Study of *M1* Strengths in ^{28}Si by the High Resolution Measurement at Forward Angles

H. Matsubara[1], A. Tamii[1], T. Adachi[2], J. Carter[3], H. Fujita[4], K. Fujita[1], Y. Fujita[2], N. Hashimoto[1], K. Hatanaka[1], M. Itoh[1], T. Kawabata[5], K. Nakanishi[1], L.A. Popescu[6], H. Sakaguchi[7], Y. Sakemi[1], Y. Shimbara[1], Y. Shimizu[1], F.D. Smit[4], Y. Tameshige[1], M. Yosoi[7] and J. Zenihiro[7]

[1] *Research Center for Nuclear Physics (RCNP), Osaka University, Ibaraki, Osaka 567-0047, Japan*
[2] *Depertment of Physics, Osaka University, Machikaneyama 1-1, Toyonaka, Osaka 560-0043, Japan*
[3] *School of Physics, University of the Witwatersrand, Johannesburg 2050, South Africa*
[4] *iThemba LABS, Somerset West 7129, South Africa*
[5] *Center for Nuclear Study, University of Tokyo, Bunkyo 113-0033, Japan*
[6] *Depertment of Mathematical Physics and Astronomy, Gent University, Krijgslaan 281, Belgium*
[7] *Depertment of Physics, Kyoto University, Sakyo, Kyoto 606-8502, Japan*

In the study of the nuclear structure, the ground state correlations play a significant role in various fields, *e.g.* core polarization, isobars and meson exchange currents. One of the sensitive probes for such correlations is the *M1* excitations from 0^+, $T_z = 0$ nucleus. A quenching problem and fragmentation mechanism of *M1* strengths are especially interesting [1, 2].

For obtaining good data for the *M1* strengths, high resolution (*p,p'*) experiments were carried out at RCNP WS course [3], with a 295 MeV unpolarized proton beam bombarding a natural Si target of 1.86 mg/cm^2 thickness. Natural abundance of ^{28}Si is 92.2%. Two spectrometers were used, one was the Grand Raiden (GR) placed at 0°, 2.5° and 4.5° for the momentum analysis of scattered protons and the other was the large acceptance spectrometer (LAS) at 59.6° as a beam spot monitor which detected quasi-inelastically scattered protons. For the LAS, this is the most forward angle when the GR is set at 0°.

We applied "*under-focus mode*" to the GR for a good angular resolution in the vertical direction. In order to reconstruct the scattered angle information from the ray-trace at the VDC, sieve slit data were taken with a 1.5 mg/cm^2 ^{58}Ni target and the GR at 16°. Owing to this sieve slit calibration, the scattering angle resolution of 0.5° (0.8°) was achieved at E_x = 6 (20) MeV. Furthermore, by applying *dispersion-matching technique* [4] to the WS course, an energy resolution of 17 (20) keV by FWHM was achieved at E_x = 5.0 (11.5) MeV. This is an amazing accomplishment comparing with previous one, 150 keV [5]. The LAS data are valuable for a software correction of the ion optics which sensitively depends on the vertical beam position. After the uniform background events were subtracted, a high quality spectrum was obtained (Fig.1).

The detailed calibrations and analysis about *M1* strength distributions are now in progress.

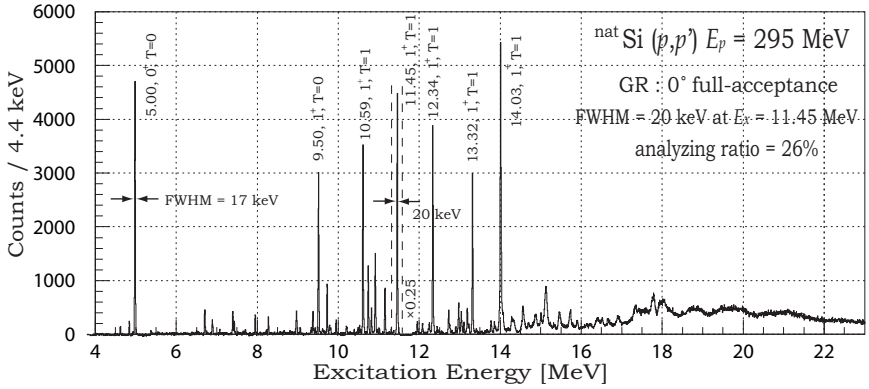

Figure 1: The ^{nat}Si(*p,p'*) spectrum. A good energy resolution of 20 keV has been achieved at the 11.45 MeV peak.

References

[1] N. Anantaraman *et al.*, Phys. Rev. Lett. **52**, 1409 (1984).
[2] G.M. Crawley *et al.*, Phys. Rev. C **39**, 311 (1989).
[3] T. Wakasa *et al.*, Nucl. Instr. and Meth. A **482**, 79 (2002).
[4] Y. Fujita *et al.*, Nucl. Instr. and Meth. B **126**, 274 (1997).
[5] T. Kawabata, Master thesis, Kyoto University 1998, unpublished ; T. Kawabata *et al.*, RCNP annual report 1997, p.53.