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National Tsing Hua University Scientist Reported a New Route to Atomic Resolution Electron Tomography in *Nature*

Hsinchu, June 14, 2012. A professor from the College of Nuclear Science of National Tsing Hua University, Professor Fu-Rong Chen (陳福榮,) in collaboration with Professor Dirk Van Dyck of the University of Antwerp of Belgium published a paper entitled "**Big-Bang tomography as a new route to atomic resolution electron tomography**" in June, 14, 2012 edition of the magazine *Nature*.

Until now, except for perfectly crystalline nano-objects imaged along a few zone axes, it has not been possible to reach atomic resolution with classical electron tomographic methods. The main challenge here is that mechanical tilting in an electron microscope with sub-Angstrom precision over a very large angular range is extraordinarily difficult. Many real-life objects such as dielectric layers in a microelectronic device impose geometrical constraints and many radiation sensitive objects such as proteins will limit the total electron dosage.

Hence there imminent need for a new tomographic scheme that is able to deduce three-dimensional (3D) information from only one or a few projections.

In this work, motivated by the so-called "**Big-Bang concept**" for physical cosmology, the authors presented an electron tomographic method that is able to determine from only one viewing direction both the position of individual atoms in the plane of observation as well as their vertical position with sub-Angstrom precision.

The concept is based on the fact that an experimentally reconstructed exit wave consists of the superposition of the spherical waves that have been scattered by the individual atoms of the object.

Furthermore the phase of a Fourier component of a spherical wave increases with the distance of propagation with a known "phase speed". If one then assumes that an atom is point-like, the relation between phase and phase speed of the different Fourier components is linear so that the distance between the atom and the plane of observation can be determined by linear fitting.

According to Professor Chen, "*to be able to carry out atomic resolution electron tomography has long been a major scientific goal. Our work was inspired by the remarkable and time-honored Big-Bang concept. Hence, in analogy to the Hubble's law in physical cosmology, we have developed a theory to precisely determine three-dimensional atomic positions from the recorded data taken from the so-called transmission electron microscopy (TEM.)*"

"*It should be mentioned that this method has been experimentally verified for a two layer graphene structure. The method will optimally work for similar layered materials, such as BN and* MoS_2*,*" concluded Chen.