Contribution ID: **68** Type: **Oral**

Pendellosung Interferometry as a Probe for New Interactions

Tuesday 22 October 2019 09:50 (20 minutes)

When neutrons are Bragg diffracted from a crystal slab, Bloch waves form in the crystal. Interference between the Bloch waves cause oscillations in the diffracted beam whose phase is a function of neutron energy and the thickness of the crystal slab. This phenomenon is known as pendellosung interference and has a spatial period, called the pendellosung length, that is on the order of 50 micrometers. By measuring the phase of pendellosung oscillations in crystals that are thick (˜1 cm) compared to the pendellosung length, the crystalline structure factor may be measured at a relative uncertainty on the order of 5 x 10ˆ-5. The measured scattering amplitude is evaluated at a very well-defined momentum transfer given by the spacing of the relevant Bragg planes. The scattering amplitudes for a number of Bragg conditions as a function of momentum transfer may be fit to a functional form which takes into account lattice dynamics and the neutron charge radius. Additionally, such measurements are sensitive to perturbations from a beyond the standard model force mediator with a length scale that is on the order of the Bragg plane spacing. Presented are results from pendellosung interferometry in silicon, where in addition to measuring the (111), (220), and (400) structure factors, the crystal thickness and scattering length density was measured with equally high precision by placing the diffracting crystal in a neutron interferometer. This technique removes the need to optically polish the crystals, alleviating systematic uncertainties that occur in the presence of strain gradients caused by subsurface machining damage. The result is an order of magnitude improvement to current limits on the strength of a beyond the standard model force mediator at the 2 keV mass scale. The near future addition of other crystalline materials, such as germanium, as well as the inclusion of higher order Bragg planes, provides a promising outlook for pendellosung interferometery as a precision probe of lattice dynamics, the neutron charge radius, and non standard model forces.

Author: Dr HEACOCK, Benjamin (Nation Institute of Standards and Technology)

Co-authors: Mr FUJIIE, Takuhiro (Nagoya University); Prof. HIROTA, Katsuya (Nagoya University); Dr HOSOBATA, Takuya (Riken); Dr HUBER, Michael (National Institute of Standards and Technology); Prof. KITAGUCHI, Masaaki (Nagoya University); Prof. PUSHIN, Dmitry (University of Waterloo); Prof. SHIMIZU, Hirohiko (Nagoya University); Mr VALDILLEZ, Robert (North Carolina State University); Dr YAMAGATA, Yutaka (Riken); Prof. YOUNG, Albert (North Carolina State University)

Presenter: Dr HEACOCK, Benjamin (Nation Institute of Standards and Technology)

Session Classification: Session