Obituary for Akira Tonomura

We learned with great sadness that on May 2, 2012 Dr. Akira Tonomura passed away during the course of a medical treatment on pancreatic cancer. This was one week before the opening of the Tonomura FIRST International Symposium on *Electron Microscopy and gauge fields*. FIRST is the acronym denoting *Funding program for world–leading Innovative R&D on Science and Technology*. In 2010 Akira Tonomura, as principal investigator, had been awarded this project, funded by the Japanese government, aiming at developing a 1.2 MV "holography electron microscope" capable of observing quantum phenomena in the microscopic level. The symposium was also intended to celebrate his 70th birthday. What had been planned to be a grand meeting with many of his scientific friends, became a memorial conference. The photograph below shows the participants, including distinguished physicists such as Chen Ning Yang (Nobel laureate 1957), Anthony J. Leggett (Nobel laureate 2003), Makoto Kobayashi (Nobel laureate 2008) and Yakir Aharonov (Wolf prize 1998) gathered around a photograph of Akira Tonomura.

Akira Tonomura was a leading figure in our world of transmission electron microscopy, and a great experimental physicist who had explored fundamental aspects of our understanding of the quantum world. Among his many contributions, the double-slit experiment constitutes a superb demonstration of the dual quantum nature of the electrons, behaving individually as particles, but producing interference fringes when accumulated. It should be included in all text books on the fundamentals of quantum mechanics.

The verification of the Aharonov-Bohm effect was another one of his great achievements, recognized by several high-level awards including the Imperial Prize in 1991, and the Benjamin Franklin Medal in physics 1999. Aharonov and Bohm had stated in 1959 that the vector potential is itself a fundamental physics entity and can therefore affect a charged particle in a region where there is no magnetic field and therefore no force acting on it. To demonstrate it, Tonomura and his colleagues fabricated a toroidal ferromagnet of 6μm in diameter, and covered it with a layer of superconducting Nb to screen perfectly the magnetic field; they then measured a phase difference between the electrons that had traveled through the central hole of the tore and those that traveled outside it. Although these electrons have only progressed through regions free of electromagnetic fields, there is an observable effect produced by the existence of vector potentials. In his address at the banquet of the FIRST symposium, C.N. Yang ranked these contributions to theoretical physics as Nobel-level experiments.

Personally, I have a preference for his beautiful experiments on the visualization of the magnetic vortices in superconductors in the early nineties. This achievement opened the way to many observations, in particular related to the dynamics and interactions of these flux lines with defects in the material, first in the conventional, then in the high Tc superconducting materials. I confess that I had personally failed in the seventies to perform these experiments when my Ph.D. supervisor, Raimond Castaing, had proposed this task as the subject of my own thesis research! But it had provided me the opportunity of welcoming and

meeting Akira Tonomura for the first time as early as in 1973, when he had visited Paris and Orsay during his one year stay as a research scientist at Tübingen with Gottfied Möllenstedt who had invented the electron biprism and realized the first electron interference experiment. This was the start of a long friendship with Akira, which lasted nearly four decades.

Over his whole career, Akira Tonomura has been an Hitachi employee, having joined the Central Research Laboratory as early as in 1965, being promoted research scientist, senior research scientist, chief scientist, senior chief scientist up to Hitachi fellow in 1999. In parallel, over the past few years, he had been appointed Group director at RIKEN and principal investigator at OIST in Okinawa. In both cases, he has conducted national projects in advanced electron microscopy, using phase contrast and interferometry, aiming at a deeper understanding of quantum effects together with the exploration of field distributions in magnetic and superconducting matter. Akira Tonomura was elected a Member of the Japan Academy in 2007.

To bring all these research efforts successful, he has demonstrated superior capabilities in leading top-level projects in instrumentation, relying on the expertise of the engineers and technicians gathered by Hitachi around him at the new Advanced Research Hitachi Laboratory in Hatoyama. In particular, he had built there in 2000 a 1 MV field emission electron microscope demonstrating the brightest electron beam and the highest lattice resolution. The new 1.2 MV microscope for atomic-resolution holography supported by the FIRST program, including a Cs corrector developed by Max Haider from CEOS in Germany, is presently under construction in the Hitachi Advanced Research Laboratory. You can visit http://www.first-tonomura-pj.net/e/ to access the most recent views on the advances of the construction of this new instrument.

For two years—2003 to 2005—Akira Tonomura served as the President of the Japanese Society of Microscopy and consequently as the vice-chairman of the organizing committee of our international conference IMC 16 in Sapporo in September 2006. The photograph below was recorded during the IMC 16 banquet, when he was giving a toast for a bright future of electron microscopy, electron microscopists and international conferences. Four years later, Akira Tonomura was one of the invited speakers during the Presidential symposium of IMC 17 in Rio de Janeiro, which he concluded with a superb speech entitled “Electron Phase Microscopy using Field-Emission Electron Beam”.

Thank you so much Akira !!

Christian Colliex

IFSM Past-President

Orsay, June 02, 2012