Dynamical Coupling of Pygmy and Giant Resonances

C.A. Bertulani

TEXAS A&M UNIVERSITY COMMERCE

Supported by the U.S. DOE grant DE-FG02-08ER41533
U.S. NSF grant No. 1415656

Meetings association bans bad PowerPoint

Category: News

View Comments

Meetings & Events Australia (MEA) has banned PowerPoint at its major conference for 2012.

MEA describes itself as a "national, independent not for profit organisation dedicated to fostering professionalism and excellence in all aspects of meetings management. It also promotes the value and effectiveness of meetings as an important high-yield sector of business travel and tourism."

Linda Gaunt, the organisation's CEO, says MEA is banning PowerPoint because it is an outmoded form of communication.

"The bullet point model was created in the pre-digital era, when there was a shortage of expert information," she said in a press release issued today. "It was worth flying somewhere to hear that kind of speech. Now the web is full of expert presentations you can watch in your own time and location, so meetings need to provide something beyond that."

Presenters at MEA's Sydney event have been issued guidelines for their talks, including a banned list of classic PowerPoint techniques. "Bullet points, flow charts, template backgrounds, clip art, reading from the screen, and other proven yawn-inducers are all forbidden," the press release says.

Simpler, more involving material including photos, videos, demonstrations and storytelling are encouraged. All on-screen images are to be accompanied by no more than ten words.

"As an industry, we manage everyone else's events. It's up to us to set an example to show that when you get people together, it doesn't have to be a process of dull, passive one-way communication," Gaunt said. "We're pushing everyone outside the comfort zone, and we think it's going to be involving and inspiring. It's the future of meetings."

Origins of Pigmy Resonance

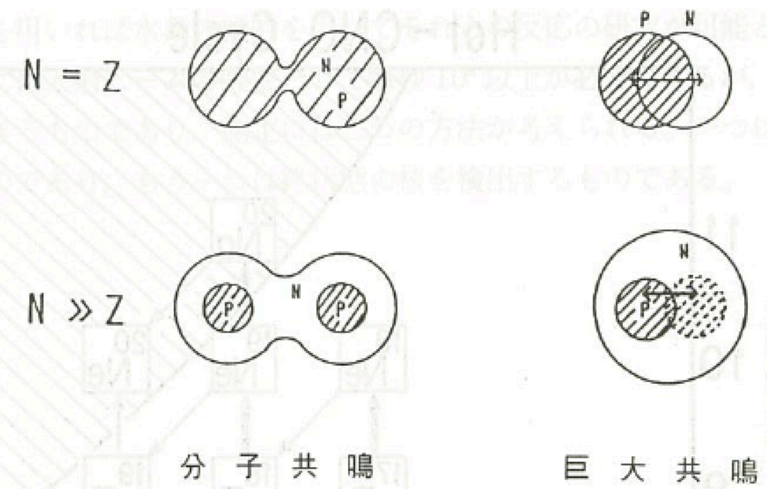


図 3E-6　N=Z 核と N≫Z 核の集団運動の例

なく，N≒Z 領域の核物質の性質及び有効相互作用の研究に関連する課題である。また，関連するテーマとしては，中性子過剰核のアイソベクトル型巨大共鳴の探求も興味深い。

安定核領域の分子状態の研究において重要な問題の一つに，出口チャンネルの分子共鳴への寄与がある。出口チャンネルは，多くの場合不安定状態の二つの原子核からなるため，これまでその効果を明瞭に調べることができなかった。不安定核のビームを用いれば，出口チャンネルの分子共鳴への寄与が調べられ，ひいてはこれまで不明瞭だった共鳴の原因がどのチャンネルにあるか特定することができる。

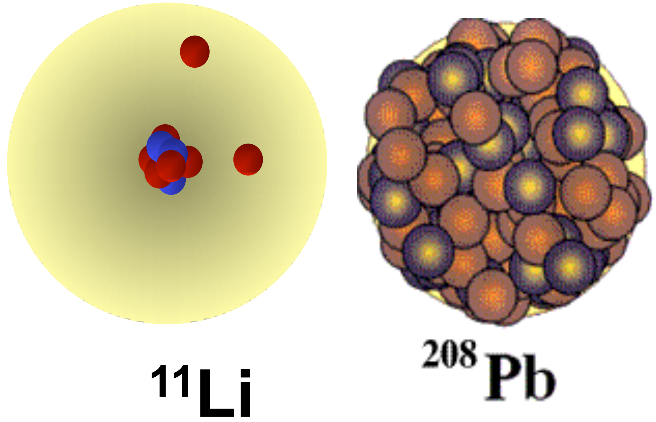
- June 1987

Nomura, Kubono, et al.

Experiment proposal (J-PARC)

Idea of Pigmy Resonance in N-rich nuclei

E & M response in neutron-rich nuclei
First studies



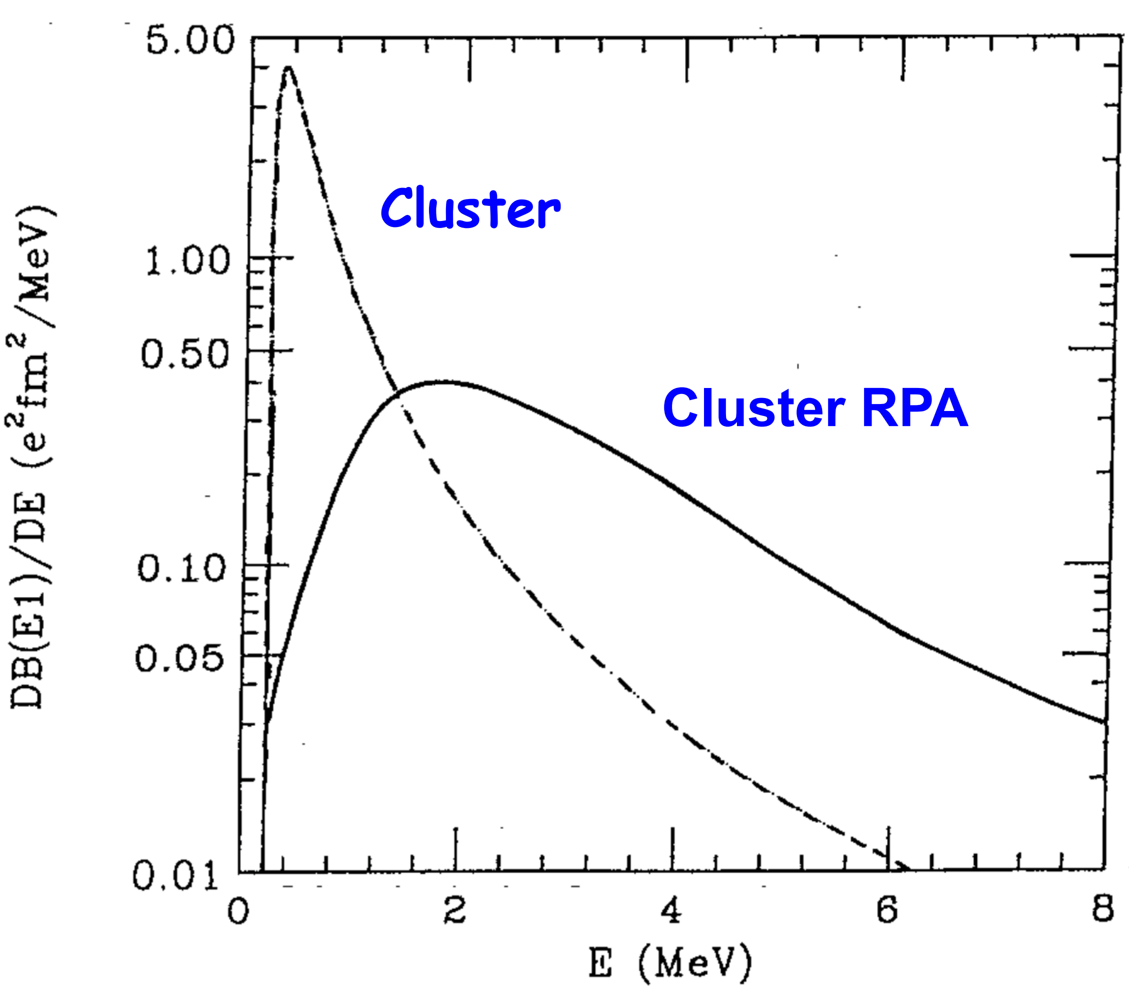
Two-body Cluster: CB, Baur, NPA 480, 615 (1988)

CB, Sustich, PRC 46 , 2340 (1993)

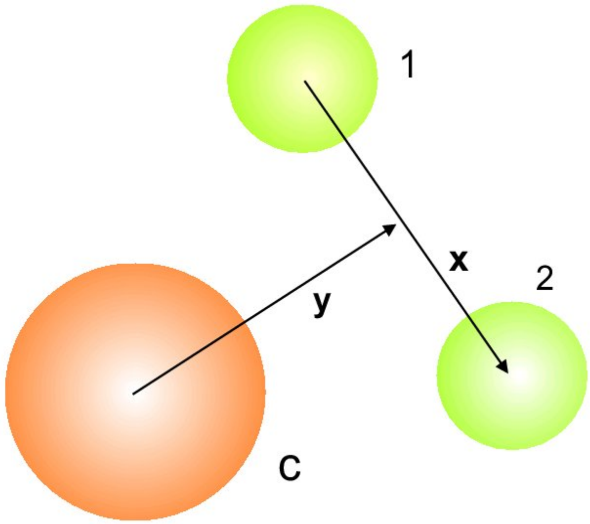
$$\frac{dB(EL)}{dE} \sim \frac{\left(E_x - S_n\right)^{L+1/2}}{E_x^{2L+2}}$$

$$E_r^{(E\lambda)peak} \cong \frac{\lambda+1/2}{\lambda+3/2} S_n$$

Cluster RPA: Teruya, CB, Krewald, Dias. Hussein, PRC 43, 2049 (1991)



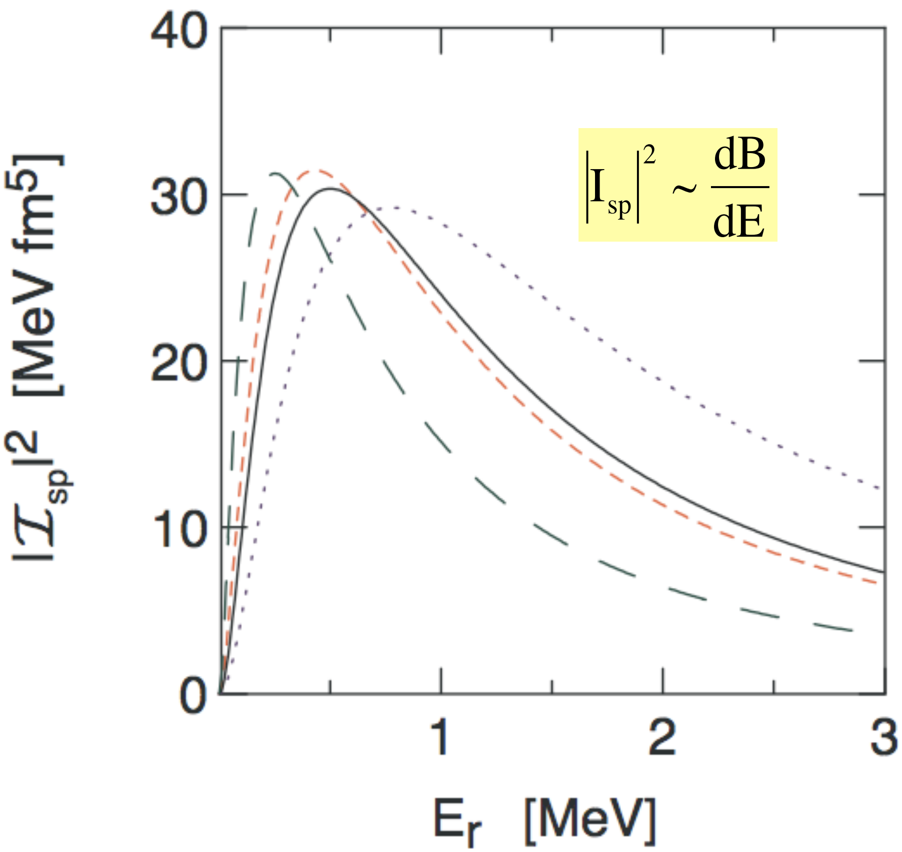
Three-body cluster

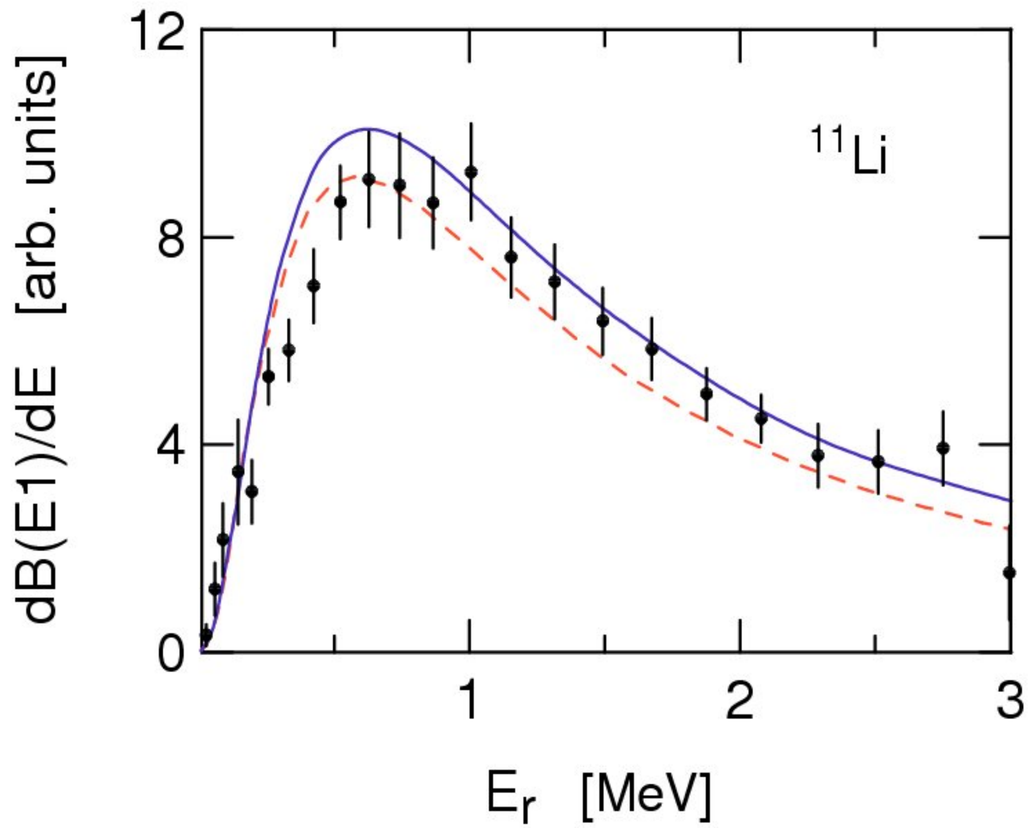


$$\frac{dB(E1)}{dE_r} \propto \frac{E_r^3}{\left(S_{2n}^{eff} + E_r\right)^{11/2}} \left(1 + FSI\right)^2$$

$$S_{2n}^{eff} \cong 1.8\, S_{2n}$$

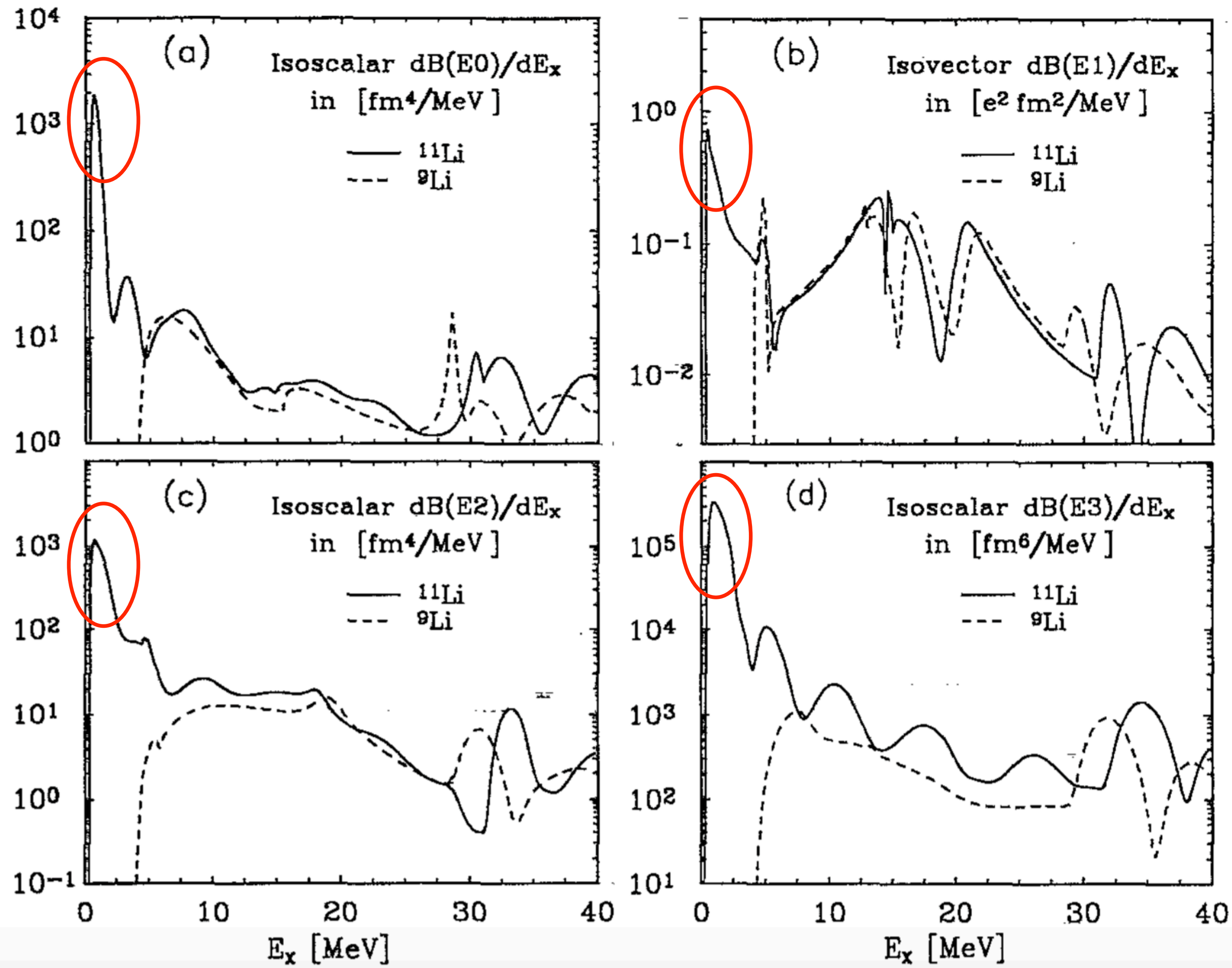
CB, PRC 75, 024606 (2007)





