Nuclear Astrophysics with ALBA

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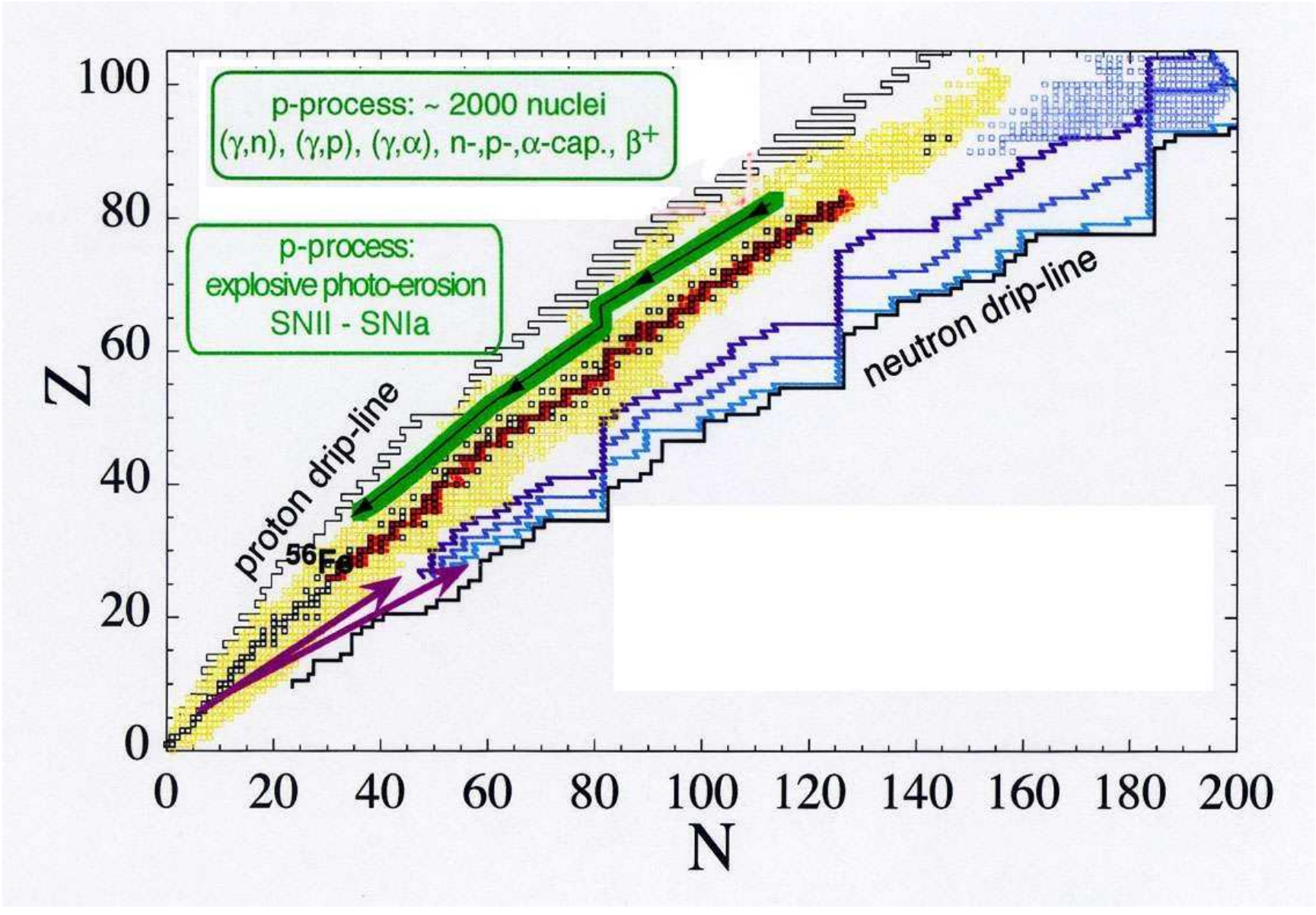
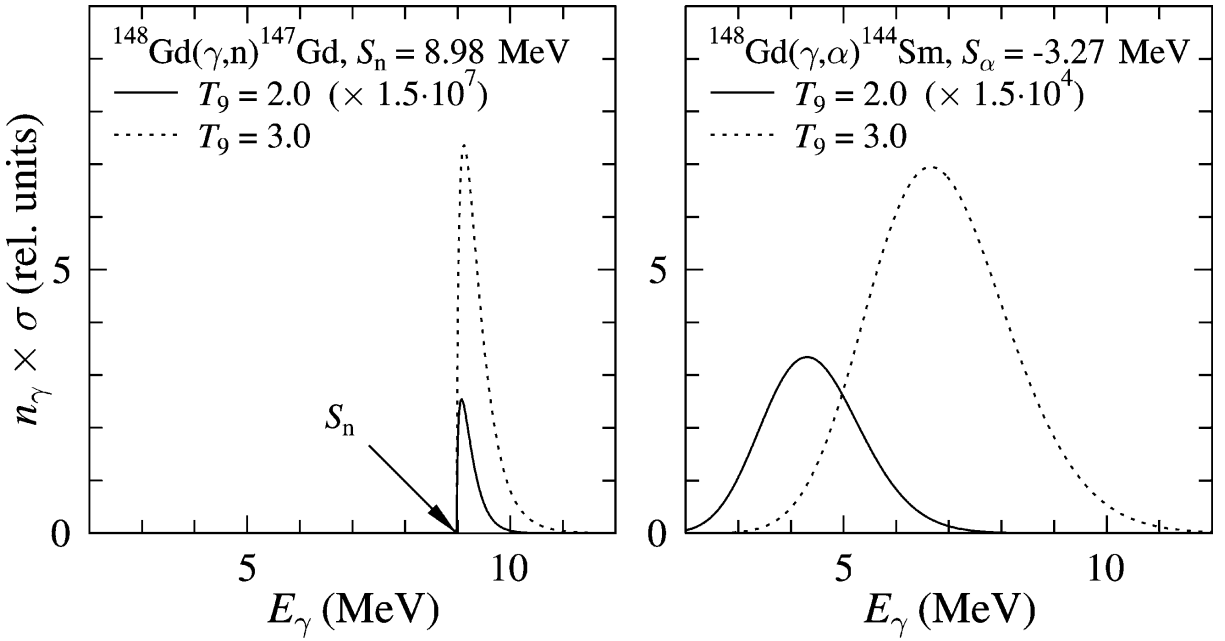
- Photoabsorption cross sections (p-process).
- Neutrino cross sections from electromagnetic probes

