RIBF ULIC Symposium/mini-WS Report

*** English only**

Date: Feb. 4, 2013

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Title	[RIBF-ULIC-miniWS:025] Prospects on reaction studies using polarized target with low energy beams
Date	January 23, 2013
Place	RIKEN, Main Research bldg. Room 424
Language	[×] English [ ] Japanese
HP address	http://indico.riken.jp/indico/conferenceDisplay.py?confId=1029
Contact Person(s) (Name, Affiliation)	Dr. Didier Beaumel (RNC RI Physics Lab.) Dr. Tomohiro Uesaka (RNC Spin-isospin Lab.)

Financial support from ULIC (Users Office Use Only)	Total : 94,520 JPY [Breakdown] Travel expense and Accommodation fee Satoshi Sakaguchi: 44,390 Kimiko Sekiguchi: 21,960 Takashi Teranishi: 28,170
Co-hosting / any financial support from other organization(s)	-

Summary of discussions and its (expected) results:

Participants list (Name, Affiliation):

See attached.

Report on the [RIBF-ULIC-miniWS-025] mini workshop

Title: Prospects on reaction studies using polarized target with low energy beams

Held at RIKEN January 23rd, 2013
Number of participants : 14

Introduction

Polarized targets offer new opportunities to investigate nuclear structure of exotic nuclei as well as elementary nuclear interaction. Experimental studies of elastic scattering have been performed at RIKEN using a solid polarized proton target operated in a low magnetic field and at a high temperature [1,2]. More recently, a nucleon quasi-free scattering experiments at high energy using the same target technology have been performed at RIBF using beams of neutron-rich oxygen isotopes. The workshop was aiming to investigate the opportunity of using polarized targets to study reactions relevant to lower incident energies regime, (e.g. transfer reactions, resonant scattering and also reactions of interest for few body physics) in view of possible experiment proposals making use of e.g. RIBF slowed-down beams.

Présentations

1. D. Beaumel, IPNO/RIKEN Nishina Center

"Study of one-nucleon transfer reactions with polarized targets"

2. T. Uesaka, RIKEN Nishina Center

"Possible polarized targets to be used with RI beams"

3. T. Teranishi, Kyushu University

"Analyzing power measurement in low-energy resonant scattering of polarized protons on unstable nuclei"

4. S.Sakaguchi, Kyushu University

"Solid polarized proton target for low-energy RI-beam experiment"

5. K. Sekiguchi, Tohoku University

"Study of three-nucleon force in few-nucleon scattering with polarized beam and/or target"

A general talk (#2) was given on presently existing techniques for polarized targets and ongoing developments. Three further talks were dedicated to low energy reaction studies with polarized targets, focusing on :

- Transfer reactions (talk#1)
  Despite the great improvement in spectroscopic power brought by spin observables no transfer reaction experiment combining RIB with a polarized target has been performed so far. Some physics opportunities as e.g. study of spin-orbit splitting were presented.
- Resonant scattering (talk#3)
  Studies of resonant scattering with a polarized target are in a more advanced stage. A feasibility study has been performed (including realistic calculations) and a code for calculating analyzing powers has been developed. The ^{7}Be+p and ^{9}C+p reactions with the RIKEN/CNS are candidate for first experiments at CRIB or RIPS.
- Few-nucleon scattering (talk#5)
  Polarized targets are of clear interest also for few-body physics. Few-nucleon scattering experiments take advantage of spin observables to extract information on three-body forces. Plans for the study of pol. d on pol. p target with SAMURAI, and for p+^{3}He with a newly developed polarized target were presented.

Talk#4 focussed on the status and ongoing developments of the RIKEN/CNS solid proton target used in [1,2], specifically developed for experiments with RIB (thickness, low magnetic field).

Conclusion and outlooks

- At short term, the study of the pickup reaction using polarized proton probes (with e.g. the RIKEN/CNS target) seems feasible mainly because of favorable kinematics. Recoil particles are emitted exclusively at forward angle with maximum angle of ~40 degrees. This is compatible with e.g. the proton target to be used for resonant scattering studies. The setup would be schematically similar to that used at the occasion of the MUST2 experiments at RIPS when the ^{11}Li(d,^{3}He) reaction was studied. Namely, a set of high-granularity Silicon telescopes placed in a wall-like configuration downstream the polarized target and covering the forward angles. A polarized target thickness ≤ 10 mg/cm^2 would allow *a priori* to study the (p,d) reaction with sufficient resolution (recoil energies depend on the Q-value so this needs be confirmed by realistic simulations). In terms of physics case, the study of spin-orbit (S.O.) splitting evolution over a chain of isotopes or isotones would be of great interest. It was noted that predictions concerning the evolution of the e.g. $1g_{7/2}$-$1g_{9/2}$ S.O. splitting in A=100 nuclei from relativistic mean field calculations differ from non-relativistic ones [3]. This should be checked for more recent calculations.
- Reactions using a deuteron target such as (d,p) cannot be considered at short term. First of all, polarization rates achieved for deuterons for a given technology is always lower than in the case of protons, typically by a factor 1.5-2. The only development performed so far in view of a use with low-energy RIB by a PSI-Oak Ridge collaboration did not reach yet the final point. Concerning the (d,p) reaction, of special interest since it does not have an equivalent in knock-out reactions, its kinematics is not favorable as compared to e.g. (p,d) or (d,t). Indeed, the recoil particle is emitted in the whole solid angle and energies are quite low (how low depending on Q-value).
- ^{3}He polarized targets are of special interest for transfer reactions since it permits the study of nucleon stripping (^{3}He,d), (^{3}He,^{2}He) and also neutron pickup (^{3}He,^{4}He). Presently developed target consists in a cell of high density gas. It is used for the study of three-nucleon forces for which it represents a good probe for their dynamical aspects. At present, a new polarized target is under construction at Tohoku University. Target container will be made of GE180 material which should allow to reduce its thickness down to 100µm. A p+^{3}He experiment at 70 MeV will be planned.

  The wall thickness of the present target prevents the study of transfer reactions. Instead, another option is now under consideration which is the development of an active target making use of polarized ^{3}He gas. Such a unique device would be of great interest for e.g. stripping reactions studies mentioned above.
- The RIKEN/CNS solid proton target is now undergoing some important developments in view of operation at room temperature. That would allow suppression of the cooled N2 gas representing a thickness of 70 mg/cm^2 as well as the entrance window (presently made of havar 6 mm). Recently, a world record polarization rate of 14% at room temperature has been achieved. A polarization larger than 30% at room temperature is now within sight, which would represent a major improvement of the existing device. The achievement of thin (0.1mm) crystal is also an important challenge to be achieved.

[1] T.Uesaka et al., Phys.Rev. C 82, 021602 (2010)
[2] S.Sakaguchi et al., Phys.Rev. C 84, 024604 (2011)
[3] J.Dobaczewski et al., Phys.Rev.Lett. 72, 981 (1994)

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List of participants

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