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Black Hole on your desktop?

Scientists in St Andrew's University, Scotland are simulating a black hole in the laboratory, says S.Ananthanarayanan.

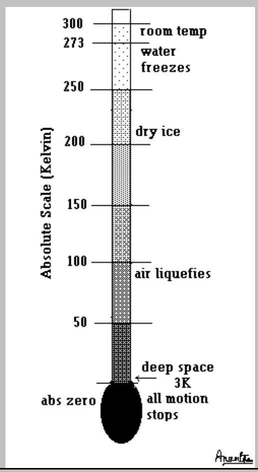
A black hole is an erstwhile star that has crushed itself under its own gravity and has become so dense that even its own light cannot escape! At the point when this happens, speeds approach that of light, time grinds to a halt and matter for millions of kms around forms a vortex as it gets sucked in, adding to the mass of the black hole itself. Pictures of what happens inside a black hole are painted more with imagination than mathematics, and there is great interest in a possible simulation.

Now Ulf Leonhardt, professor of theoretical physics at St Andrew's and Paul Piwnicki, of the Royal Institute of Technology in Stockholm, hope to create an 'optical black hole', with the help of swirling chilled atoms and light whose speed has been brought down to one inch a second, which reduces the scale of things by a factor of 10 billion. This slowdown is achieved by passing light through 'Bose-Einstein condensate', or atoms so cold that they are almost stationary.

Bose-Einstein Condensation

How hot a substance is depends on how fast the motion of its molecules is. In a gas the molecules are 'free' and zip about, bouncing off each other and the walls of their container. When the gas cools and the molecules move slower and get trapped into droplets of a liquid. In the solid phase, molecules are fixed in a lattice and can only vibrate.

And in this way, molecules get slower and slower, till, at -273^{o} C, they are nearly at rest, and the temperature is called 'Absolute' zero!



We can see that the study of substances and heat has to do with the statistical behavior of particles in motion, their average energy, and so on. In 1920, Satyendra Nath Bose and others developed a method of working out the numbers of particles at various energies, and rules to decide when particles, like photons, could be treated as 'identical'. Einstein extended the work by applying the rules to certain kinds of atoms and it as found that at very low temperatures, most of the atoms of helium would come crashing down to the same energy level!

What's so remarkable about that?

If the atoms were just like marbles at the bottom of a jar, well, nothing much. But as atoms get slower, the Heisenberg uncertainty principle becomes important. According to this, the reducing uncertainty of the speed of atoms, as their actual speed lessens, leads to increasing uncertainty in their positions. And at low temperatures, the atoms are no more with well defined positions, like marbles in a jar, but like fuzzy blobs of diffuse dimensions!

In fact, at low enough temperatures the atoms lose their identities and merge into a single 'superatom'! This is considered yet another 'phase' of matter and the transition is called the 'Bose-Einstein Condensation'.

How cold is that?

The trouble is that even getting to a thousandth of a degree above abs zero is not cold enough. A method called ‘laser cooling’, developed by Chu, Cohen-Tannoudji and Phillips came down as cold as 10,000th part of a degree Absolute!

The trio got the Nobel in 1997 for this, but it is still not cold enough for a BEC! Eric Cornell and Carl Weiman did better and reached about 50 billionth of a degree above Abs zero. In a BEC at this temperature, the velocity of light drops to 38 kmph! Now Leonhardt and Piwnicki, hope get light down to 1 inch per sec, which would allow building a model of a black hole right in the lab!