Nucleosynthesis heavy nuclei



p-process nucleosynthesis

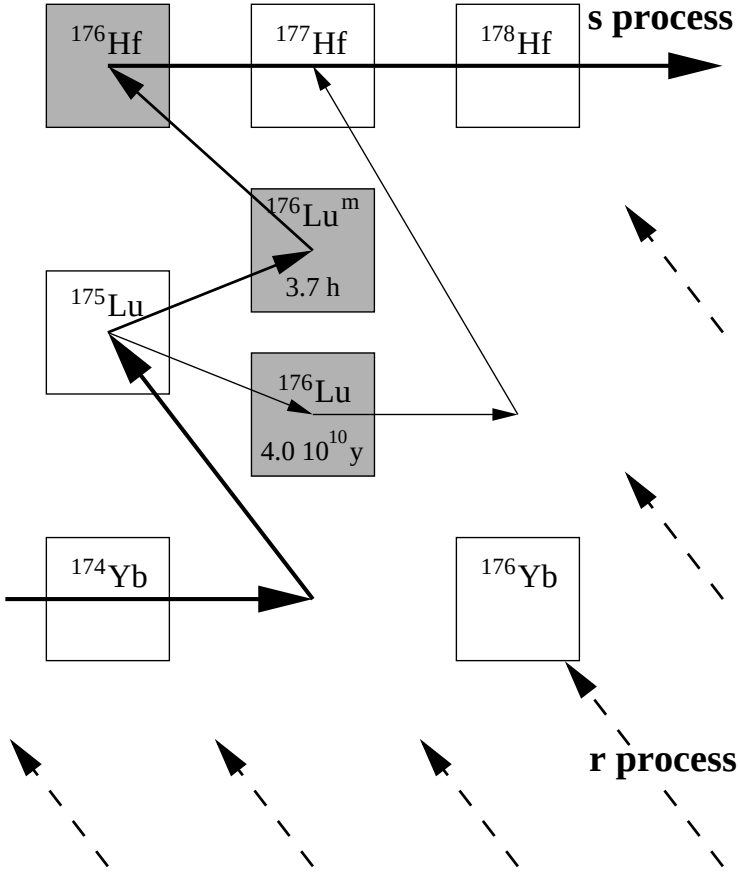
- 35 neutron deficient nuclei: from Z = 34 (Se) to Z = 80 (Hg).
- Occurs for T = 130–300 keV. (ONe layers of stars).
- (p, γ) only relevant for some light p nuclei.
- main reactions (γ, n), (γ, p), (γ, α).
- rate determined from product $n_\gamma(E, T)\sigma(E)$.

