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New theory of imaging ultracold atoms: First Nigerian paper in top physics journal since 1986

Researchers from the National Institute of Informatics in Japan and the Federal University of Technology in Nigeria have discovered the mechanism behind how ultracold atoms are imaged.

For several decades physicists have been producing extremely cold gases with temperatures in the nanokelvin range - a temperature that is colder than deep space by over a million times.

The cooling method was pioneered by President Obama's ex-Secretary of Energy Steven Chu, a Nobel laureate in physics.

To image the cold gases, physicists illuminate the gases with light of a special frequency. By measuring the changes in the phase of the light through the gases, physicists can deduce many properties of the gas itself.

While physicists have been able to perform the experiments, the precise mechanism behind the technique was unknown until the recently announced results to be published in the US journal *Physical Review Letters*.

The theory developed by Nigerian Ebubechukwu Ilo-Okeke and Tim Byrnes proposed a new model for the measurement, correctly reproducing the experimentally observed data, and predicting precisely how much information could be read off from the images.

The discovery is significant not only from a scientific perspective, but that it is the first paper with a Nigerian affiliation to appear in a top physics journal in 28 years. *Physical Review Letters* and *Nature Physics* are widely regarded as the top journals in physics.

The last paper to appear in *Physical Review Letters* with a Nigerian affiliation was on 26 May 1986 by B. Olaniyi, who was on leave from the University of Ife to the University of British Columbia. Dr. Olaniyi co-authored the particle physics paper titled "Constraints on Massive Neutrinos in $\pi \to e\nu$ Decay". No author with a Nigerian affiliation has published a scientific paper in *Nature Physics*, the other top journal in physics.

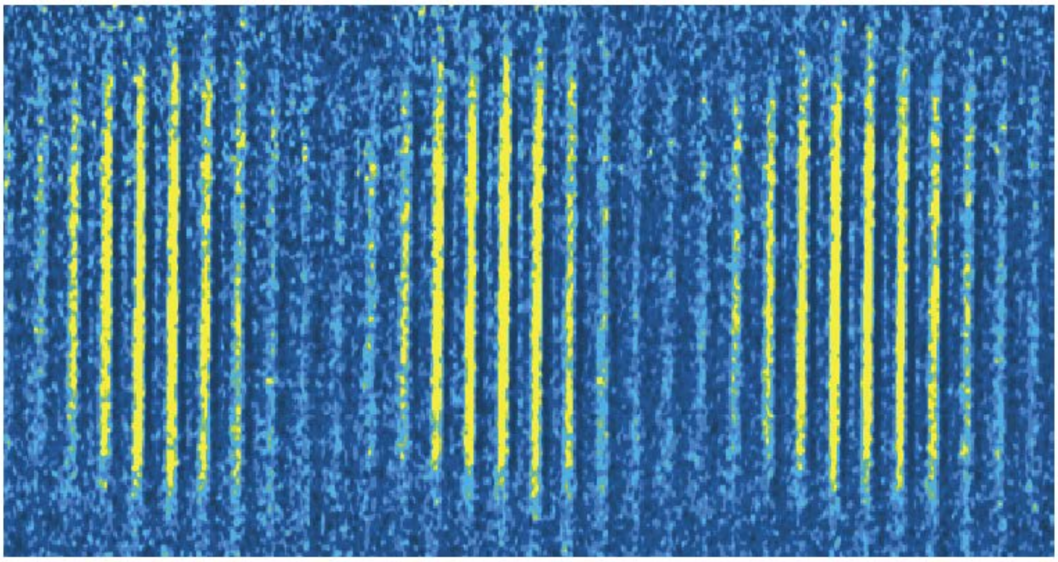

Figure 1 Typical images produced when ultracold atoms are imaged using the optical technique. Reproduced from Higbie et al. Phys. Rev. Lett. 95, 050401 (1995).

