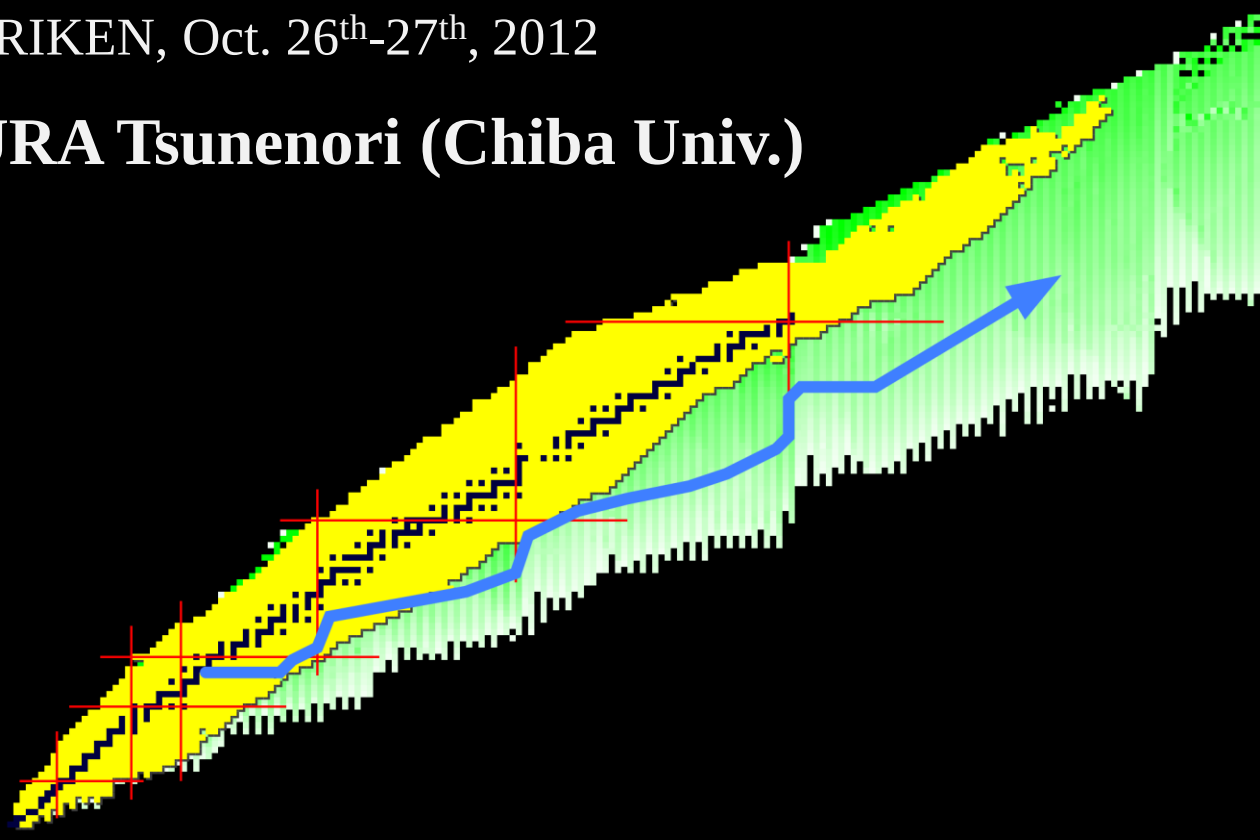
# 中性子過剰核のピグミー共鳴

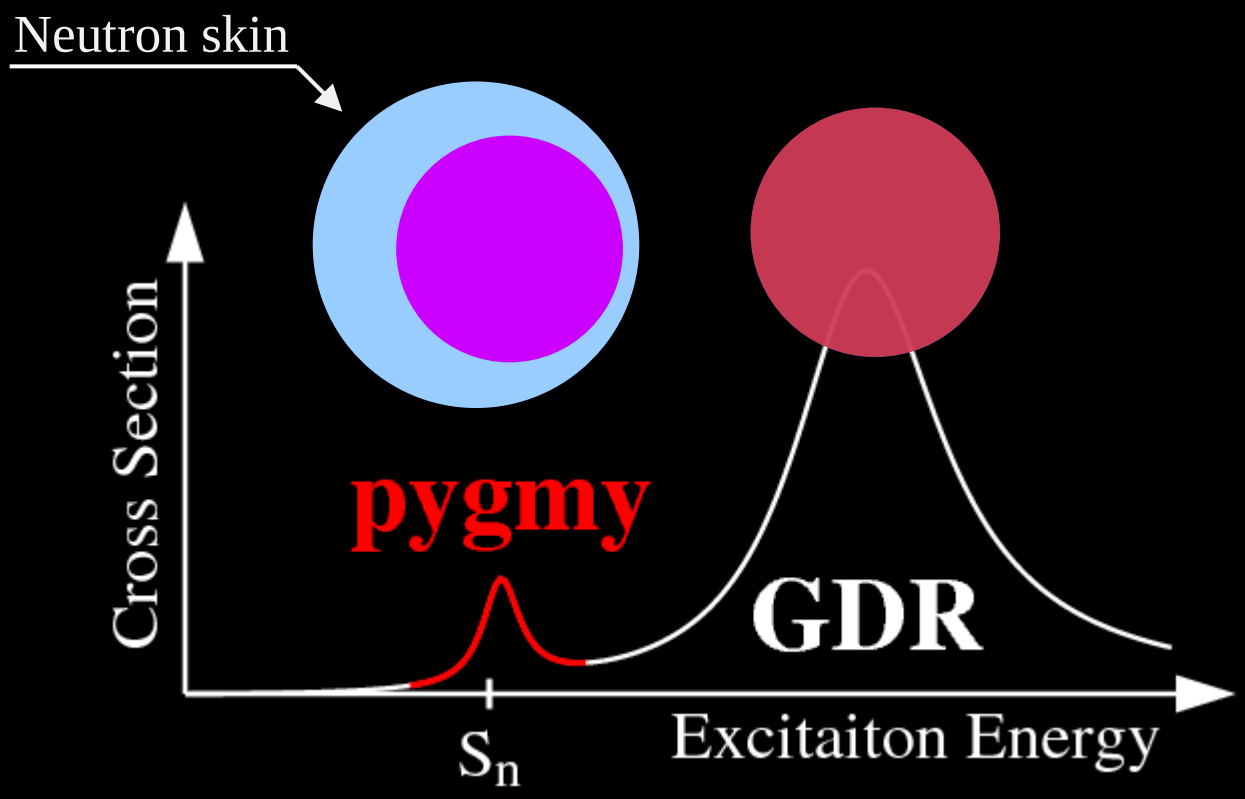
Kick-off Symposium of the innovative area:
"Nuclear Matter in Neutron Stars investigated by Experiments and Astronomical Observations"

