Пигми-дипольный резонанс в ядрах

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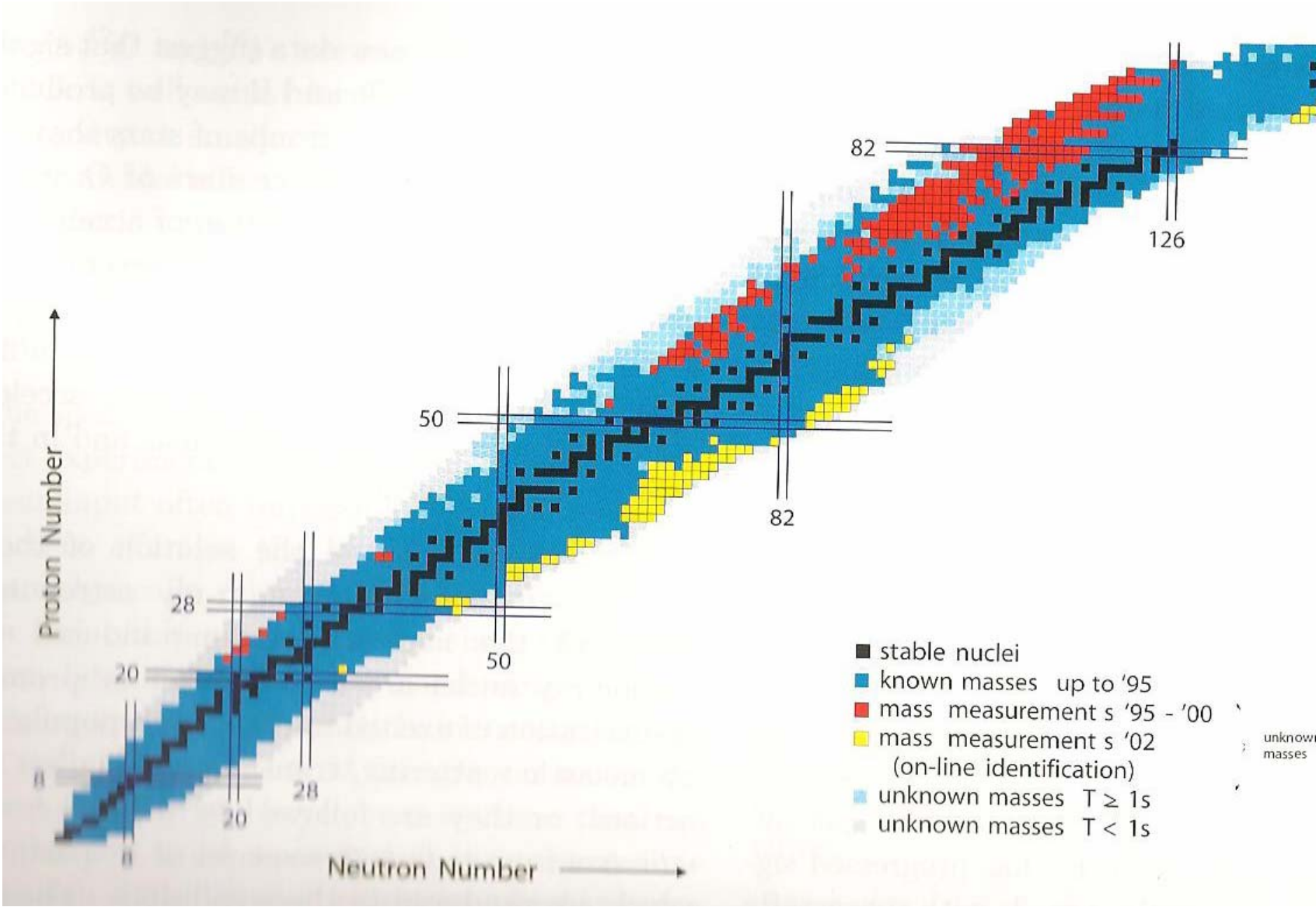
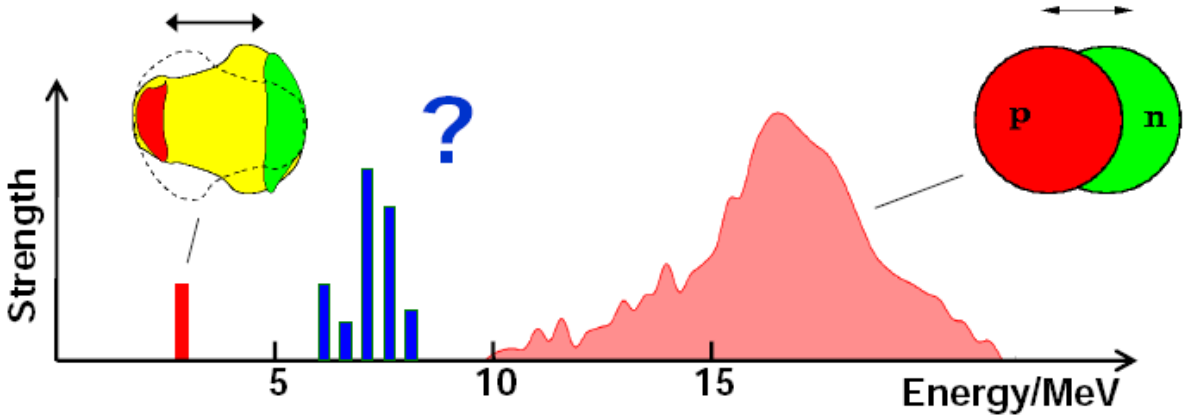
EMAX-09, 7-8.04.2009


