Statistical γ decay and pygmy resonance in ^{204}Tl measured at DANCE

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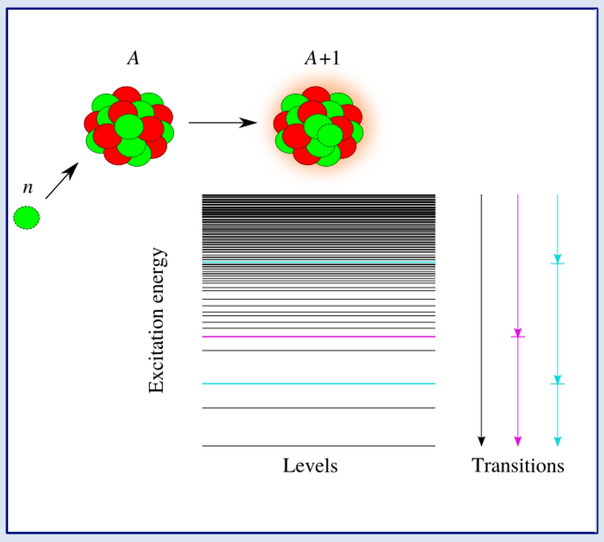
Motivation

RADIATIVE NEUTRON CAPTURE

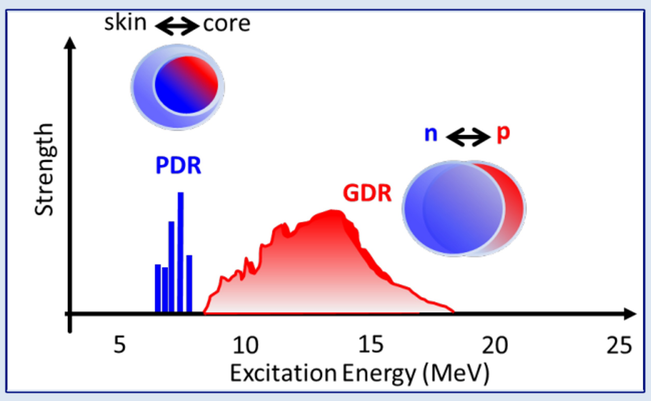


Neutron capture reaction

- Statistical γ decay described by **level density** (LD) and **photon strength functions** (PSFs)
- LD and PSF key ingredients for calculations of neutron capture cross sections

Pygmy resonance plays a crucial role in astrophysical calculations for neutron-rich nuclei.

- Electric dipole (*E*1) PSF dominated by Giant Dipole Resonance (GDR)
- Neutron-rich nuclei – a smaller resonance at lower energies observed, **pygmy dipole resonance** (PDR)
- PDR expected to become stronger when moving towards neutron-rich nuclei [1]



Resonances in electric dipole PSF [2]

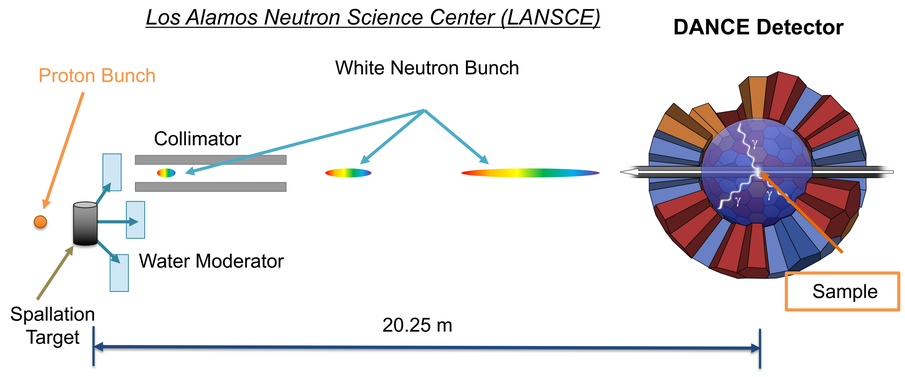
Preliminary results

- **First experimental data** in PDR region for Tl isotopes
- Reference **PSF database [2] and RIPL3 [3] models not satisfactory** in ^{204}Tl
- **Resonance-like structure around 5-6 MeV** clearly observed in the experiment
- Experimental spectra cannot be reproduced without a resonance at these energies

