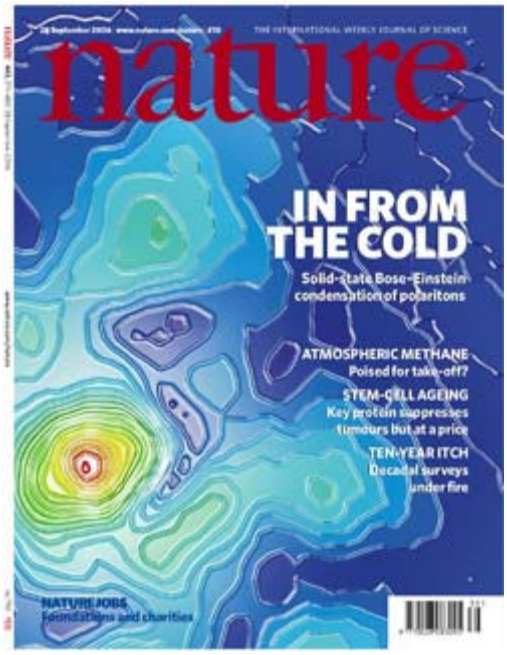
A Fifth State of Matter

Thursday, 28 September 2006 **Written by Mathias Biilmann Christensen**

A team of researchers led by **Benoít Deveaud-Piédran** from **École Polytechnique Fédérale de Lausanne** have announced that they have observed the strange **fifth state of matter**, known as the **Bose-Einstein condensate**, at a temperature of 19 Kelvin. While 19 Kelvin is still almost unimaginably cold, it is an extremely high temperature compared to the temperatures of less than a millionth degree Kelvin that have previously been needed to observe a Bose-Einstein condensate.

When the indian physicist **Satyendra Nath Bose** wrote his article "Planck's Law and the Hypothesis of Light Quanta" in 1924, he was unable to get it published and ridiculed for what was simply considered an embarrassing statistical error. In desperation over the physics journals' continued rejections of his article, Bose sent it directly to the physicist he admired the most: none other than **Albert Einstein**. The german scientist immediately realized the importance of Bose's findings, translated the paper to German and got it published in "Zeitschrift für Physik." He even added the note: "An important forward step."



The cover of todays new edition of Nature

Einsteins contribution did not stop there. He also realized that the strange behavior Bose described for photons - the particles of light - would also apply to atoms. This lead to the prediction of a strange fifth state of matter, the Bose-Einstein condensate, a state of matter where the individual atoms would all be at the same energy level, and thus appear undistinguishable from each other. It's as if the lump of matter is made out of one huge super-particle.

It took 70 years from Einstein's prediction until this strange fifth state of matter could be observed. But in 1995 two American researchers at the Joint Institute for Laboratory Astrophysics, Eric Allin Cornell and Carl E. Wieman, managed to cool down a vapour of Rubidium atoms to a temperature of Less than one millionth of a degree above Absolute Zero, and the predicted state of matter indeed appeared. They were later awarded a shared Nobel prize together with Wolfgang Ketterle for this accomplishment.

In today's new edition of Nature, researchers at Ecole Polytechnique fédérale de Lausanne, collaborating with colleagues at Université de Grenoble, Cambridge, Oxford and MIT, claim they have been able to observe the condensate by cooling a special kind of quasi-particles, known as polaritons, down to the relatively easily attainable temperature of 19 Kelvin.

Polaritons are formed from photons and only live for a trillionth of a second. But the team of researchers managed to reach a critical density of the particles at 19 K where the particles formed a Bose-Einstein condensate in solid state.

The shared quantum state of the particles in a Bose-Einstein condensate resembles the coherent state of photons in a laser. And predicting the practical applications of Bose-Einstein condensates are as impossible as it would have been to predict the widespread uses of lasers when the first working laser was constructed in 1960.

For now the most important aspect of the discovery, is the unique opportunity for scientists to better understand and possibly exploit the quantum effects that occur in these very special conditions.