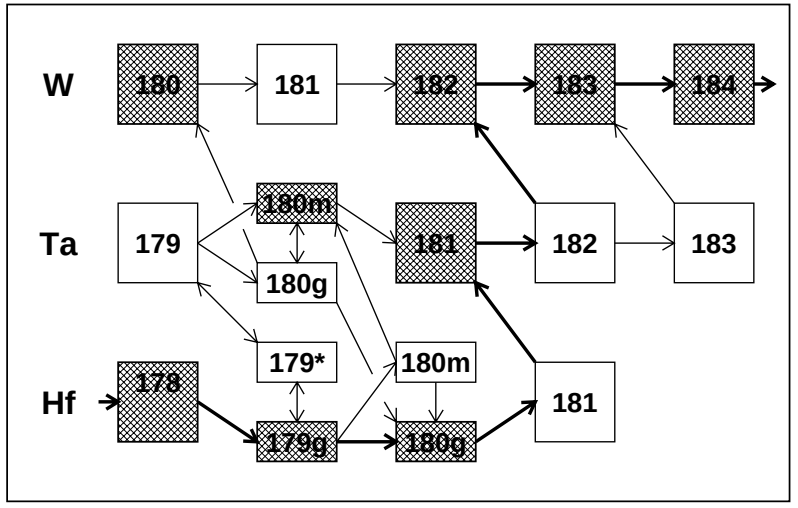


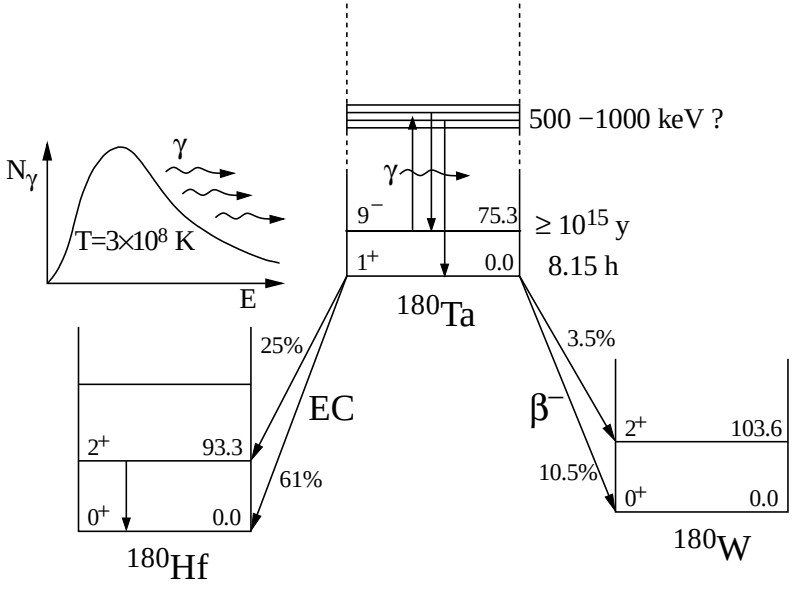
$$E_\gamma = S_n + \frac{kT}{2} \qquad E_\gamma = S_{p,\alpha} + a\sqrt[3]{Z_1^2 Z_2^2 A T^2}$$

Photoactivation experiments

^{176}Lu and most probably ^{180}Ta are produced in the s-process.

