# Thermal neutron-capture cross section of the $_{39}Y^{90}$ isotope

$Y^{89}(n,\gamma)E=Thermal$

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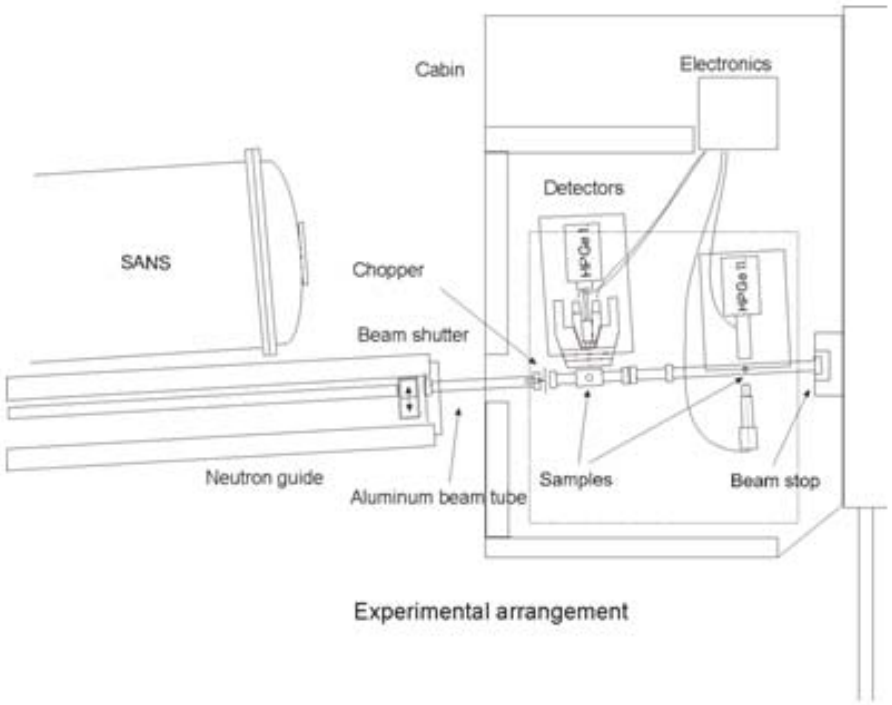
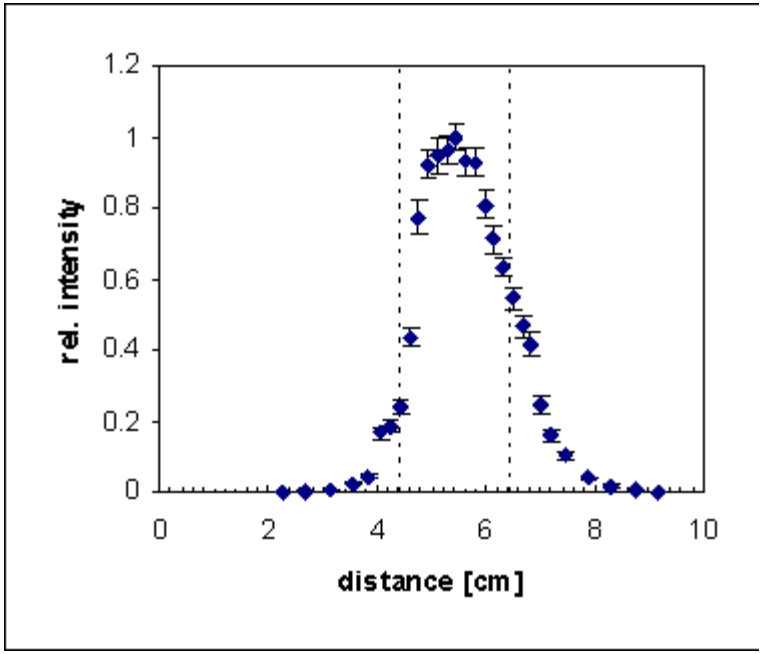
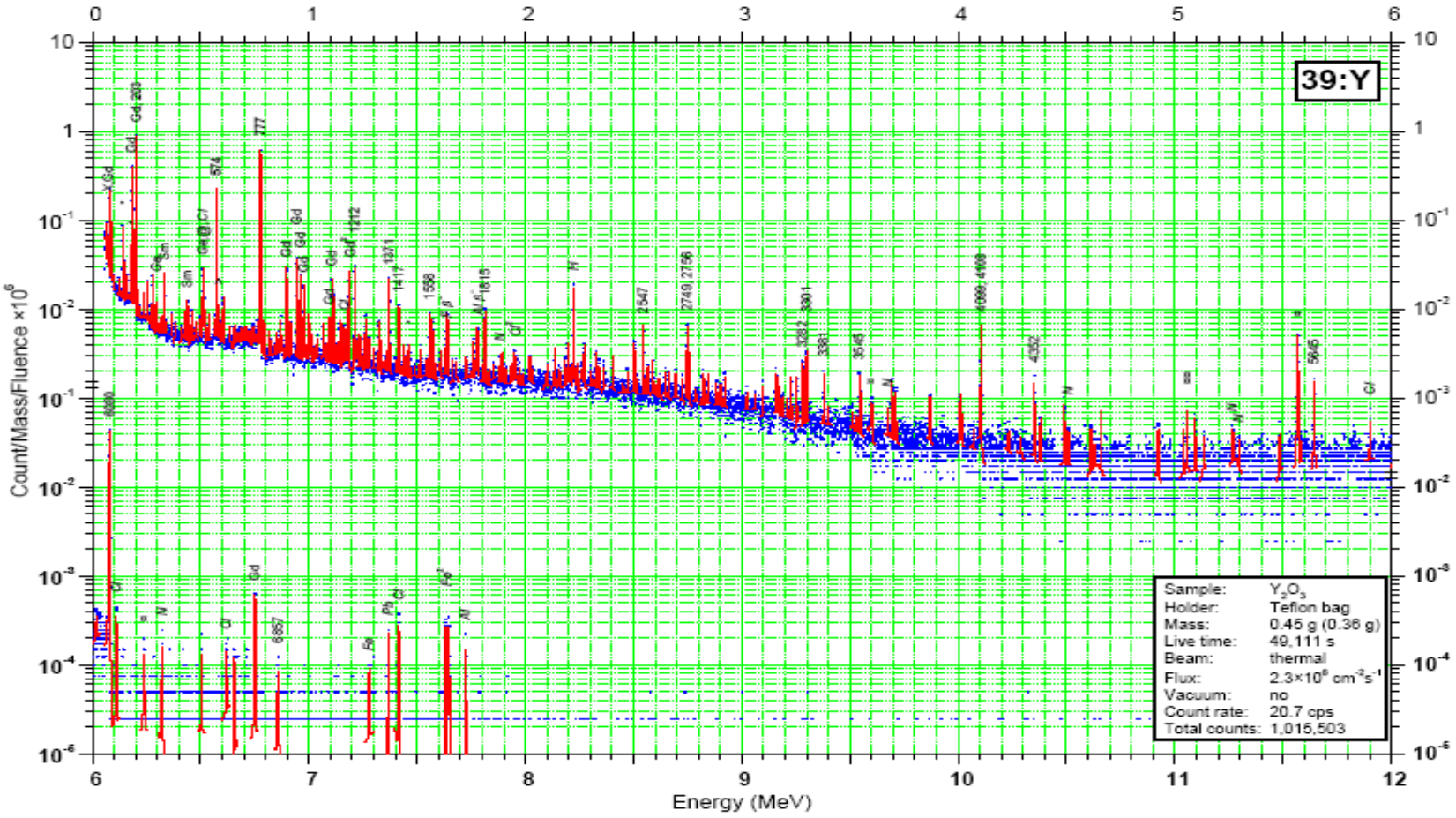
# Experimental Setup




