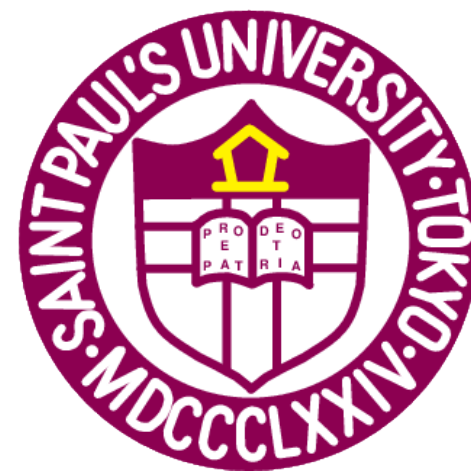
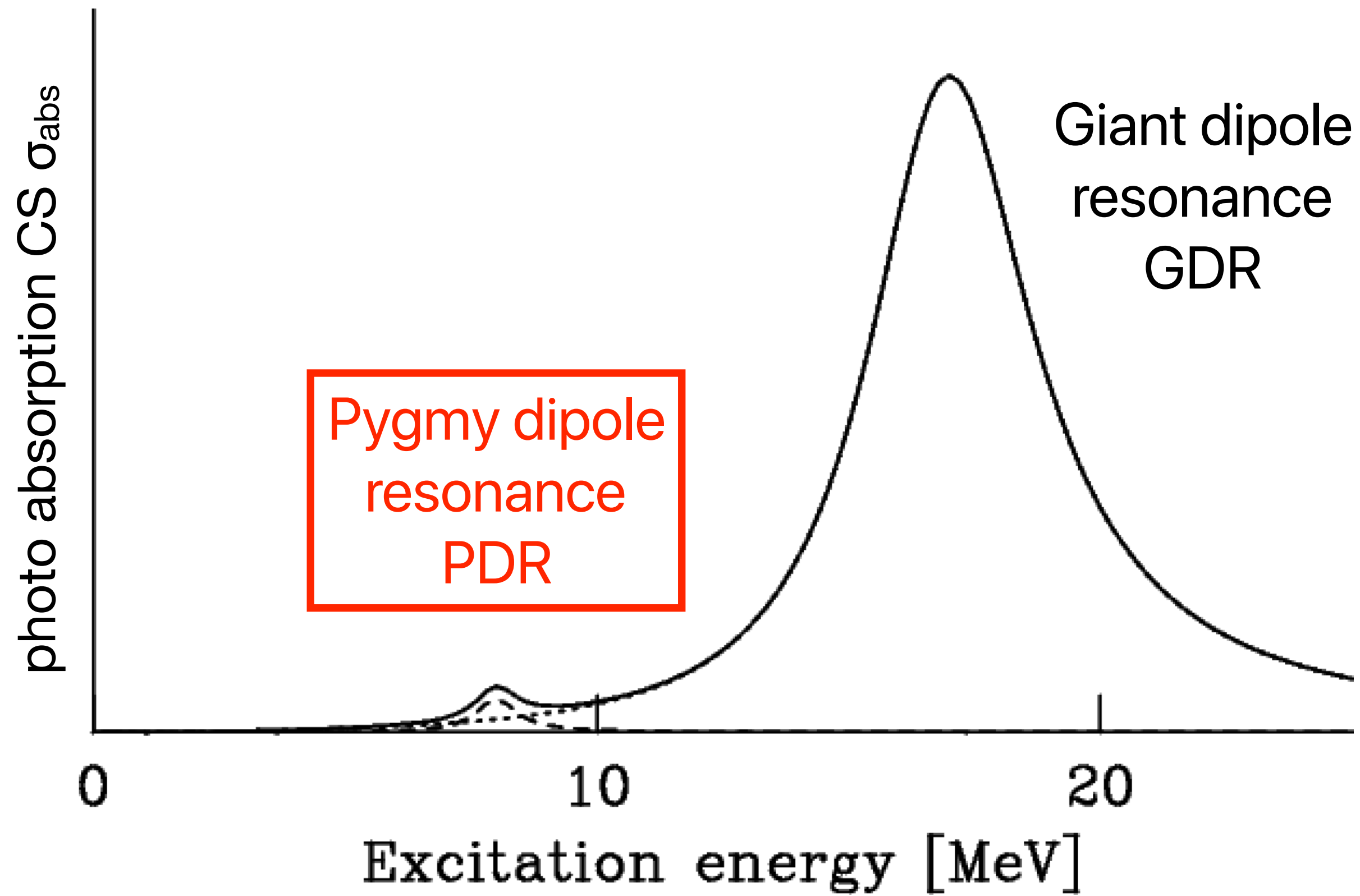