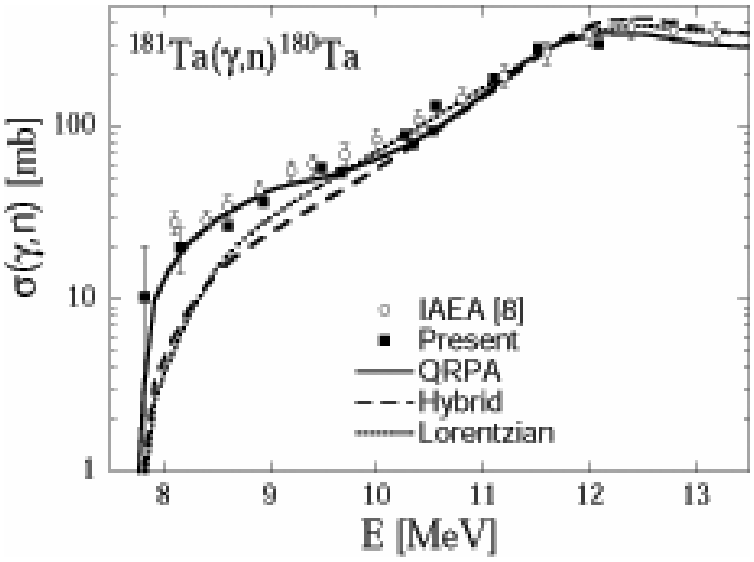


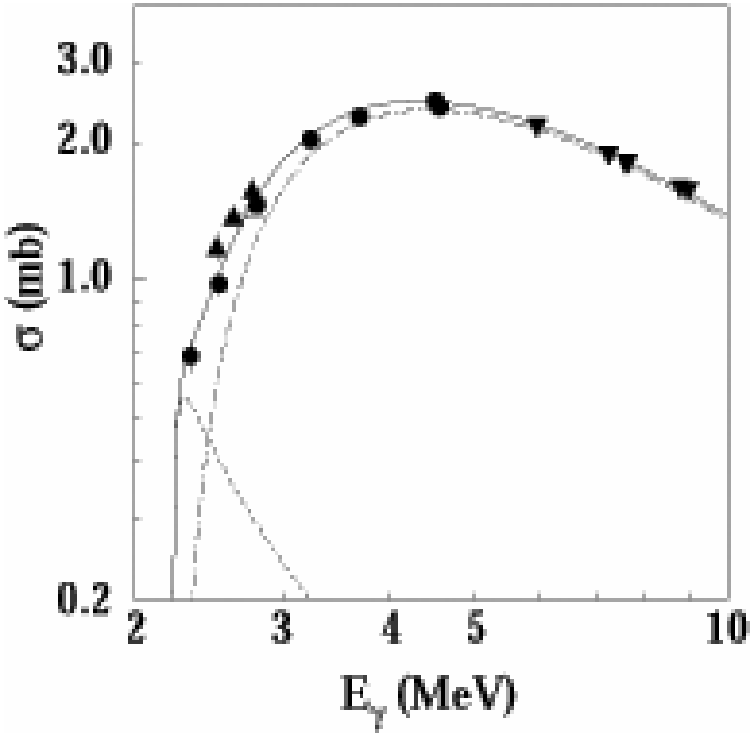




Photodisociation experiments

- Bremsstrahlung photons.
- Laser Inverse Compton.
  - ➢ Higher intersities at astrophysical energies
  - ➢ Quasi-monochromatic γ-rays.
  - ➢ Experiments done: $^{9}\mathrm{Be}(\gamma, n)\alpha, \alpha$, $^{181}\mathrm{Ta}(\gamma, n)^{180}\mathrm{Ta}$, $\mathrm{D}(\gamma, n)p, \ldots$