82
126
50
82
28
50
20
28
20
8
8
Proton Number
Neutron Number
stable nuclei
known masses up to '95
mass measurement s '95 - '00
mass measurement s '02
(on-line identification)
unknown masses T ≥ 1s
unknown masses T < 1s
unknown masses

Electric Dipole Strength in Nuclei



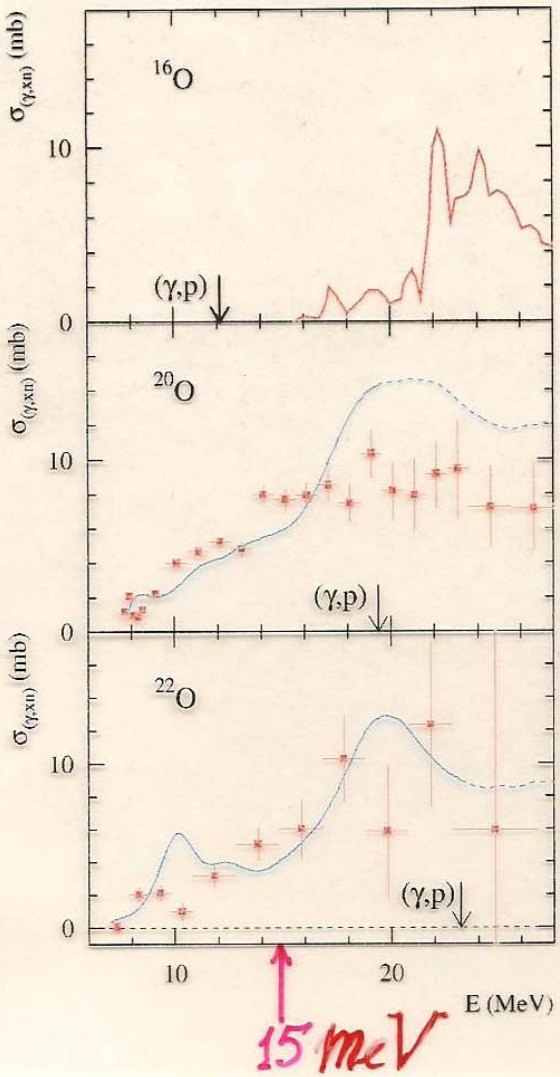
- Two Phonon Excitation: E_x ~ 3 MeV, B(E1) ~ 10^{-2} W.u.
- Giant Dipole Resonance: E_x ~ 18 MeV, B(E1) ~ 10 W.u.
- Pygmy Dipole Resonance ?

МГР:

- Определение: исчерпывание EWSR на (50-) 100% . (E1- до 1972г.)