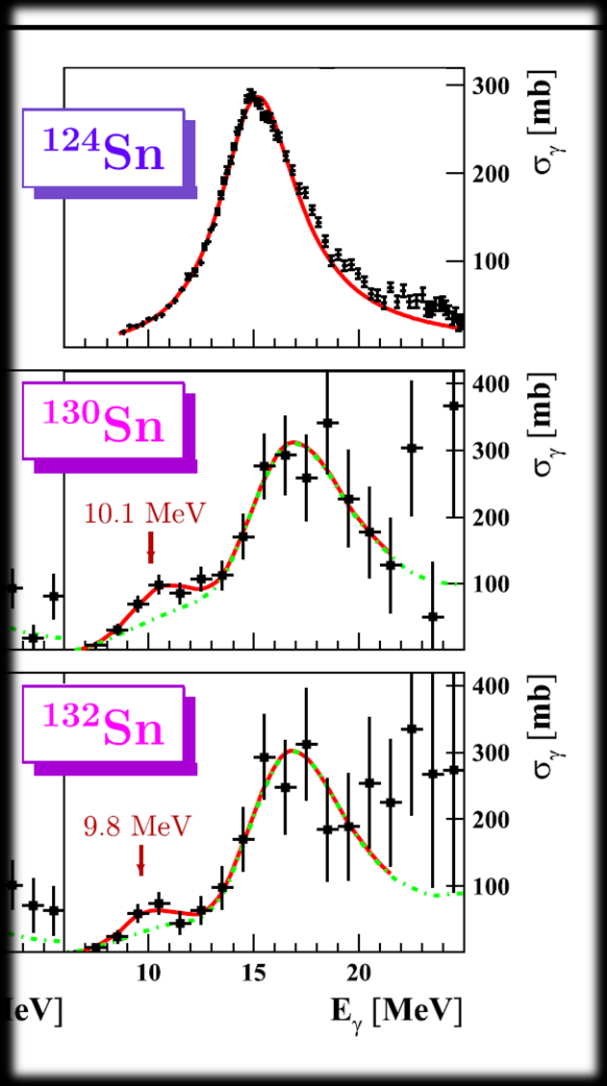
新学術領域研究「実験と観測で解き明かす中性子星の核物質」
RIKEN, Oct. 26th-27th, 2012