# Low-lying dipole strength in neutron-rich Ca isotopes $^{50,52}\text{Ca}$

Yasuhiro Togano  
Department of Physics, Rikkyo University

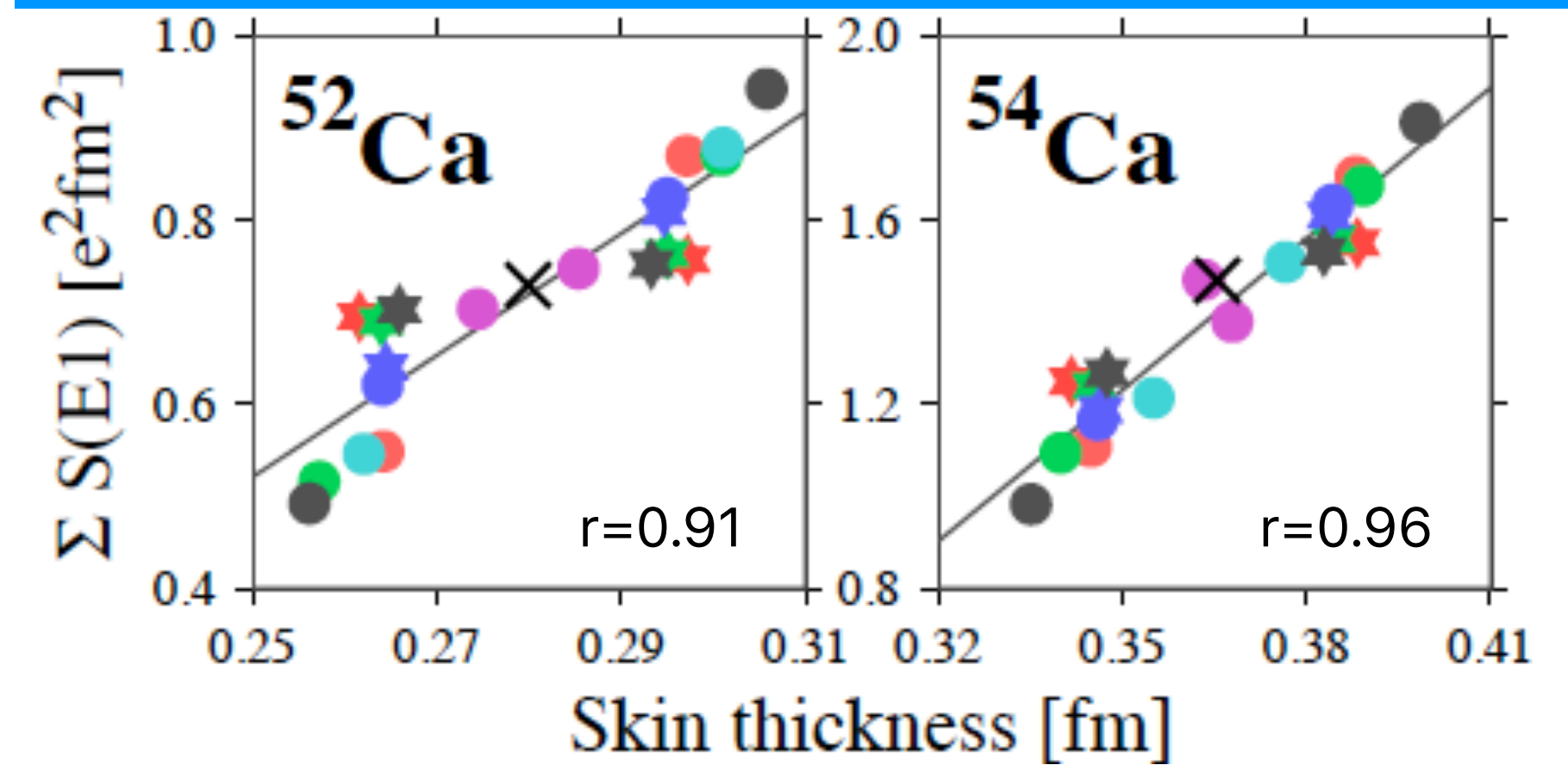


# Low-lying dipole strength in neutron-rich nuclei



$E_x : 5 \sim 10$  MeV (around neutron threshold)  
 Strength:  $\sim 5\%$  of TRK sum rule  
 Isoscalar and isovector  
 Structure: oscillation of neutron skin?

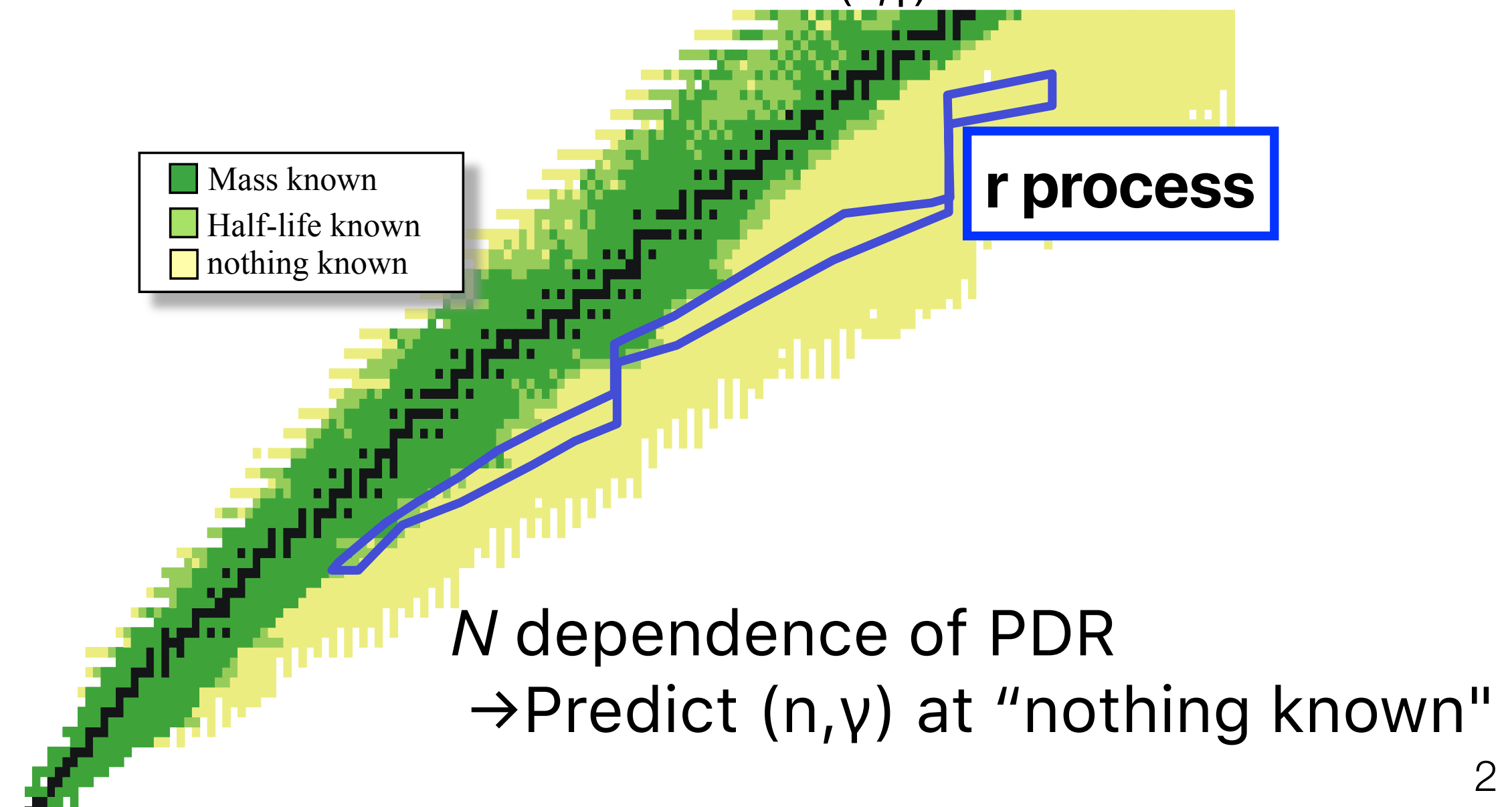
## Neutron skin thickness & Symmetry energy



