Magnetic Dipole and Gamow-Teller Modes in Neutrino-Nucleus Reactions: Impact on Supernova Dynamics and Nucleosynthesis*

P. von Neumann-Cosel[1], T. Adachi[2], A. Byelikov[1], H. Fujita[3], Y. Fujita[2], A. Heger[4], E. Kolbe[5] K. Langanke[6], G. Martinez-Pinedo[7], A. Richter[1], A. Shevchenko[1], Y. Shimbara[2]

[1] *Institut für Kernphysik, Technische Universität Darmstadt, D-64289 Darmstadt, Germany*
[2] *Department of Physics, Osaka University, Toyonaka, Osaka 560-0043, Japan*
[3] *School of Physics, University of the Witwatersrand, Johannesburg 2050, South Africa*
[4] *Theoretical Astrophysics Group, Los Alamos National Laboratory, Los Alamos, NM 87545, U.S.A*
[5] *Institut für Physik, Universität Basel, CH-4056 Basel, Switzerland*
[6] *Gesellschaft für Schwerionenforschung, D-64291 Darmstadt, Germany*
[7] *ICREA and Institut d'Estudis Espacials de Catalunya, Edifici Nexus, Gran Capità 2, E-08034 Barcelona, Spain*

Contact e-mail: vnc@ikp.tu-darmstadt.de

The magnetic dipole (M1) and Gamow-Teller (GT) response are elementary excitation modes of the nucleus governed mainly by the spin-isopin part of the effective NN interaction. In medium-mass fp-shell nuclei, the detailed knowledge of the M1 and GT strength distribution provides a stringent test of state-of-the-art shell-model calculations, validating their applicability in astrophysical network calculations [1]. As an example, it is demonstrated that high-precision M1 data on $N = 28$ isotones from electron scattering at Darmstadt permit the extraction of neutral-current neutrino-nucleus scattering cross sections important for supernova dynamics and nucleosynthesis [2].

The influence of configuration mixing on the GT strength distribution at low energies is investigated for the heavy odd-odd nuclei ^{138}La and ^{180}Ta. The nucleosynthesis of these exotic nuclides, amongst the rarest in nature, is a long-standing problem. A possible source are charged-current neutrino-nucleus reactions [3,4] of the type (ν_e, e^-) which would be dominated by the GT_- response. However, the main GT_- resonance lies above the particle threshold and, therefore, does not contribute. At present, the modelling is based on (1p-1h) RPA calculations only, whose capability to describe the response below the main GT resonance is questionable. However the corresponding GT_- strength distributions can be measured with the (^{3}He,t) reaction at intermediate energies under 0° (see e.g. [5]). Recent measurements of the ^{138}Ba(^{3}He,t)^{138}La and ^{180}Hf(^{3}He,t)^{138}Ta reactions performed at RCNP, Osaka, and their astrophysical implications are discussed.

[1] K. Langanke and G. Martínez-Pinedo, Rev Mod. Phys. **75**, 819 (2003).
[2] K. Langanke, G. Martínez-Pinedo, P. von Neumann-Cosel, and A. Richter, Phys. Rev. Lett. **93**, 202501 (2004).
[3] A. Heger et al., Phys. Lett. B **606** 258 (2005).
[4] S. Goriely, M. Arnould, I. Barzov, M. Rayet, Astronomy Astrophys. **375**, L35 (2001).
[5] Y. Fujita et al., Phys. Rev. C **70**, 054311 (2004).

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