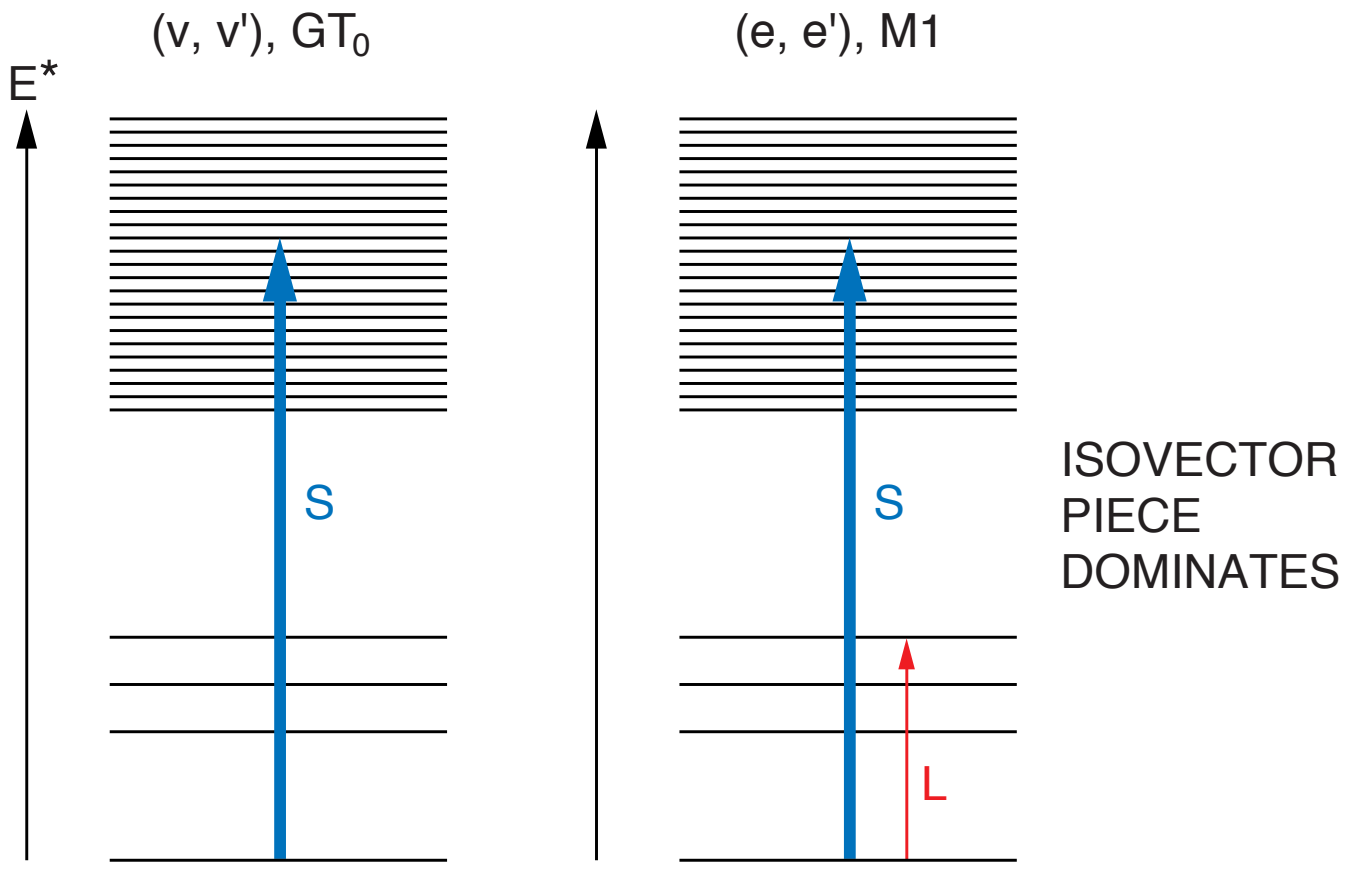
Neutrino cross sections from EM probes

Neutrino cross sections relevant in several astrophysical scenarios.

- Supernova collapse physics.
- Neutrino nucleosynthesis.
- Supernova neutrino detection on Earth.

Direct measurements with neutrinos are not always possible.

Neutrino Scattering from (e, e')