T. Inakura et al., PRC88, 051305 (2013)

## $(n, \gamma)$ reaction in stellar nucleosynthesis

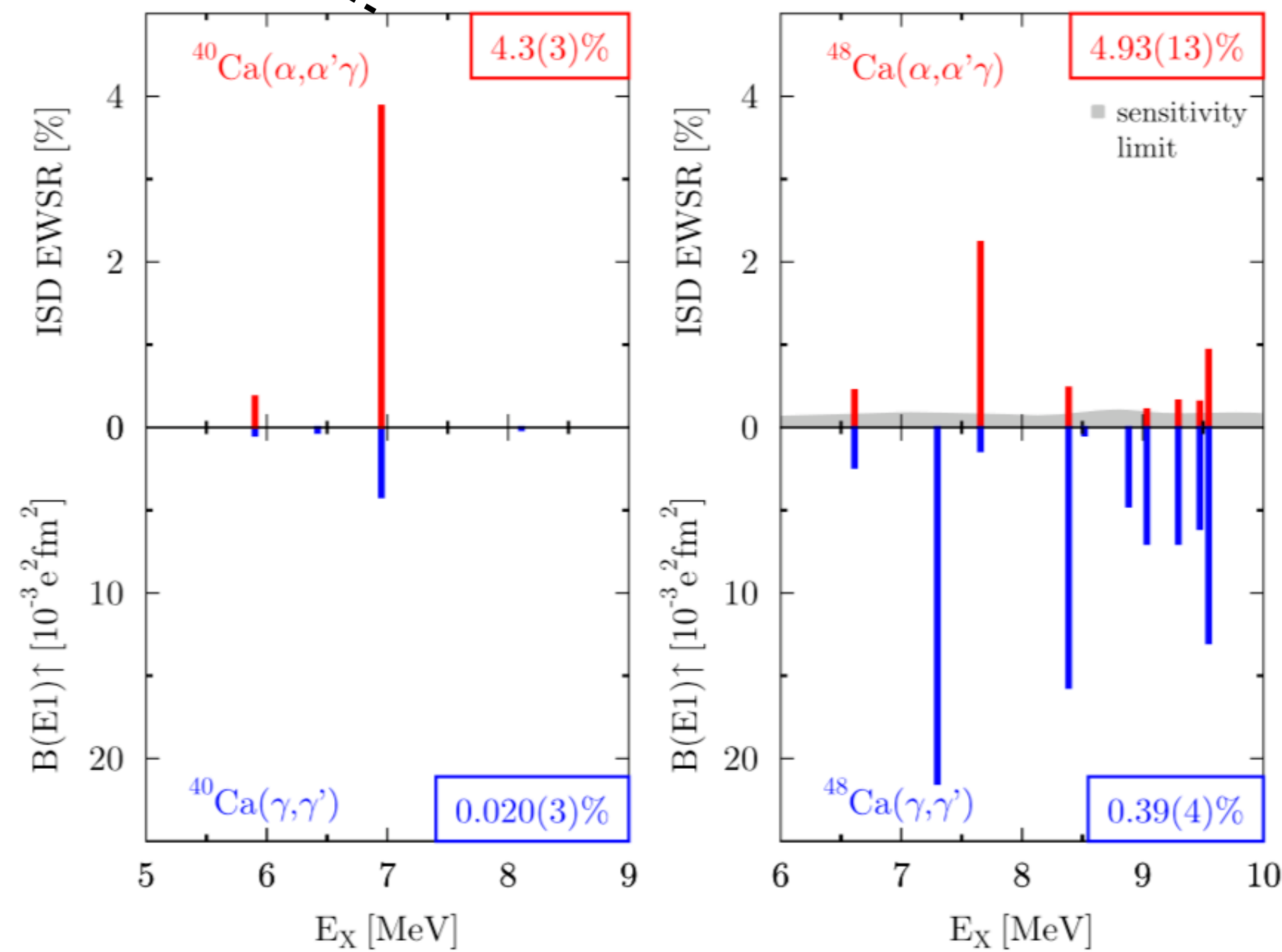
$\sigma_{\text{abs}}$  around threshold  $\leftrightarrow \sigma_{(n, \gamma)}$



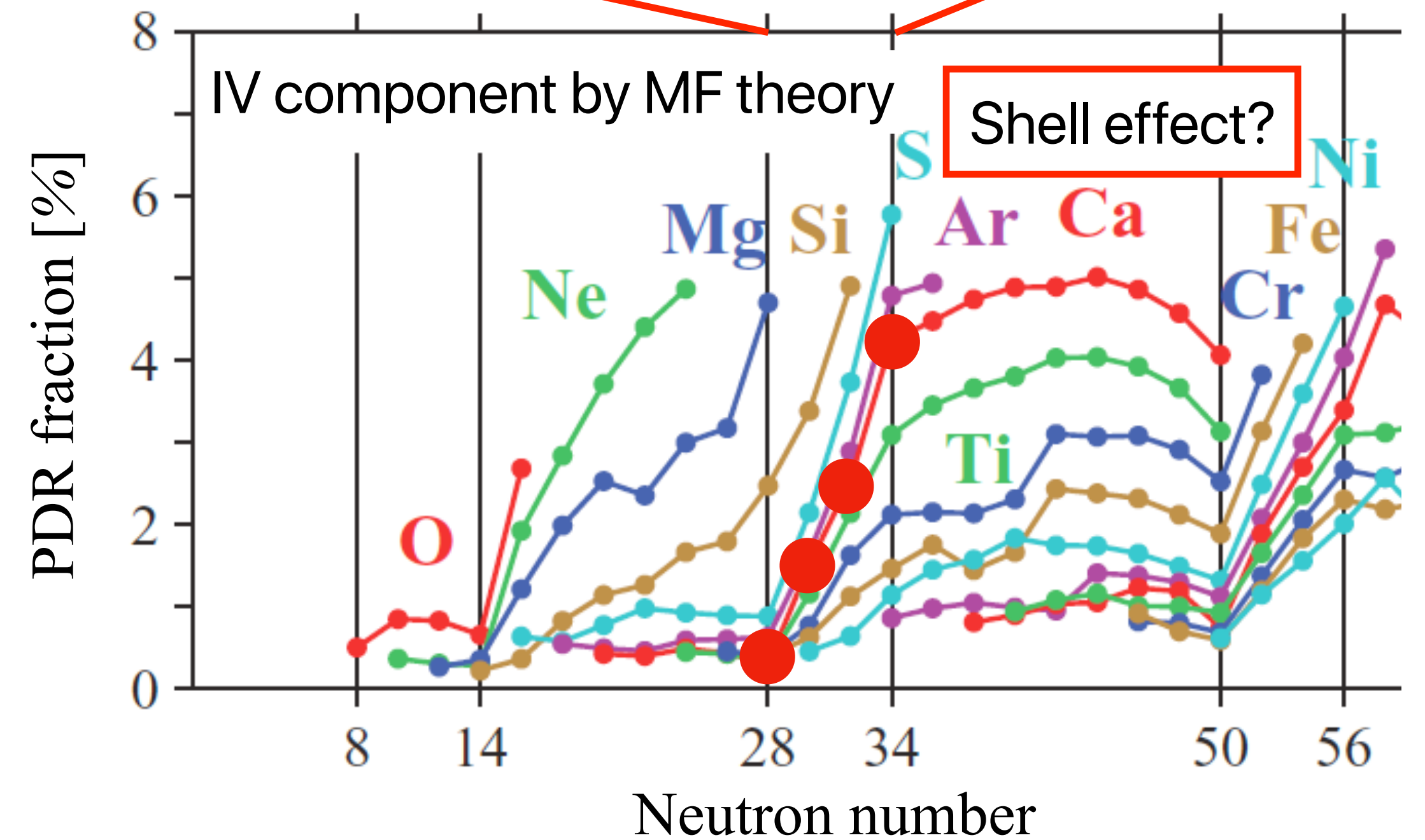
# East side of $^{48}\text{Ca}$ : sudden change on PDR?