Experimental arrangement

# Neutron Flux as a function of distance from the base of the target holder




39:Y
Count/Mass/Fluence ×10^6
Energy (MeV)
Sample: Y2O3
Holder: Teflon bag
Mass: 0.45 g (0.36 g)
Live time: 49,111 s
Beam: thermal
Flux: 2.3×10^6 cm^-2s^-1
Vacuum: no
Count rate: 20.7 cps
Total counts: 1,015,503

# Statistical model simulation

$$\left\langle \Gamma_{i\gamma f} \right\rangle = \frac{f^{(XL)}(E_\gamma, \xi) \times E_\gamma^3}{\rho(E_i, J_i^\pi)}$$

$$\sigma_0 = \sum \sigma_\gamma^{\exp}(GS) + \sum \sigma_\gamma^{sim}(GS)$$

# Statistical model formalism

Boltzman formula:

$$S(E) = \log \rho(E)$$

Laplace transform to get:

$$\rho(E') = \frac{1}{2\pi i} \int e^{\beta(E'-F)} d\beta$$

$$T = \frac{1}{\beta}$$

F is the thermodynamic free energy

# Level density model

- Back-shifted Fermi gas formula

$$\rho(E,J) = f(J)\frac{\exp(2\sqrt{a(E-E_1)}}{12\sqrt{2}\sigma_c a^{1/4}(E-E_1)^{5/4}}$$

$$f(J) = \frac{2J+1}{2\sigma_c^2}\exp\left[-\frac{(J+1/2)^2}{2\sigma_c^2}\right]$$

