Physics group corrals record number of neutrons into one place

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(PhysOrg.com) -- Neutrons, the particles that along with protons, exist in the nuclei of atoms (except for hydrogen) have been intensely studied ever since their discovery in the 1930's. And while many interesting developments have occurred as a result (fission reactions, etc) physicists have continued to be frustrated in their attempts to get a closer look at them, due to their not having an electric charge which could be used to hold them in place. Now however, a team working at the Institut Laue Langevin (ILL) in Grenoble, France, led by Oliver Zimmer, has found a way to do just that. In their paper published in *Physical Review Letters* they describe a technique they've developed that allows for bunching neutrons up in a group; as many as 55 per cubic centimeters, to get a better look at them.

To achieve this result, Zimmer and his team shot the neutrons into a container full of the coldest possible liquid, helium-4, to slow them down. Doing so brings them down to almost absolute zero which causes them percolate up through a valve which then corrals them into a single space. Using this process the team was able to amass five times the previous amount of neutrons in one place. Dr. Zimmer and his team have been working on the process and refining it since 2007. They believe that they can refine it even further to the point where they will be able to gather as much as 1000 cubic centimeters of the neutrons in one place.

The whole point behind such research is the belief that neutrons might hold the key to understanding some really tough physics problems, such

as the nature of gravity or how the universe formed after the Big Bang. To get there though, other phenomena must first be studied and explained. One such example is that despite neutrons having no electric charge they still appear to have an electric dipole; but so far, because of the very nature of neutrons, no one has been able to measure it. By gathering more neutrons in one place and slowing them down in the process, researchers will hopefully be able to do exactly that, and more as gathering more neutrons in one place allows for more statistically precise observations and measurements.

Zimmer and his team believe the results they have achieved thus far might help answer some such questions, but acknowledges that denser groups of neutrons will still be needed to find the answers to the deeper questions.

More information: Superthermal Source of Ultracold Neutrons for Fundamental Physics Experiments, Phys. Rev. Lett. 107, 134801 (2011) DOI:10.1103/PhysRevLett.107.134801

Abstract
Ultracold neutrons (UCNs) play an important role for precise measurements of the properties of the neutron and its interactions. During the past 25 years, a neutron turbine coupled to a liquid deuterium cold neutron source at a high-flux reactor has defined the state of the art for UCN production, despite a long history of efforts towards a new generation of UCN sources. This Letter reports a world-best UCN density available for users, achieved with a new source based on conversion of cold neutrons in superfluid helium. A conversion volume of 5 liters provides at least 274 000 UCN in a single accumulation run. Cyclically repeated operation of the source has been demonstrated, as well.