NUCLEAR RESONANT SCATTERING PROGRAM AT HPCAT

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Thanks to the high brightness third generation synchrotron sources and development of tunable monochromators with sub-meV resolution, nuclear resonant X-ray scattering has become a relatively new method since late 90s and widely used to study materials under extreme conditions. Nuclear resonant X-ray scattering can be divided into two methods: nuclear resonant inelastic X-ray scattering (NRIXS) and nuclear forward scattering (NFS).[1]

Typical beam size at sample position is ~4 (V) x 6 (H) μm^2 at FWHM and the flux for NRS experiment is ~$1x10^9$ ph/s at 16 ID-D of HPCAT.[2] The 2-meV high resolution monochromator (HRM) is used for ^{57}Fe nuclear resonance at 14.414keV and consists of two channel cut silicon crystals (Si (4 4 0) and Si (9 7 5)). We can now routinely measure NRIXS under high pressures using panoramic DAC and two or three APD detectors in close proximity. In addition to the pressure dependent studies at room temperature, we have two cryostats coupling with membrane control, online ruby system to do NFS experiment under low temperature and high pressure.

In this presentation, we will give summary on the nuclear resonant scattering program at HPCAT and present several science highlights in last a few years to demonstrate HP NRS applications in geophysics, condensed matter physics and materials science [3-6]. Future plans after APS-U will also be discussed.

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References

1) W. Sturhahn, J. Phys. Condens. Matt., 16, 497-530 (2004).
2) Y.M. Xiao et al, Rev. Sci. Instrum, 86, 072206 (2015).
3) A. Shahar et al. Science, 352, 6285, pp.580-582 (2016).
4) J. Liu et al, Nat. Commun., 10, 153-1-153-8 (2019).
5) F.C. Yang et al, Phys. Rev. B., 98, 024301 (2018).
6) K. Kothapalli et al, Nat. Commun., 7, 12728(2016).