**INAKURA Tsunenori (Chiba Univ.)**



# Pygmy Dipole Resonance (PDR)

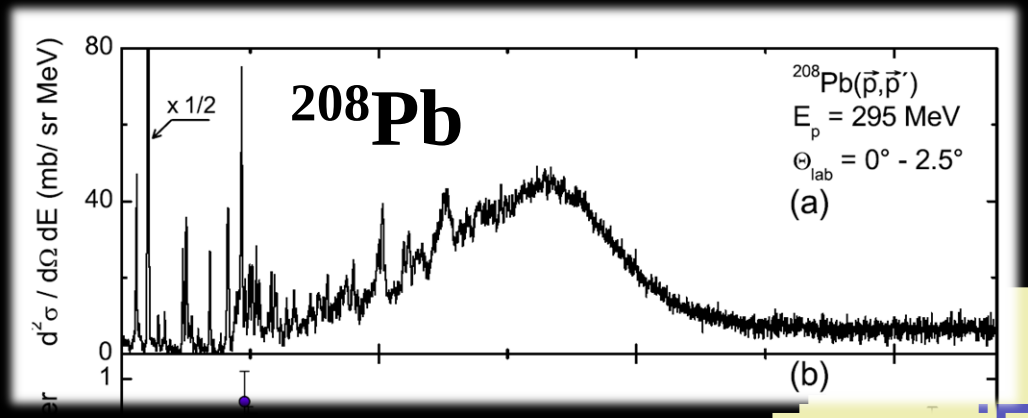



**PDR in stable nuclei: < 1% Cross Section**
**PDR in ν-rich nuclei: < 5% Cross Section**

P. Adrich et al., PRL 95, 132501.

# Observed PDRs



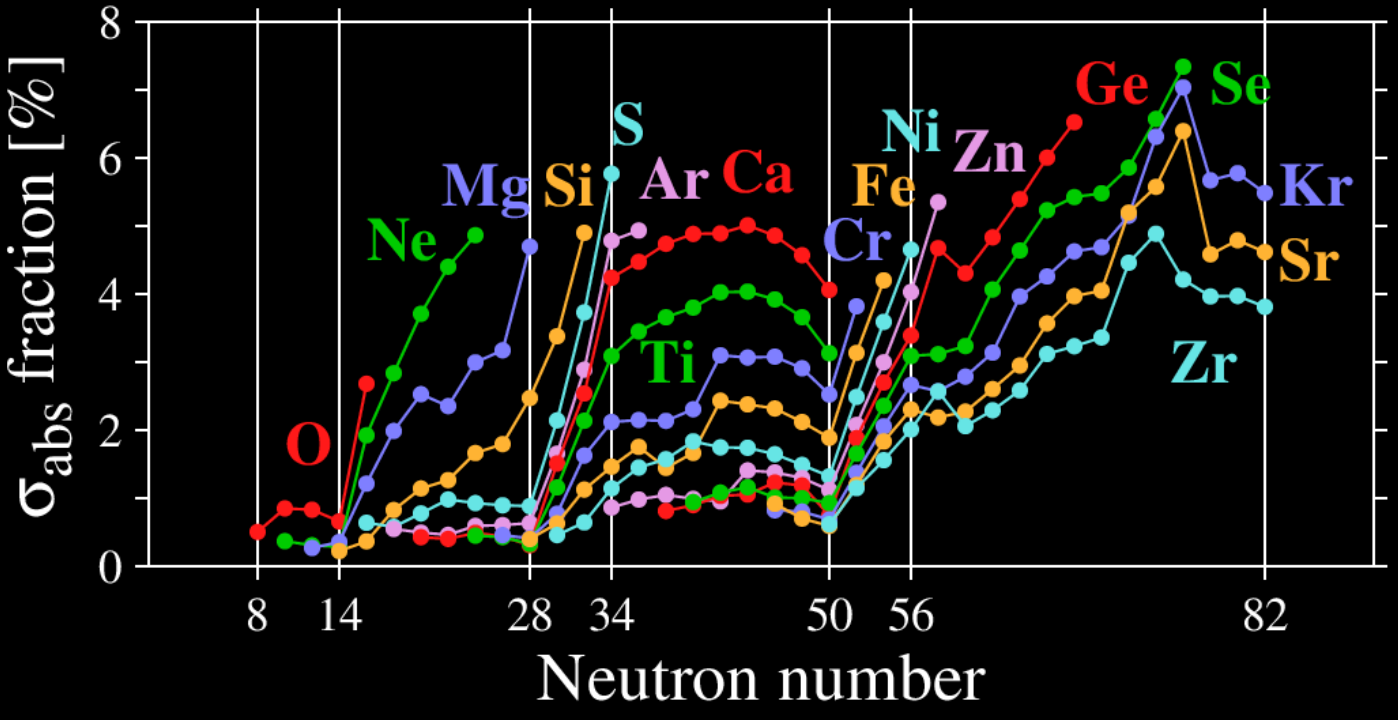

A. Tamii et al.,
PRL 107, 062502.

P. Adrich et al.,
PRL 95, 132501.

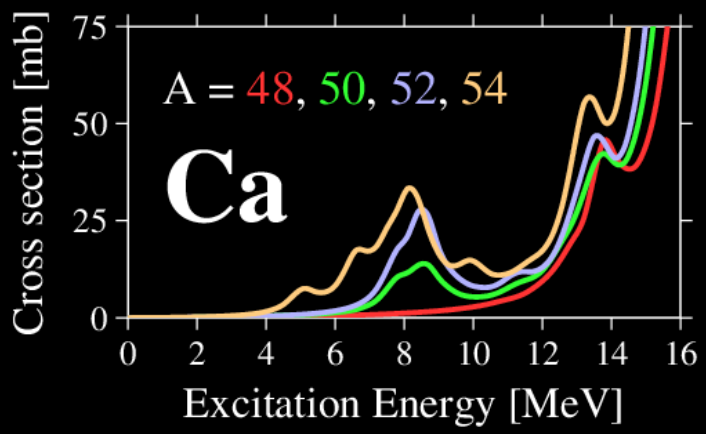


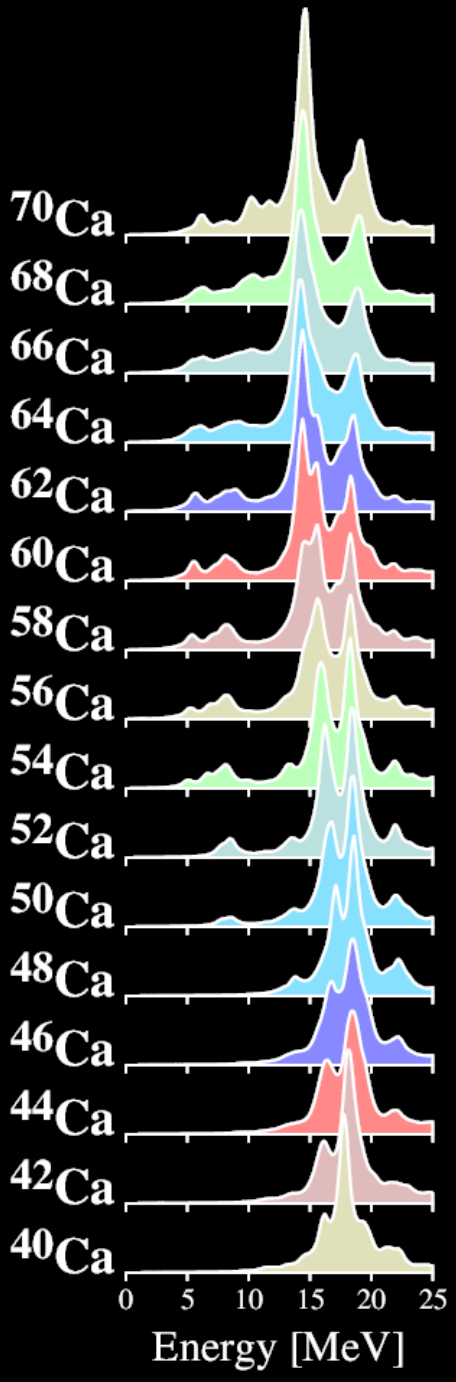

O. Wieland et al.
PRL 102, 092502