E & M response in neutron-rich nuclei
First studies

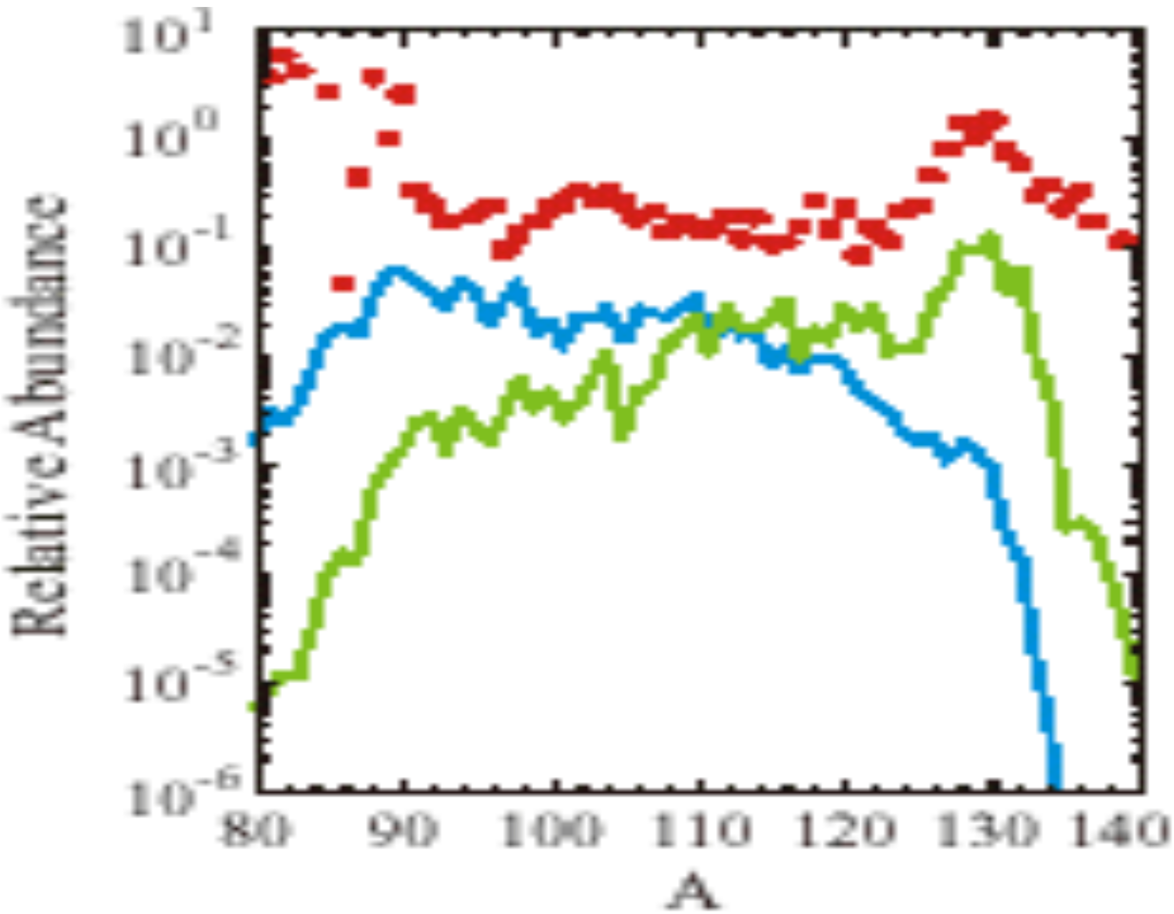
Continuum RPA: CB, Sustich, PRC 46 , 2340 (1993)



Pigmy resonance & Nucleosynthesis

Nucleosynthesis: (γ,n) or (n,γ) cross sections in the r-process

Importance of the "pygmy" states



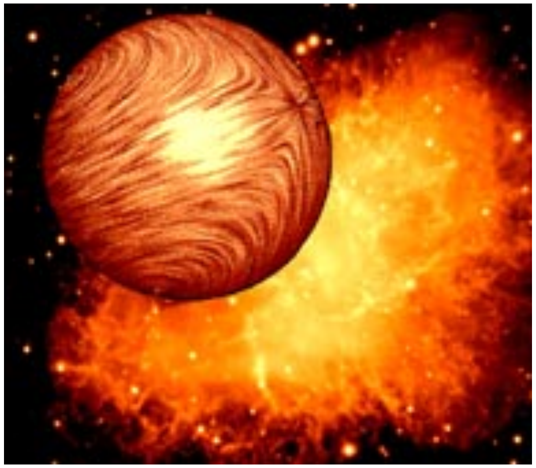
Red: empirical

Blue: no pygmy

Green: with pygmy

S. Goriely, PLB 2000

EOS & Neutron stars



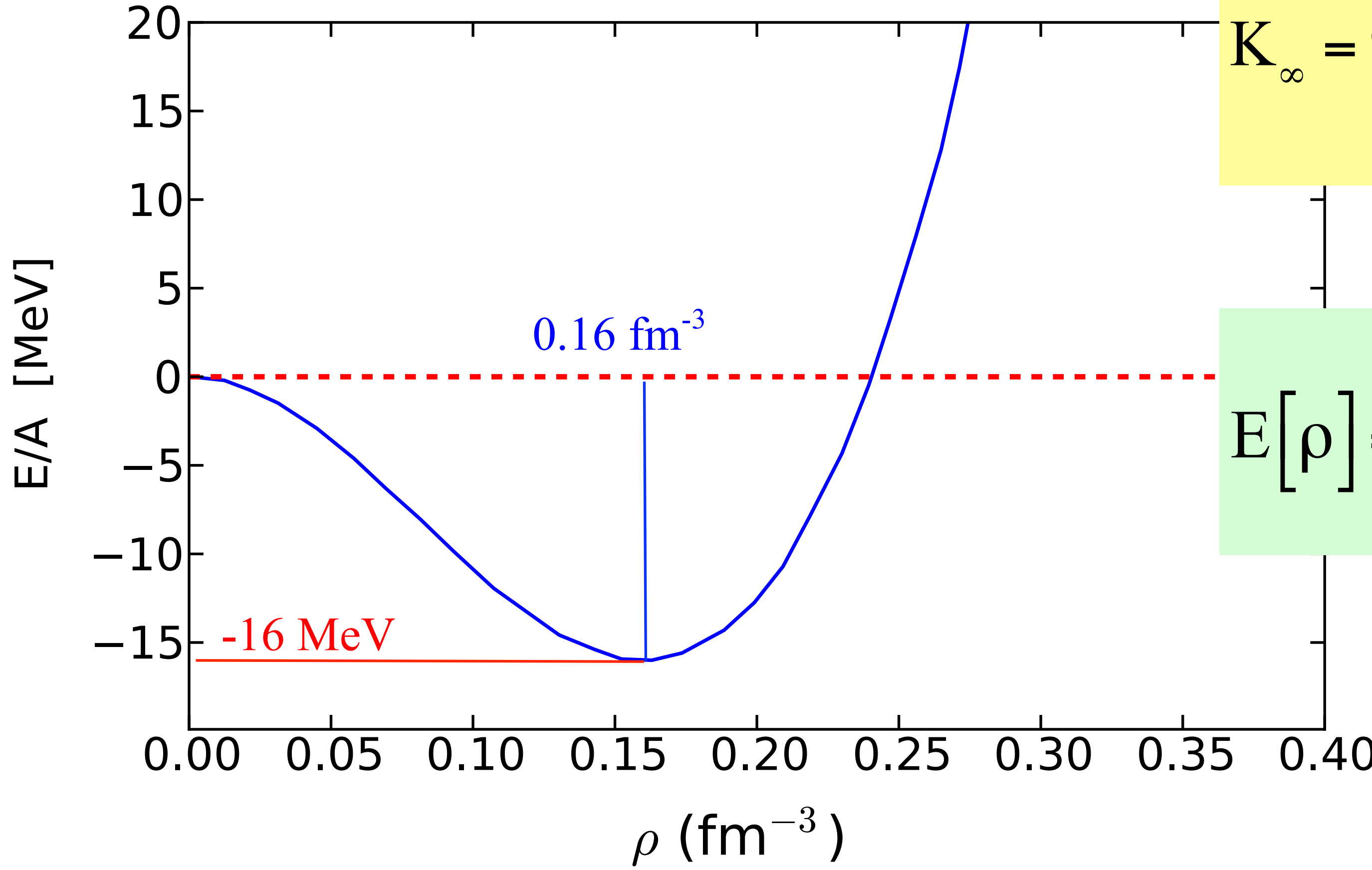
$$\frac{dP}{dr} = -\frac{G\rho(r)M(r)}{r^2}\left[1+\frac{P(r)}{\rho(r)}\right]\left[1+\frac{4\pi r^3 P(r)}{M(r)}\right]\left[1-\frac{2GM(r)}{r}\right]^{-1}$$

$$\frac{dM}{dr} = 4\pi r^2 \rho(r)$$

Tolman-Oppenheimer-Volkoff

$$K_\infty = 9\rho^2 \left.\frac{d^2\left[E(\rho)/\rho\right]}{d\rho^2}\right|_{\rho_0}$$

$$E[\rho] = E[\rho_0] + \frac{1}{18}K_\infty\left(\frac{\rho-\rho_0}{\rho_0}\right)^2$$



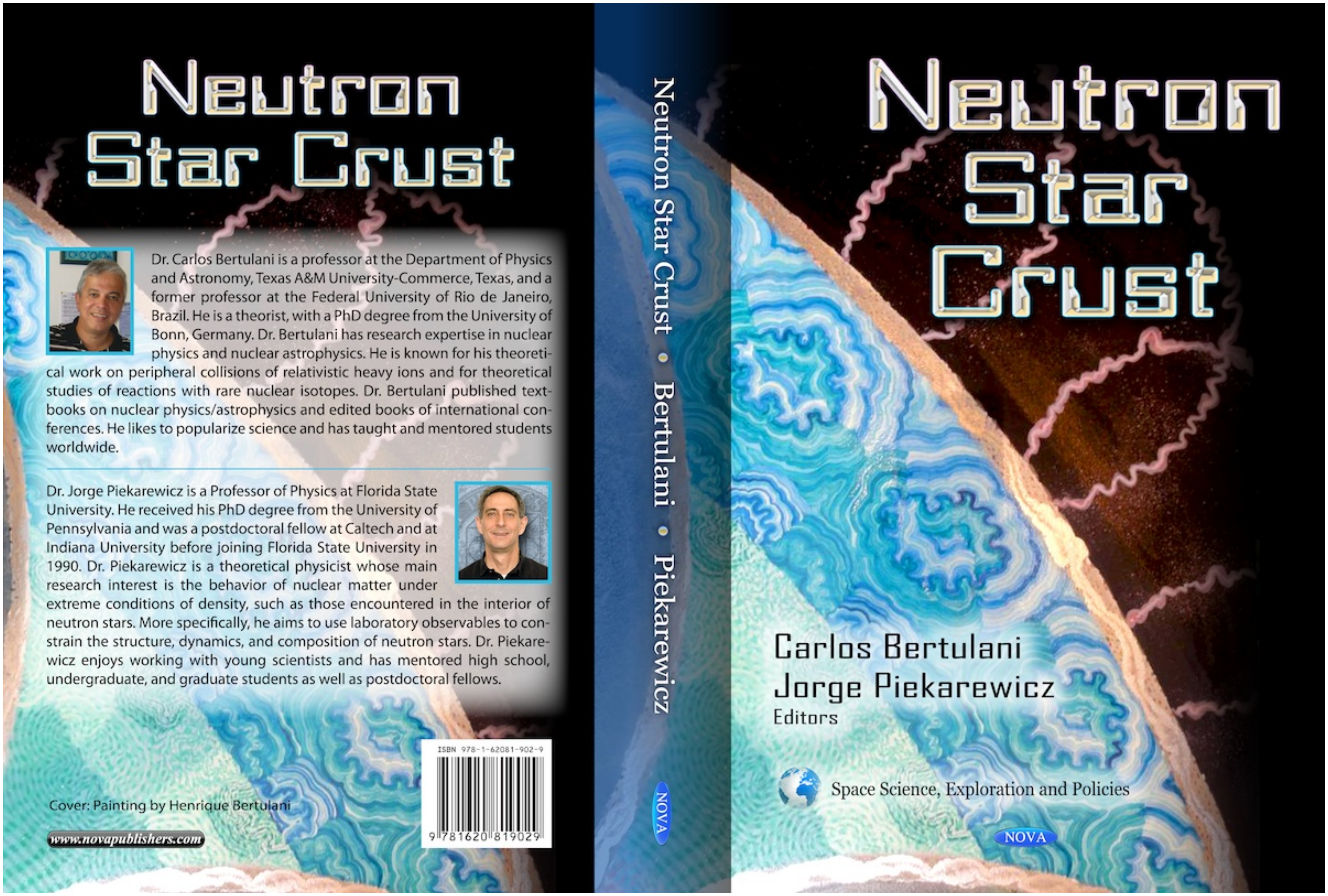
EOS + symmetry energy

$$E[\rho] = E[\rho_0] + \frac{1}{18} K_\infty \left(\frac{\rho - \rho_0}{\rho_0} \right)^2 + S \left(\frac{\rho_n - \rho_p}{\rho} \right)^2 + \cdots$$

$$S = \frac{1}{8} \frac{\partial^2 (E/\rho)}{\partial y^2} \bigg|_{\rho, y=1/2}, \qquad y = \frac{\rho_p}{\rho}$$

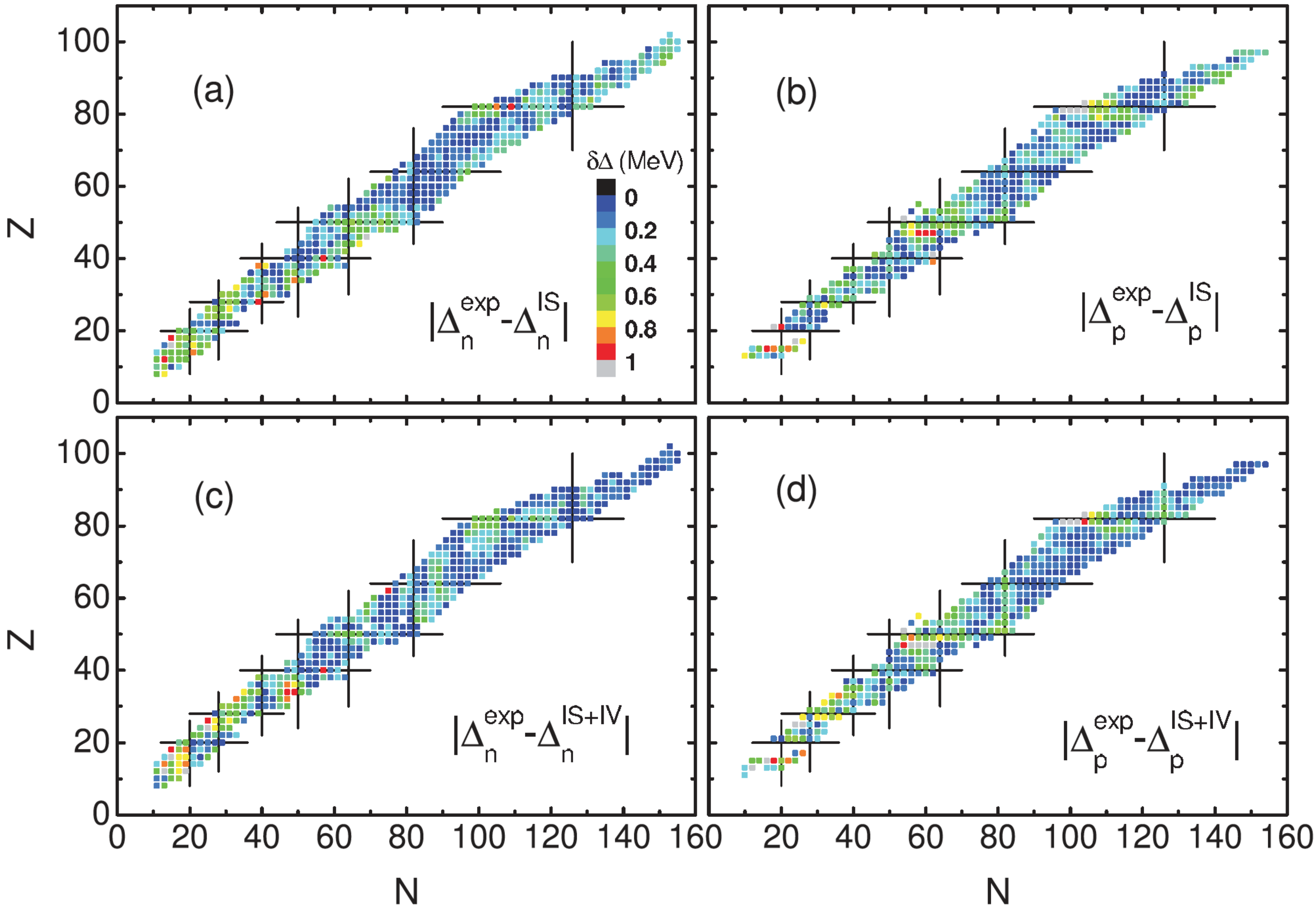
$$= J + Lx + \frac{1}{2} K_{sym} x^2 + O(x^3), \qquad x = \frac{(\rho - \rho_0)}{3\rho_0}$$