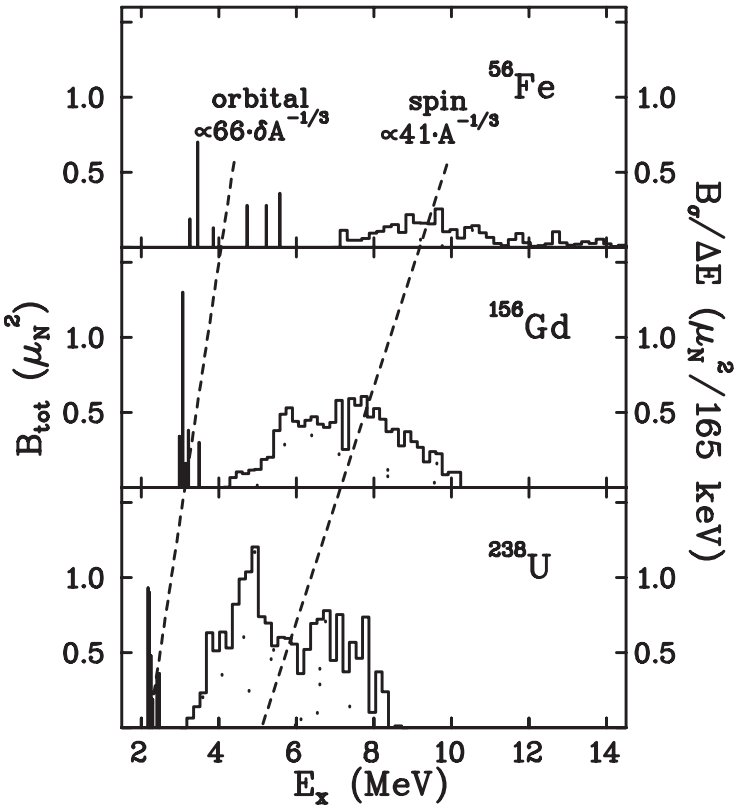


M1 data give GT_0 information

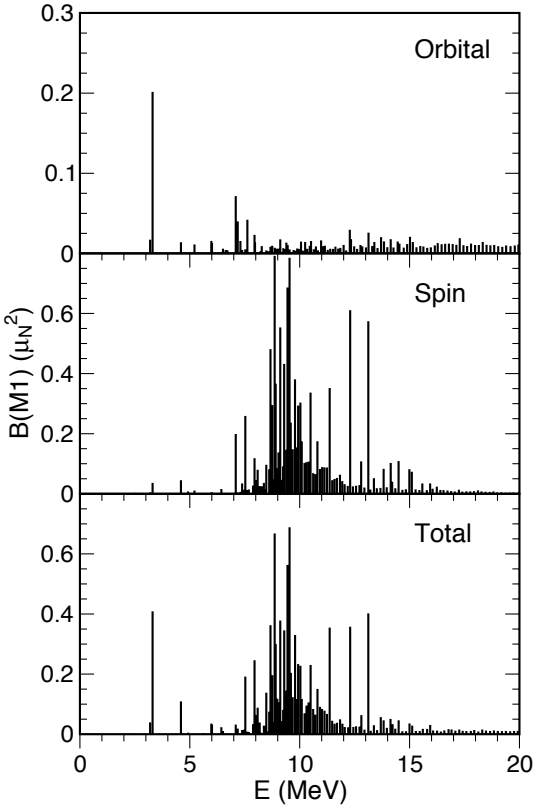
if Orbital contribution can be removed

Neutrino Scattering from (e, e')

M1 DATA
(A. Richter)

