RCNP EXPERIMENT E299

# PROPOSAL FOR EXPERIMENT AT RCNP

February 5, 2007

**TITLE:**
**Investigation of $M1$ quenching in $sd$-shell region**

**SPOKESPERSON:**


| | |
|---|---|
| Full Name | Hiroaki Matsubara |
| Institution | RCNP, Osaka University |
| Title or Position | D1 |
| Address | 10-1 Mihogaoka, Ibaraki, Osaka, 567-0047 |
| Phone number | +81-6-6879-8949 |
| FAX number | +81-6-6879-8899 |
| E-mail | matubara@rcnp.osaka-u.ac.jp |


**EXPERIMENTAL GROUP:**


| Full Name | Institution | Title or Position |
|---|---|---|
| A. Tamii | RCNP, Osaka University | (AP) |
| T. Adachi | RCNP, Osaka University | (D3) |
| J. Carter | School of Physics, University of the Witwatersrand | (P) |
| M. Dozono | Department of Physics, Kyusyu University | (M2) |
| H. Fujita | School of Physics, University of the Witwatersrand | (PD) |
| K. Fujita | RCNP, Osaka University | (D3) |
| Y. Fujita | Department of Physics, Osaka University | (AP) |
| K. Hatanaka | RCNP, Osaka University | (P) |
| M. Itoh | CYRIC, Tohoku University | (RA) |
| M. Kato | RCNP, Osaka University | (M1) |
| T. Kawabata | CNS, University of Tokyo | (RA) |
| H. Nakada | Department of Physics, Chiba University | (AP) |
| K. Nakanishi | CNS, University of Tokyo | (PD) |
| P. von Neumann-Cosel | IKP, Tech. University of Darmstadt | (P) |
| R. Neveling | iThemba LABS | (R) |
| H. Okamura | RCNP, Osaka University | (P) |
| I. Poltoratska | IKP, Tech. University of Darmstadt | (D) |
| A. Richter | IKP, Tech. University of Darmstadt | (P) |
| B. Rubio | CSIC-Universidad de Valencia | (P) |
| H. Sakaguchi | Department of Applied Physics, Miyazaki University | (P) |
| Y. Sakemi | CYRIC, Tohoku University | (P) |
| Y. Sasamoto | CNS, University of Tokyo | (D1) |
| A. Shevchenko | IKP, Tech. University of Darmstadt | (R) |
| Y. Shimizu | RCNP, Osaka University | (PD) |
| Y. Shimbara | NSCL, Michigan University | (PD) |
| F.D. Smit | iThemba LABS | (SR) |
| Y. Tameshige | RCNP, Osaka University | (D3) |
| M. Yosoi | RCNP, Osaka University | (AP) |
| J. Zenihiro | Department of Physics, Kyoto University | (D2) |


| | | |
|---|---|---|
| **RUNNING TIME:** | Development of new gas target system | 1.0 day |
| | Test running time for experiment | 2.5 days |
| | Data runs | 12.5 days |

| | | |
|---|---|---|
| **BEAM LINE:** | | Ring : WS course |
| **BEAM REQUIREMENTS:** | Type of particle | unpolarized / polarized p |
| | Beam energy | 295 MeV |
| | Beam intensity | $\geq$ 3 nA (unpol.), $\geq$ 10 nA (pol.) |
| | Any other requirements | energy resolution $\leq$ 20keV |
| | | high resolution, halo-free, small emittance |
| **BUDGET:** | Experimental expenses | 2,550,000 yen |
| | Traveling and living expenses | 600,000 yen |

RCNP EXPERIMENT E299

**TITLE:**
**Investigation of $M1$ quenching in $sd$-shell region**

**SPOKESPERSON:** Hiroaki Matsubara

## SUMMARY OF THE PROPOSAL

Missing strength, called quenching, in Gamow-Teller (GT) and $M1$ excitations has been one of interesting subjects in nuclear physics. Sophisticated experimental studies on GT resonances have revealed that a coupling with $2p$-$2h$ states is the main source of quenching phenomena, while a coupling with $\Delta$-$h$ states plays a minor role. As for the $M1$ strengths, comparison of the amount of quenching between isoscalar (T=0) and isovector (T=1) strengths is essential for understanding quenching mechanism owing to the following reason. The $M1$ isoscalar excitation has no contribution from the coupling with $\Delta$-$h$ states due to the isospin selection rule, while both couplings can occur in the isovector one. Recently we have performed a $(p, p')$ measurement on $^{28}$Si with high resolution to extract $M1$ strengths; the result is that the quenching factor of the isoscalar transition is smaller than that of the isovector one. Although it can be recognized that th e coupling with $\Delta$-$h$ states does not play an important role in the $M1$ strengths, it is an unexpected result because the quenching factor of the isoscalar transitions should be equal or larger than that of the isovector ones. Lack of data on the isoscalar strength may bring such inconsistency because the isoscalar strength is small and therefore has been hard to be observed. Actually, few states are known as the isoscalar $M1$ states. Our realization of $(p, p')$ experiments with high resolution at forward angles, however, has provided a reliable method to study it.
We propose to measure the $(p, p')$ reactions on $^{16}$O, $^{20}$Ne, $^{24}$Mg, $^{32}$S, $^{36}$Ar and $^{40}$Ca at forward angles including zero-degrees at 295 MeV with high resolution for systematic study on $M1$ isoscalar strengths. Even-even N=Z nuclei are good targets to study $M1$ excitations because of their ground state property, $0^+$, and good separation of isospin. We can test by a systematic study whether the unexpected trend of the quenching factor seen in $^{28}$Si between the isoscalar and the isovector excitation is just a peculiar case or not. Furthermore, these data are valuable to test the isoscalar spin-flip component $V_\sigma$ of the effective nucleon-nucleon interaction since we have only limited knowledge on the component from experiments.