Skyrme	ρ_0	E0	K_∞	J	L	K_{sym}	m*/m
SLy5	0.161	-15.99	229.92	32.01	48.15	-112.76	0.70
SkM*	0.160	-15.77	216.61	30.03	45.78	-155.94	0.79
Skxs20	0.162	-15.81	201.95	35.50	67.06	-122.31	0.96



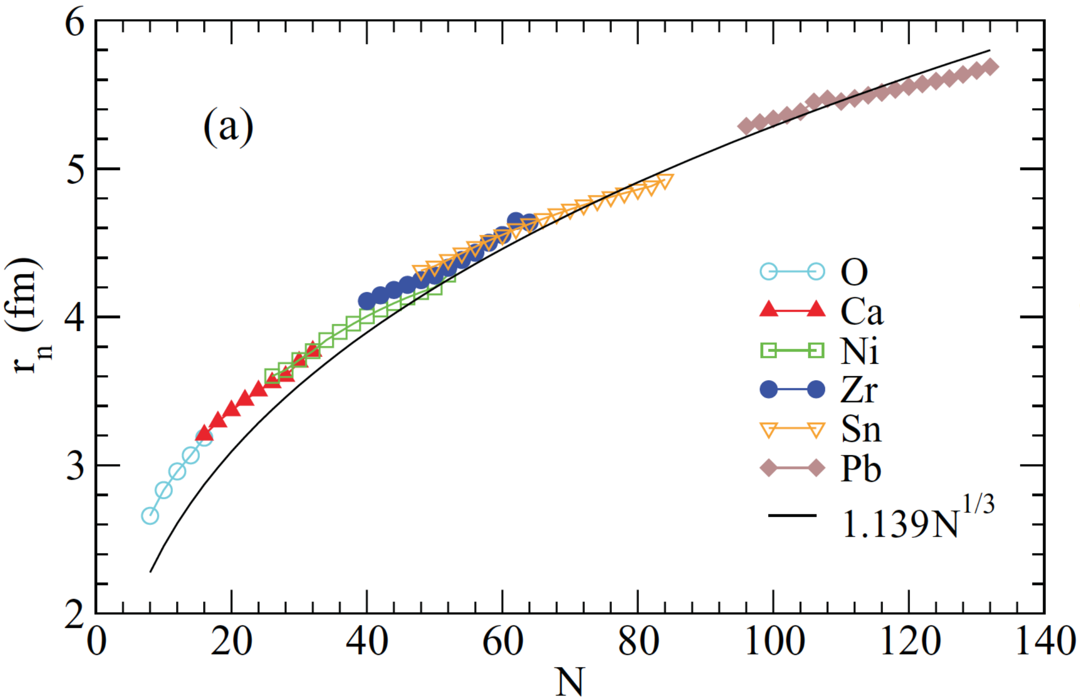
Contributors: Jocellyn Bell-Burnell, C. J. Horowitz, J Hughto, A. Schneider, D. K. Berry, G. Watanabe, T. Maruyama, A. Gezerlis, J. Carlson, J. Margueron, N. Sandulescu, R. Negreiros, S. Schramm, F. Weber, X. Roca-Maza, T. Garcia-Galvez, M. Centelles, G. Shen, C.O. Dorso, P.A. Gimenez-Molinelli, J.A. Lopez, M. Baldo, E.E. Saperstein, D.P. Menezes, S.S. Avancini, C. Providencia, M.D. Alloy, S. Goriely, J. M. Pearson, N. Chamel, W.G. Newton, M. Gearheart, J. Hooker, Bao-An Li, A.L.Watts, D. Page, S. Reddy, P. Avogadro, F. Barranco, R.A. Broglia, E. Vigezzi

From 100 to 10^{57} nucleons, Skyrme & pairing

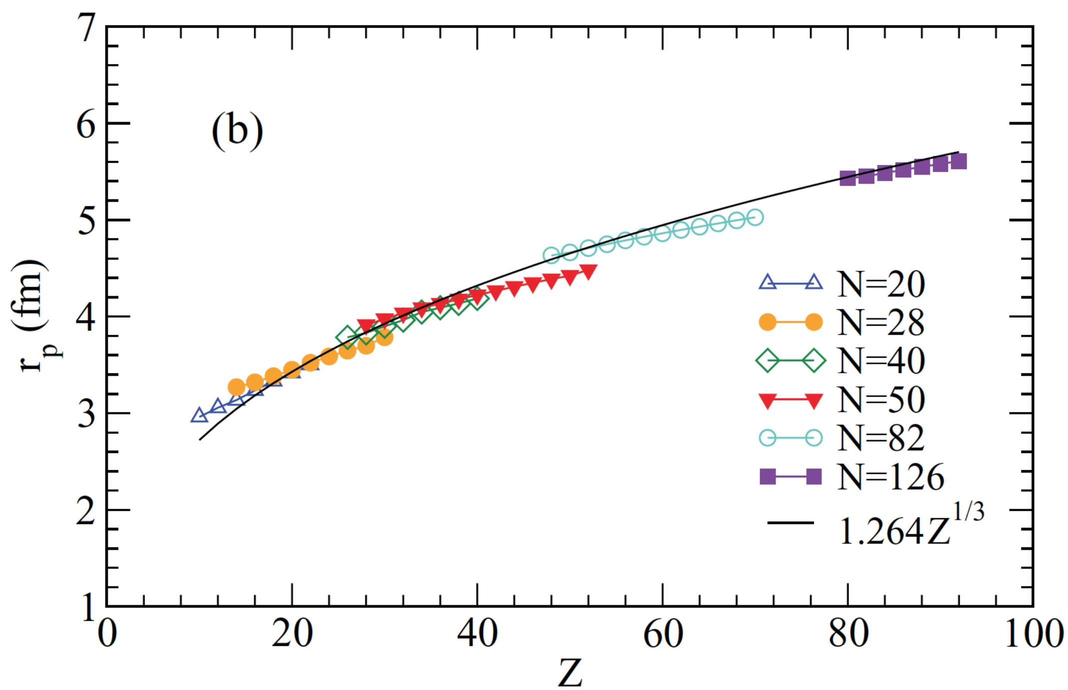


CB, Hongfeng Lu, Sagawa, PRC 80, 027303 (2009)
W. J. Chen, CB, F. R. Xu and Y. N. Zhang, PRC 91, 047303 (2015).

Skyrme + Isovector pairing – Reasonable Nuclear Radii

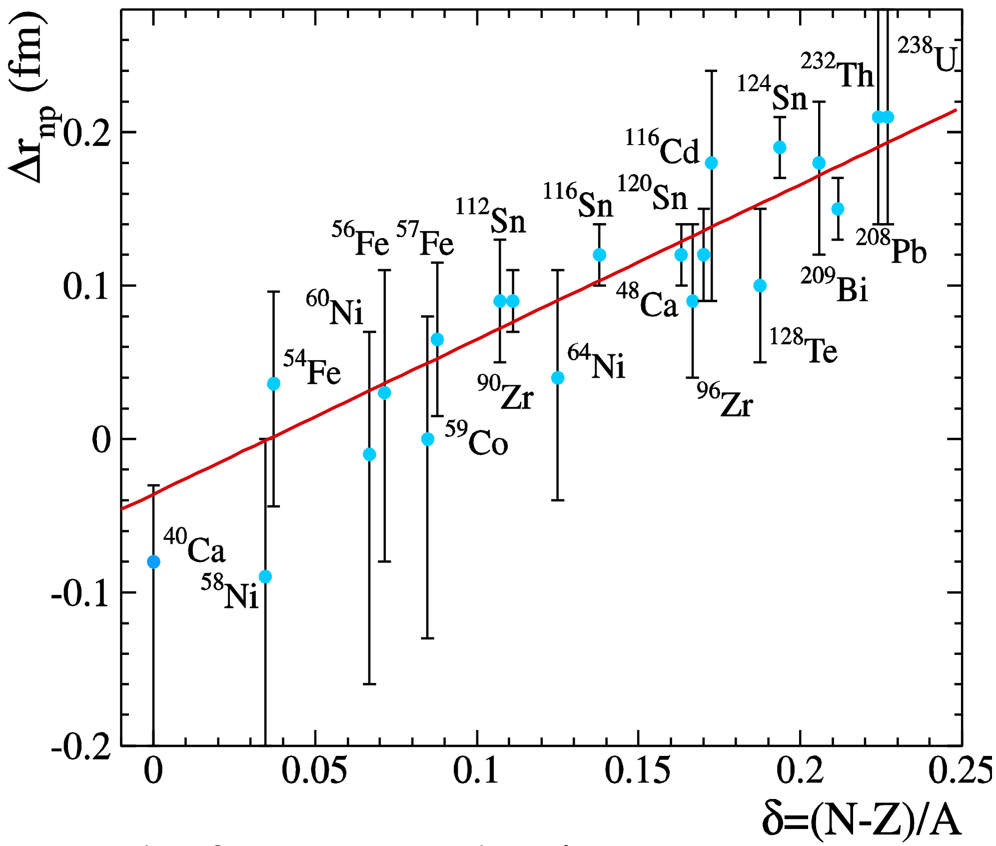


CB, Hongliang Liu, Sagawa,
PRC 85, 014321 (2012)

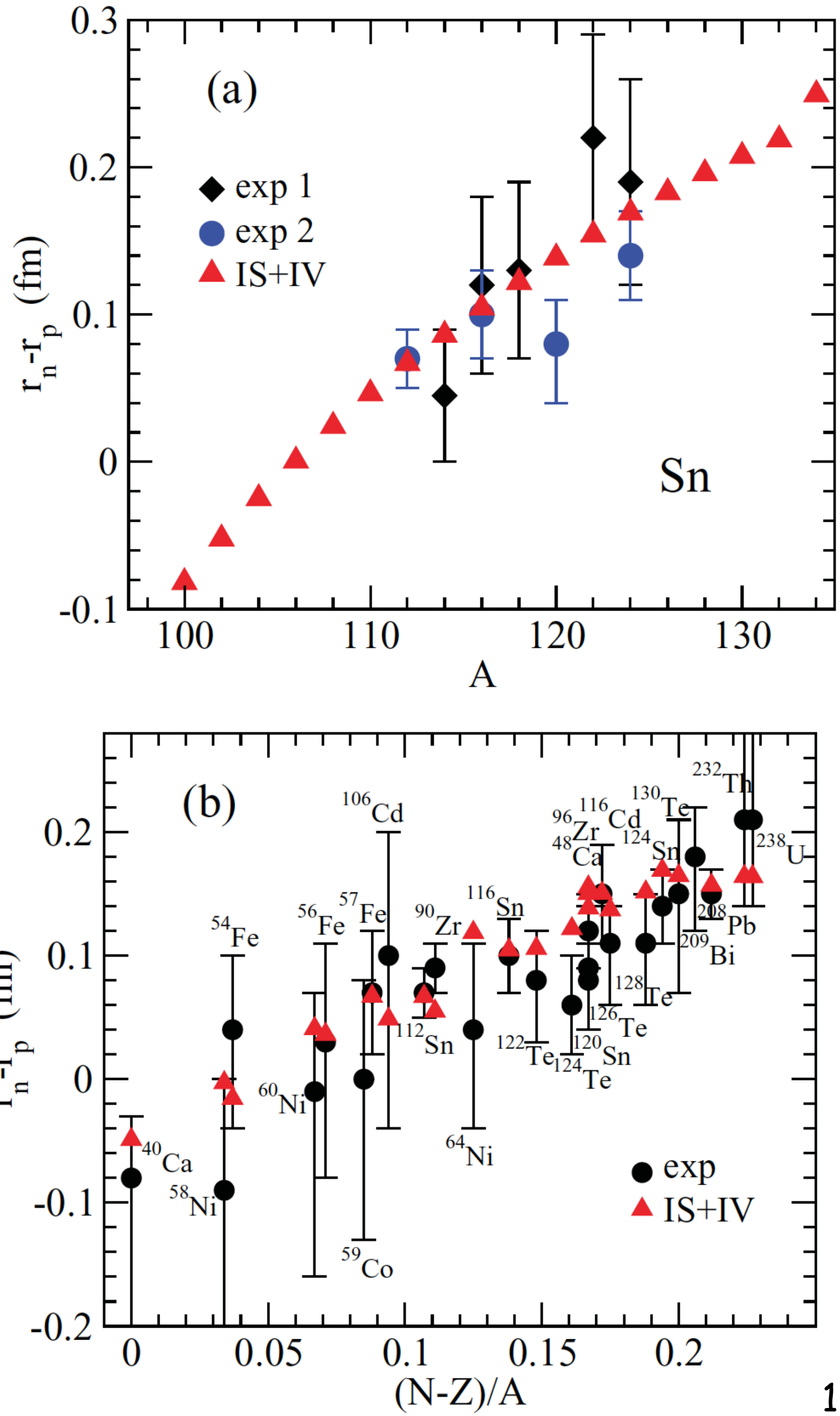


Neutron Skins

CB, Hongliang Liu, Sagawa,
PRC 85, 014321 (2012)



Radii from spin-dipole resonances
Krasznahorkay et al., PRL 82, 3216 (1999)
&
Antiprotonic atoms
Trzcinskaet al., PRL 87, 082501 (2001)

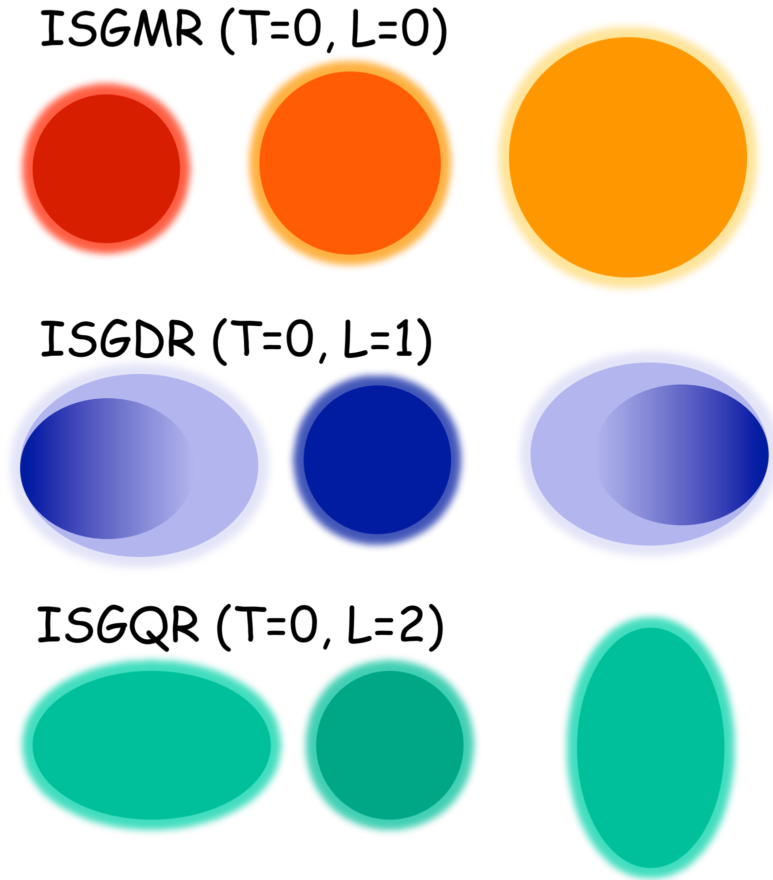


EOS + symmetry energy

- **Analysis of Giant Isoscalar Resonances**
- High energy heavy ion collisions

Giant Resonance: Coherent vibration of nucleons in a nucleus

- Resonances related to incompressibility: **ISGMR**, ISGDR, ISGQR



$$E_{ISGMR} \approx \sqrt{\frac{K_A}{m\langle r^2 \rangle}}$$

$$c \approx 1$$

$$K_A = K_\infty \left(1 + cA^{-1/3}\right) + K_{sym}\left(\frac{N-Z}{A}\right)^2 + K_{Coul} Z^2 A^{-4/3}$$

- K_{Coul} is basically model independent
- Measurements over several isotopes should give $K\tau$
- K_{sym} critical to understand neutron stars