# PDR in n-rich nuclei



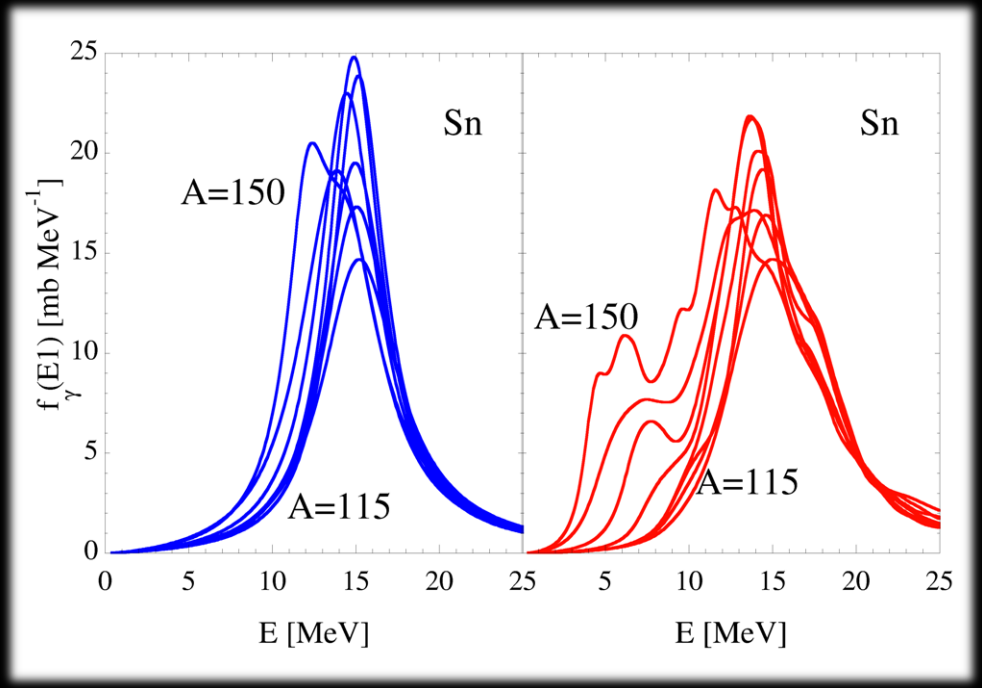

Inakura *et al.*,
PRC84, 021302

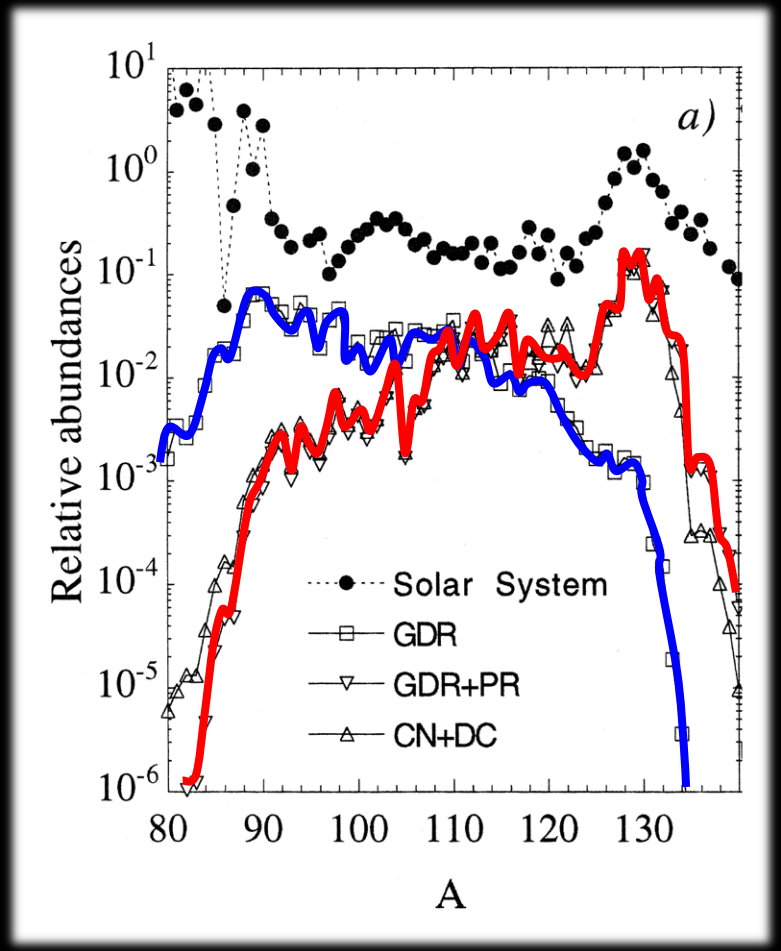


# Pygmy Dipole Response: impact on the r-process

**GDR only** **PDR + GDR**

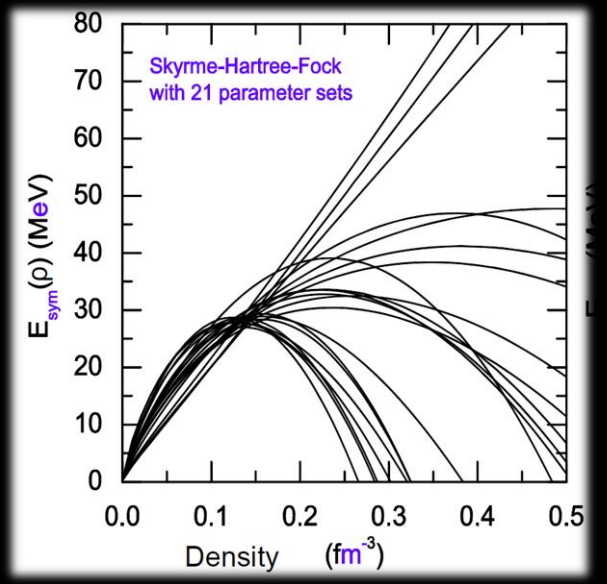



S. Goriely, PLB436, 10

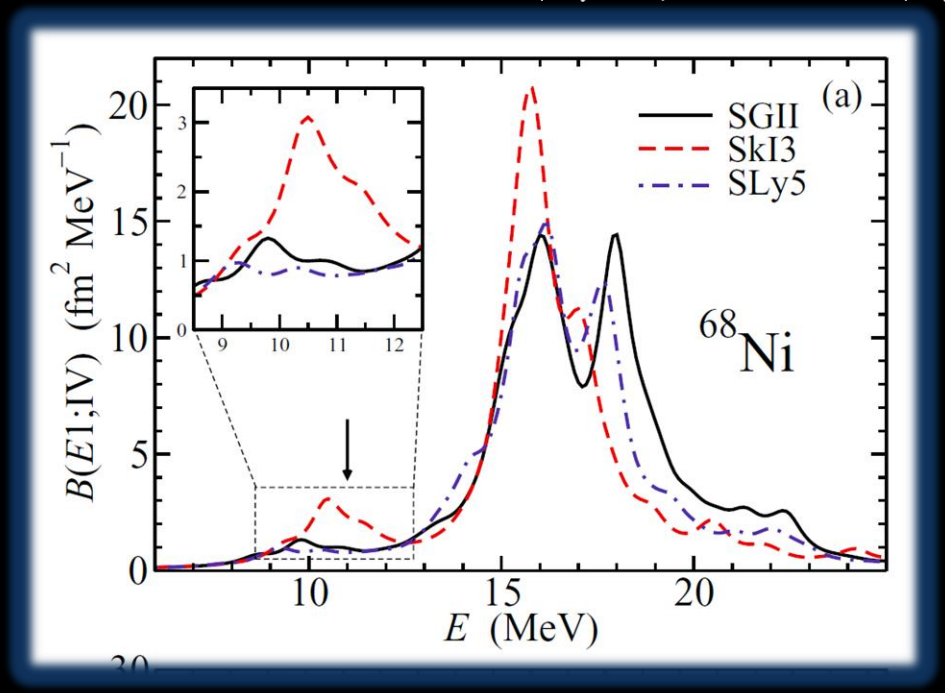
# PDR & *L*

L.W.C hen et al.,
PRC72, 064309




$$\frac{E}{A}(\rho,\delta) = \frac{E}{A}(\rho,\delta{=}0) + E_{\rm sym}(\rho)\delta^2 + \mathcal{O}(\delta^4)$$

