PHYS ORG

Researchers develop breakthrough technique to unlock the secret of plasmas

November 21 2008

University of British Columbia researchers have developed a technique that brings scientists a big step closer to unlocking the secrets of the most abundant form of matter in the universe.

A plasma - or ionized gas - can be as commonplace as in fluorescent light bulbs, or exotic in the extreme, as a thermonuclear explosion. The Earth's upper atmosphere is a plasma, as are lightning bolts and virtually all stars that light up the night sky.

For nearly a hundred years, physicists have worked to develop intricate mathematical theories for dealing with the plasma state, but detailed knowledge about plasma constituents and their precise interaction dynamics has been hard to come by. Conventional plasmas are hot, complex and difficult to characterize either in the natural world or in the laboratory.

Recently, a handful of laboratories have begun work on a new class of plasma so simple that it promises to take our understanding to a new level. Termed ultracold plasmas, these systems start with trapped atoms, cooled to a fraction of a degree above absolute zero, to form clouds of ions and electrons that are nearly standing still. With this control, scientists have found it possible to study the elementary steps by which atomic plasmas are born and grow.

Now, for the first time, UBC researchers have found a way to make ultracold plasmas out of molecules. Starting with a gaseous sample cooled in a supersonic molecular beam, a team led by Ed Grant, Professor and Head of the Department of Chemistry, has formed a plasma of nitric oxide that has ion and electron temperatures as cold as plasmas made from trapped atoms.

These plasmas last 30 microseconds or more even though, unlike atoms, molecular ions can quickly dissociate by recombining with electrons. "It's amazing that our plasmas have sustained life at all," says Grant. "We think that the high charged particle density we create interferes with ion-electron recombination."

Their technique, detailed in the current issue of the journal *Physical Review Letters*, not only produces plasmas three orders of magnitude denser than those made with trapped atoms, but appears to reach much higher levels of correlation, a factor describing the onset liquid-like collective motion.

"Molecules represent a holy grail of ultracold science," says Grant. "The ability to break out of the atom 'trap' is tremendously liberating and could lead to a whole new field of physics."

Grant adds that further understanding of ultracold plasma on a molecular level could lead to new knowledge about gas planets (Jupiter, Saturn, Uranus, and Neptune in our solar system), White Dwarf stars, thermonuclear fusion and X-ray lasers.

Source: University of British Columbia