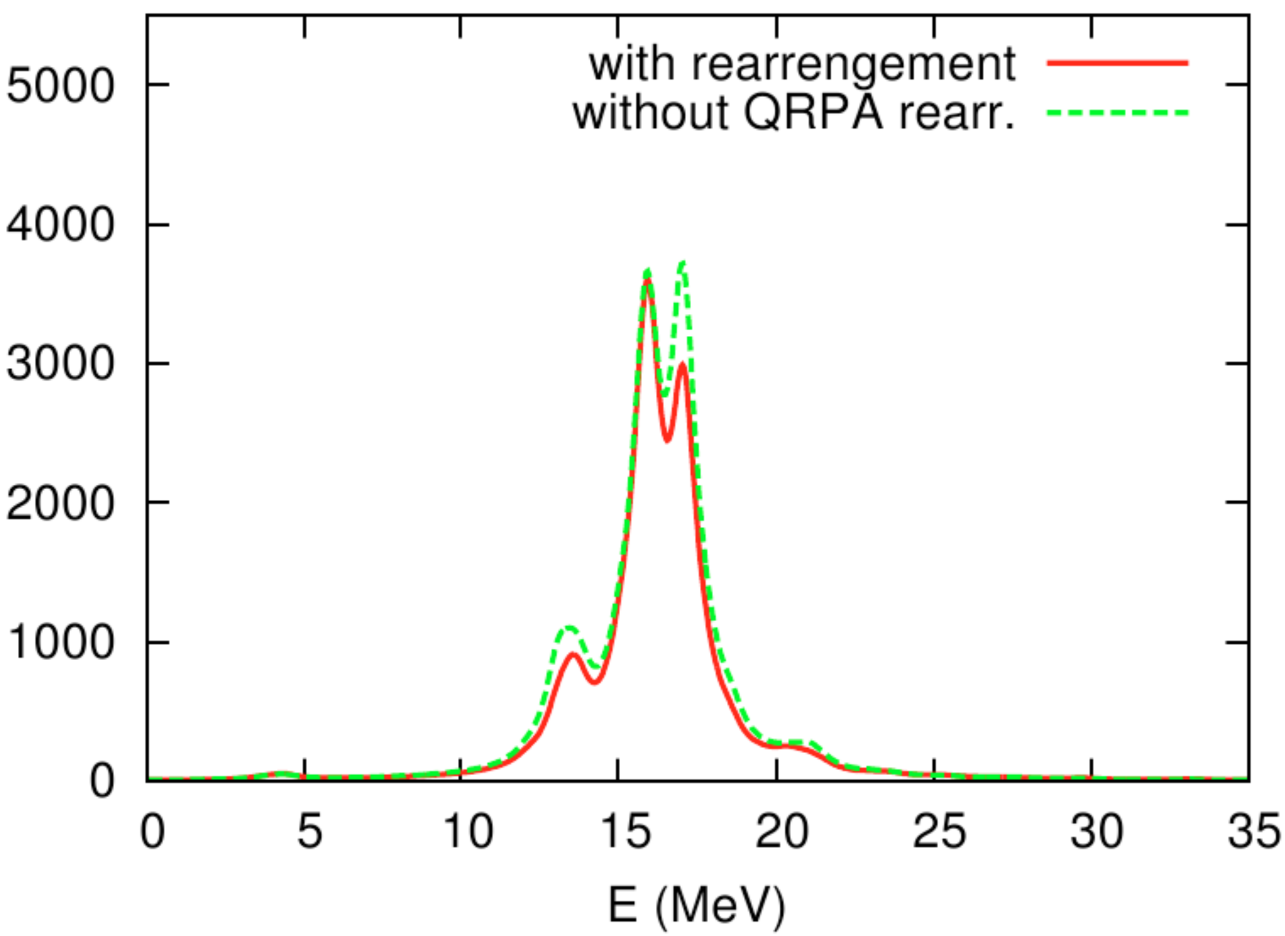
QRPA: The Role of the Rearrangement Term

Avogadro, CB, PRC 88, 044319 (2013)

$$h = \frac{\delta E_{kin}}{\delta \rho} + \frac{\delta E_{skyrme}}{\delta \rho} + \frac{\delta E_{pair}}{\delta \rho} + \frac{\delta E_{Coul}}{\delta \rho}$$

- **Fully self consistent EWSR = 99.2%**
- **Without rearrangement in EWSR =116%**

^{112}Sn, SkM* + surface



$$\frac{\delta h_{rearr}}{\delta \rho} = \frac{\delta}{\delta \rho}\left(\frac{\delta E_{pair}}{\delta \rho}\right)$$

$\neq 0$ if E_{pair} depends on density

Calculations without rearrangements tend to return higher centroids respect to the fully self-consistent case.

Pairing – ISGMR – Comparison to data

	nucleus	ph	pp	diff.
TAMU/ RCNP	$^{204-206-208}$Pb	SLy5	all	< 0.1
TAMU/ RCNP	^{144}Sm	SkM*	*volume*	- 0.1
TAMU/ RCNP	^{90}Zr	SLy5	all	+ 0.2
TAMU	^{92}Zr	SLy5	*volume*	- 0.4
	^{94}Zr	Skxs20	*surface*	+ 0.8
TAMU	^{92}Mo	SLy5	*volume*	- 1.6
	^{94}Mo	Skxs20	*surface*	+ 0.0
RCNP	$^{112-114-118-120}$Sn [4]	Skxs20	*mixed*	< 0.1
	$^{122-124}$Sn [4]	Skxs20	*surface*	< 0.1
	^{116}Sn [4]	SkM*	*surface*	< 0.1
TAMU	$^{112-124}$Sn [35]	Skxs20	*surface*	≈ 0.8
	^{116}Sn [35]	Skxs20	*surface*	+ 0.2
RCNP	$^{106-110-112-114-116}$Cd [6]	Skxs20	*surface*	< 0.1
TAMU	$^{110-116}$Cd [46]	Skxs20	*surface*	≈ 0.9

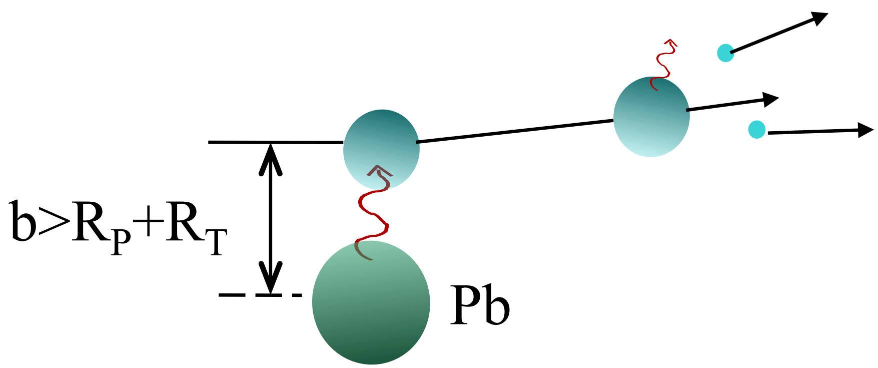
Avogadro, CB,
PRC 88, 044319 (2013)

ISGMR is better reproduced with the soft interaction Skxs20 ($K_\infty \approx 202$ MeV), in contrast with the generally accepted value for $K_\infty \approx 230$ MeV.

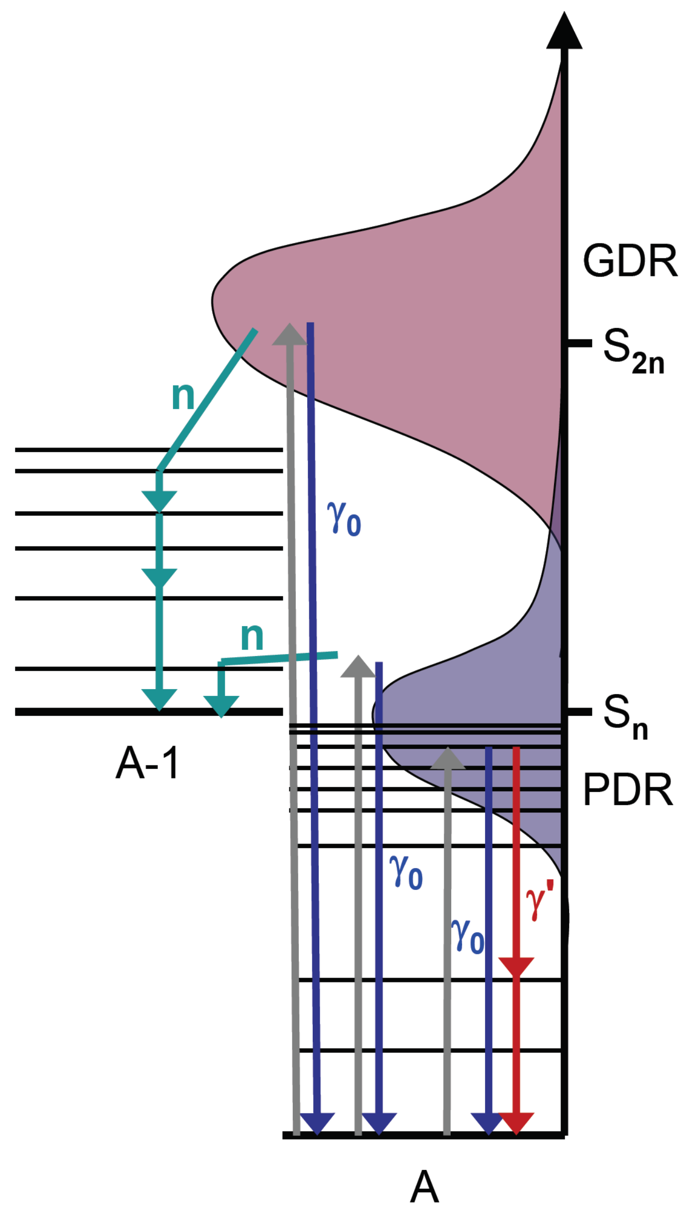
Coulomb excitation of PRs

Rossi et al.
PRL 111 (2013) 242503

Wieland et al.
PRL 102, 092502 (2009)



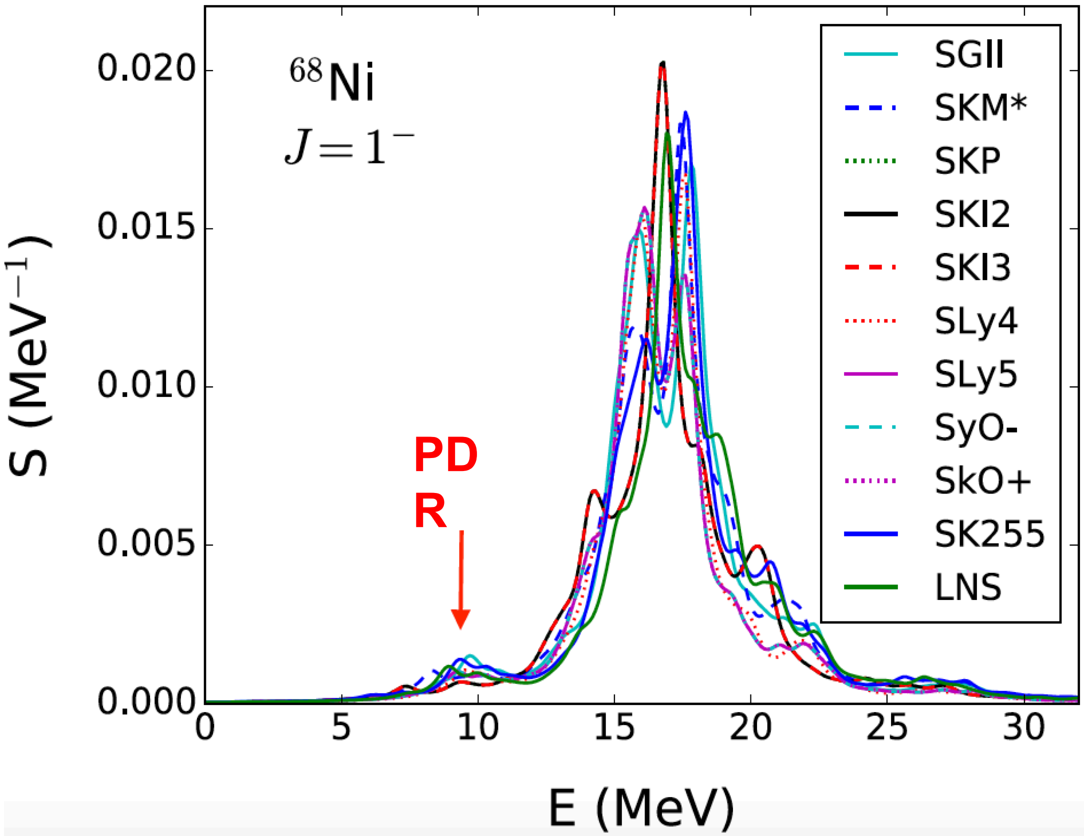
Experimental analysis based on 1st order perturbation theory



Dipole polarizability

$$\alpha_D = \frac{\hbar c}{2\pi^2}\int_0^\infty \frac{\sigma_\gamma(E)}{E^2}dE$$

E & M response in heavy neutron-rich nuclei

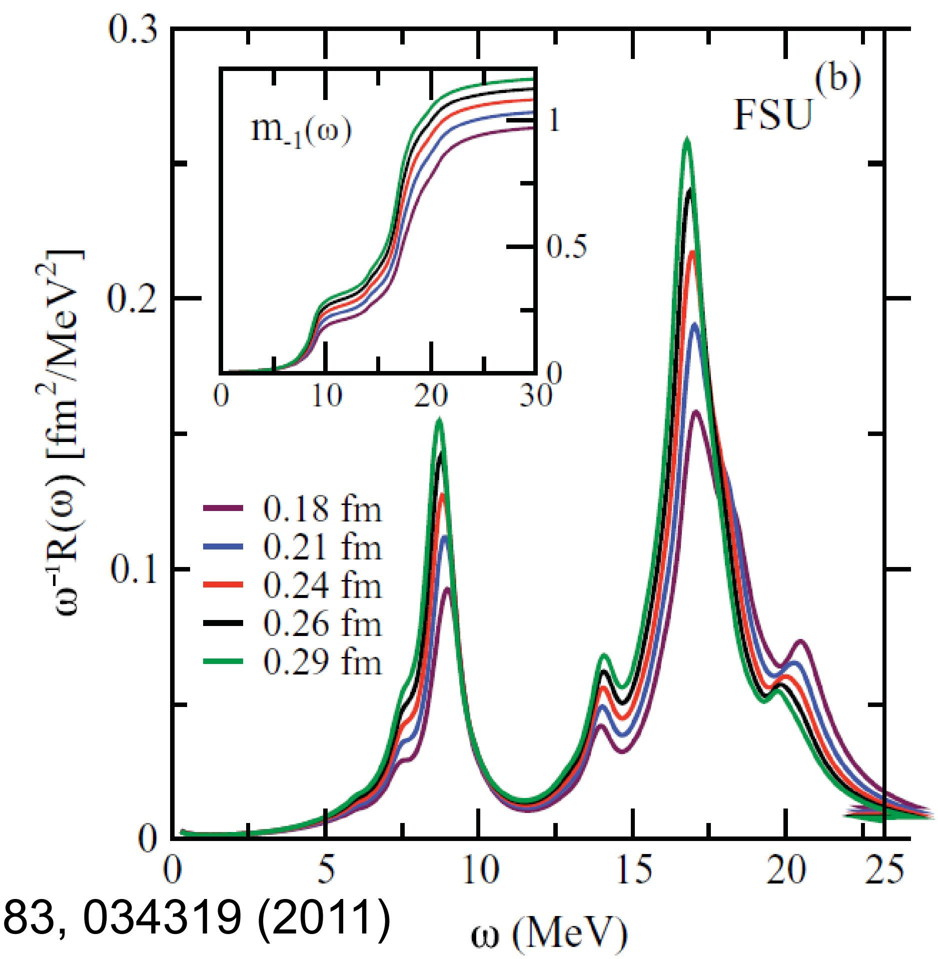


$$S(E) = \sum_{\nu} \left| \left\langle \nu \left\| j_L\left(\frac{Er}{\hbar c}\right) \right\| 0 \right\rangle \right|^2 \delta(E - E_\nu)$$

Colo, Cao, Giai, Capelli,
Comput. Phys. Comm. 184, 142 (2013)

$$\alpha_D = \frac{\hbar c}{2\pi^2} \int_0^{\infty} \frac{\sigma_\gamma(E)}{E^2} dE$$

Dipole polarizability



Piekarewicz,PRC 83, 034319 (2011)

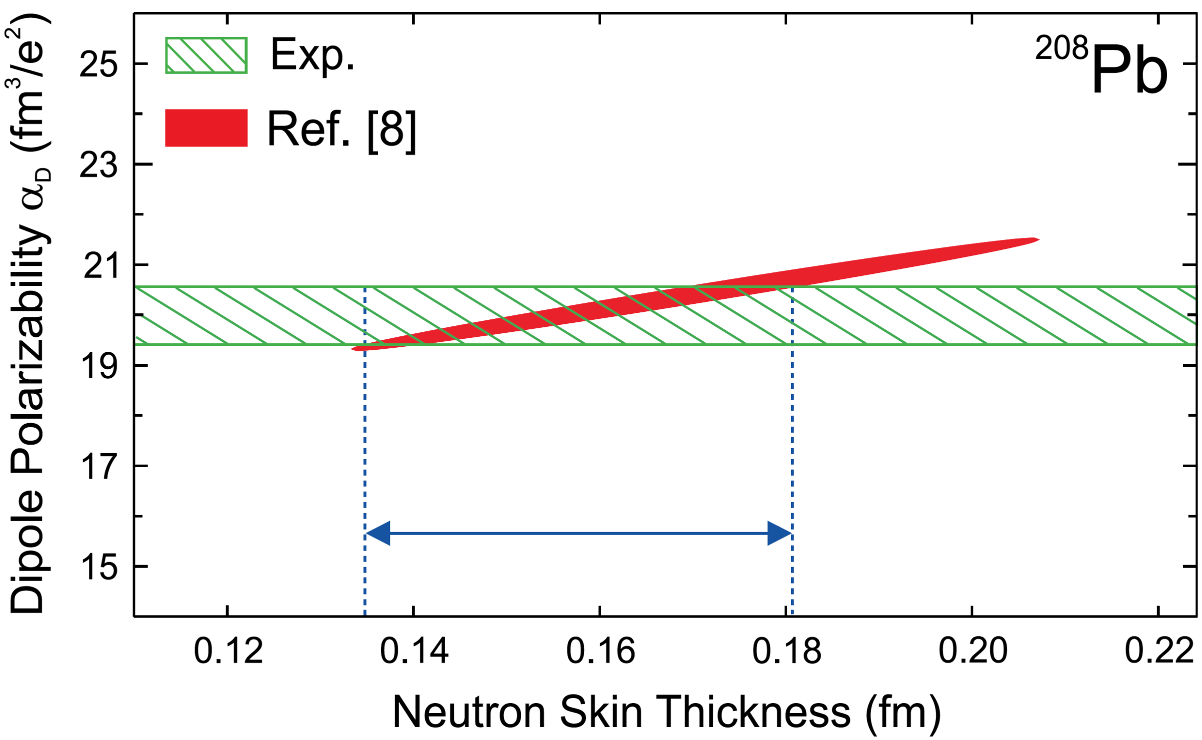
Symmetry energy, neutron skin, and neutron stars