$$E_{\rm sym}(\rho) = E_{\rm sym}(\rho_0) + \frac{L}{3}\left(\frac{\rho-\rho_0}{\rho_0}\right) + \frac{K_{\rm sym}}{9}\left(\frac{\rho-\rho_0}{\rho_0}\right)^2 + \cdots$$




X. Roca-Maza et al.,PRC 85, 024601(2012)

# PDR & *L*

L.W.C hen et al.,
PRC72, 064309

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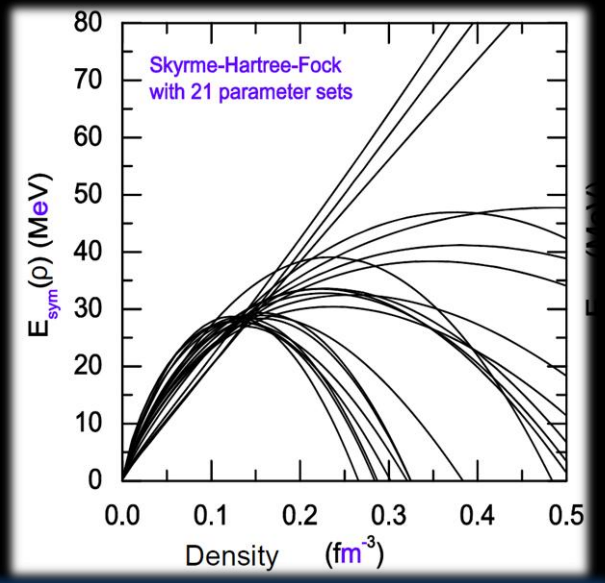
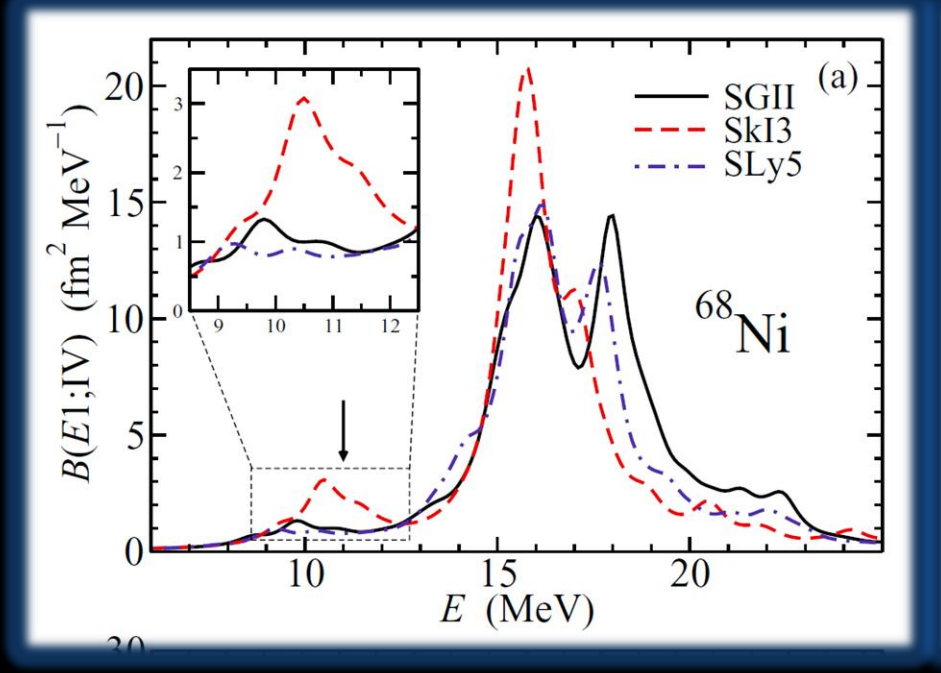
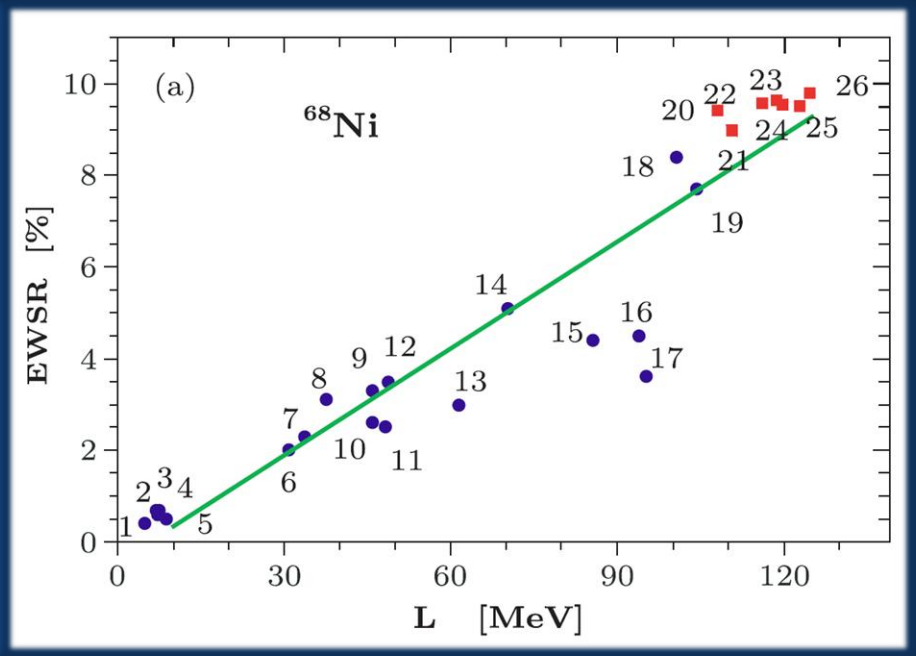
$$E_{\rm sym}(\rho) = E_{\rm sym}(\rho_0) + \frac{L}{3}\left(\frac{\rho-\rho_0}{\rho_0}\right) + \frac{K_{\rm sym}}{9}\left(\frac{\rho-\rho_0}{\rho_0}\right)^2 + \cdots$$