[1] D. Savran et al., Prog. Part. Nucl. Phys 70 (2013) 210
[2] A. Bracco et al., Prog. Part. Nucl. Phys 106 (2019) 360
[3] https://www-nds.iaea.org/PSFdatabase/
[4] https://www-nds.iaea.org/RIPL-3/

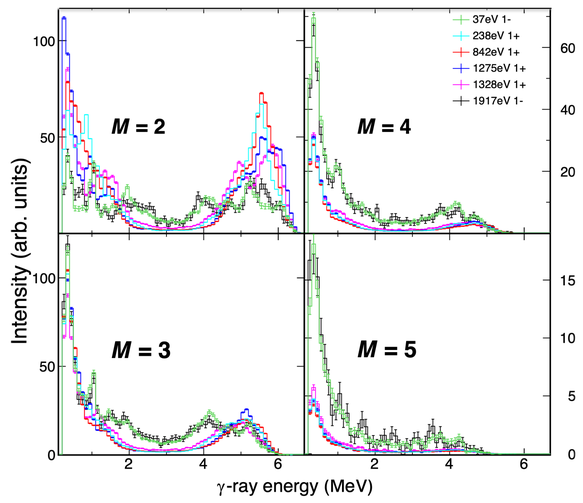
Experiment

- 160 BaF_2 scintillators, 4π ball
- Measuring γ cascades from ^{203}Tl(n,γ)
- E_n – thermal to hundreds of keV
- **γ-cascade observables**:
  1) neutron energy E_n
  2) total detected energy E_{tot}
  3) individual γ - ray energies E_γ
  4) multiplicity M

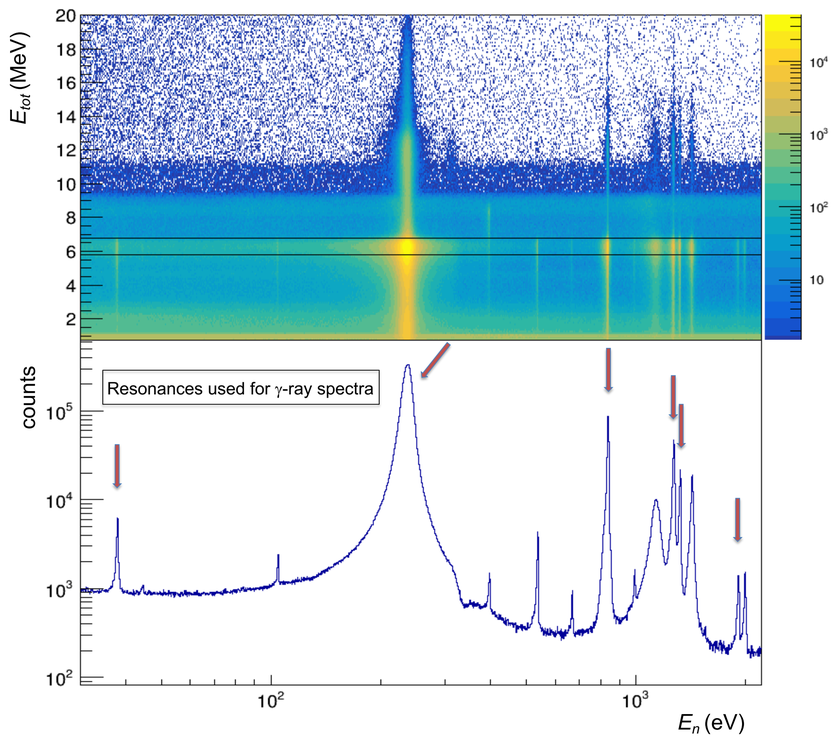


EXPERIMENTAL SPECTRA

- Cut on E_{tot} = 5.8-6.8 MeV (S_n = 6.656 MeV)
- Gate on well-isolated *s*-wave and *p*-wave resonances
- Spectra of E_γ for different M



