Table I . Deficiency of charge at tetrahedral, octahedral sites and the total.

	Li_2CsC_{60}	Rb_2CsC_{60}
Tetrahedral site	0.3(1) e	2.1(2) e
Octahedral site	0.2(1) e	2.0(2) e
Total value	**0.5(2) e**	**4.1(4) e**

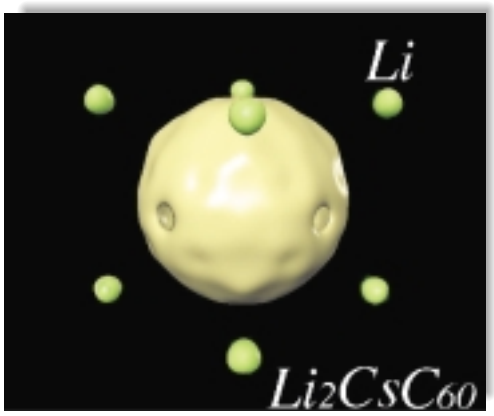

Fig. 3: Three-dimensional equi-contour (2.0 e Å^{-3}) density map of Li_2CsC_{60} .

Makoto Sakata[a] and Masaki Takata[b]
(a) Nagoya University
(b) Shimane University

E-mail : a40366a@nucc.cc.nagoya-u.ac.jp

References

[1] P.W. Stephens *et al., Nature* **351** (1991) 632.
[2] R.M. Fleming *et al., Nature* **352** (1991) 787.
[3] K. Tanigaki *et al., Nature* **356** (1992) 419.
[4] I. Hirosawa *et al., Science* **264** (1994) 1294.
[5] M. Takata *et al., Jpn. J. Appl. Phys.* in press (1999).
[6] M. Sakata and M. Sato, *Acta Cryst. A* **46** (1990) 263.

NUCLEAR RESONANT INELASTIC AND QUASI-ELASTIC SCATTERING EXPERIMENTS

Nuclear resonant inelastic scattering has many interesting features, and one of the most important is that it is possible to excite a specific nuclides [1]. For the compounds composed of more than one element, not all of the atomic motions are the same, and they depend on their mass differences, binding states and atomic positions. Furthermore, in a solution that contains different kinds of ions, the motion of each ion is different. For atomic motions limited to one- or two-dimensional regions, it is desirable to observe only their intrinsic dynamics without the influence of the surroundings. The nuclear resonant scattering method is effective for these areas of research and is expected to be a new tool for the study of dynamics of atoms. We have measured nuclear resonant inelastic and quasi-elastic scattering for several samples at the beamline **BL09XU**. Here, we introduce two examples of these.

Graphite is a typical layered material, which intercalates various atoms. Intercalated graphites show various stage structures depending on the sample preparations. We synthesized stage-1 graphite-ferric-chloride-intercalation compounds and measured the phonon energy spectra [2]. Our purpose is to study the dynamics of ferric chloride confined in the layers by observing the phonon densities of states projected to the layer direction and its vertical direction [3]. Energy spectra of nuclear resonant inelastic scattering were measured for two angles (0˚ and 90˚) between the direction of incident X-ray and the normal to the graphite layers.

The experimental setup is shown in Figure 1, and the observed spectra are shown in Figure 2. When the incident X-ray direction is parallel to the graphite layers, phonon modes with parallel components to the layers are excited. In case the incident X-ray direction is perpendicular to the graphite layers, phonon modes with perpendicular components to the layers are excited. The observed phonon modes parallel and perpendicular to the layers increase below 5 meV and around 10 meV, respectively. That is, the phonon modes

perpendicular to the layers are harder than those parallel to the layers. Because of the small recoilless fraction, multi-phonon contributions in the observed spectra are estimated to be large at room temperature from Mössbauer measurements. Though the angular dependence of the spectra are somewhat obscured by the multi-phonon contributions, an angular-dependent difference is observed.