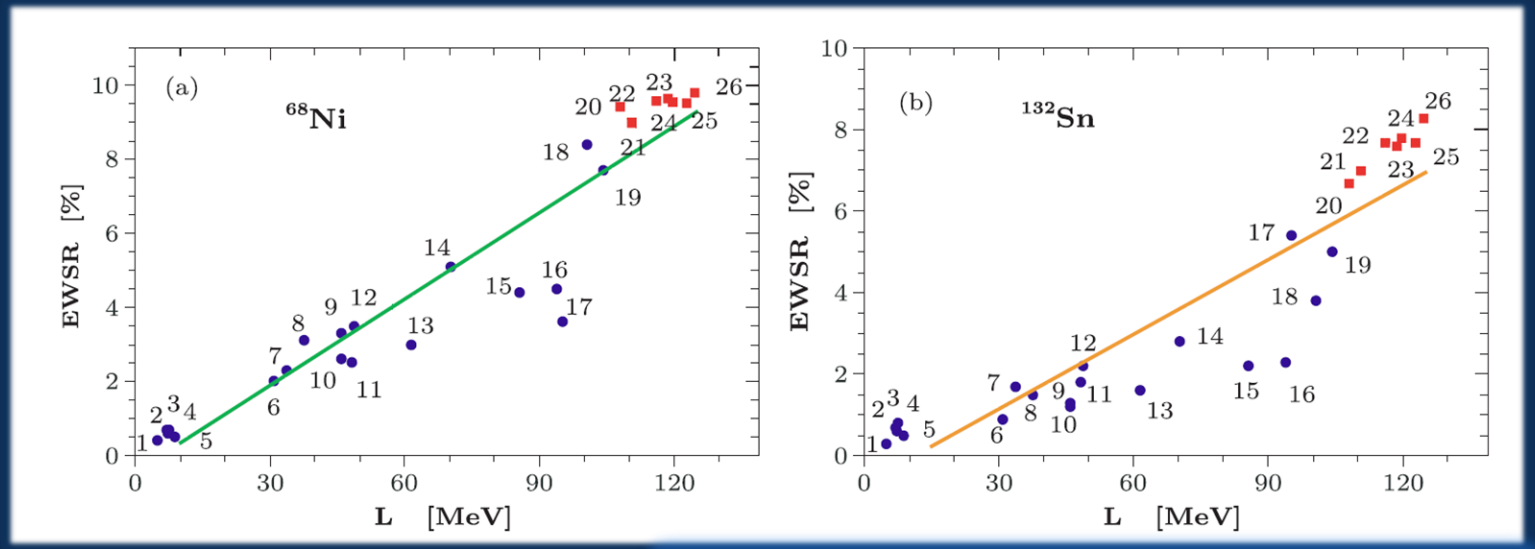

X. Roca-Maza et al.,PRC 85, 024601(2012)

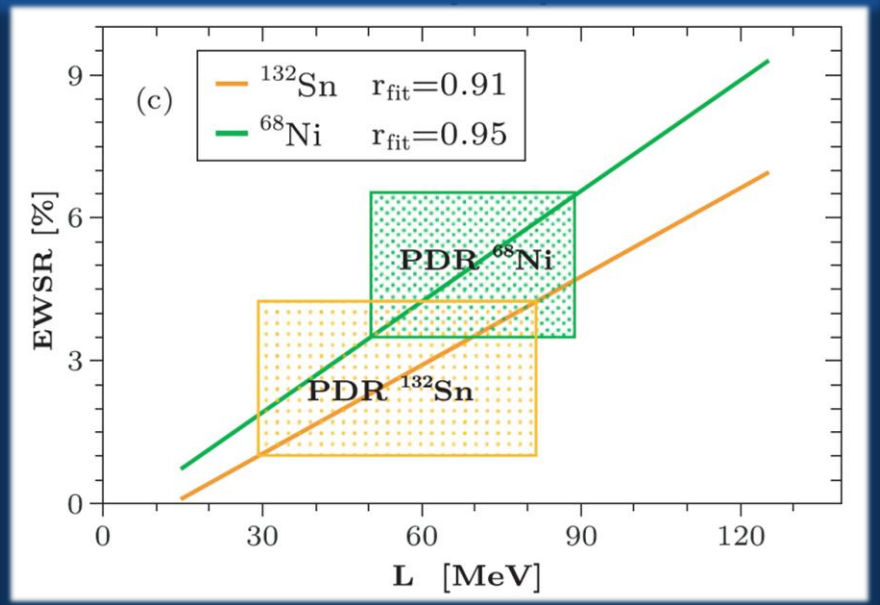



Carbone et al., PRC81, 041301® (2010)

# $L$ from PDR

Carbone et al.,
PRC81, 041301® (2010)