V. Derya et al., PLB 730, 288 (2014).



Strong IS, weak IV



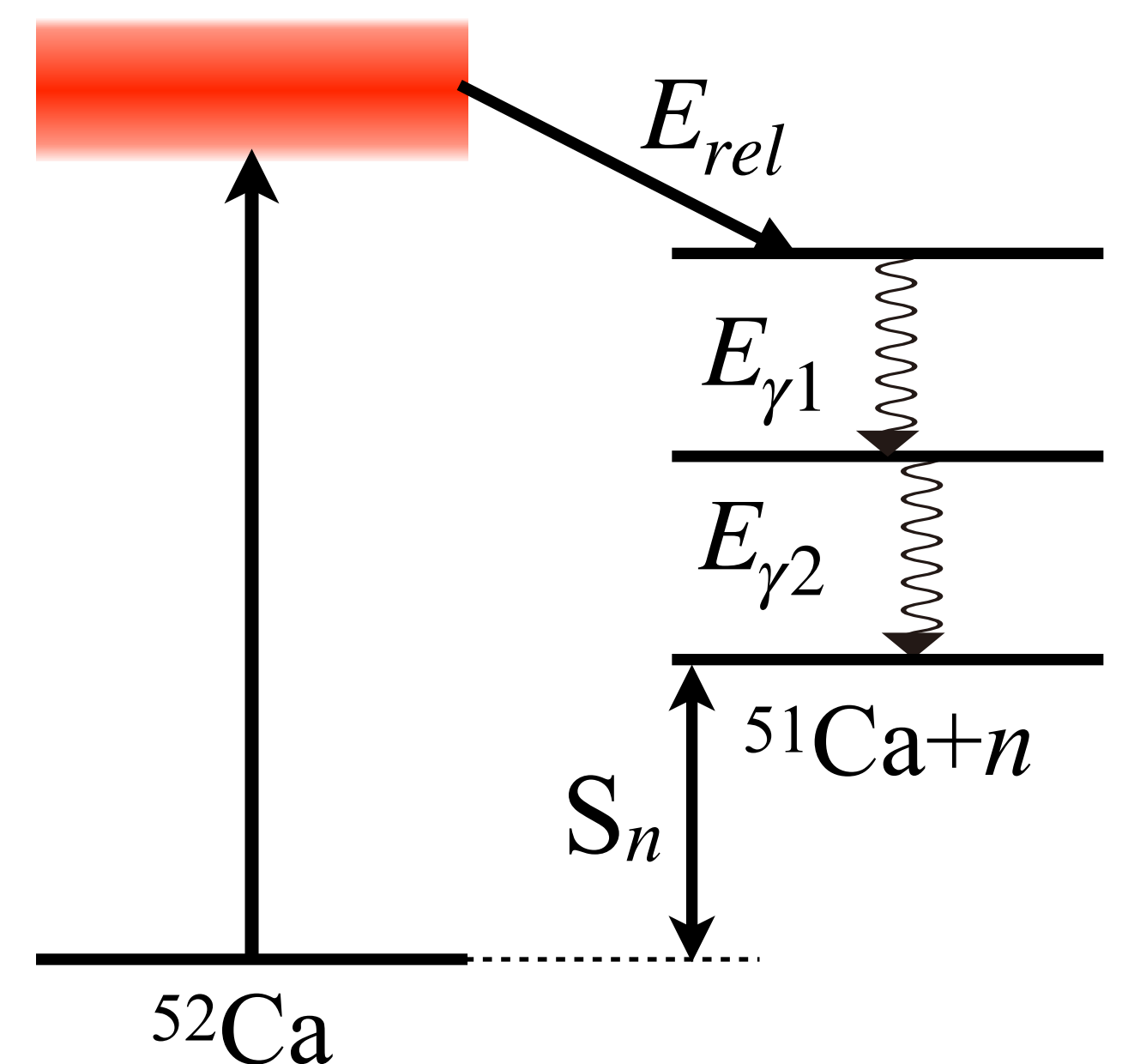
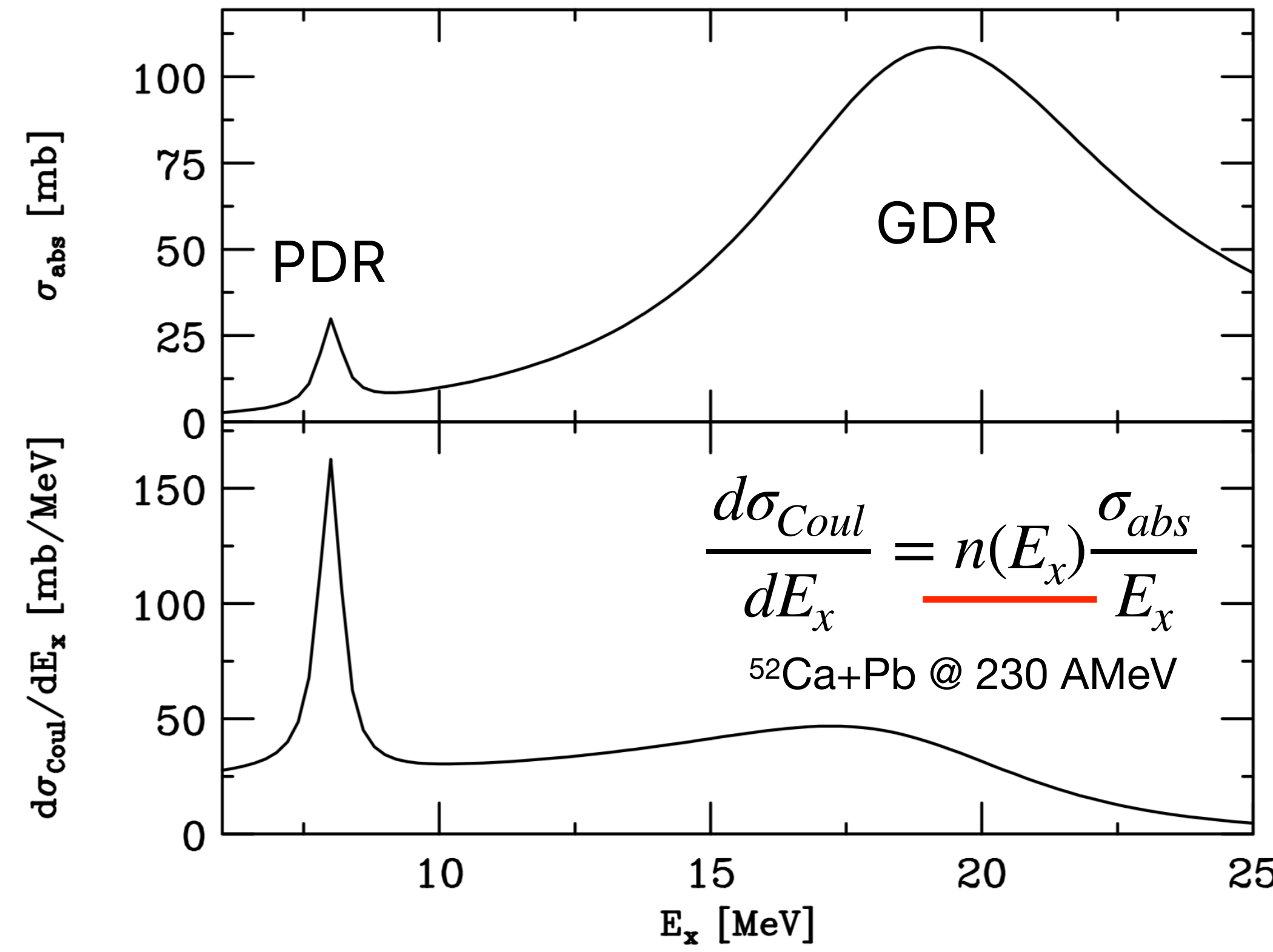
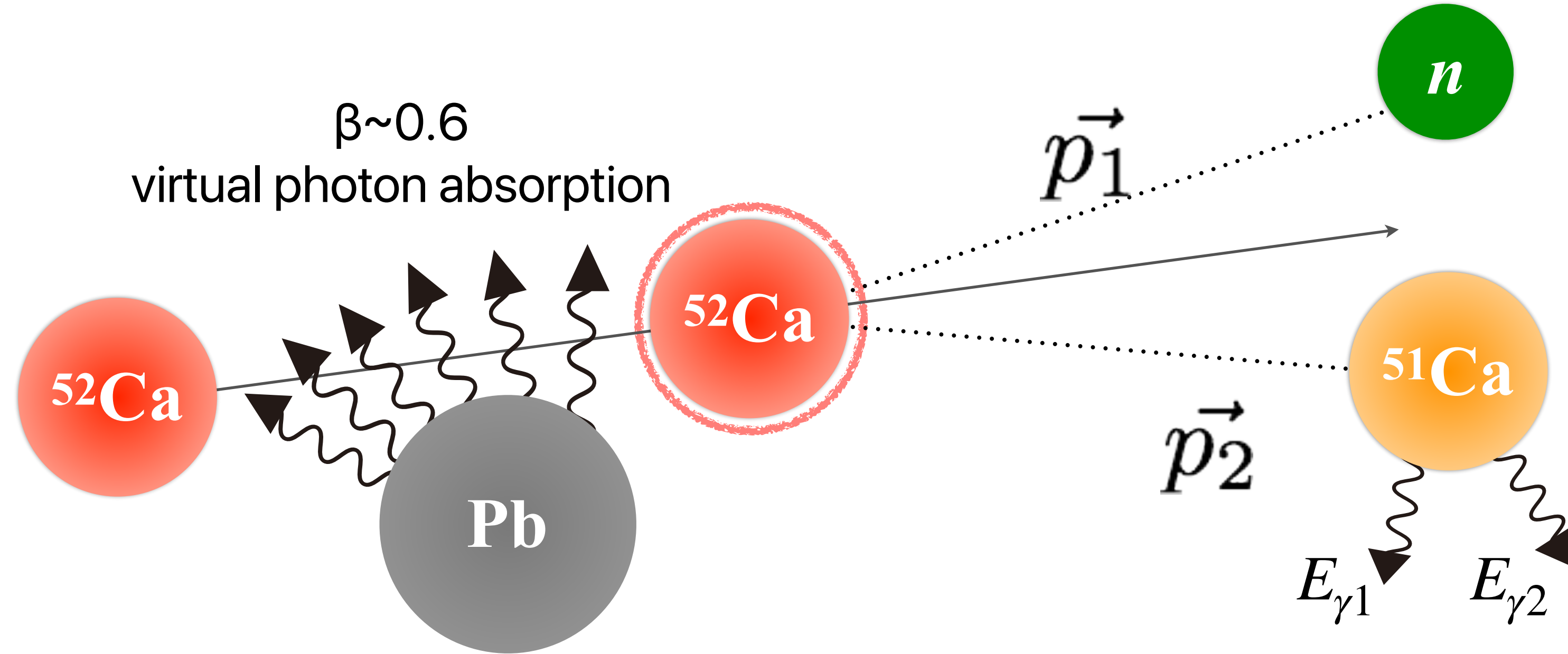
T. Inakura et al., PRC 84, 021302 (2011).