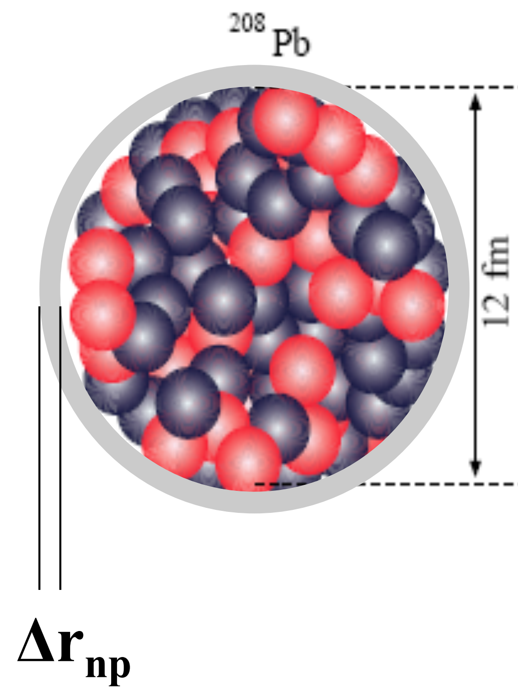
$$E(\rho,\alpha) = E(\rho,0) + S_2(\rho)\alpha^2 + O(\alpha^4)\,,\ \alpha = \frac{N-Z}{A}$$

$$S_2(\rho) = \frac{1}{2}\frac{\partial^2 E(\rho,\alpha)}{\partial\alpha^2}\Big|_{\alpha=0} =$$

$$= a_4 + \frac{p_0}{\rho_0^2}(\rho-\rho_0) + \frac{\Delta K_0}{18\rho_0^2}(\rho-\rho_0)^2 + \ldots$$

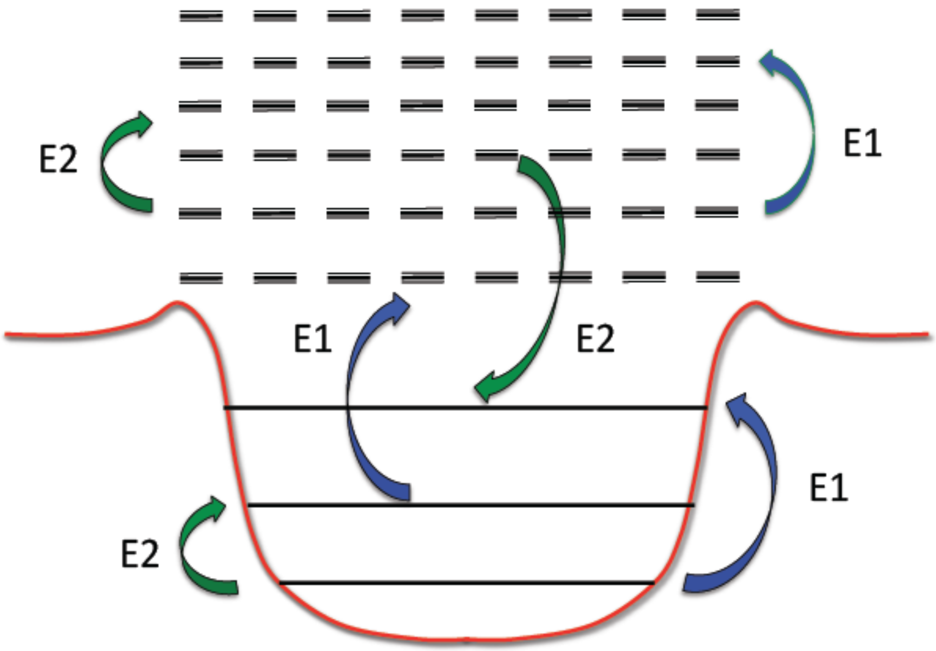
Strong correlation between neutron skin and S_2





Tamii et al., PRL 107, 062502 (2011)

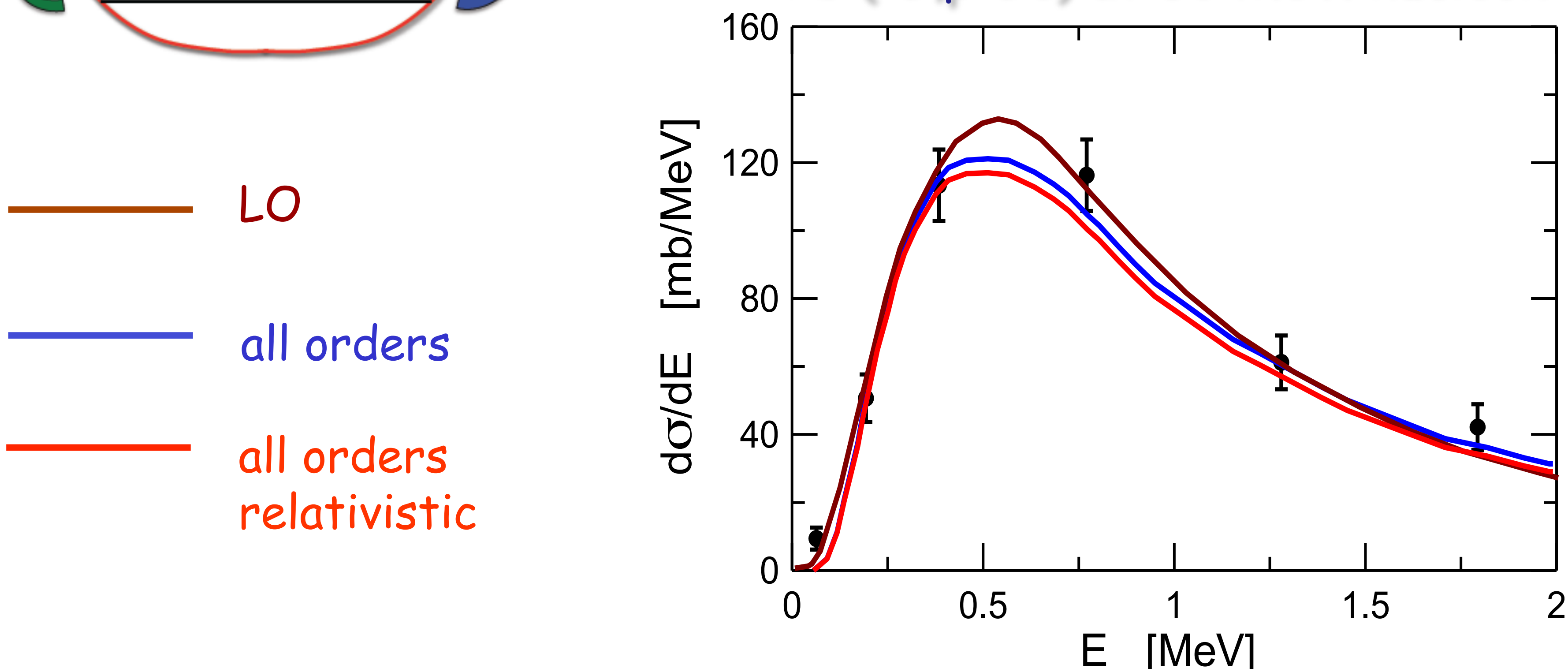
Reaction theory:
Higher-order effects and relativistic corrections



Relativistic CDCC
CB, PRL 94, 072701 (2005)

Ogata, CB, PTP 121 (2009), 1399
PTP 123 (2010) 701

Pb (^{8}B,p^{7}Be) at 83 MeV/nucleon



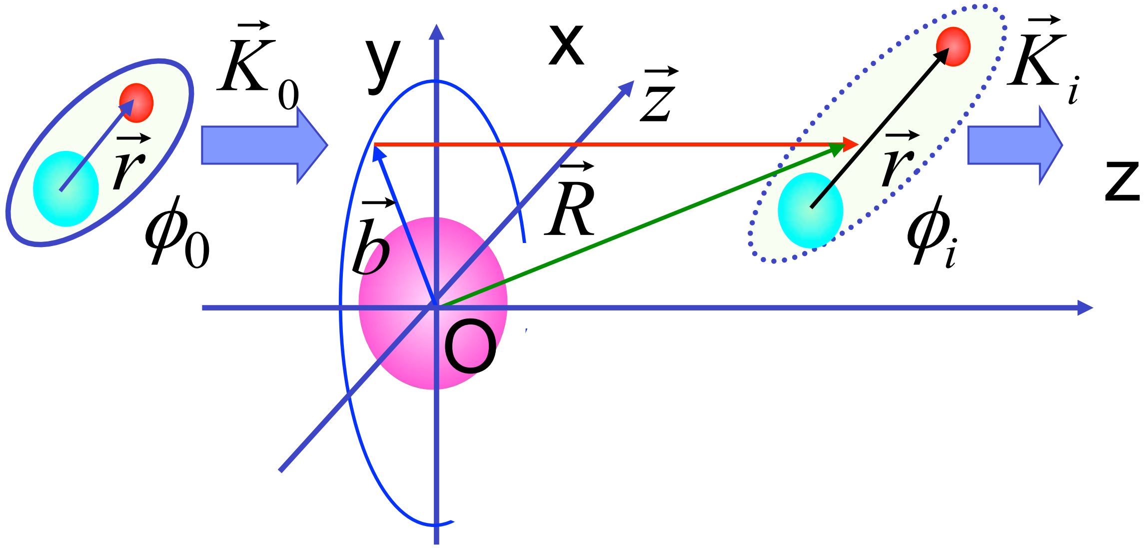
Higher order effects

Eikonal scattering waves $\hat{S}_i(K_i,\vec{R})$

$$\psi^{E-CDCC} = \sum_i \hat{\phi}_i(\vec{r})\ \hat{S}_i(b,z)\exp(i\vec{K}_i\cdot\vec{R})$$

$$K_i = \sqrt{2\mu_R(E-\varepsilon_i)}/\hbar,$$

Energy conservation



- Boundary condition

$$\hat{S}_i(b,z) \xrightarrow{z\to-\infty} \delta_{i,0}$$

$$\Delta\hat{S}_i(b,z)\cong 0 \Rightarrow \frac{i\hbar^2K_i}{\mu_R}\frac{d}{dz}\hat{S}_i^{(b)}(z) = \sum_{i'}\mathrm{F}_{ii'}^{(b)}(z)\ \hat{S}_{i'}^{(b)}(z)e^{i(K_{i'}-K_i)z}$$

Relativistic effects

Form factor of non-rel. CDCC

$$F_{c'c}^{(b)}(Z) = \left\langle \Phi_{c'} \middle| U_{1A} + U_{2A} \middle| \Phi_c \right\rangle_{\mathbf{r}} e^{-i(m-m')\phi} = \sum_{\lambda} F_{c'c}^{(b);\lambda}(Z)$$

Lorentz tranformation of form factor and coordinates

$$F_{c'c}^{(b);\lambda}(Z) \rightarrow f_{\lambda,m'-m} \gamma F_{c'c}^{(b)\lambda}(\gamma Z)$$

$$f_{\lambda,m'-m}^{\mathrm{Coul}} = \begin{cases} 1/\gamma & (\lambda=1,\ m'-m=0) \\ \gamma & (\lambda=2,\ m'-m=\pm 1) \\ 1 & (\mathrm{otherwise}) \end{cases}$$

$$f_{\lambda,m'-m}^{\mathrm{nucl}} = 1$$

Ogata, CB, PTP 121 (2009), 1399
PTP, 123 (2010) 701

Swiss candidate's platform: PowerPoint

By **Moni Basu**, CNN
September 17, 2011 -- Updated 1513 GMT (2313 HKT)

Mathias Poehm believes PowerPoint presentations dilute the point, dull the speech and make people less persuasive.

(CNN) -- Taxes, health care, jobs. These are issues that are center stage in U.S. elections. But a parliamentary candidate in Switzerland has a slightly different platform: PowerPoint.

Come again? Yes, we're talking about the computer program that has become the tool of choice for public speakers of all varieties -- such as politicians, businessmen, and educators.

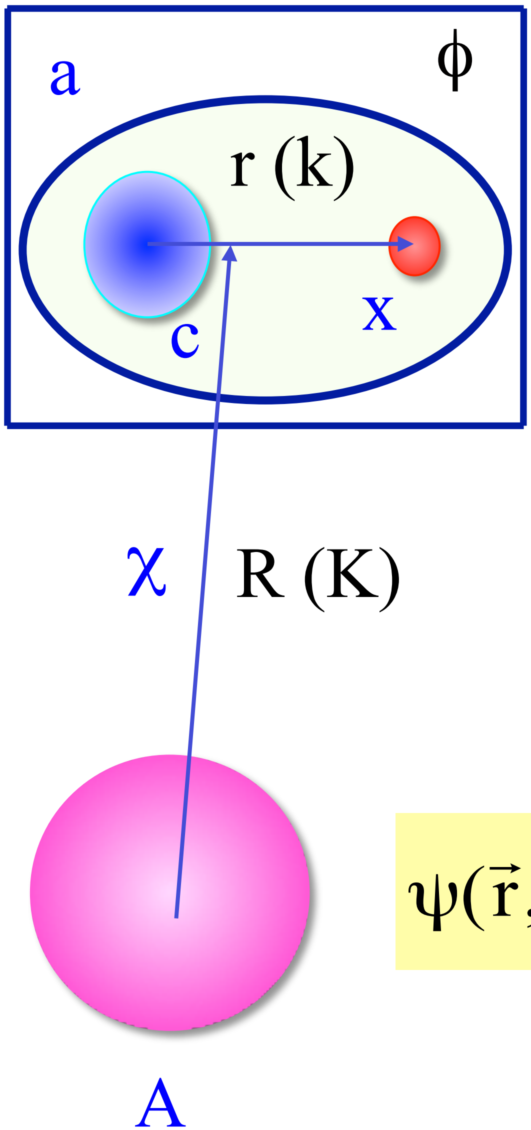
Matthias Poehm would rather see it all stopped. No more discussion points. No more, "Next slide, please." No more droopy eyes tired of following along.

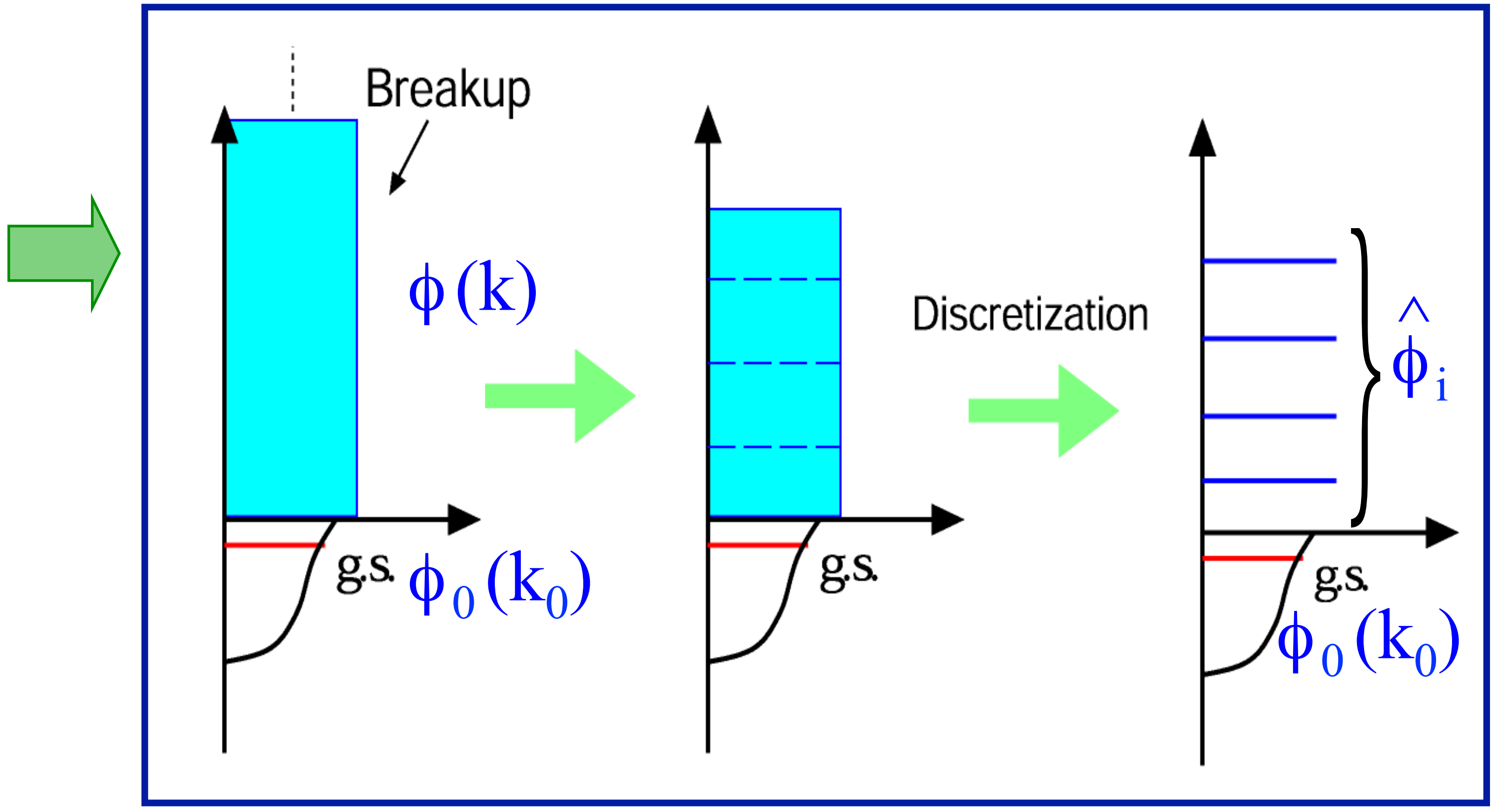
The Swiss public speaking coach believes PowerPoint presentations dilute the point, dull the speech and in the end, make people less persuasive. They are also a huge waste of money, Poehm says.

