International Cryogenic Materials Conference (ICMC)

ICMC LIFETIME ACHIEVEMENT AWARD 2013
FOR

Professor Harald Weber

ICMC has presented its Award for Lifetime Achievement biannually at the CEC/ICMC conference since its 30th anniversary conference in Keystone in 2005 to an individual to "recognize a lifetime's achievement in advancing the knowledge of cryogenic materials". In 2013, the ICMC awards committee carefully considered all the nominations received that met the very stringent criteria laid down in the awards statutes and then made a recommendation to the Board of Directors, which the Board endorsed unanimously.

The fifth recipient of the ICMC Lifetime Achievement Award, following Ted Collings in 2005, David Larbalestier in 2007, Kyoji Tachikawa in 2009 and René Flükiger in 2011 is Professor Harald Weber.

Harald completed his PhD in 1969 at the University of Vienna on the application and test of a novel technique to study the flux line lattice in Nb using polarised neutrons. He was one of the few students who, having attained distinction in all compulsory exams since the age of 14, received his doctorate from the President of Austria personally in a special ceremony that dates back to the times of the Emperor and was revived again in 1952. He joined the Technical University of Vienna (TUV) as a Research Assistant towards the end of his PhD and subsequently spent his entire career at TUV, being promoted, ultimately, to Professor of Low Temperature Physics in 1981. He was appointed Director of the Atomic Institute, Vienna, 2005-2009, retiring three years later in October 2012.

Harald started his career in the mid-1960's with the investigation of the spatial distribution of the magnetic field within type-II superconductors by means of neutron depolarization. Superconductivity at that time was again a "hot topic" 50 years after its discovery, and following the advent of the Bardeen-Cooper-Schrieffer (BCS) theory and the Abrikosov theory of type-II superconductivity, which predicted a regular magnetic quantum structure in external magnetic fields ("the so-called mixed state"). At that time, Harald was able not only to confirm the presence of a regular vortex lattice by neutron diffraction techniques that time, but also to detect distortions of the vortices caused by flux pinning and, finally, to reconstruct all details of the periodic field variation. In addition, Harald identified a clear correlation between the symmetry of the flux line lattice and the crystallographic properties of the parent niobium single crystal (known subsequently as “anisotropy effects”), which represented a key contribution to the field. Such correlations manifest themselves as an angular dependent upper critical field of the superconductor, and Harald was able to point out a spectacular feature of the anisotropy in the region of the transition between type-I and type-II superconductivity. The nature of superconductivity was found to depend on the crystallographic orientation in a Ta single crystal with respect to the applied field, with type-I superconductivity prevailing for fields close to the [100] direction, whereas the material remains a type-II superconductor at all other field directions! Significantly, this research lead to renewed interest in the region between type-I and type-II superconductivity, previously called type-II/1, with type-I.5 superconductivity being claimed subsequently, which is a closely related phenomenon.

The discovery of high temperature superconductivity (HTS) in the cuprates by Bednorz and Müller in 1986 lead, understandably, to a shift in Harald’s main research focus from materials at the border of type-II to extreme type-II superconductors, and from materials with low to high anisotropy. Neutrons turned out to be extremely useful for exploring the various new phenomena in the phase diagram of the flux line lattice and the extremely peculiar flux pinning properties of the cuprates. Harald observed very soon that the defects produced by fast neutron irradiation were of the right size for optimal flux pinning, which eased concern that HTS appeared to lose their ability to carry loss-free supercurrents at certain temperatures and magnetic fields, which had previously cast doubt on their potential for practical applications. Harald’s irradiation experiments, in particular, demonstrated clearly that this so-called “irreversibility line” above which flux pinning disappeared abruptly, was related primarily to the lack of pinning centers with sufficiently deep pinning potentials. Harald’s research identified clear evidence for this breakthrough observation via the observed shift of the irreversibility line to higher fields and temperatures when a sufficient concentration of radiation-induced, strong pinning centers was introduced to the type-II lattice. Neutron irradiation has emerged subsequently as an effective bench mark technique for probing optimal flux pinning in many international projects on all forms of HTS materials.

Harald continued to expand his laboratory and his research interests in the two decades following the discovery of HTS, during which time he established one of the leading and best equipped laboratories in the world for the characterization of practical forms of HTS. This resulted in his involvement in a diverse range of scientific collaborative projects with leading research institutions all over the world, for which he is renowned. He and his group made particularly significant contributions to the role of anisotropy for current flow in the cuprates and magnesium diboride, as well as to the current distribution within bulk and coated conductor superconductors. Unique innovative techniques were developed by Harald’s group during this period to map the local currents and to distinguish between inter- and intra-granular currents and between correlated and uncorrelated pinning, of which the so-called magneto-scan technique is now well established internationally as an important investigative tool.

Harald has retained an active interest in more fundamental research throughout his career, despite the obvious technological distractions of HTS, as is evident from his successful work on the the interplay between magnetism and superconductivity in the borocarbides and the nature of superconductivity in the fullerenes, alkali metal doped C_{60} molecules.

Throughout his fundamental and materials work, Harald has retained a continuous interest in the development of the huge magnets required for nuclear fusion devices, which is one of the most demanding applications of superconductivity. Initially, he worked on the radiation response of NbTi and Nb_3Sn superconductors, which was carried out in collaboration with industry and partly at different irradiation facilities around the world. His interest then shifted to insulating materials as part of the ITER project, which turned out to be a “weak link” of the magnet in a radiation environment. This involved directing systematic studies of a wide range of candidate materials for insulating large magnet structures, and led to the important conclusion that they would all fail under the radiation load specified for the ITER device over its lifetime. Detailed studies of alternatives in collaboration with industry worldwide were ultimately successful, leading to the development of mixtures of cyanate esters and epoxies, which are sufficiently radiation-hard and which will be employed for the manufacture of the large toroidal field coils for ITER by industries in Europe and Japan. Indeed, an important innovation for the future, and a legacy for generations to come!

Harald has authored over 570 publications, including 8 books, and has received more than 3700 citations during a hugely impressive career, which is clear testimony to the high quality, impact and significance of his work over the past 50 years. He has given over 800 scientific lectures over this time and has, at some point, been instrumental in numerous collaborations with eminent researchers in every continent of the world, including most European states, and has supervised more than 100 research students. Harald is respected widely for giving his time freely to members of the superconductivity community, and has been instrumental in guiding many researchers, young and old, along a successful career path. He has been a member, often as chair, of numerous international and European steering committees, conferences, review committees and funding organisations and has been instrumental in defining and leading a variety of projects under the auspice of the EU Framework program. Fittingly, Harald was awarded an honorary doctorate from the University of Latvia in 1993 and has held an Honorary Professorship at Southwest Jiaotong University, PR China since 2007, in recognition of his considerable achievements and international reputation in the field of type-II superconductivity.

It is a privilege and pleasure for the ICMC Board, on behalf of the worldwide cryogenic materials community, to present this award to Professor Harald Weber. The citation reads:

“The Lifetime Achievement Award for his contribution to the understanding of the effects of radiation in cryogenic materials, to the fundamental science, technology and development of type-II superconductors for practical applications and for his general contribution to the superconductivity community during a long and distinguished career is presented to Professor Harald Weber”.

We wish Harald all the best for the continued success of a distinguished and highly regarded career, of course balanced by a long and well-deserved retirement!

David Cardwell
Chair, ICMC Awards Committee
Anchorage, June 2013