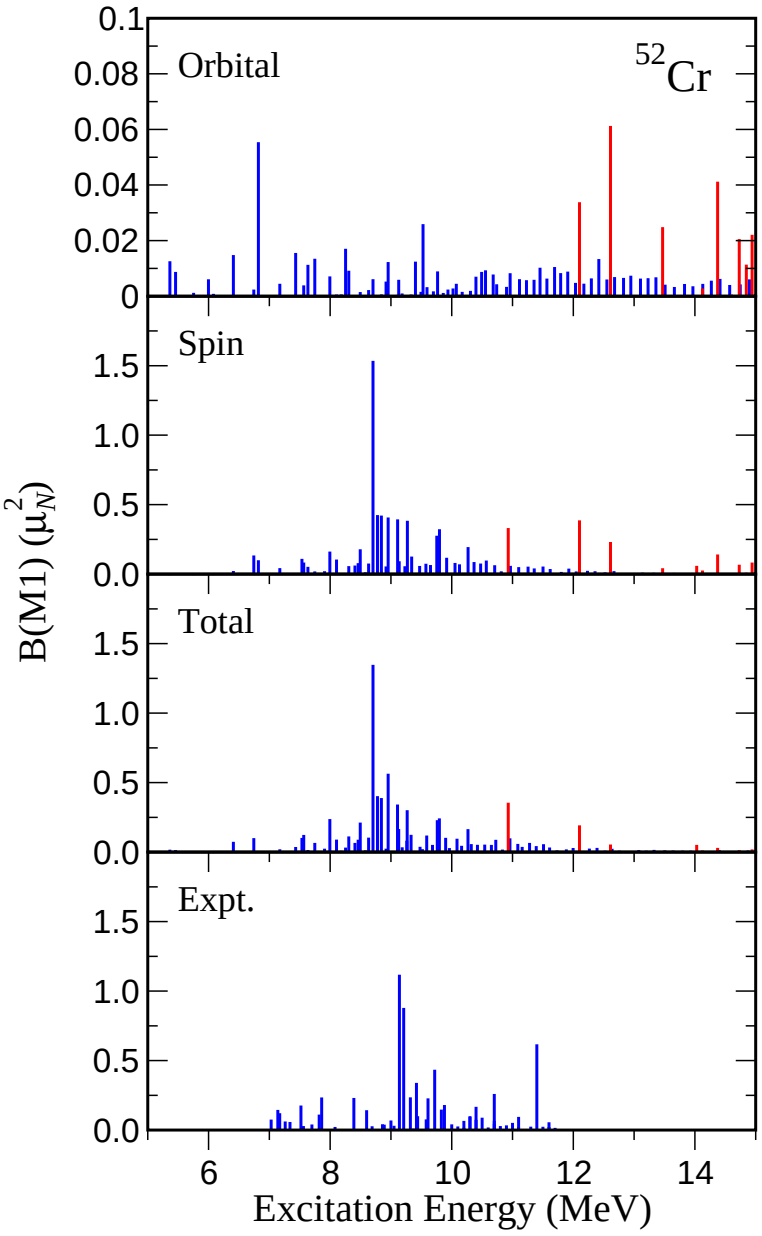


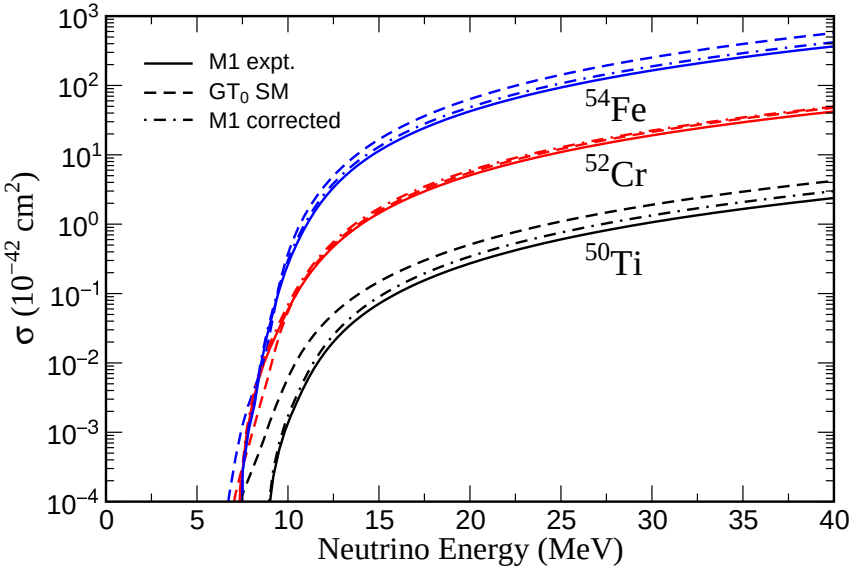
DECOMPOSITION OF
M1 STRENGTH
(SHELL MODEL)



Usually orbital and spin parts well separated.
Spherical nuclei: Orbital part strongly suppressed.

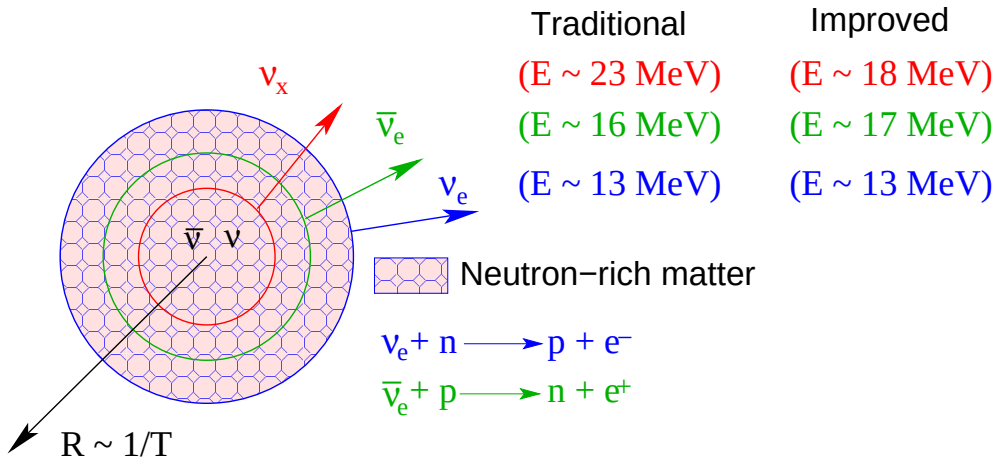
Neutrino Scattering from (e, e')