Sigma_c is spin cut-off parameter

E1=0.57 a=9.03

# Photon Strength Functions

- Electric dipole (E1) transitions governed by the standard Lorentzian function:

$$f_{BA}^{E1}(E_\gamma) = \frac{1}{3(\pi\hbar c)^2} \frac{\sigma_G E_\gamma \Gamma_G^2}{\left(E_\gamma^2 - E_G^2\right)^2 + E_\gamma^2 \Gamma_G^2}$$

$E_G$, $\Gamma_G$, $\sigma_G$ are energy, width, and the cross section

# Electric dipole strength models

$$f_{BA}^{E1}(E_\gamma) = \frac{1}{3(\pi\hbar c)^2} \frac{\sigma_G E_\gamma \Gamma_G^2}{\left(E_\gamma^2 - E_G^2\right)^2 + E_\gamma^2 \Gamma_G^2}$$

$$f_{GLO}^{(E1)}(E_\gamma, \Theta) = \frac{1}{3(\pi\hbar c)^2} \left[ \frac{E_G \Gamma_G(E_\gamma, \Theta)}{(E^2 - E_\gamma^2)^2 \Gamma_G^2} + F_K \frac{4\pi^2 \Theta^2 \Gamma_G}{E_\gamma^5} \right] \sigma_G \Gamma_G$$

# GDMR

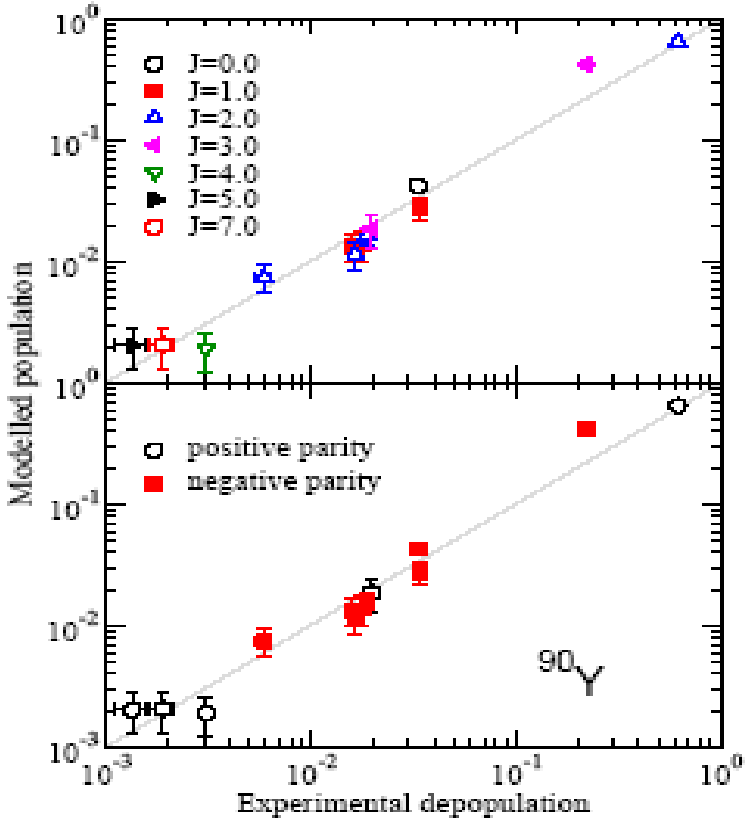
- model = spin-flip (SF)

E=9.15 MeV; Gamma=4.00 MeV;
sigma=3.00 mb

Capture state fractions: 0-(0%); 1-(100%)
Critical energy = 1.815 MeV (17 low-lying levels used in input deck)

# GQER

- model = isovector+isoscalar
  E=14.06 MeV; Gamma=5.03 MeV;
  sigma=2.00 mb


J=0.0
J=1.0
J=2.0
J=3.0
J=4.0
J=5.0
J=7.0
positive parity
negative parity
90Y
Modelled population
Experimental depopulation