- Ренессанс 1972-1991 (M.Harakeh, Van der Woude “Giant Resonances”, 2001)
- E2, E3, E4, M1, M2 (T=0,1); E0
- Г Т

T. Aumann et al.
Nucl. Phys. A687 (2001) 103c



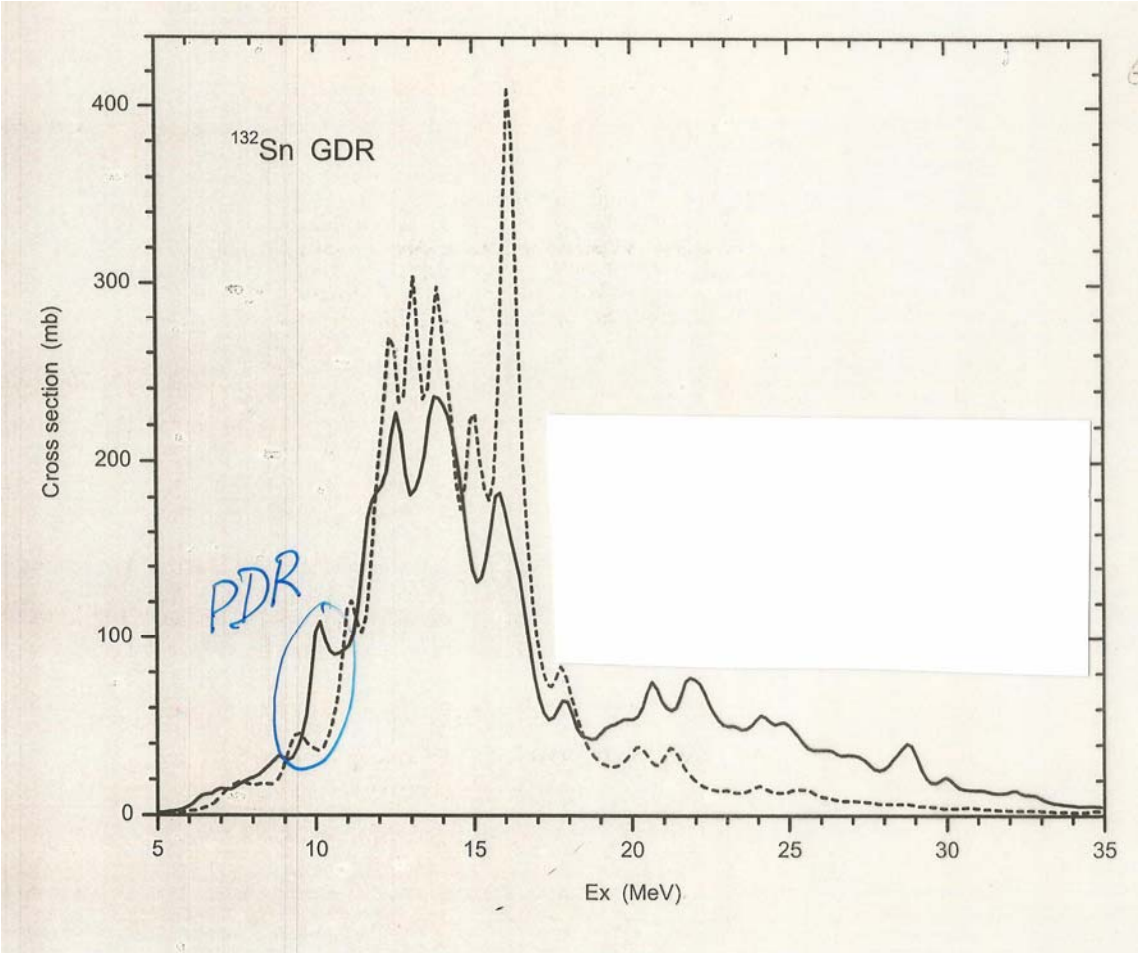
E1 Pygmy Resonance:

~10% of EWSR
up to E=15 MeV

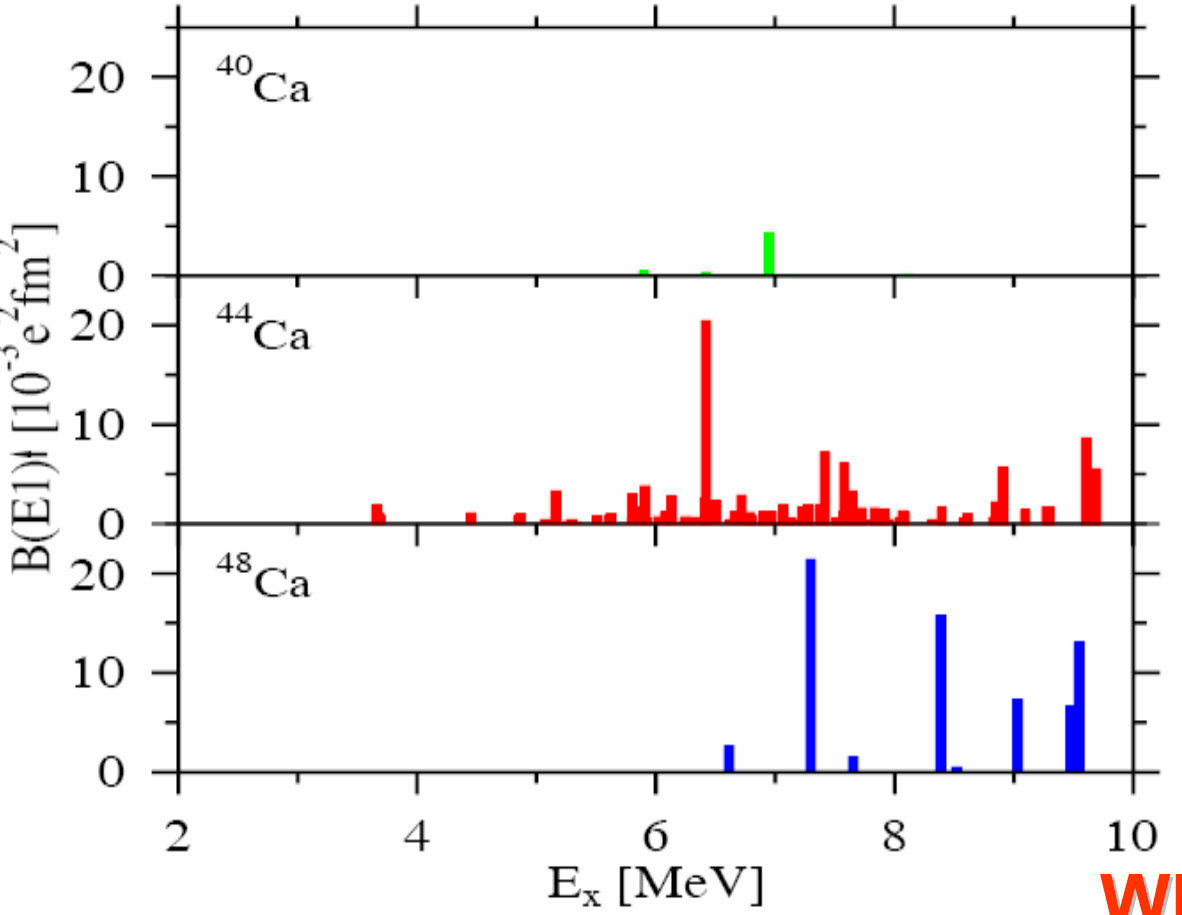
Figure 1.7: Photo-neutron cross sections measured for the unstable oxygen isotopes $^{20,22}O$ in comparison to that of the stable isotope ^{16}O. The blue curves show the result of a large-scale shell-model calculation [30]. The (γ,p) thresholds are indicated by arrows. Adapted from [29].

GDR and PDR in 150Sn

("primitive" ETFFS)



PDR in Ca isotopes (exp)



non-magic

T. Hartmann et al., Phys. Rev. Lett. ***93*** *(2004) 192501,*
Phys. Rev. C ***65*** *(2002) 034301,*
Phys. Rev. Lett. ***85*** *(2000) 274*

What kind of theory do we need?