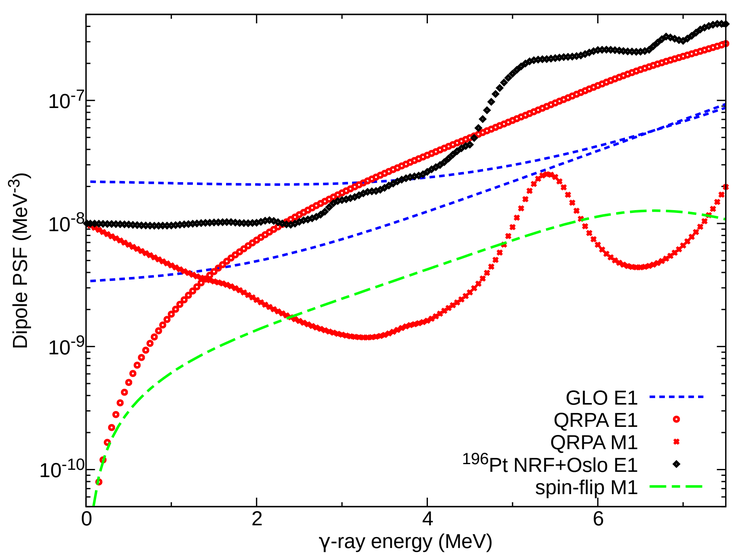
Exp. γ-ray energy spectra from 1^+ and 1^- resonances



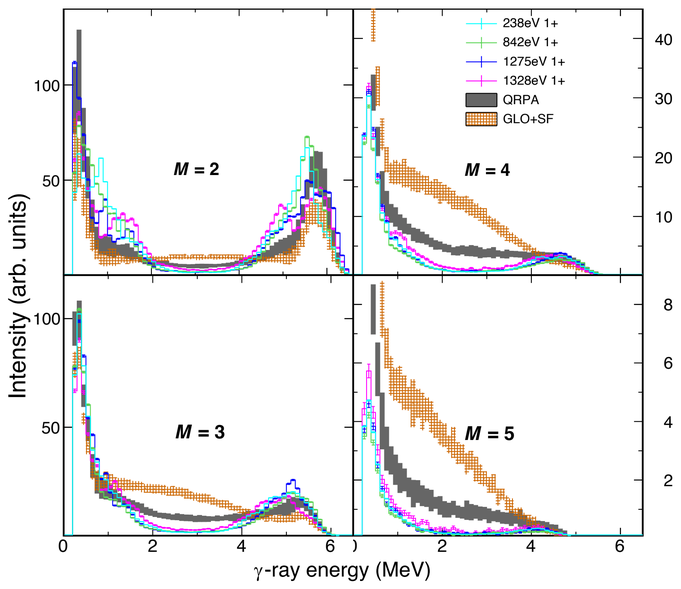
E_{tot} as a function of E_n, projected onto E_n axis

DICEBOX simulations

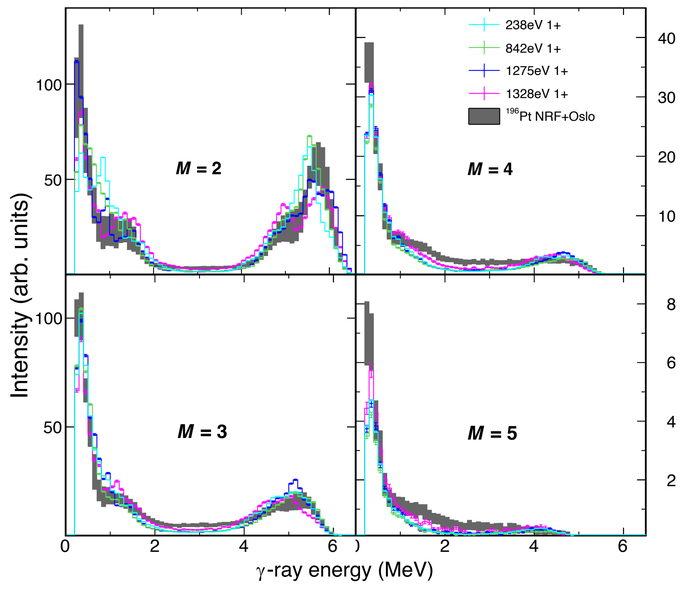
- Monte-Carlo modelling of γ decay based on provided models of LD and PSFs
- Up to a given excitation energy E_{crit} = levels and their properties from evaluated data
- Above E_{crit} – **statistical approach**
- **Porter-Thomas fluctuations** of partial radiation widths
- Simulating different realizations – sets of levels and their decay probabilities
- γ cascades fed to **Geant4 simulation** of the detector response



Models of *E*1 and *M*1 PSF in ^{204}Tl



Simulated γ-ray spectra with widely used models of *E*1 PSF compared to the experiment



Simulated γ-ray spectra with *E*1 PSF based on ^{196}Pt exp. data compared to the experiment

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