STORY HIGHLIGHTS

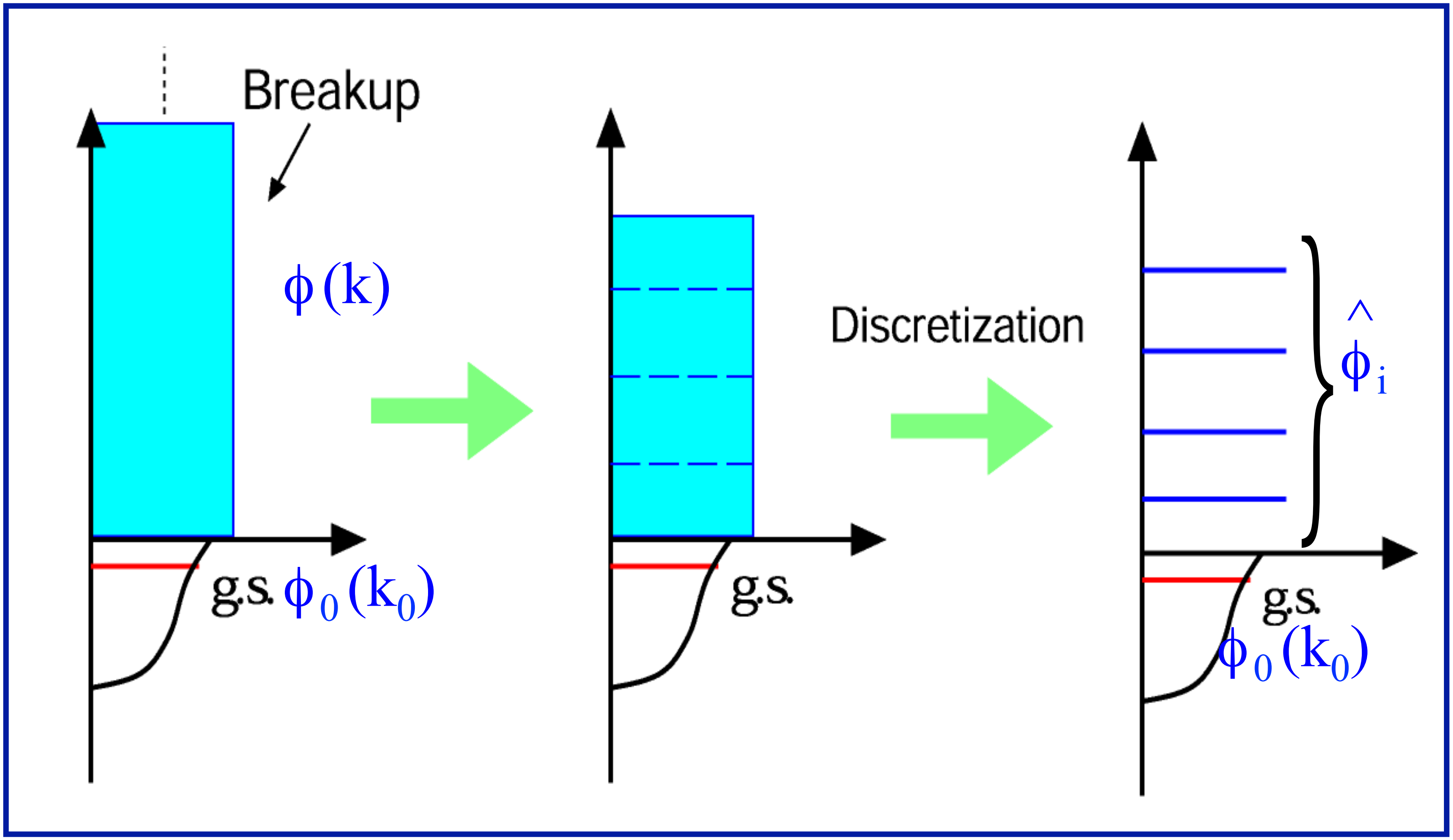
- Forget taxes or jobs. Mathias Poehm is rallying against PowerPoint
- The Swiss public speaking coach thinks the program dulls speech

Theory movie in next 5 transparencies (enjoy!)©

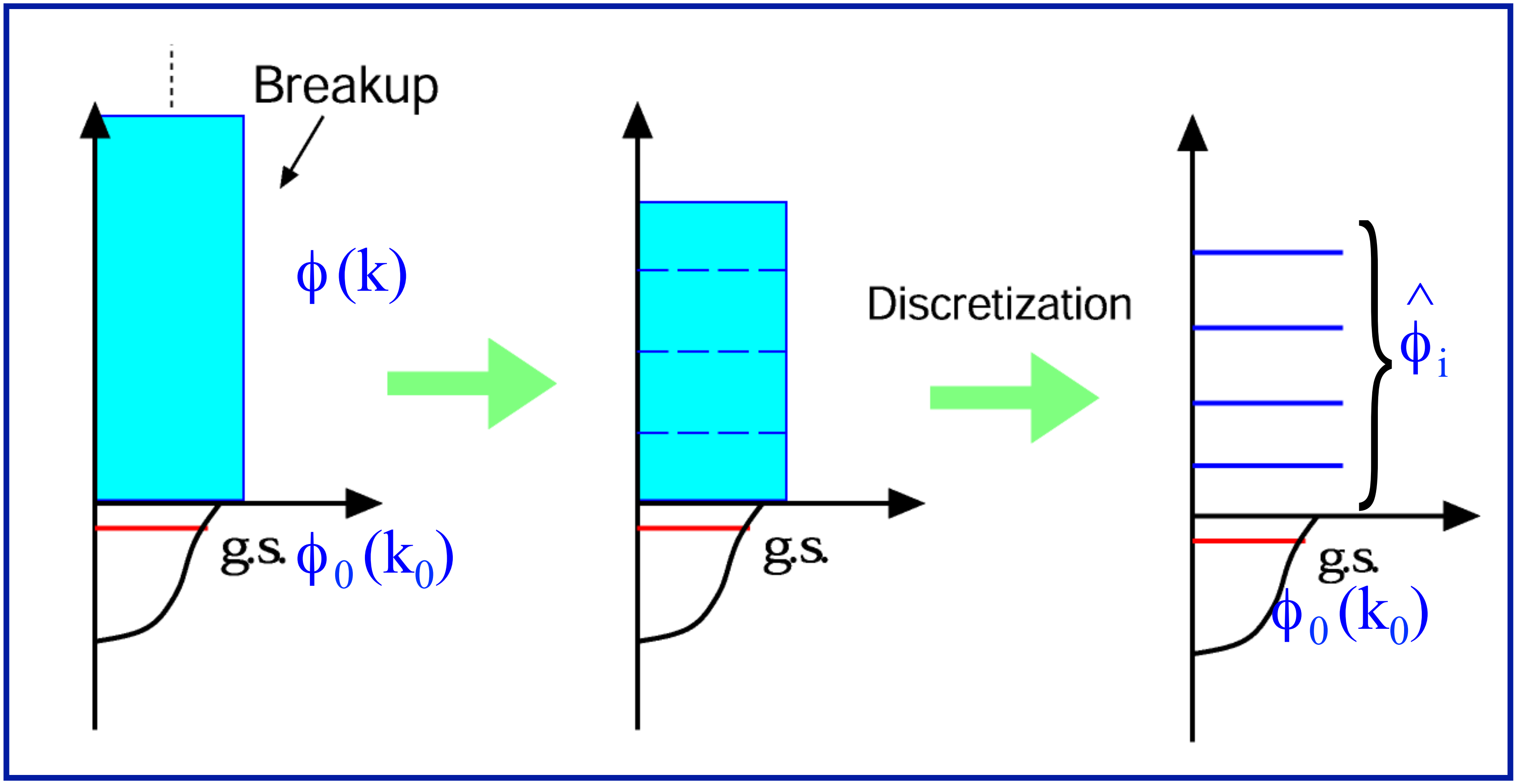




$$\psi(\vec{r},\vec{R}) = \varphi_0(k_0,\vec{r})\chi_0(K_0,\vec{R}) + \int_0^\infty \varphi(k,\vec{r})\chi(K,\vec{R})\,dk$$

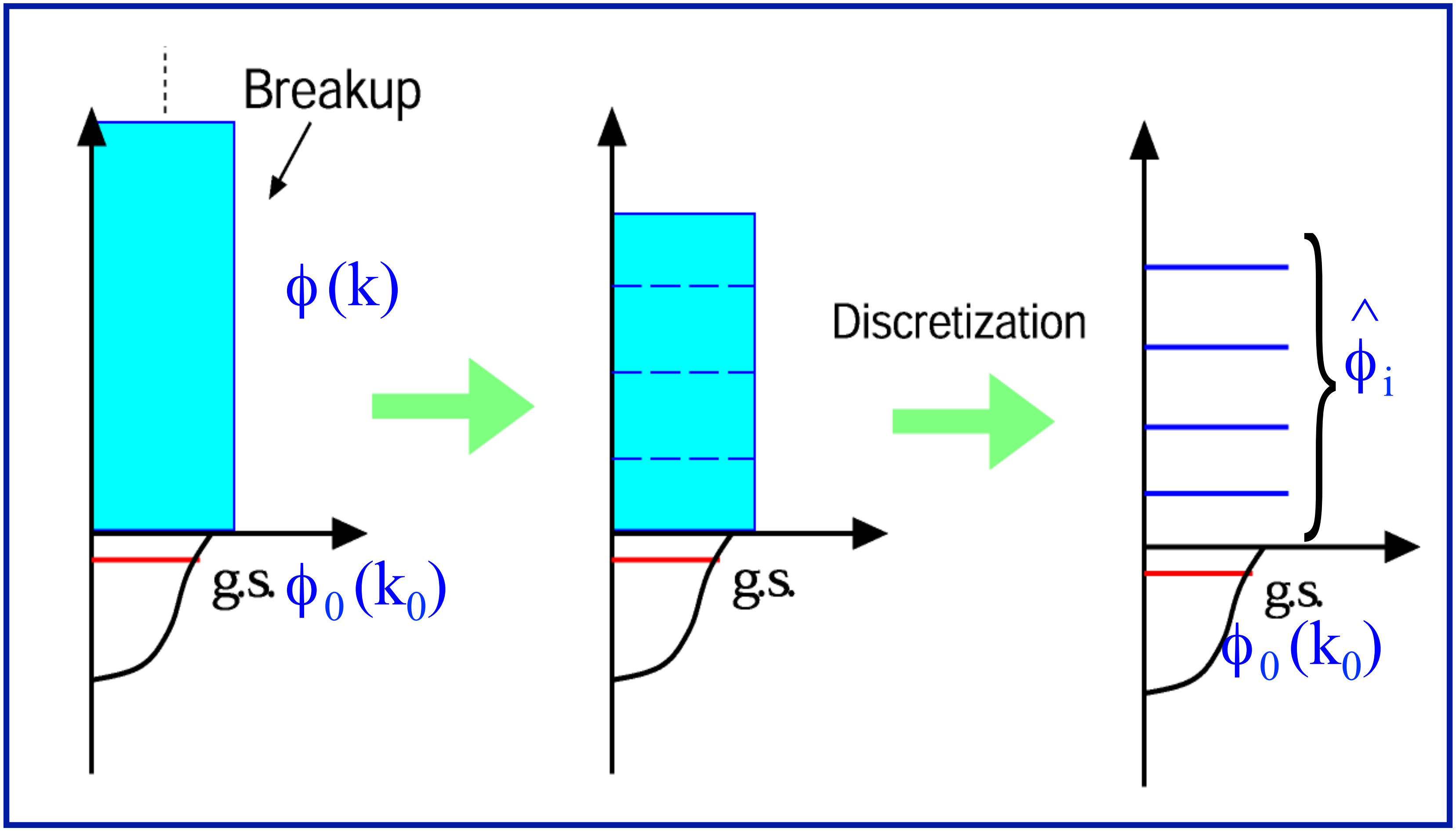


$$\psi(\vec{r},\vec{R}) = \varphi_0(k_0,\vec{r})\chi_0(K_0,\vec{R}) + \int_0^\infty \varphi(k,\vec{r})\chi(K,\vec{R})\,dk$$



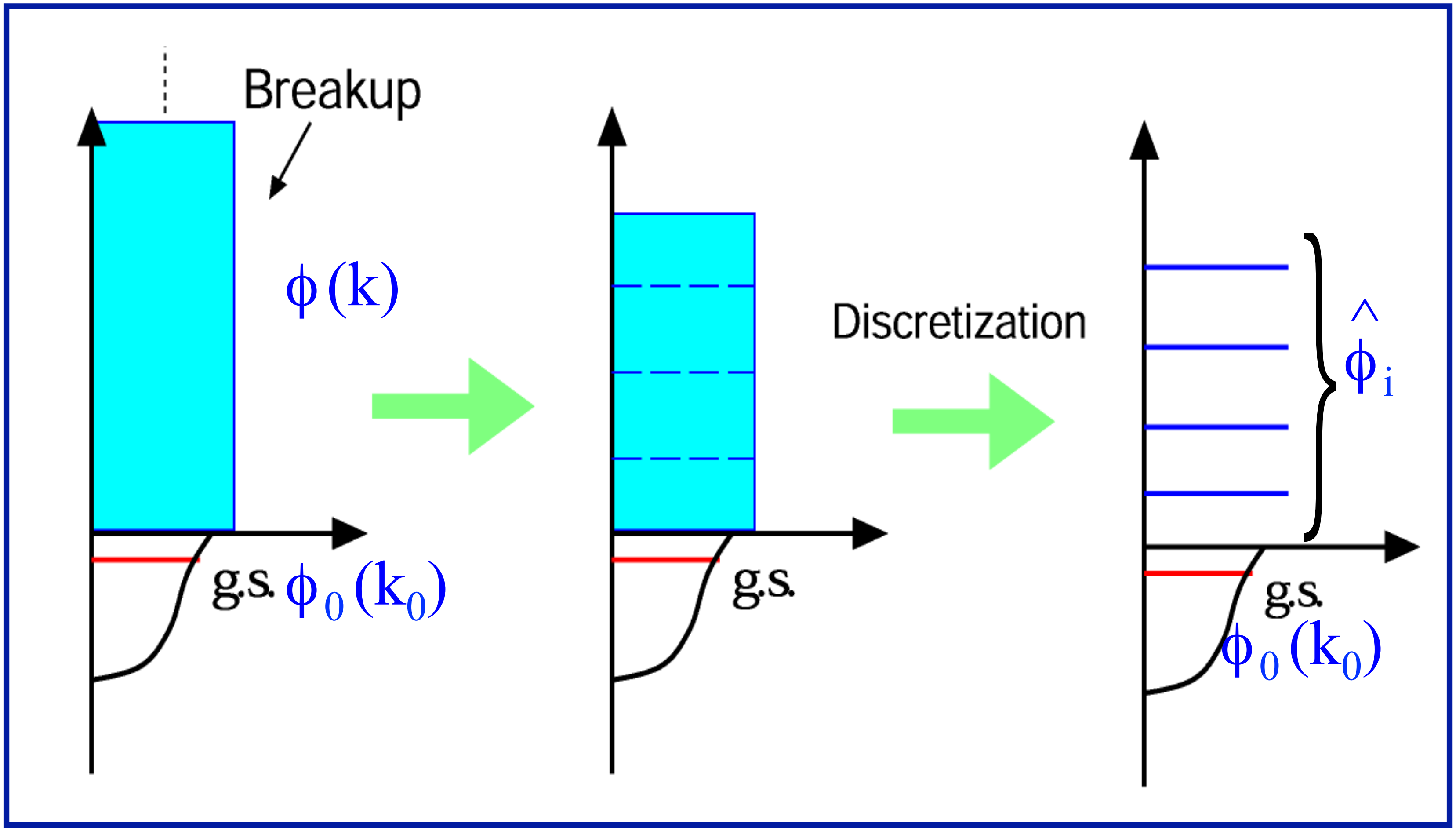
$$\psi(\vec{r},\vec{R}) = \varphi_0(k_0,\vec{r})\chi_0(K_0,\vec{R}) + \int_0^\infty \varphi(k,\vec{r})\chi(K,\vec{R})\,dk$$

Truncation and Discretization



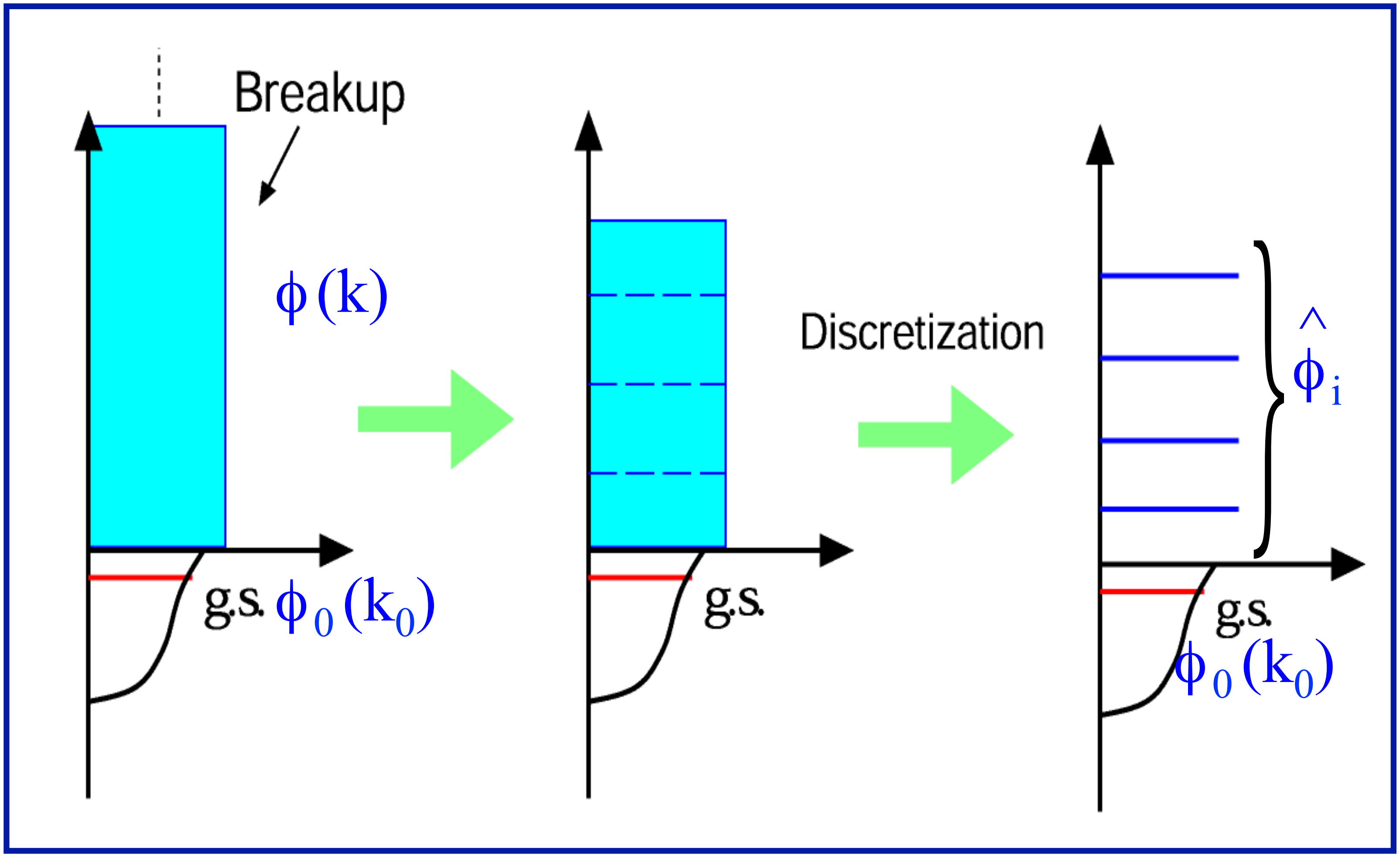
$$\psi(\vec{r},\vec{R}) \cong \varphi_0(k_0,\vec{r})\chi_0(K_0,\vec{R}) + \sum_{i=1}^{i_{max}} \int_{k_{i-1}}^{k_i} \varphi(k,\vec{r})\chi(K,\vec{R})\,dk$$

