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SYNCHROTRON AND NEUTRON DIFFRACTION FOR THE STUDY OF STRUCTURAL AND MAGNETIC FEATURES OF MULTIFERROIC

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Abstract

In hard condensed-matter-physics, there are hot topics that have been developed during the last twenty years: multiferroic materials, low dimensional magnetism, topological insulators, skyrmions, etc. In order to understand the microscopic physical behaviour of this kind of materials, the precise knowledge of the crystal and magnetic structure as a function of temperature or external fields is of paramount importance. For that, single crystal and powder diffraction are necessary. The availability of synchrotron and neutron sources has made possible to increase the precision of structural and magnetic data using powder diffraction. The development of the Rietveld method to refine crystal and magnetic structures was possible because the peak shape of powder diffraction lines, in neutron diffractometers, was nearly Gaussian and this was simple enough to be treated by computers of 50 years ago. Nowadays, the method has been largely improved incorporating new methods of calculating structure factors in terms of symmetry modes or modulation functions. Moreover, more complex peak shapes can be treated easily and the Rietveld method is routinely applied to the treatment of synchrotron and neutron powder diffraction. Concerning magnetic structures, neutron powder diffraction is dominating the scene. Synchrotron X-rays interact with atomic magnetic moments providing X-ray magnetic scattering, however the signal is very weak and single crystals are needed. In this lecture, I will present a comparison of the different characteristics of neutron and X-ray synchrotron radiation for the study of the crystal and magnetic structures of crystalline solid presenting interesting physical properties. I will select few examples to illustrate the advantages and drawbacks of both neutrons and synchrotron X-rays in the study of multiferroic materials and low dimensional magneto-structural phase transitions.

About

Juan Rodriguez-Carvajal (JCR) has been involved in large scale projects for developing new neutron sources, in particular the European Spallation Source (ESS). He was the Coordinator for the Structural Science and Solid State Chemistry group of the Scientific Case of the ESS project (1995-1996); he was member of the Instrumentation Task Group of the ESS (2000-2002) and member of Scientific Advisory Committee of the ESS (2009-2012). JRC has participated in many committees and selection panels for research projects in large scale facilities, in particular at ISIS (U.K.), PSI (Switzerland) and SNS (USA). JRC has, and has had, also a strong activity in training young researchers through many courses on diffraction and crystallography organized by universities and research institutions in many places of the world. During the major part of his career JRC has been interested in the following fields: 1. Data analysis and software development in Crystallography and Diffraction Physics. 2. Theoretical analysis of magnetic Structures. Frustration and low dimensional magnetism. 3. Physics of Transition Metal-Rare Earth and Superconducting oxides and intermetallics.

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