The coldest object in the universe

A newspaper article on my research - Marcius Extavour, 1 Feb. 2005

What is the coldest thing in the universe? Is it ice cream on a hot day? Is it super-cold ice? Is it the surface of the moon? Some far off asteroid? The answer may surprise you, but physicists at the University of Toronto and others are working on producing tiny samples of ultra-cold gases at temperatures one *billion* times colder than ice and use them to study a fundamental theory of nature, quantum mechanics.

Think of the air around us – the same air that we breathe and feel on our faces when walking down the street. Although we can't detect it with our eyes, the air around us (and all other solids, liquids or gases for that matter) is composed of tiny atoms that are free to zip to and fro in space and bump into one another. In solids and liquids, though, the atoms are so closely packed that they are no longer free to move about the way atoms in a gas can. You may be wondering at this point what this all has to do with being cold – here is the connection. In the language of physics, the temperature of a gas of atoms is defined in terms of the mean velocity of the atoms. In English, quickly moving atoms are said to be "hot" and slow moving atoms "cold". This means the trick to making an ordinary gas like air into an ultra-cold gas is somehow to slow each atom down to a crawl.

In modern experiments on these ultra-cold gases of atoms, physicists use lasers and magnets to coax the atoms out of their high speeds and down to a near standstill. Unlike the relatively "hot" gas air, the atoms in these ultra-cold gases don't "whoosh" about, but rather, because they are moving so slowly (velocities of 1 cm/s or 0.000000004 km/hr) and are so spread out in space, they behave more like a very light jelly.

If you believe and this (and it *is* true), you may still be wondering what a collection of slow atoms has to do with any fundamental study of nature. To understand the answer to that question, it is important first to realize that this condensed, ultra-cold state of an atomic gas is an extremely rare phenomenon, usually only observed in controlled laboratory environments. Because they are so difficult to obtain in the lab, all aspects of the experiment must be extremely well organized and controlled. This precise experimental control, in fact, is exactly what makes this system worth studying as a model for other systems in nature. Quantum mechanics - a modern foundation of physics – often studies solids such as copper or lead. The atoms in solids are not free to move and are very near to their neighbour atoms, making experiments difficult to control. In an ultra-cold gas, however, the atoms are moving so slowly and are so well separated (it is a gas after all) that experiments on the fundamental nature of matter may be carried in a very precise way, free from much of the "noise" usually associated with experiments on solids.

So the next time you're out in summer and looking for something ultra-cold to cool you down, just remember that some of the coldest things in the universe may be just off of St. George street in the department of physics!

COMMENT: Excellent article, Marcius. Hits just the right note – clear, entertainingly written, well organized. My comments are mere quibbles. Tony

Comment [PD1]: good title

Comment [PD2]: good first para

Comment [PD3]: you might consider replacing this by 'Now, in the language of ..'

Comment [PD4]: omit - I'd omit the whole phrase - just start with 'You may still ...'

Comment [PD5]: a

Comment [PD6]: omit

Comment [PD7]: adverb good here! excess is good in a newspaper article!

Comment [PD8]: omit?

Comment [PD9]: or combine these two e.g. The precise experimental control, necessary for the creation of these ultra cold gases, makes this system worth ...

Comment [PD10]: omit? should be obvious by now, and it interrupts the flow

Comment [PD11]: great ending too