Truncation and Discretization



$$\psi(\vec{r},\vec{R}) \cong \varphi_0(k_0,\vec{r})\chi_0(K_0,\vec{R}) + \sum_{i=1}^{i_{max}} \chi(K_i,\vec{R}) \int_{k_{i-1}}^{k_i} \varphi(k,\vec{r})\,dk$$

Truncation and Discretization



$$\psi(\vec{r},\vec{R}) \cong \varphi_0(k_0,\vec{r})\chi_0(K_0,\vec{R}) + \sum_{i=1}^{i_{max}} \chi(K_i,\vec{R}) \int_{k_{i-1}}^{k_i} \varphi(k,\vec{r})\,dk$$

THE END.

$$\psi^{CDCC}(\vec{r},\vec{R}) = \sum_{i=0}^{i_{max}} \hat{\varphi}_i(\vec{r})\hat{\chi}_i(K_i,\vec{R})$$

Truncation and Discretization

Example

Reation

^{208}Pb(^{8}B, ^{7}Be+p) at 250 A MeV and 100 A MeV

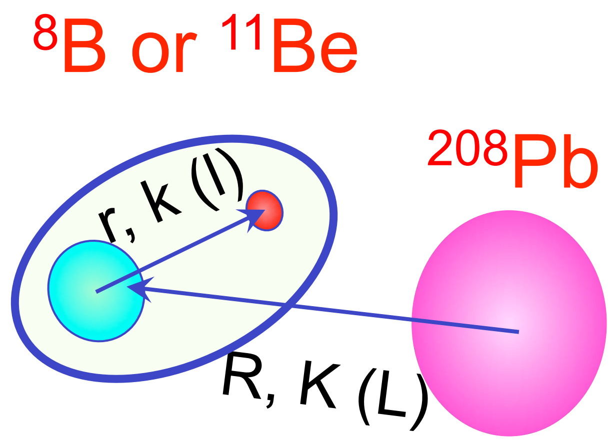
^{208}Pb(^{11}Be, ^{10}Be+n) at 250 A MeV and 100 A MeV

Projectile wave function and distorting potential

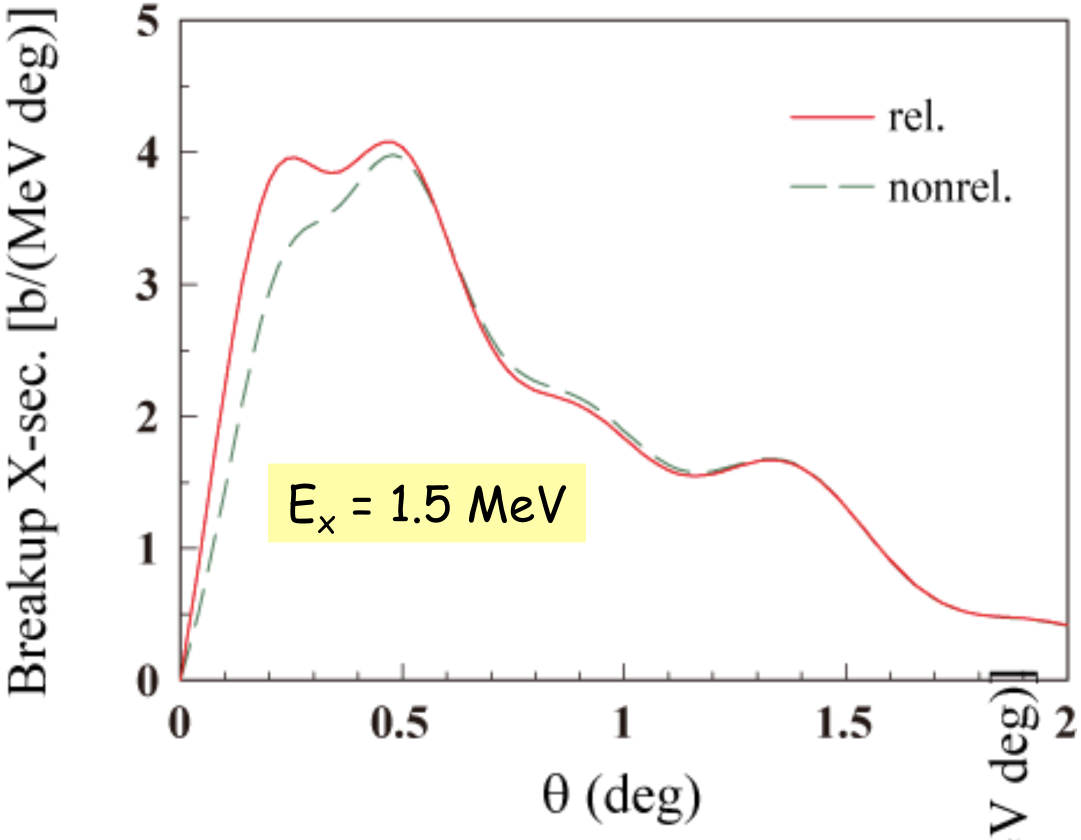
Standard Woods-Saxon

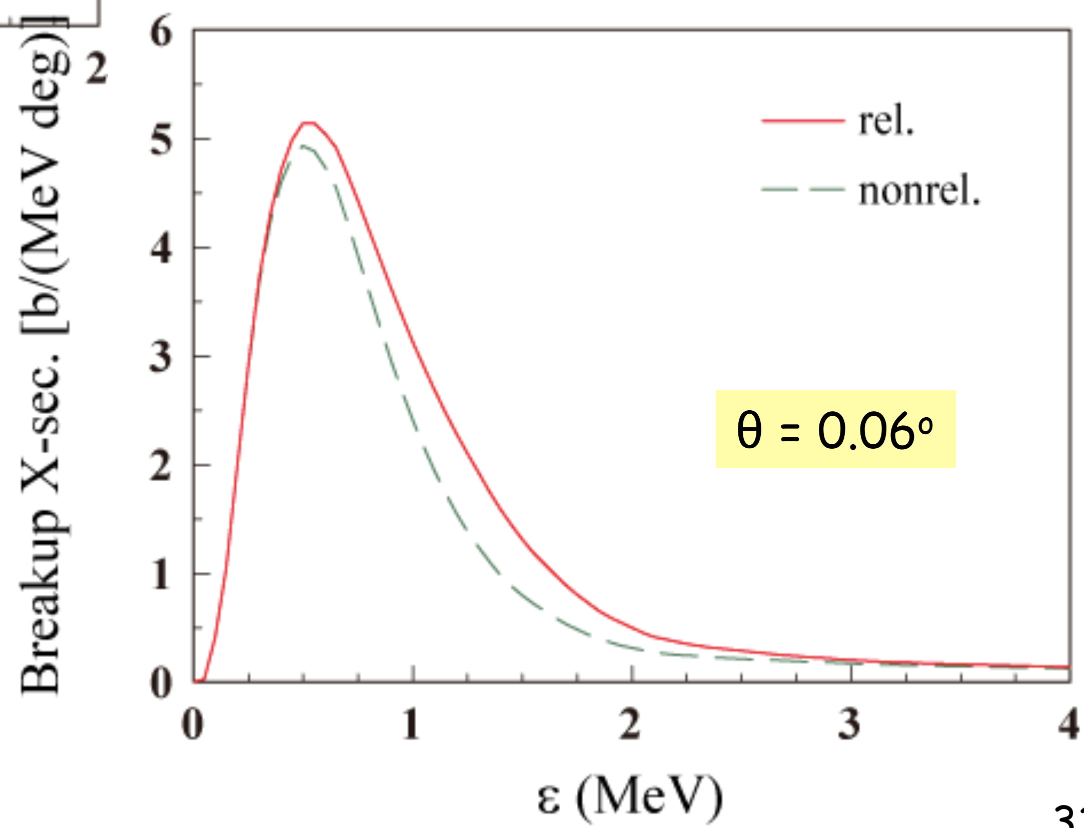
Modelspace

^{8}B	^{11}Be
l_{max}= 3	l_{max}= 3
N_s=20, $N_{p\text{-}d}$=10 ,	$N_{s,p}$=20, N_d=10 ,
N_f=5	N_f=5
ε_{max}=10 MeV	ε_{max}=10 MeV
r_{max}= 200 fm	r_{max}= 200 fm
R_{max}= 500 fm	R_{max}= 450 fm
N_{ch} = 138	N_{ch} = 166



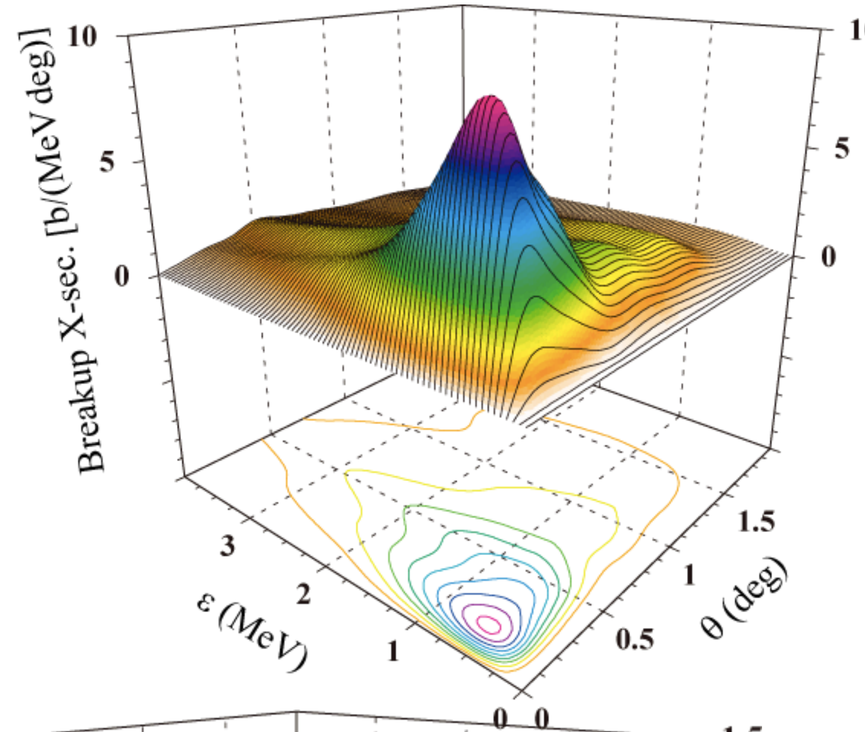
Pb(^{8}B,p^{7}Be) at 250 MeV/nucleon



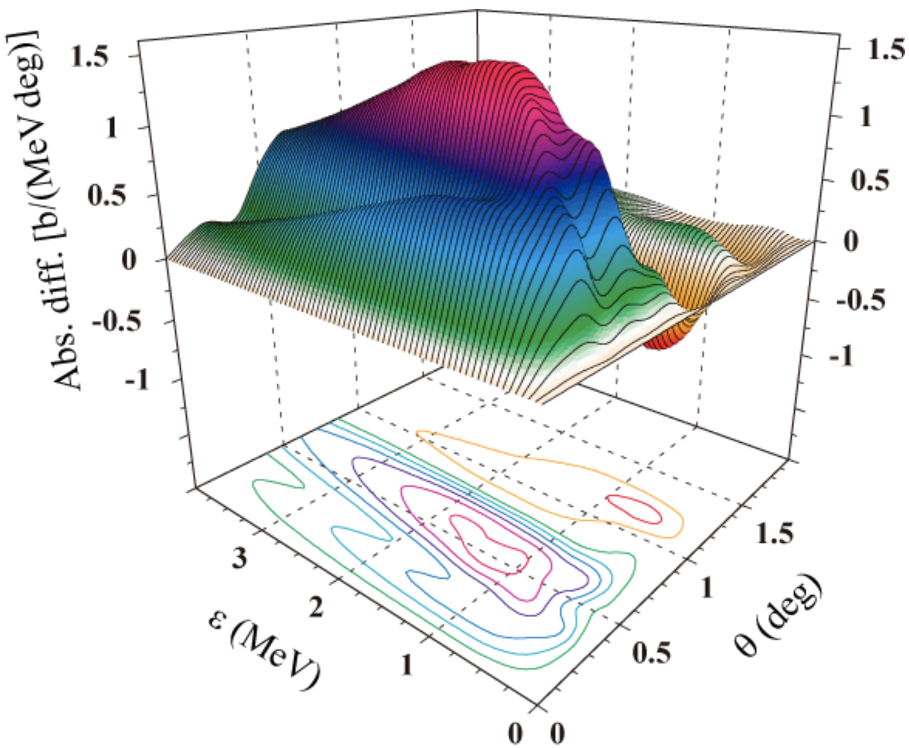


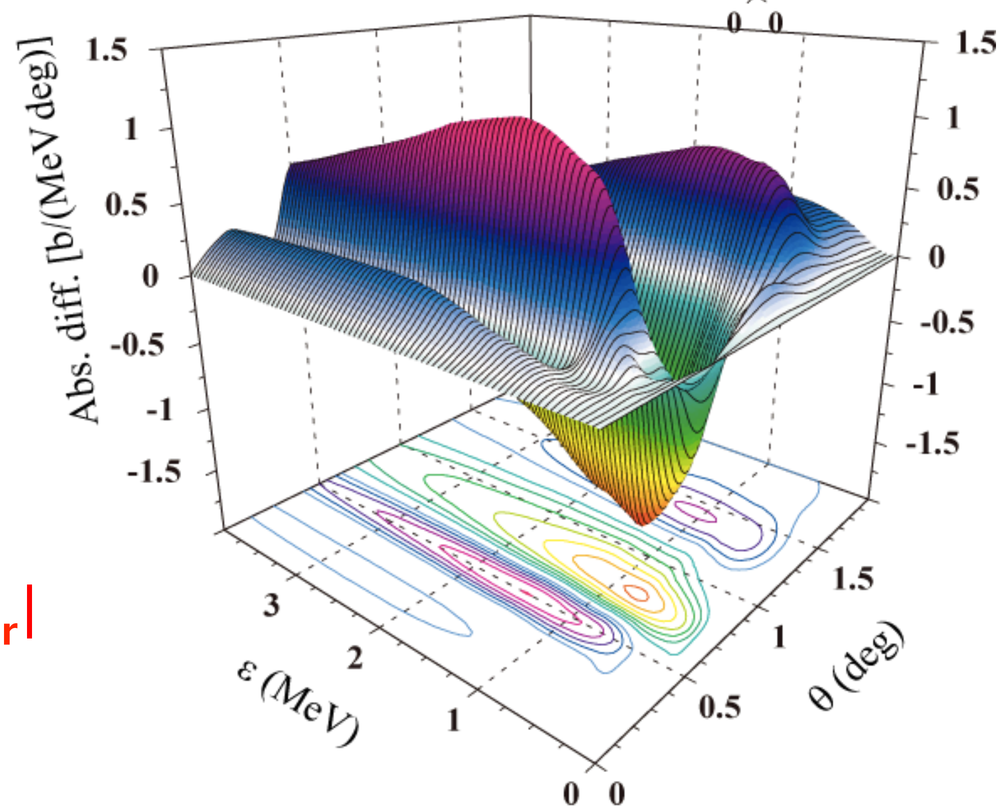
Pb(^{8}B,p^{7}Be) at 250 MeV/nucleon

all orders



$|\sigma_{all} - \sigma_{NR}|$





$|\sigma_{all} - \sigma_{no\text{-}nuclear}|$

Pentagon Declares War Against PowerPoint

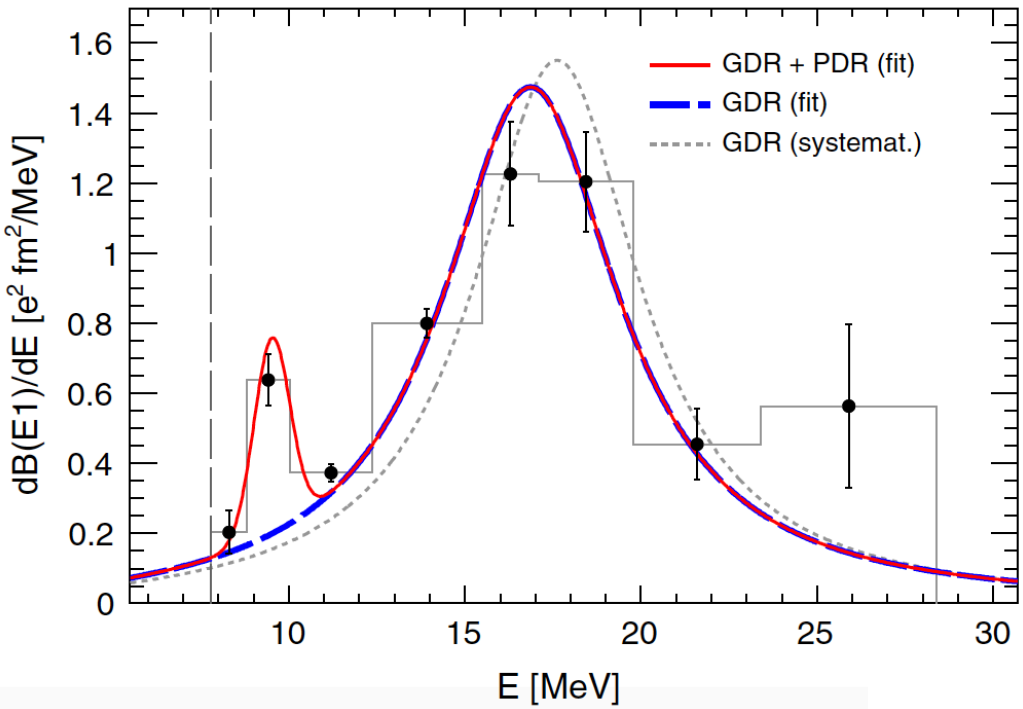
2 JANUARY 2009   5,751 VIEWS   NO COMMENT

The Wall Street Journal headline (4/26/00) announced, "The Pentagon Declares War on Electronic Slide Shows That Make Briefings a Pain." Not long after, General Hugh Shelton, chairman of the Joint Chiefs of Staff, issued an order to all military bases worldwide which translated as, "enough with the bells and whistle get to the point!"