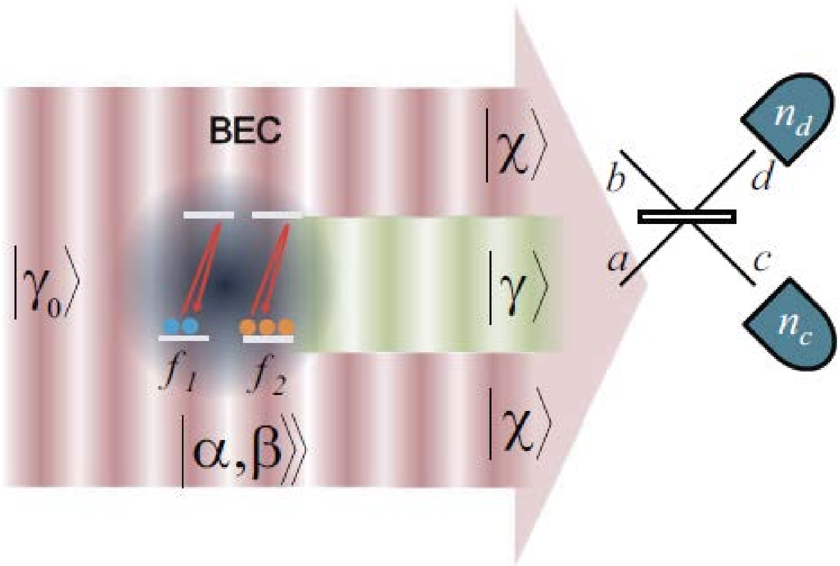

Figure 2 The theoretical model that was used to model the imaging technique. The cold atoms (marked as "BEC") are illuminated by the light (shown in pink). The light which passes through (shown in green) picks up a phase when it passes through the atoms. The light is then interfered such as to give the images such as that shown in Figure 1.

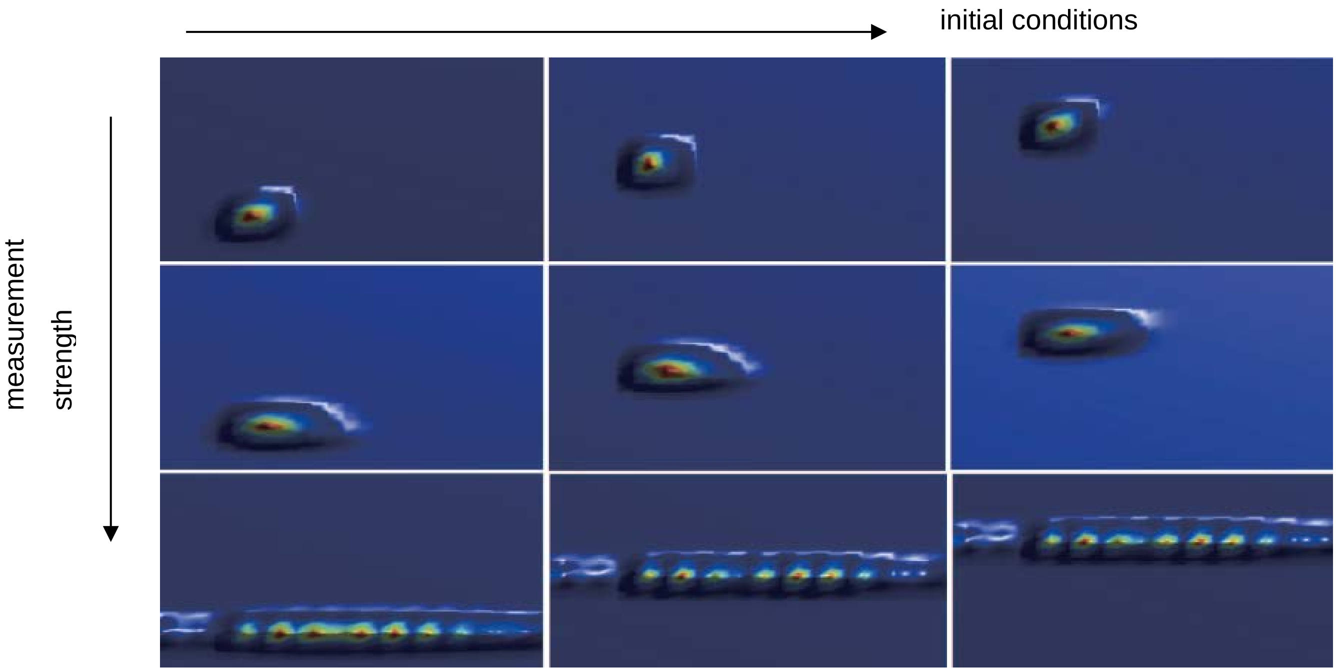

Figure 3 Theoretically predicted effects of the measurement on the cold atoms. The different rows correspond to different measurement strengths. The columns start with different initial conditions.

Journal paper: " Theory of single-shot phase contrast imaging in spinor Bose-Einstein condensates", to appear in *Physical Review Letters*

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Preprint: http://arxiv.org/abs/1405.6016

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