Evolution of PDR at  $N=28 \sim 34$



Relativistic Coulomb excitation of  $^{50,52}\text{Ca}$

# Relativistic Coulomb excitation in inverse kinematics



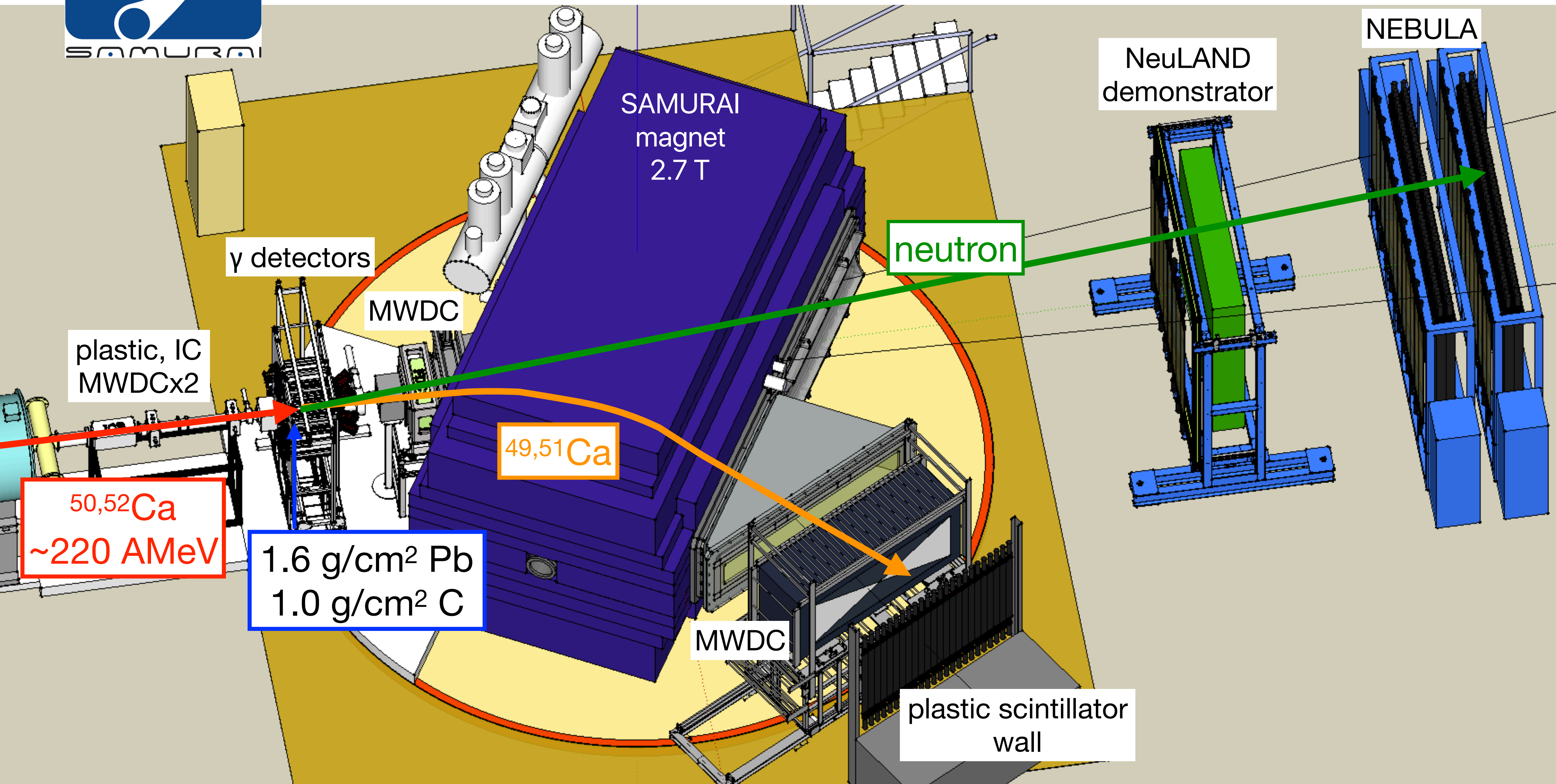
$$E_{\text{rel}} = \sqrt{\left(\sum E_i\right)^2 + \left(\sum \vec{p}_i\right)^2} - (m_{^{51}\text{Ca}} + m_n)$$