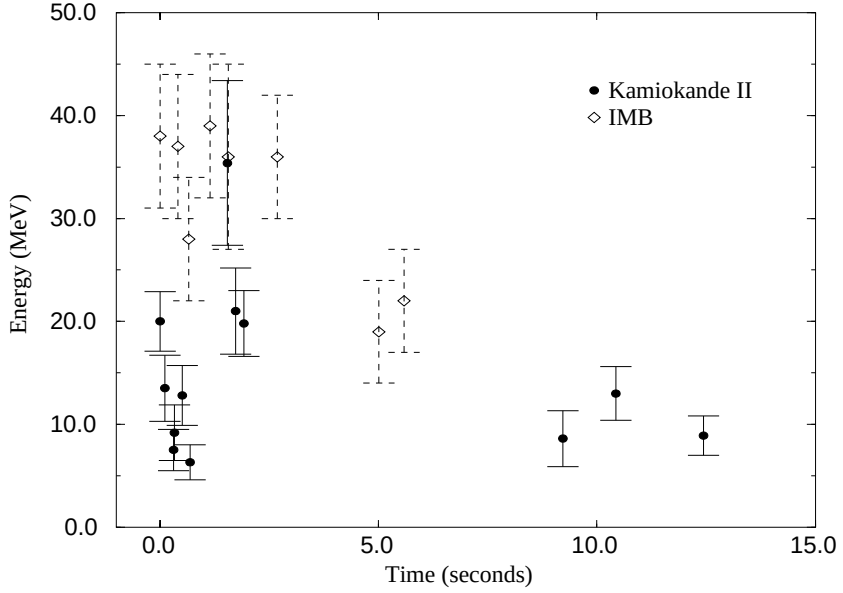


Neutrinos from supernovae

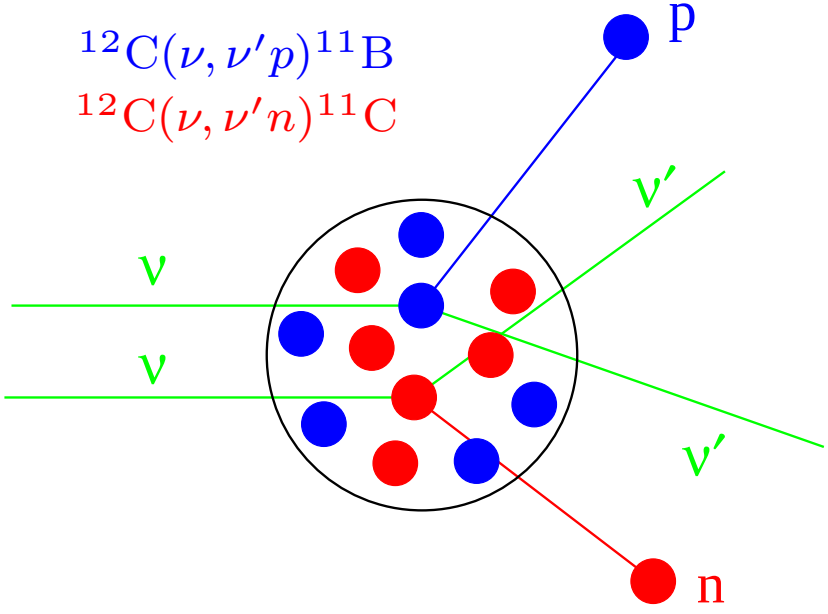
Raffelt *et al.*, astro-ph/0303226



neutrino detection (SN1987A)



Neutrino nucleosynthesis



Neutrino nucleosynthesis

A. Heger *et al*, astro-ph/0307546

Product	Parent	Reaction
^{11}B	^{12}C	$(\nu,\nu' n),(\nu,\nu' p)$
^{19}F	^{20}Ne	$(\nu,\nu' n),(\nu,\nu' p)$
^{138}La	^{138}Ba	(ν,e^-)
	^{139}La	$(\nu,\nu' n)$
^{180}Ta	^{180}Hf	(ν,e^-)
	^{181}Ta	$(\nu,\nu' n)$