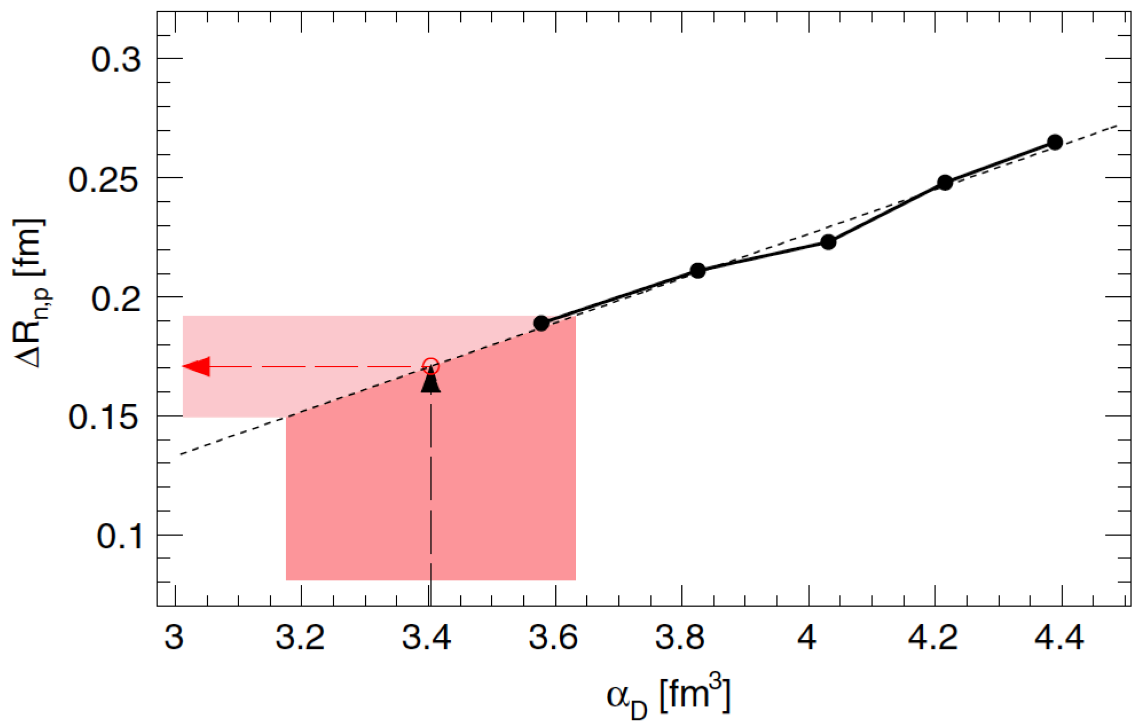
Army Secretary Louis Calderna suggests that the Pentagon's PowerPoint presentations are alienating lawmakers. He says, "People are not listening to us because they are spending so much time trying to understand these incredibly complex slides." Navy Secretary Richard Danzig announced that he was no longer willing to sit through PowerPoint slide shows, saying they were necessary only if the audience was "functionally illiterate."

It is true. Misuse of this wonderful, exciting technology can turn speakers into mere readers of captions for slides with the result being that *all personal communication is lost.* Bloated PowerPoint presentations have become a dance to the death-a veritable cure for insomnia.

Nuclear response for PDR, GDR and GQR



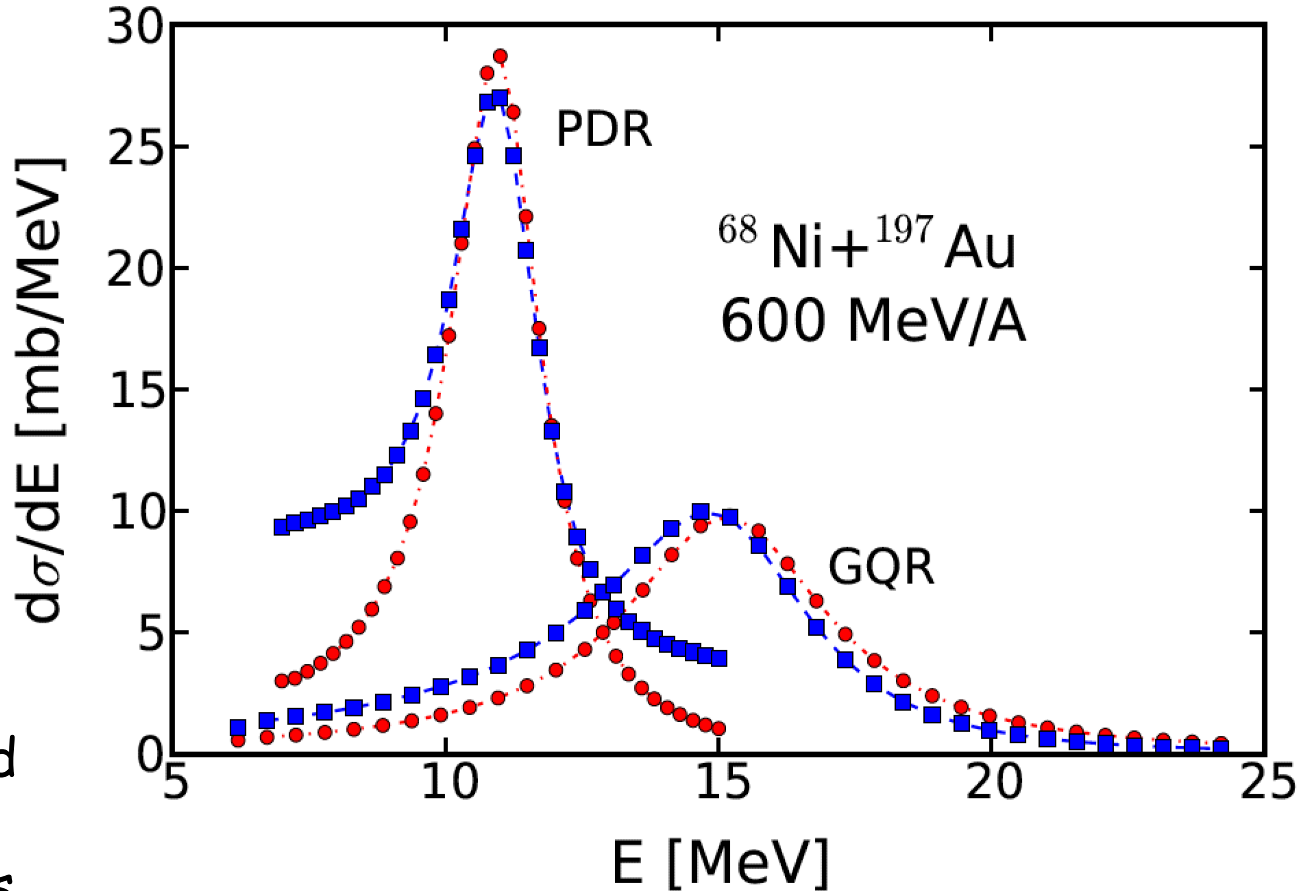
^{68}Ni



Rossi et al.,
PRL 11, 242503 (2013)

Dynamical coupling of PDR, GDR and GQR

Brady, Aumann, CB, Thomas
Phys. Lett. B 757, 553 (2016)



- Nuclear response fitted with Lorentzians
- Nuclear response discretized
- Coupled Channels calculations
- Cross sections

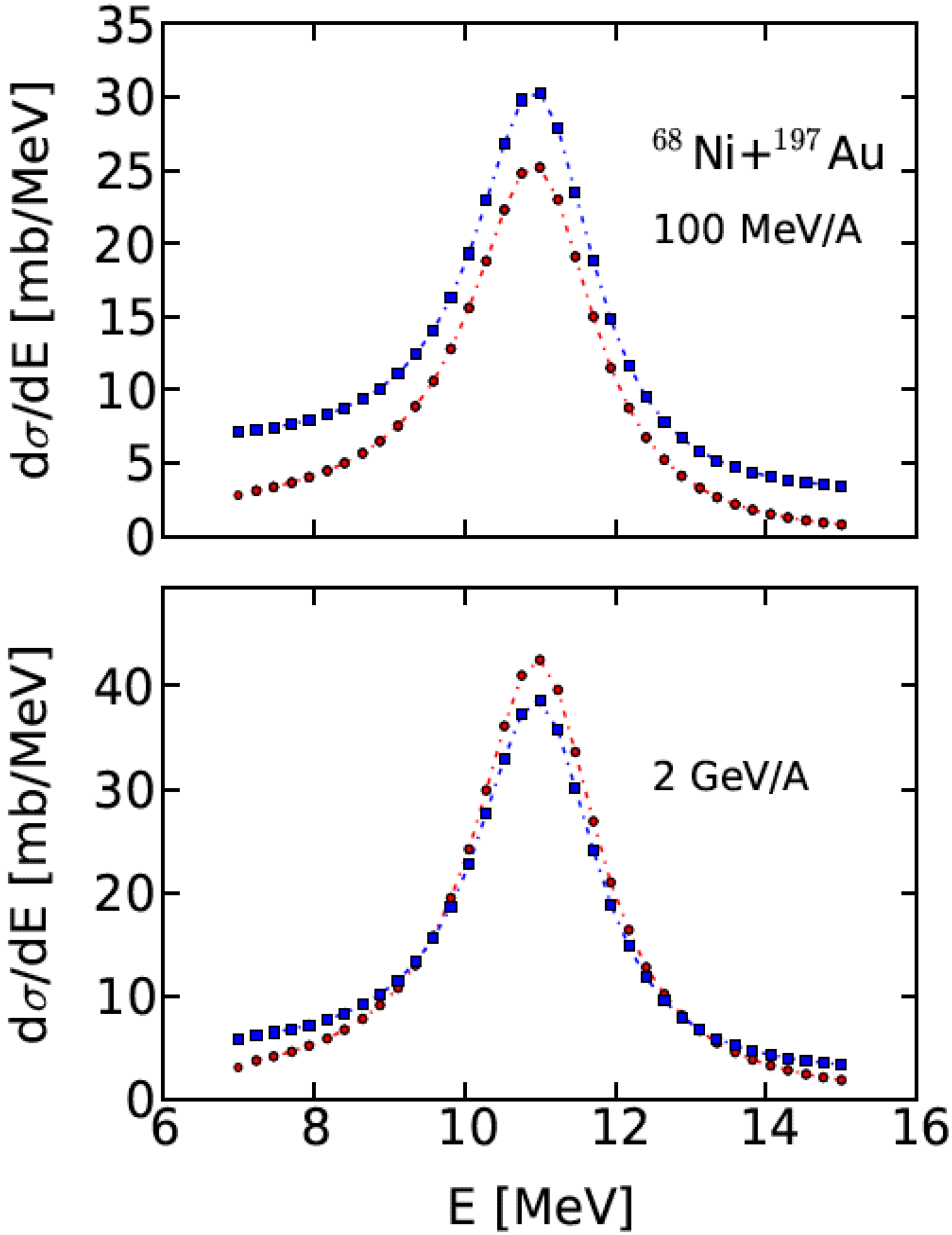
●. First order

● all orders relativistic

Dynamical coupling of PDR, GDR and GQR

Brady, Aumann, CB, Thomas
Phys. Lett. B 757, 553 (2016)

- Nuclear response fitted with Lorentzians
- Nuclear response discretized
- Coupled Channels calculations
- Cross sections



●. First order

● all orders relativistic

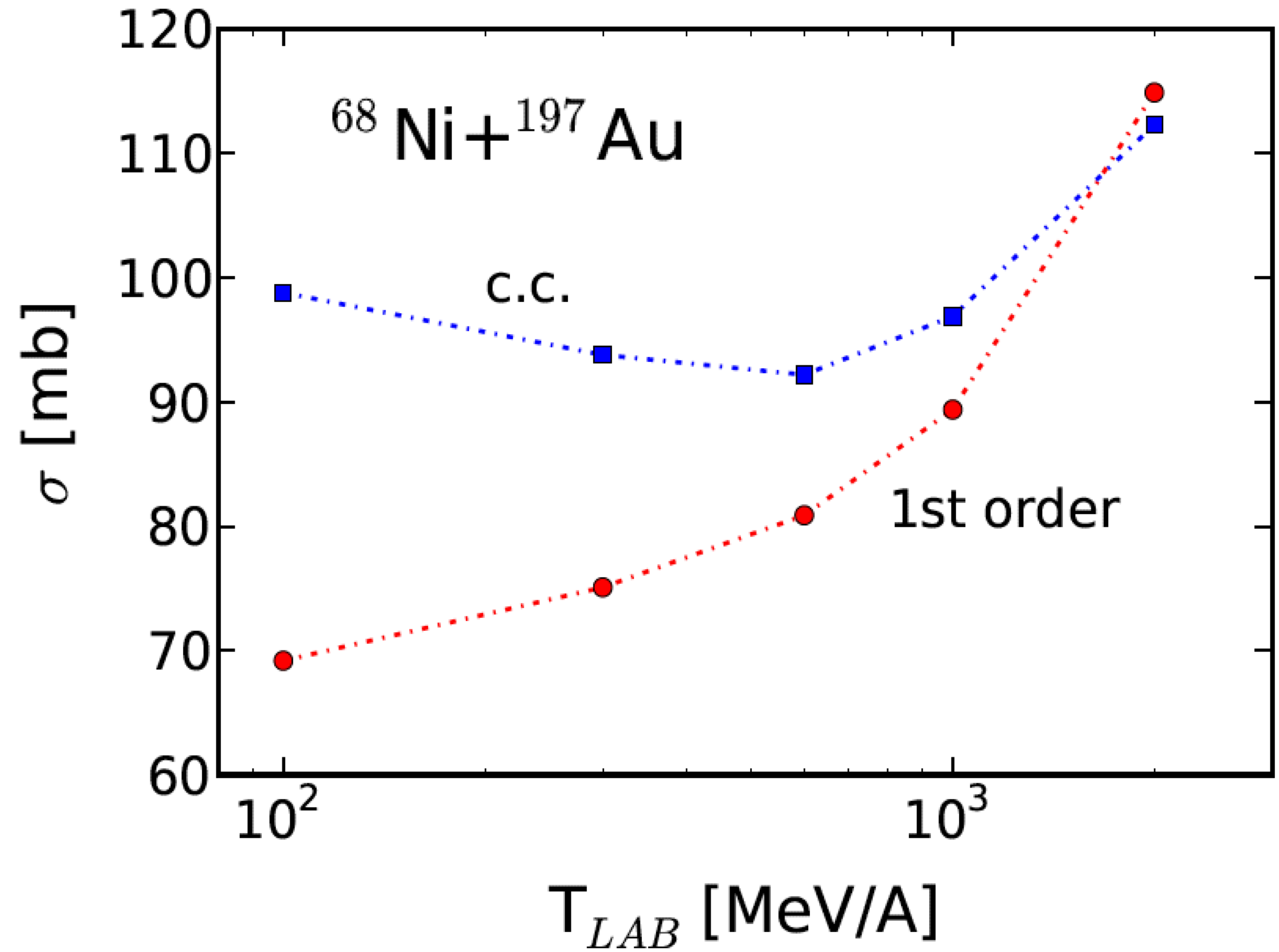
Dynamical coupling of PDR, GDR and GQR

Rossi at al.,
PRL 111, 242503 (2013)
→ α_D = 3.40 fm^3

Our new analysis
→ α_D = 3.16 fm^3

Neutron skin
→ Δr_n = 0.17 fm

Our new analysis
→ Δr_n = 0.16 fm



BUT, experimental error
= 7% for α_D and
= 0.2 for Δr_n

Summary:

- PDR
  - skins and halos (neutron stars, sun, supernovae)
  - structure in the continuum (effective interactions)
  - all depends on experimental precision – needs to improve
  - Because of low energies and high excitation probabilities

  → Higher order effects crucial for future experimental analyses of PDR strength

Important contribution to this work from:
Nathan Brady (A&M-Commerce)
Thomas Aumann (TU Darmstadt)
James Thomas (A&M-Commerce)