$$E_x = E_{\text{rel}} + \sum E_{\gamma i} + S_n$$

Reconstruction of excitation energy  
 → Momenta of  $n$ ,  $\gamma$  and charged particles.  
 → Dominic's talk in session 7

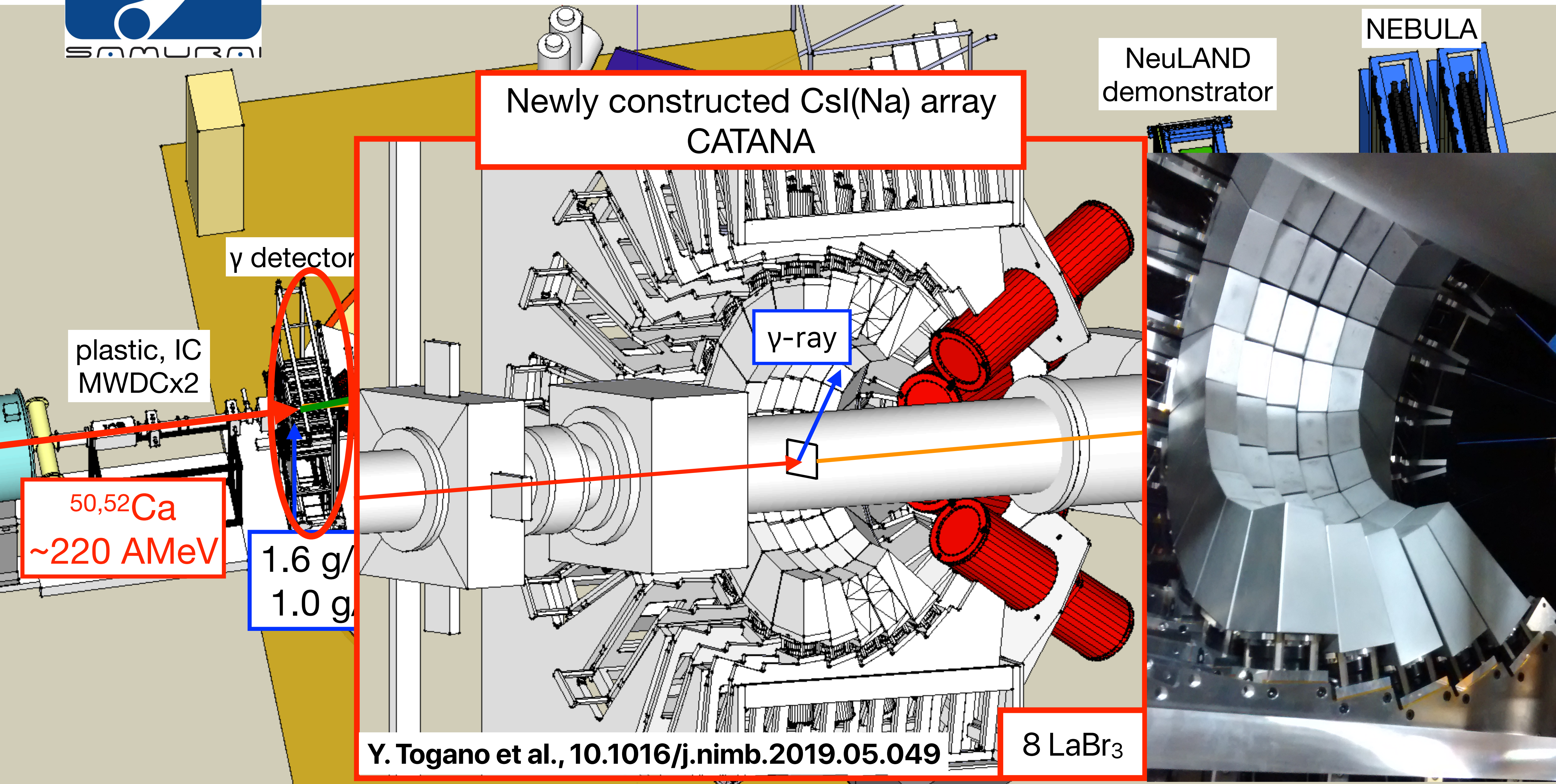


# Experimental setup: SAMURAI+CATANA





# Experimental setup: SAMURAI+CATANA



Newly constructed CsI(Na) array  
CATANA

NeuLAND  
demonstrator