- At present we were able to understand, in fact, only one important question in the PDR (microscopic) theory, namely

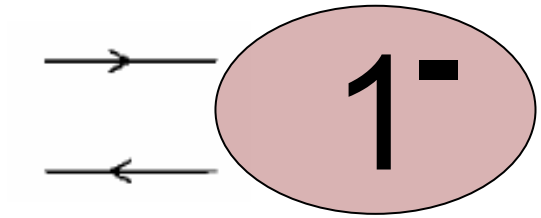
  it is necessary to go beyond the standard RPA or QRPA approaches and take into account :

  1. the phonon coupling
  2. and single-particle continuum

The wave function must contain simple (1p1h) and complex 1p1h⊗phonon configurations :

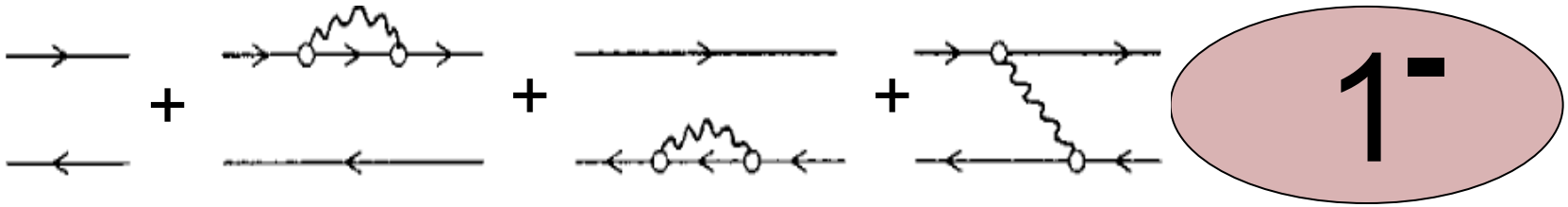
$$\Psi_i = \sum_{1,2} c^i_{12} \varphi^*_1 \varphi_2 + \sum_{1,2,s} c^i_{12s} \varphi^*_1 \varphi_2 \Phi_s$$