This method is applicable to studying the dynamics of atoms in liquids, and, in a simple case, we can obtain the diffusion constant of the atoms. Quasi-elastic scattering was measured on iron ions in a Nafion membrane [4], which is of particular interest as an ion exchange membrane. In a water-soaked Nafion membrane, hydrated ferrous ions are assumed to exist in a region surrounded by sulphonic groups. The motion of ferrous ions was studied by Mössbauer spectroscopy below 250 K and is thought to be diffusive. As the membrane is usually used at room temperature, the motion at room temperature is important. It has been difficult to know the dynamics of ferrous ions at room temperature. However, the nuclear resonant quasi-elastic scattering method has made it possible to study the dynamics at room temperature. The measured spectrum is shown in Figure 3. The width of the monochromator resolution function is 6.5 meV, but the width of the spectrum is about 12 meV. This broadening is due to the diffusive motion of ferrous ions in the soaked Nafion membrane at room temperature. This indicates that the ions in the Nafion membrane move as in a solution.

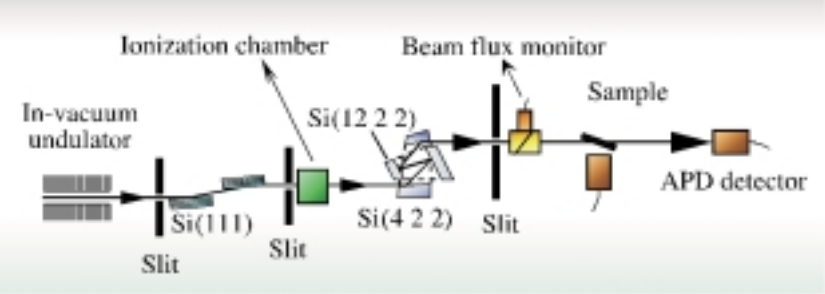

Fig.1: Experimental setup.

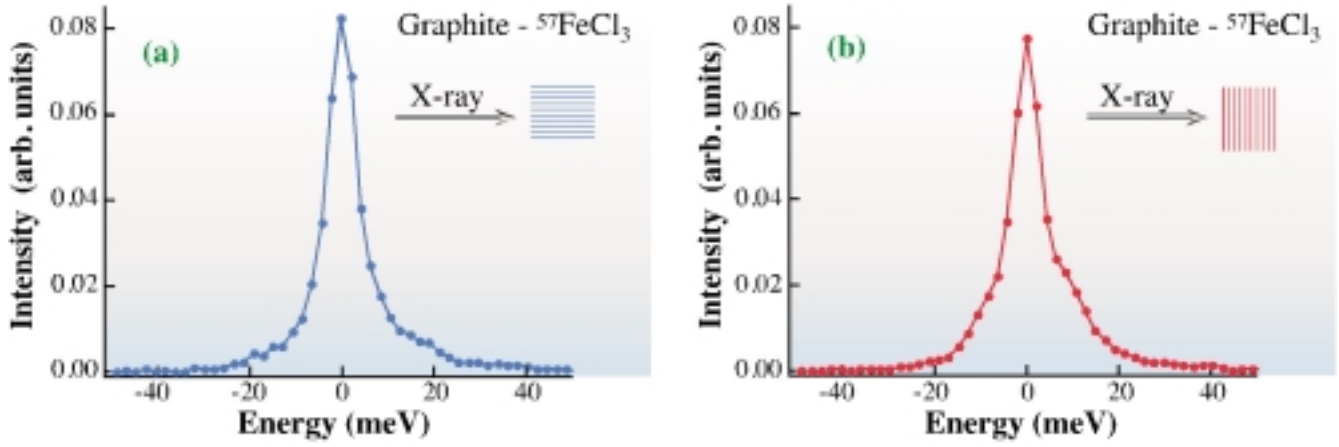

*Fig. 2: Nuclear resonant inelastic scattering of stage-1 graphite-$^{57}FeCl_3$ intercalation compounds at 298 K. Incident X-ray direction is **(a)** parallel and **(b)** perpendicular to the graphite layers.*