NEBULA

$\gamma$  detector

$\gamma$ -ray

plastic, IC  
MWDCx2

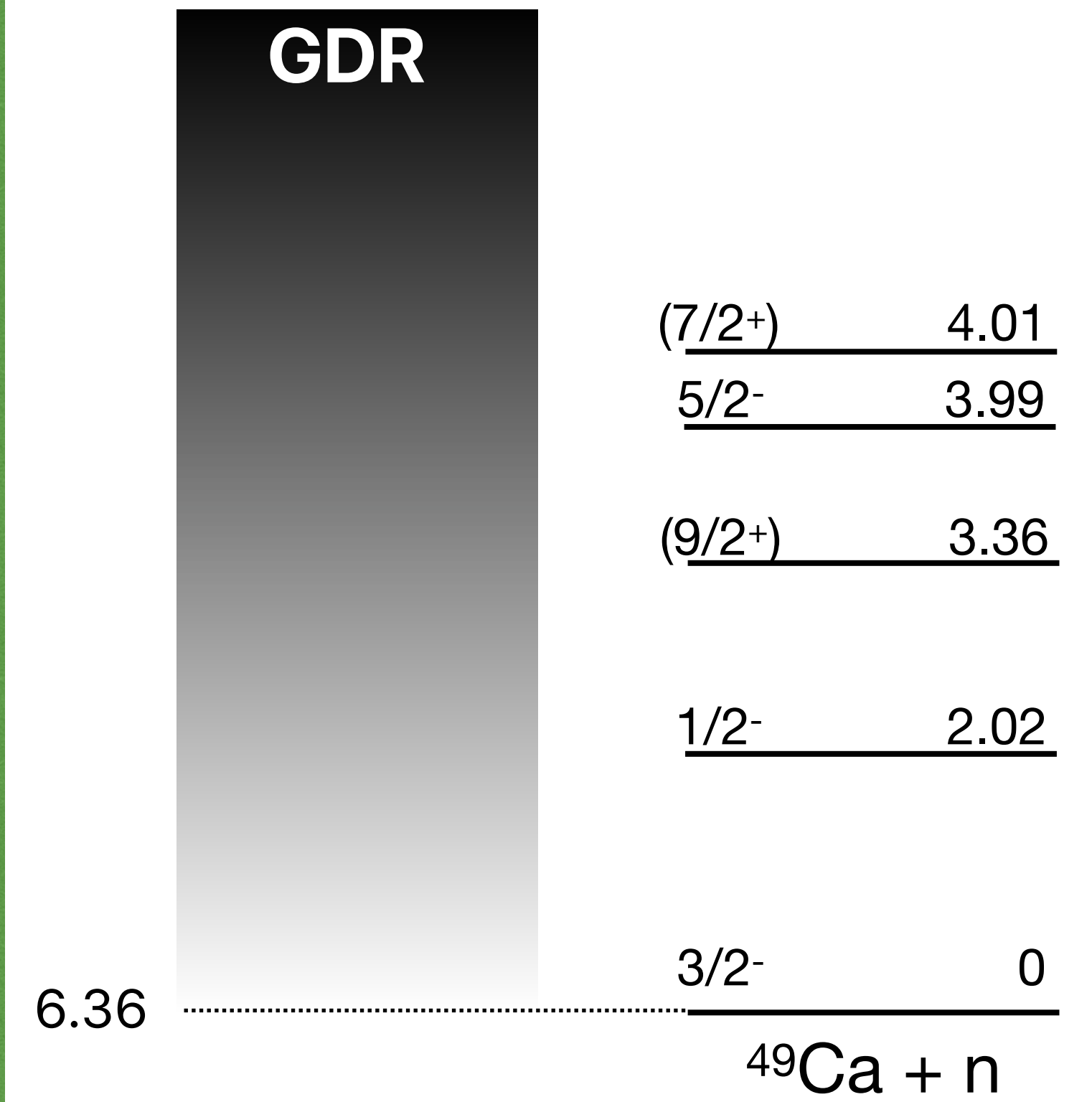
$^{50,52}\text{Ca}$   
 $\sim 220 \text{ A MeV}$

1.6 g/  
1.0 g

8  $\text{LaBr}_3$

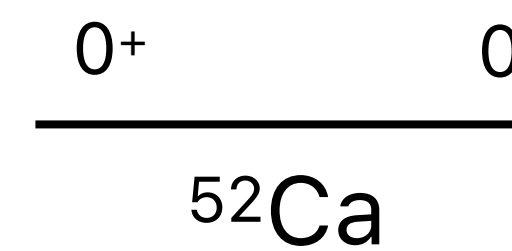
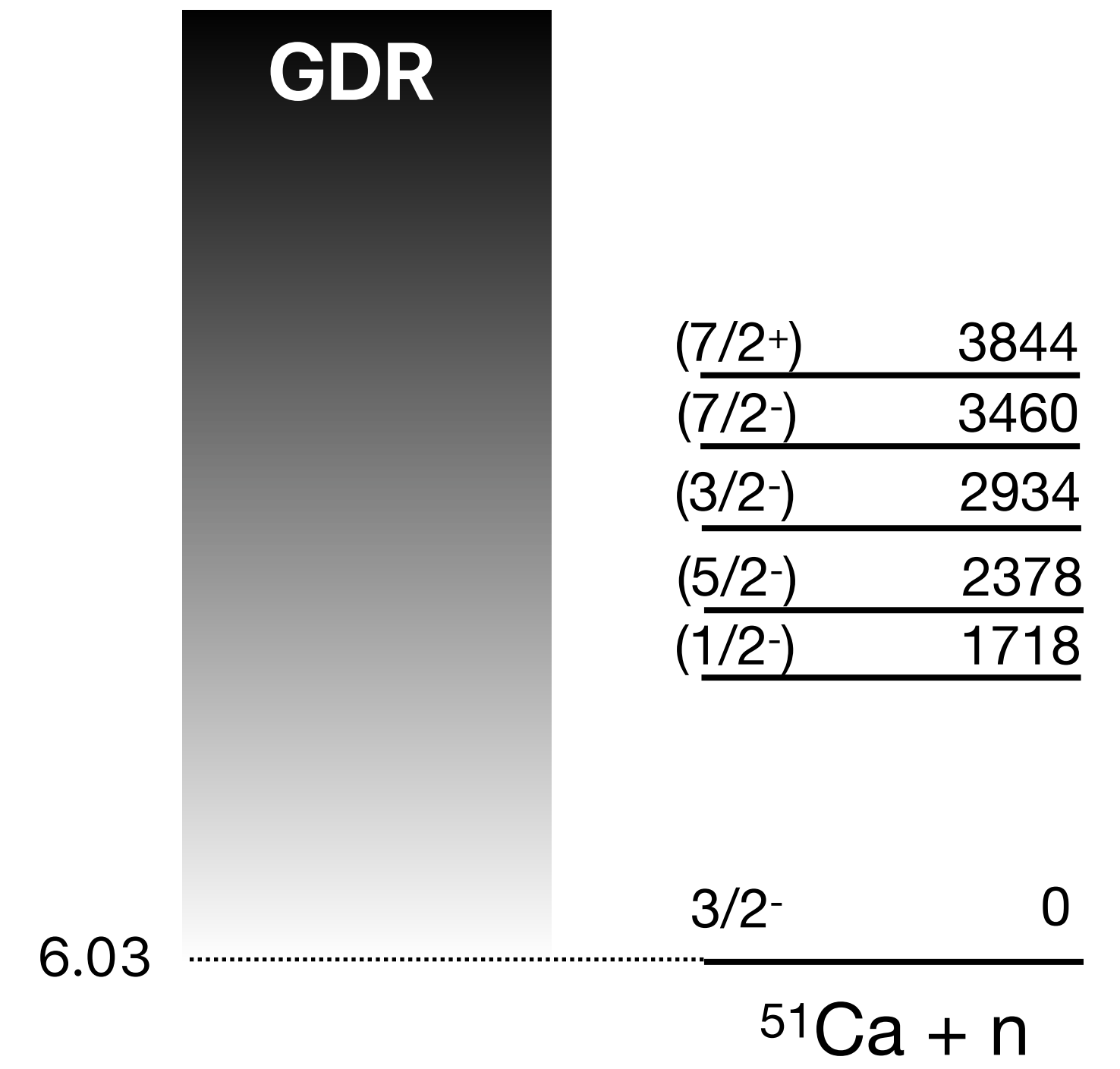
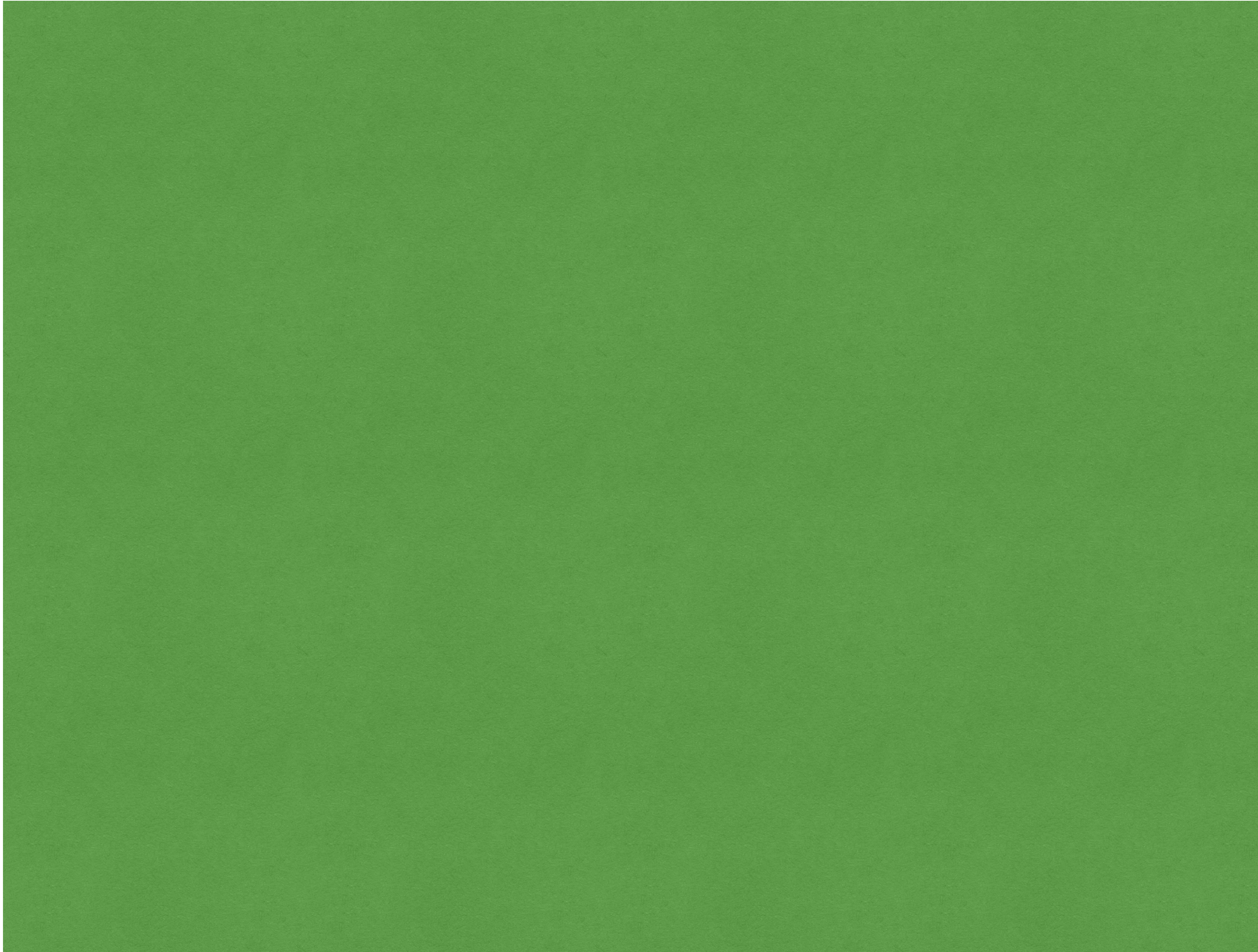
Y. Togano et al., 10.1016/j.nimb.2019.05.049

