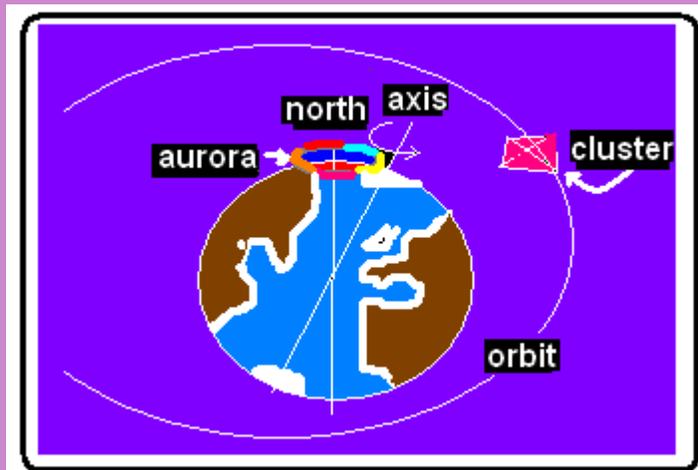


The earth is a radio flashlight!

A cluster of satellites is listening to how the earth sounds from out in space, says S.Ananthanarayanan.

The European Space Agency's *Cluster* mission consists of 4 satellites orbiting the earth and mapping magnetic fields and radio signals. The 4 identical spacecraft are placed at the 4 corners of a tetrahedron (like a pyramid) with a distance of 600 km to 20,000 km between the corners and the group goes around the earth in an elliptical orbit.



Instruments carried by the satellites transmit continuous data and computers on the earth combine the signals of the 4 satellites to generate a minute-to-minute and 3 dimensional picture of earth's magnetic envelope.

The magnetosphere

Apart from the magnetic field of the earth itself, the earth is surrounded by strong currents of charged particles that stream in from the sun, the 'solar wind', and also particles from outer space. This barrage of charged particles is fortunately deflected by the earth's magnetic field and flow like a river around the earth. The deflected streams, in turn, generate their own magnetic fields and create radio waves. The atmosphere out there, some 3 times the earth's radius away, is thus pretty 'electric' and full of charges and radio waves. A layer of the earth's atmosphere, called the 'ionosphere', about 80 kms up, protects the earth from these disturbances, else they would wreck radio communication and broadcasts on the earth. Even now, when there is a burst of radiation due to 'sun spot activity' on the sun, we have these waves leaking in and affecting aircraft navigation.

Aurora Borealis

This phenomenon, named after Aurora, the Roman Goddess of the dawn and Boreas, which is Greek for the North wind, also known as Northern Lights, consists of bright, coloured streaks and arcs in the sky, in the north and over the North Pole. The effect is now understood to be caused by the collision of charged particles of the solar wind with atoms of oxygen or nitrogen in the upper atmosphere. These atoms get energized in the collisions and when they relax, they give off energy – oxygen as red or green light and nitrogen as blue or violet light. As the atoms themselves are charged at high altitudes, they follow the lines of magnetic field and weave continuous patterns of merging colours. The auroras around the South Pole are called Aurora Australis (Australis is Latin for ‘south’).



Tribals in the North Pole region call the phenomenon the ‘Dance of the Spirits’ and Benjamin Franklin attributed the shifting lights to a concentration of electrical charges in the polar regions intensified by the snow and other moisture. But evidence of connection with magnetic effects and also of sun-spot activity soon accumulated and the phenomenon is pretty well documented, as seen from the ground.

The Cluster satellites

The European Space Agency’s project of 4 orbiting satellites has now studied the radio waves emitted by the current of charged particles around the earth from the outside. While the charged stream produces a vivid display down on the earth, it should be radiating radio waves out to space in all directions. Studying what it looks like from outside should help us understand the radiation that we receive from distant worlds and also the aurorae that are displayed by other planets, like Jupiter and Saturn and also Venus and Mars.

The radio wave radiation mainly comes through the acceleration of free electrons, breaking off from atoms and also other charged particles in the upper atmosphere. This radiation has wavelengths of above 100 kms and is known as *Auroral Kilometre Radiation* or *AKR*. The cluster programme has analysed over 12,000 bursts of AKR and has discovered that unlike what was expected, the radiation that emerges into space from the earth is not equal in all directions but stays in a narrow plane. “Like placing a mask over the torch with just a slit for the light to escape”, says the press release from ESA.

The understanding of how AKR behaves has put a powerful instrument into the hands of astronomers engaged in searching for extra-solar planets. The AKR from planets will help locate

planets and will also help map their magnetic characteristics. Finding out the time for AKR to wink on an off would help determine how fast the planet rotates.

The audio signal that the radio waves from the earth would generate, at 50 to 500 kHz, would be high pitched clicks and whistles, something like the sounds of the robot in Star Wars. This is what a being from outer space may hear when she first focuses her radio equipment on the earth!