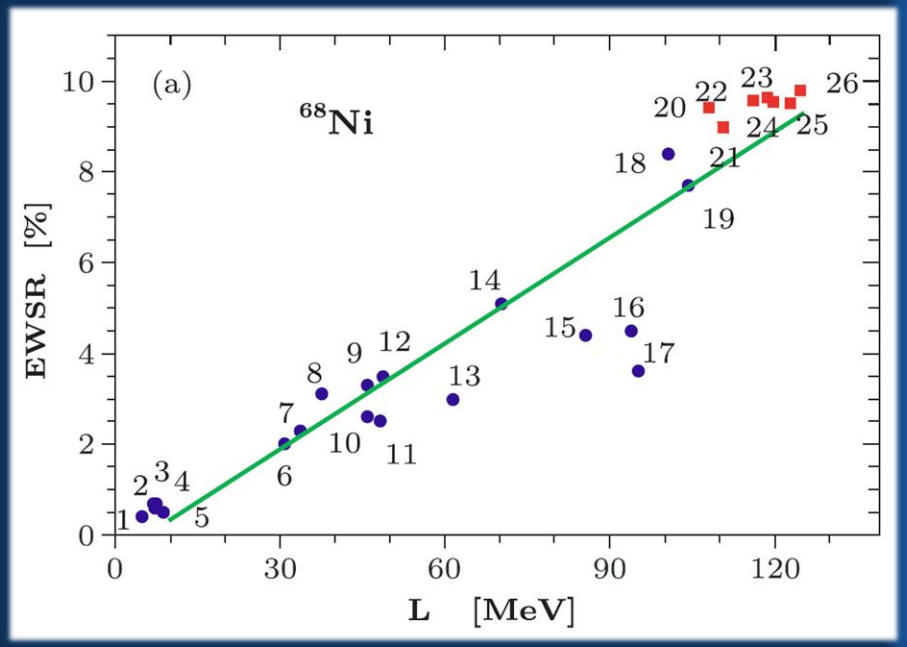


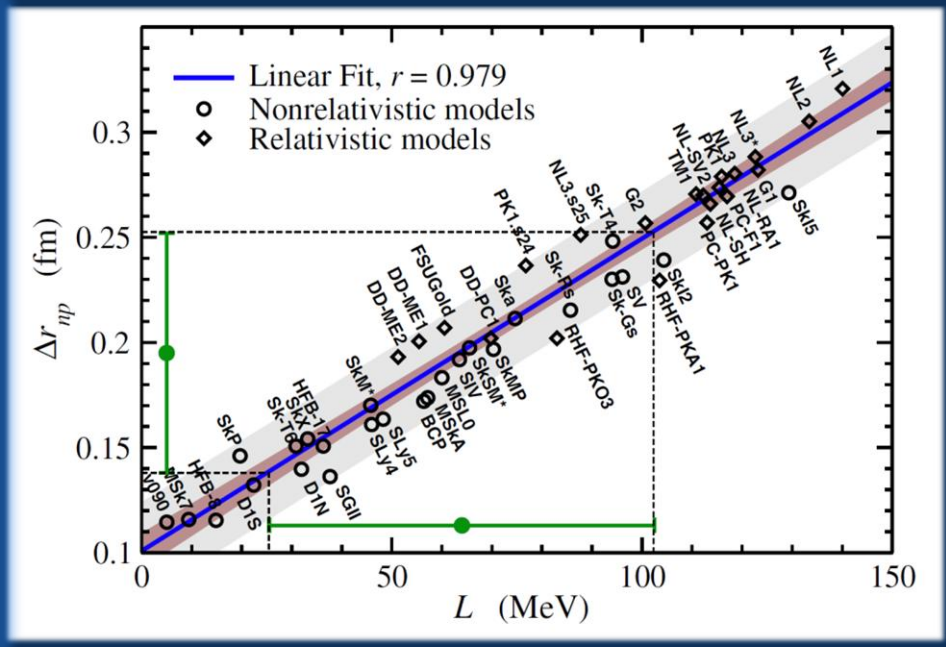




$$L = 65 \pm 16 \text{ MeV}$$

# PDR, *L*, and skin thickness

Carbone et al., PRC81, 041301® (2010)
Roca-Maza et al., PRL 106, 252501 (2011)