Theory:(Q)RPA versus ETFFS

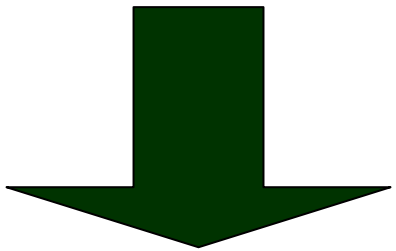


(Q)RPA

ETFFS

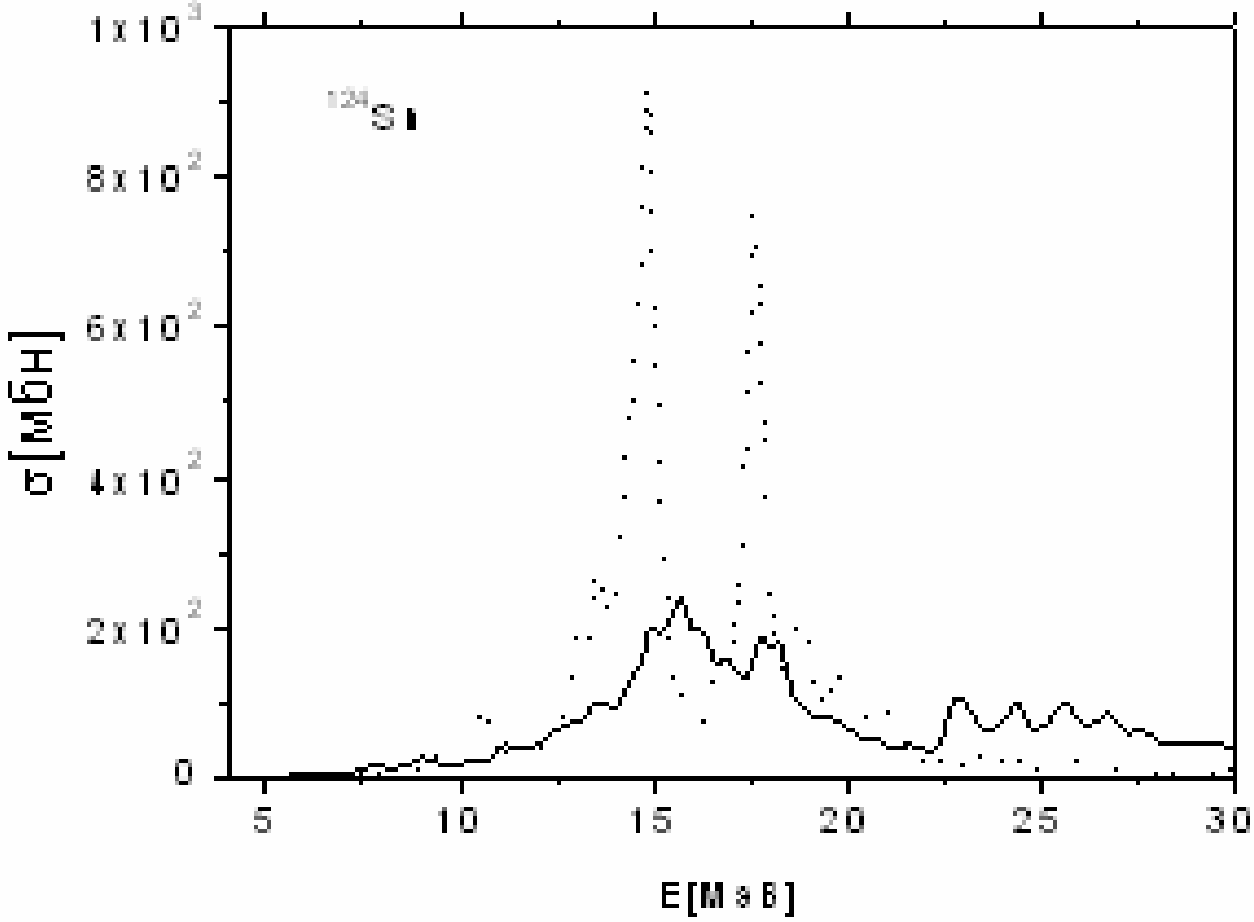


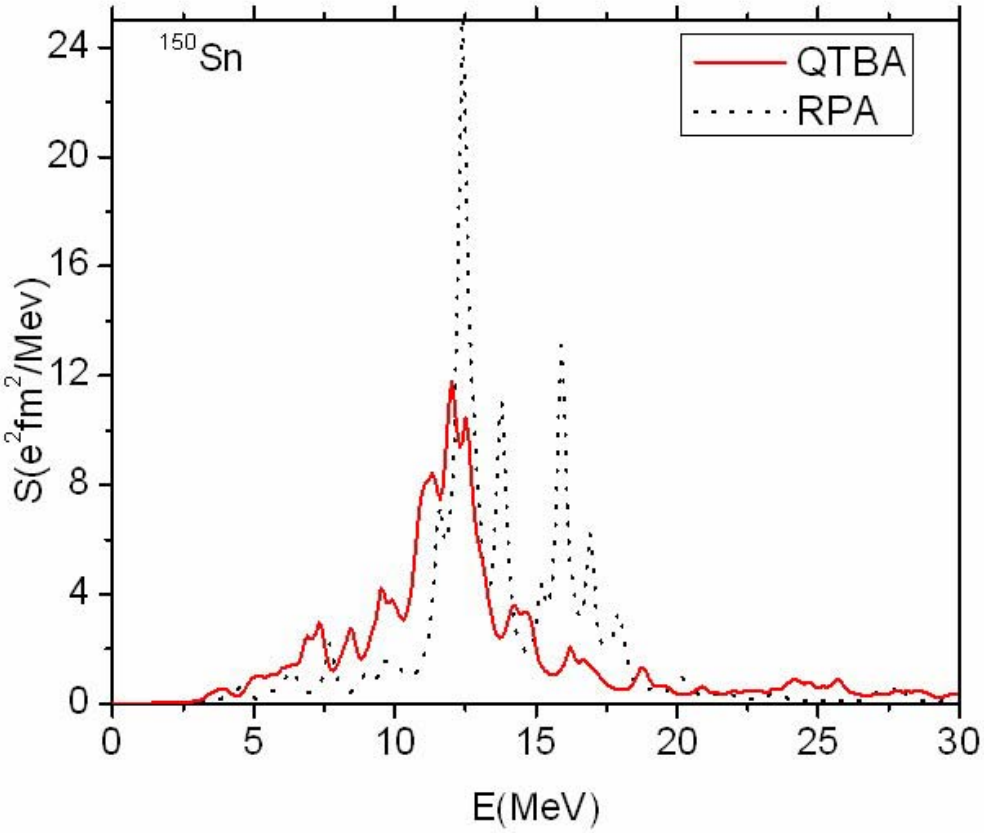
What is the role of complex configurations?