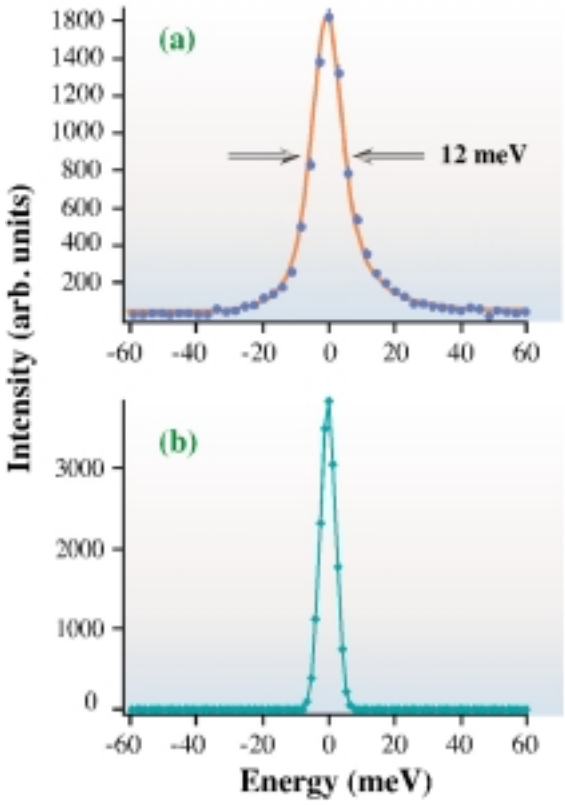

Fig. 3: ***(a)*** *Nuclear resonant quasi-elastic scattering from ^{57}Fe ions in Nafion.*
(b) *Nuclear resonant forward scattering from ^{57}Fe foil.*

OBSERVATION OF MAGNETIC RELAXATION IN AN $^{57}FeBO_3$ CRYSTAL BY USING NUCLEAR FORWARD SCATTERING

The Mössbauer time-domain spectroscopy using synchrotron radiation is suitable for the study of periodically perturbed nuclear resonant scattering. The time divided measurements are realized by phase-locking the periodic perturbation to the SR pulse. The quantum beats and dynamical beats give us information on the hyperfine interactions, the nuclear excited states and the motion of the resonant atom [1,2]. Recently, by applying the polarimetry technique, it has been shown that the oscillation of a hyperfine field on the plane perpendicular to the light axis can change the direction of the electric field vector of nuclear forward scattering (NFS) [3] (Figure 1).

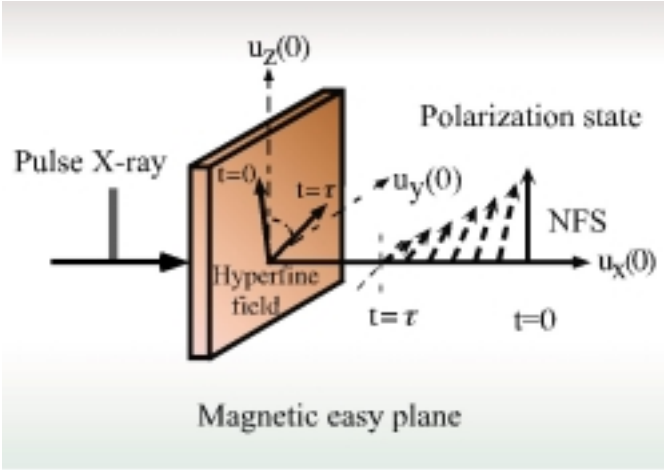

Fig. 1: Rotation of the polarization plane of NFS.

Makoto Seto[a], Rie Haruki[a] and Shinji Kitao[b]
(a) Kyoto University
(b) SPring-8 / JAERI

E-mail: seto@rri.kyoto-u.ac.jp

References

[1] M. Seto *et al., Phys. Rev. Lett.* **74** (1995) 3828.
[2] S. Kitao *et al.*, to be published in *Jpn. J. Appl. Phys. Suppl.*
[3] A. I. Chumakov *et al., Phys. Rev. B* **56** (1997) 10758.
[4] R. Haruki *et al.*, in preparation.

In the present study, we investigated the beam properties of NFS in the magnetic relaxation system of the $^{57}FeBO_3$ antiferromagnetic single crystal. The experiment was performed at the undulator beamline **BL09XU**. The storage ring was operated in 21-bunch mode at 20 mA. A SR pulse was emitted only at 228 ns intervals with a typically 50 ps width. The experimental setup is shown in Figure 2. The magnetic relaxation was caused by the fall-off of the external pulse magnetic field. Then, the