The Beams and Applications Seminar Series

Mass and wavelength standards: Metrology with X-ray interferometry, status report

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Bldg. 401, Rm. A1100
Monday, June 16, 1:30 pm
(please note special day and room)

Host: Kwang-Je Kim, ASD

By X-ray interferometry both the lattice constant of silicon at 0.5 nm and the wavelength of 57Fe Moessbauer radiation at 0.09 nm can be traced back to the SI system. In the first application a silicon Mach-Zehnder interferometer is used, the basis of the second application is a sapphire Fabry-Perot-interferometer.

The precise knowledge of the silicon lattice constant is the prerequisite for an improved attempt of several national metrology institutes to replace the present definition of the kilogram with the mass of a certain number of 12C atoms. This requires the determination of the Avogadro constant, NA, via the silicon route with a relative uncertainty better than 2·10-8. Previously, the limiting factor is the measurement of the average molar mass. Consequently, a world-wide collaboration has been set up, to produce, approximately, 5 kg of 28Si single-crystal with an enrichment factor greater than 99.985% to be used for an improved determination of NA. All technological steps (enrichment of SiF4, purification and synthesis of silane, deposition of polycrystalline 28Si, single crystal growth, fabrication of two 1 kg 28Si spheres) have been finished successfully. A new measurement of the Avogadro constant is now under way.

The limiting factor for using the lattice constant of silicon as a length standard in the subnanometer regime is the variation of the lattice constant due to impurities and isotopic mixture ratios. In order to define a better standard on this length scale we aim to measure the wavelength of 57Fe Moessbauer radiation with a combined Fabry-Perot-interferometer for the Moessbauer radiation and the light of a iodine-stabilized frequency-doubled Nd:YAG laser (IR = 532 nm). Two properly cut sapphire crystals are used as mirrors for both types of radiation. The scanning mechanism has to provide very linear movement practically without angular deviations (3 nrad). It consists of two circular flexure hinges which are connected by a cylinder. The sapphire crystals have to be free of dislocations in the region of interest. By screening of numerous samples via X-ray topography proper crystals have been found.

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