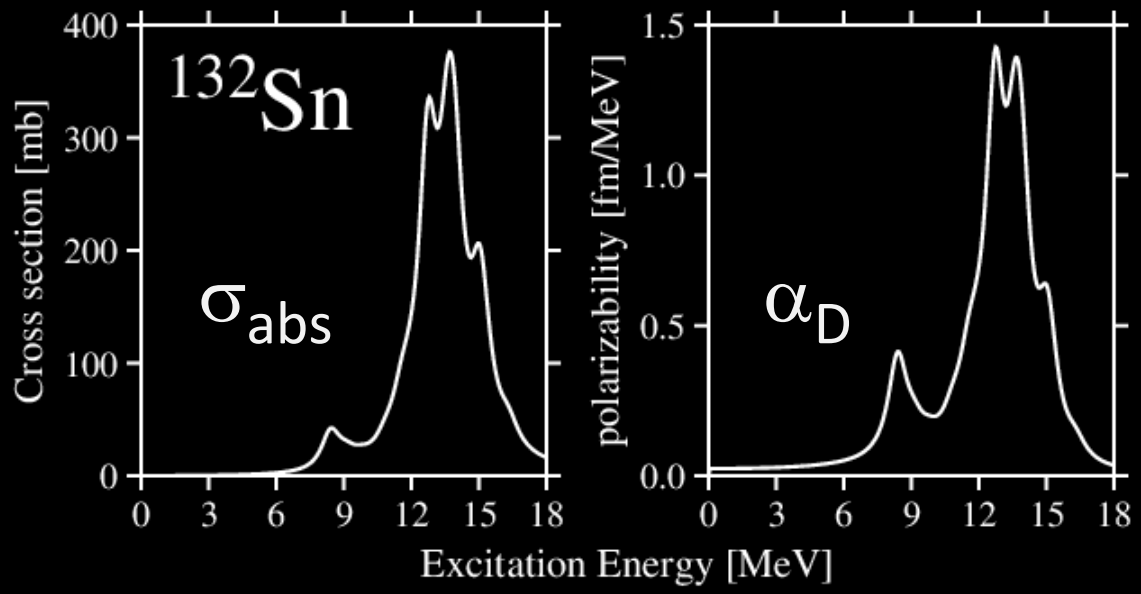



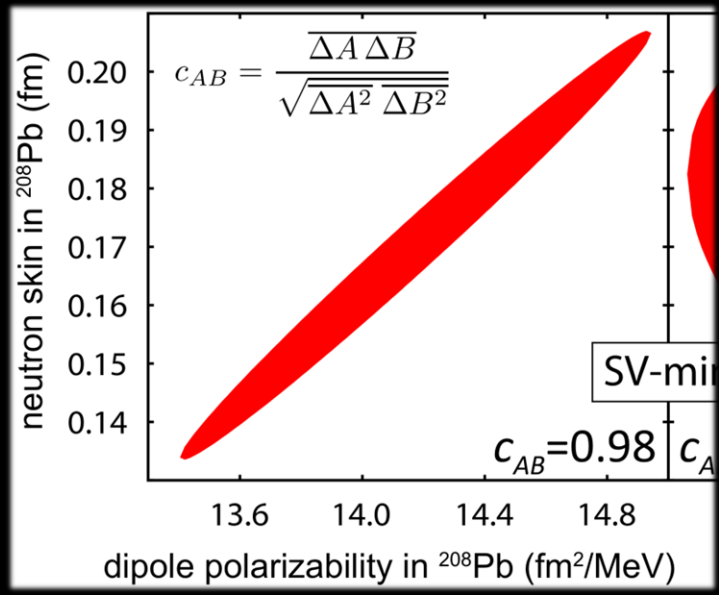

PDR ⇔ L ⇔ skin thickness

# Cross section($m_1$) & Polarizability($m_{-1}$)

$$\sigma_{\rm abs} \propto m_1 = \int {\rm d}E\, S(E1) E$$

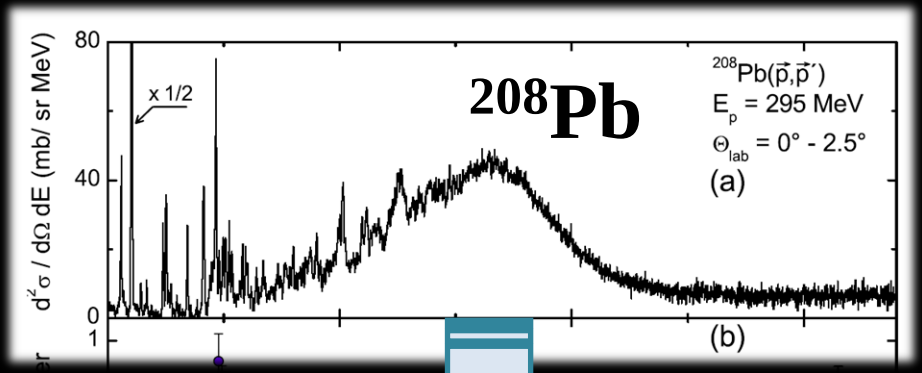
$$\alpha_D \propto m_{-1} = \int {\rm d}E\, \frac{S(E1)}{E}$$



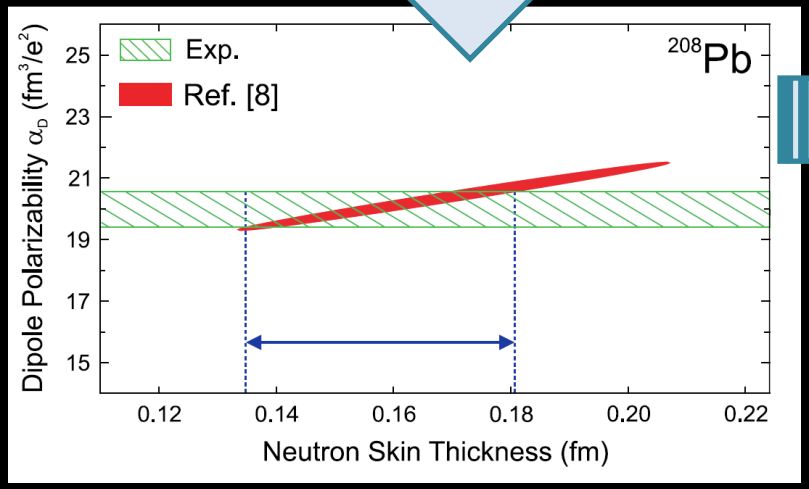




Reinhard & Nazarewicz
PRC81, 051303(R)

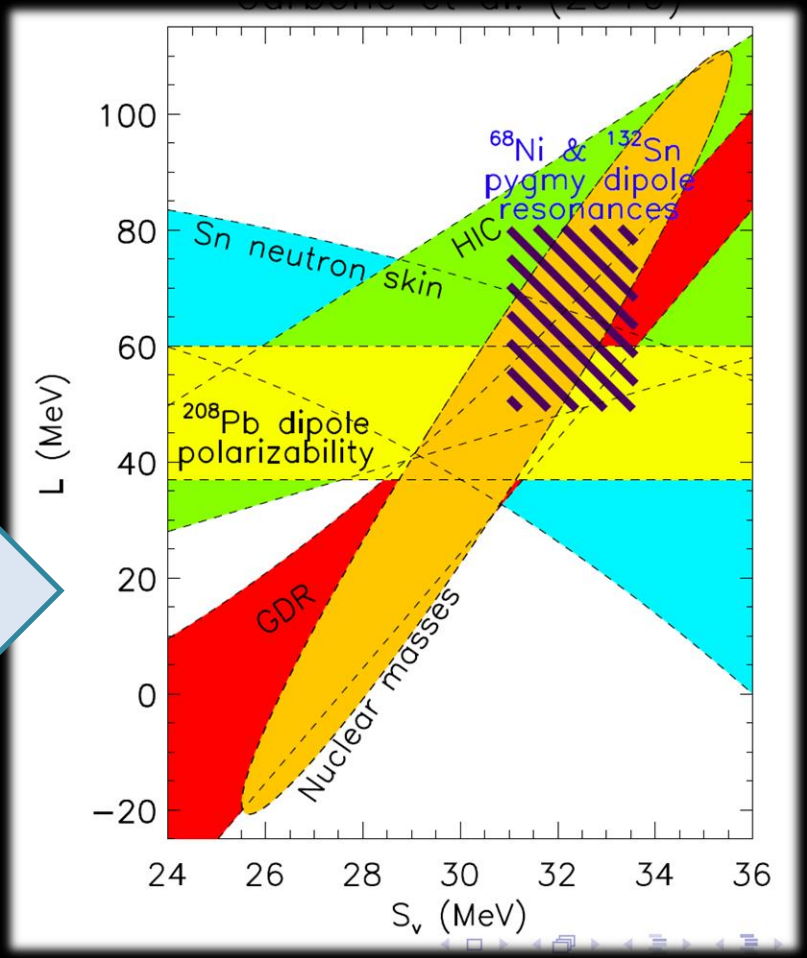
# *L* from polarizability




polarizability




L vs. skin




A. Tamii et al.,
PRL 107, 062502.

Lattimer's figure
from ECT* workshop on June, 2012

# Summary

PDR ⇔ EOS ⇔ skin thickness

in 68Ni ,132Sn, 208Pb

↑

interaction