Nuclear Isovector Excitations

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Some of the fundamental modes of nuclear vibrations are the spin and isospin oscillations in which nucleons and their spins are collectively excited. These isovector vibrations are selectively excited in nucleon charge-exchange reactions. The simplest of these collective vibrations occur when there is no spin contribution and no change in the nuclear shape, i.e., no change in the angular momentum ($\Delta L = 0$, $\Delta S = 0$, $\Delta J = 0^+$) and are called Fermi transitions. If there is spin contribution to these isovector excitations, they are called Gamow-Teller resonances ($\Delta L = 0$, $\Delta S = 1$, $\Delta J = 1^+$). At higher values of the momentum transfer, these oscillations are accompanied by shape oscillations, given rise to giant dipole and giant spin-dipole resonances, quadrupole and spin-quadrupole resonances, etc. At higher momentum transfers and higher excitation energies, the isovector excitation of the quasifree region is the dominant feature in the observed nucleon charge-exchange reactions spectra.

Specific cases for these excitations, observed in (p,n) and (n,p) reactions will be presented with relevance to nuclear structure effects in nuclear reaction calculations, including applications to solar neutrino detectors.

Although data have been obtained with beam energies up to 800 MeV, this presentation will emphasize data obtained with beam energies up to 200 MeV. Sensitivity of the calculated cross section to the nucleon optical parameters used in the analysis will be presented.