Mössbauer Spectroscopy

Buffalo State College, July 9–12, 2017.

One set-up available

Host and Mentor

Michael DeMarco, Professor and Chair in the Department of Physics at Buffalo State College and Research Professor at the University of Buffalo, has been using Mössbauer Spectroscopy since the late 1970's when he was a graduate student at the University of Cincinatti working for S. Jha. For the past fifteen years he has been working on the ruthenates using the ^{99}Ru Mössbauer Effect to study superconducting and magnetic compounds as a function of temperature and external magnetic fields. Recently he has also worked on pnictides and nano-particle systems containing Fe as a function of temperature and magnetic field.

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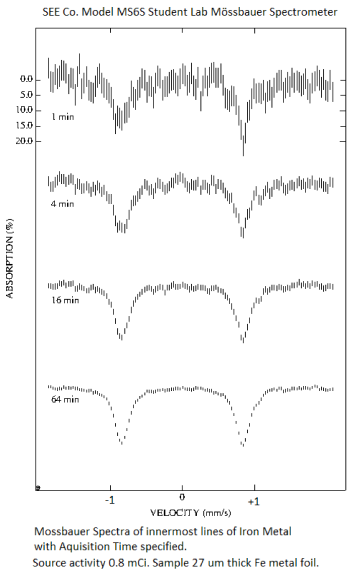
The Mössbauer Effect forms the basis of this learning experience. It is a nuclear resonance technique from which physics is obtained about the solid state of matter. It involves, specifically, the recoil free fraction, isomer shift, nuclear magnetic splitting and electric quadrupole interaction. These interactions are measured through observation of the Doppler shifted 14.4 keV gamma ray in the decay of ^{57}Co to ^{57}Fe in the source and the resonant absorption in the absorber of interest. This effect can be used as a technique to

study any iron bearing compounds from moon (and Mars!) rocks to human blood. Presently, for instance, the iron Mössbauer effect is being used to study the iron pnictides which are magnetic and superconducting. And, also, there are some forty or so other Mössbauer isotope probes other than iron such as: Ru, Ir, Os, Au and Sn which can be used in a similar manner.



Mössbauer spectra showing lines 3 and 4 of the sextet of a 27 um thick natural Iron foil at room temperature. Data acquisitions times are noted. The Co-57 source activity was 0.8 mCi. The sample had diameter 18 mm and was 35 mm from the source.

Specifically in this set of experiments, we will first investigate the standard iron foil experiment using the early seminal paper by S.S. Hanna on the iron Mössbauer effect as a reference. Then we will investigate hematite, Fe_2O_3, first studied by O.C. Kistner, which shows a combined magnetic and electric quadrupole interaction. Participants will expect to learn about gamma ray spectroscopy, some low temperature physics, Mössbauer spectroscopy, radiation safety and magnetism.

A student Mössbauer spectrometer system, including a 2 mCi ^{57}Fe source, and all the required nucleonics, electronics, and mechanical parts, is commercially available for about $9000.

Please note that the Jonathan F. Reichert Foundation has established a grant program (ALPhA webpage; Foundation website) to help purchase apparatus used in Laboratory Immersions. Limitations and exlusions apply, but generally speaking the foundation may support up to 40% of the cost of the required equipment.
