# OBSERVATION OF THE ISOVECTOR GIANT MONOPOLE RESONANCE VIA THE $^{28}$SI($^{10}$BE,$^{10}$B+γ) REACTION

**Remco G.T. Zegers, NSCL, Michigan State University, East Lansing, U.S.A.**

M. Scott[1, 2, 3], R. Almus[4], Sam M. Austin[1, 2, 3], D. Bazin[1], B.A. Brown[1,2,3], A. Gade[1, 3], M. Bowry[1, 2] S. Galès[5], U. Garg[6], M.N. Harakeh[7], N. Kalantar-Nayestanaki[7], C. Langer[1, 2], C. Loelius[1, 2, 3], S. Lipschutz[1, 2, 3], E. Litvinova[1, 8], E. Lunderberg[1, 3], K. Miki[9], C. Morse[1, 2, 3], S. Noji[1, 2], G. Perdikakis,[1, 4] T. Redpath[4], H. Sakai[9], Y. Sasamoto[10], M. Sasano[9], C. Sullivan[1, 2, 3], J. Tostevin[1, 11], T. Uesaka[9], and D. Weisshaar[1]

1 National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, USA
2 Joint Institute for Nuclear Astrophysics, Michigan State University, East Lansing, USA
3 Department of Physiscs and Astronomy, Michigan State University, East Lansing, USA
4 Department of Physics, Central Michigan University, Mount Pleasant, USA
5 Institut de Physique Nucl´eaire, IN2P3-CNRS, Orsay, France
6 Department of Physics, University of Notre Dame, South Bend, USA
7 Kernfysisch Versneller Instituut, University of Groningen, Groningen, The Netherlands
8 Department of Physics, Western Michigan University, Kalamazoo, USA
9 RIKEN, Nishina Center, Wako, Japan
10 Center for Nuclear Study, University of Tokyo, Wako, Saitama 351-0198, Japan
11 Department of Physiscs and Astronomy, University of Surrey, Guilford, Surrey GU2 7XH, United Kingdom

The Isovector Giant Monopole Resonance (IVGMR) is one of the most fundamental giant resonance excitations. In a hydrodynamic picture, the IVGMR represents and oscillation in which the proton and neutron fluids undergo out-of-phase breathing-mode oscillations and the IVGMR is the isovector partner of the well-known Isoscalar Giant Monopole Resonance (ISGMR). Compared to the ISGMR, very little is known experimentally about the IVGMR. The strongest experimental indications come from pion charge-exchange experiments, although the extraction of the IVGMR in those experiments relies heavily on the description of background below the resonance.

In this work, the ($^{10}$Be,$^{10}$B+γ) reaction was used for the study of non-spin-transfer giant resonances, in particular the IVGMR. By gating on a γ-ray associated with the decay of the $^{10}$B $0^+$(1.74 MeV) state, which is the analog of the $^{10}$Be ground state, a clean non-spin transfer filter is obtained. The nucleus investigated was N=Z $^{28}$Si, for which the IVGMR is the only strong monopole excitation.

The experiment was performed at NSCL, using a secondary $^{10}$Be beam at ~100 MeV/u. The $^{28}$Si target was placed at the S800 spectrometer target, and surrounded by the Gamma-Ray Energy Tracking Array GRETINA. $^{10}$B particles were momentum analyzed in the spectrometer and used for the kinematical reconstruction of the event. γ-rays were detected in GRETINA, which allows for accurate Doppler reconstruction. Contributions from different multipole excitations were decomposed in a Multipole Decomposition Analysis.

In addition to the well-known Isovector Giant Dipole Resonance (IVGDR), a clear signature for the excitation of the IVGMR was found. The measured cross section for the IVGMR compared well to that expected for full exhaustion of the associated non-energy-weighted sumrule. The strength distribution of the IVGMR also compared quite well to theoretical calculation in the Relativistic Time Blocking Approximation (RTBA). In the presentation, the experiment, results and evidence for the excitation of the IVGMR will be presented.

GRETINA was funded by the US DOE Office of Science. Operation of the array at NSCL is supported by NSF under Cooperative Agreement PHY-11-02511 (NSCL) and DOE under grant DE-AC02-05CH11231 (LBNL).