Study of symmetry energy using isospin diffusion process in heavy-ion collision at RIBF

N. Nakatsuka,[*1] R.H. Showalter,[*2] T. Isobe,[*3] J. Winkelbauer,[*2] T. Murakami,[*1] W.G. Lynch,[*2] B. Tsang,[*2] H. Sakurai,[*3] J. Lee,[*3] M. Nishimura,[*3] S. Nishimura,[*3] Y. Nakai,[*3] N. Fukuda,[*3] N. Inabe,[*3] D. Kameda,[*3] T. Kubo,[*3] H. Suzuki,[*3] H. Takeda,[*3] Y. Yanagisawa,[*3] S. Yennello,[*4] A.B. McIntosh,[*4] L. Heilborn,[*4] A. Zarrella,[*4] W. Powell,[*5] J. Sampson,[*5] J. Estee,[*2] L. Fei,[*6] G. Zhang,[*6] A. Chbihi,[*7] A. Galindo-Uribarri,[*8] E.P. Rodal,[*9] B. Hong,[*10] G. Jhang,[*10] W. Reviol,[*11] D.G. Sarantites,[*11] and L.G. Sobotka[*11]

The nuclear equation of state (EoS) is an important information that helps in understanding the astrophysical phenomena such as neutron stars and type-2 supernovae. The EoS shows highest uncertainty on a symmetry energy term, which is proportional to the square of the isospin asymmetry. We strive to improve the remaining uncertainties of constraints on the density dependence of the symmetry energy at subsaturation densities, $\rho/\rho_0 \approx 0.4$-1 in the so called isospin-diffusion process of heavy-ion collisions. The isospin diffusion process has been observed in the experiments performed at NSCL/MSU using stable nuclear beams[1]. We performed the experiment to measure the isotopic distribution of the projectile residues from the collision of cocktail beams, where the $^{107}_{49}$In and the $^{112}_{50}$Sn beams are on $^{124}_{50}$Sn and $^{112}_{50}$Sn targets at 70MeV/u respectively. The particle identification of projectile residues is performed by the $B\rho$-ΔE-TOF technique using the ZeroDegree spectrometer. The Washington University Microball[2] was used to obtain the centrality information. We used $B\rho$ settings of 2.41 and 2.52 T·m in order to avoid beam particles with any charge states hitting the detectors at F11. The standard beam tracking and timing detectors at F10 and F11 were used for reconstructing the beam tracks through the spectrometer. Fig#1 shows a preliminary PID plot of Z versus $A = Q$ for the ^{107}In on ^{124}Sn reaction. Isotopes with Z=30-40 are clearly shown separated in the figure. Fig#2 shows a preliminary plot of Z versus multiplicity of the charged particles obtained by the Microball. From the obvious correlation between the multiplicity and the size of the residue, we can determine the collision centrality with the help of a model calculation. In the offline analysis, we will select the data in the ZeroDegree Spectrometer only from the peripheral events using obtained information from the Microball. Then the measured yields of isotopes with $Z = 30 \sim 40$ will be compared with the theoretical predictions to extract a new constraint on the symmetry energy at sub saturation densities.

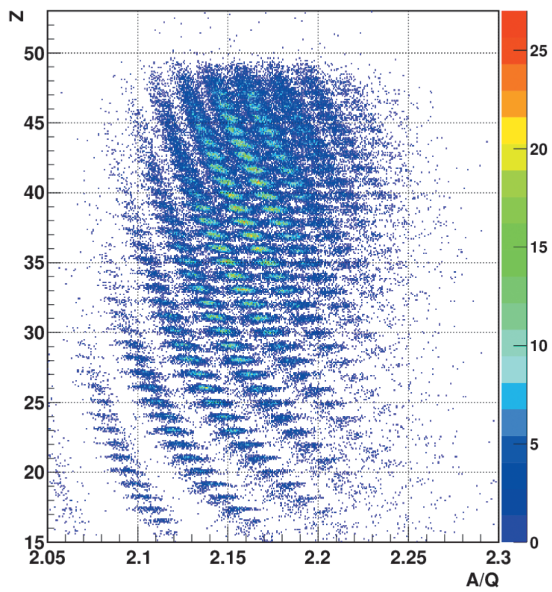

Fig. 1. PID of heavy-ion collision residue performed using ZeroDegree Spectrometer

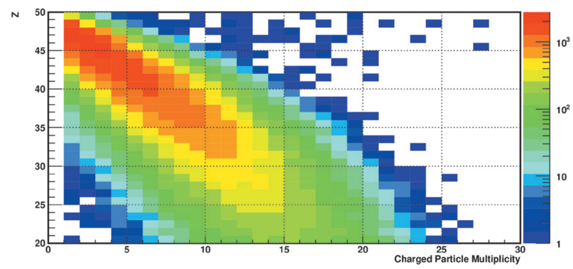

Fig. 2. Correlation between multiplicity and Z of residue using Microball

*1 Department of Physics, Kyoto University
*2 National Superconducting Cyclotron Laboratory, Michigan State University
*3 RIKEN Nishina Center
*4 Cyclotron Institute, Texas A&M University
*5 Department of Physics, University of Liverpool
*6 Chinese Academy of Sciences
*7 Physics Division, GANIL
*8 Physics Division, Oak Ridge National Laboratory
*9 Institute of Nuclear Sciences, National Autonomous University of Mexico
*10 Department of Physics, Korea University
*11 Department of Chemistry, Washington University

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