# $^{50}\text{Ca}$ : $^{49}\text{Ca}+1\text{n}$ relative energy and $\gamma$ -ray spectra



$0^+$       0  
-----  
 $^{50}\text{Ca}$

# $^{52}\text{Ca}$ : $^{51}\text{Ca}+1\text{n}$ relative energy and $\gamma$ -ray spectra



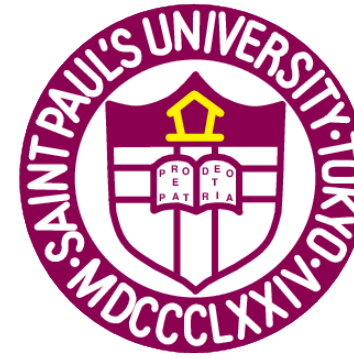


# Summary and outlook

- Relativistic Coulomb excitation of  $^{50,52}\text{Ca}$  at SAMURAI in RIKEN.
  - New gamma-ray detector CATANA: Y. Togano et al., 10.1016/j.nimb.2019.05.049
- 1 neutron decay channels were analyzed.
  
- Ongoing analysis
  - 2&3 neutron decay channels. → GDR & dipole polarizability
  - Bound excited states in  $^{52}\text{Ca}$  → B(E2) (and B(E3))

# SAMURAI09 collaboration

- **Y. Togano, Y. Fujino**, K. Ieki (Rikkyo Univ.)
- T. Nakamura, Y. Kondo, A. T. Saito, T. Tomai, M. Yamada, M. Yasuda, M. Matsumoto (TokyoTECH)
- H. Otsu, N. Chiga, H. Baba, F. Browne, S. Chen, L. Cortes, T. Isobe, Y. Kubota, T. Motobayashi, I. Murray, V. Panin, M. Sasano, H. Sato, Y. Shimizu, T. Uesaka, Z. Yang, K. Yoneda (RIKEN)
- T. Kobayashi (Tohoku Univ.)
- I. Gašparić (Ruđer Bošković Institute)
- T. Aumann, A. Horvat, D. Rossi, H. Törnqvist (TU Darmstadt)
- K. Boretzky, D. Körper, H. Simon (GSI)
- Z. Elekes, Z. Halasz, I. Kuti (ATOMKI)
- A. Bracco, F. Camera, S. Ceruti, B. Million, O. Wieland (INFN)
- N. Nakatsuka (Kyoto Univ.)
- L. Stuhl (CNS)
- K. H. Hahn, D. Kim, G. Kim, S. Park (Ewha Womans University)
- Y. Sun (CEA Saclay)
- S. Koyama, K. Wimmer (Univ. of Tokyo)
- H. Chae, H. Choi, H. Ko (Seoul National Univ.)
- F. Delaunay, J. Gibelin, A. Matta, N. Orr (LPC CAEN)
- V. Soto (CSIC)
- D. Dell'Aquila (IPN Orsay)
- W. Rodriguez (Univ. Nacional de Colombia)
- T. Inakura (Nigata Univ.)



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