Nuclear resonant scattering program in China: past, present and future

Wei Xu

Beijing Synchrotron Radiation Facility, Institute of High Energy Physics, Beijing, 100049, P.R. China,

xuw@mail.ihep.ac.cn

As the first 4th generation synchrotron source in China, the High Energy Photon Source (HEPS) is being built at Huairou district in the northeast of Beijing. [1] Featuring 6 GeV, 1.3 circumference storage ring with ultralow emittance (<60 pm rad), the HEPS source is promising in the quality of photons in terms of coherence and brilliance.

The nuclear resonant scattering program (NRS) was touched upon in the late 1980s and early 1990s in China [2]; however, the development of NRS program lagged behind due to the lack of a brilliant synchrotron source. In 2013, the high energy resolution monochromator has been selected as one of instrumentation development in the R&D projects for HEPS. [3] With the development of crystal optics and time-resolved detectors (i.e. Avalanched Photodiode Detector), the nuclear resonant scattering program is being launched, thanks to international collaborations and funding opportunities. [4]

The hard X-ray high energy resolution spectroscopy beamline was selected in the PHASEI of HEPS project, which began in 2019. [5] With special timing mode (72ns bunch spacing), the nuclear resonant forward scattering (NFS) will be performed for ^{151}Eu, ^{119}Sn, and ^{161}Dy nuclei isotopes. Fortunately, the nuclear resonant inelastic X-ray scattering (NIS) or nuclear vibrational spectroscopy can be readily performed for ^{57}Fe isotope. The focused beam size of 2μm (H) ×2μm (V) (FWHM) will be achieved using a pair of KB mirrors. The flux at sample is expected to be 3.50×10^{10}ph/s/2meV or 1.58×10^{10}ph/s/1meV for ^{57}Fe. The photon flux at sample position for ^{151}Eu, ^{119}Sn is around 1×10^{10}ph/s/1meV. The photon flux at sample position for ^{161}Dy will be slightly lower due to the reduced reflectivity of the first white beam mirror. The Mössbauer spectroscopy community, high pressure sciences, biochemistry, quantum optics and energy related materials sciences and many other fields will benefit from the new NRS beamline in China.

References:

[1]Y. Tao, Groundbreaking Ceremony at the High Energy Photon Source in Beijing. *Synchrotron Radiation News* **32**, 40-40 (2019).

[2]H.Z. Jiao, Nuclear resonant excitation by synchrotron radiation, Nuclear Physics Review (in Chinese) 1987, 4(4): 41-46. doi: 10.11804/NuclPhysRev.04.04.04. Y.C. Zhao, Nuclear Resonant Bragg scattering by synchrotron radiation. Physics (in Chinese), 722-725+732 (1992). http://www.wuli.ac.cn/CN/Y1992/V21/I12/0

[3]High-Energy Photon Source and its R&D Project. *Synchrotron Radiation News* **27**, 27-31 (2014).

[4]W. Xu, E. Alp, First Nuclear Resonant Scattering Workshop in China. *Synchrotron Radiation News* **30**, 51-52 (2017).

[5] W. Xu, Nuclear resonant scattering program in China: opportunities and challenges at the High Energy Photon Source in Huairou. *Möss. Eff. Ref. Data J.* **40**, 213-218 (2017).