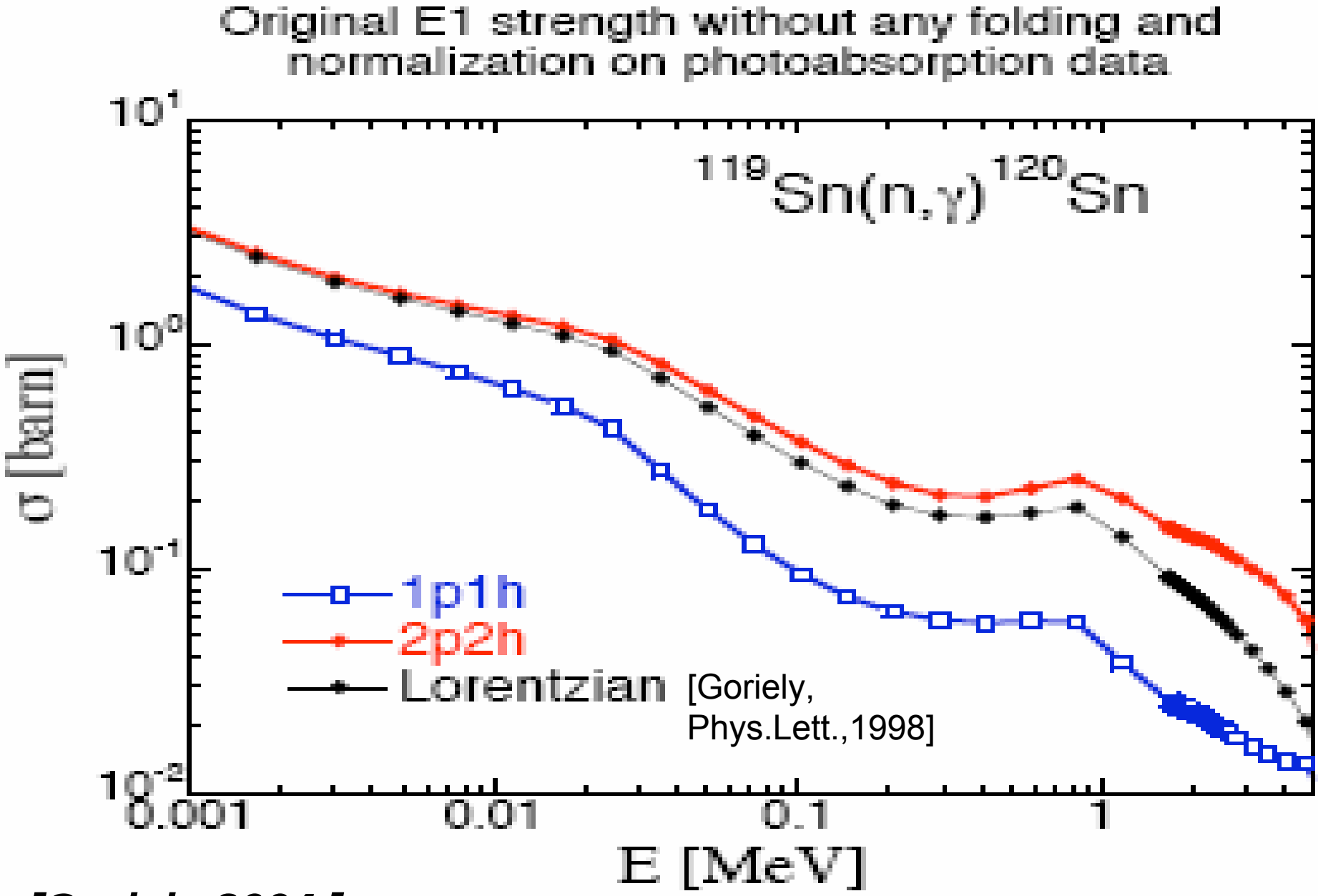


- Для астрофизики нужна теория с максимальной предсказательной силой.

- В настоящее время – это
- микроскопическая
- самосогласованная теория
- “QRPA+phonon coupling+continuum”
- (Skyrme forces)

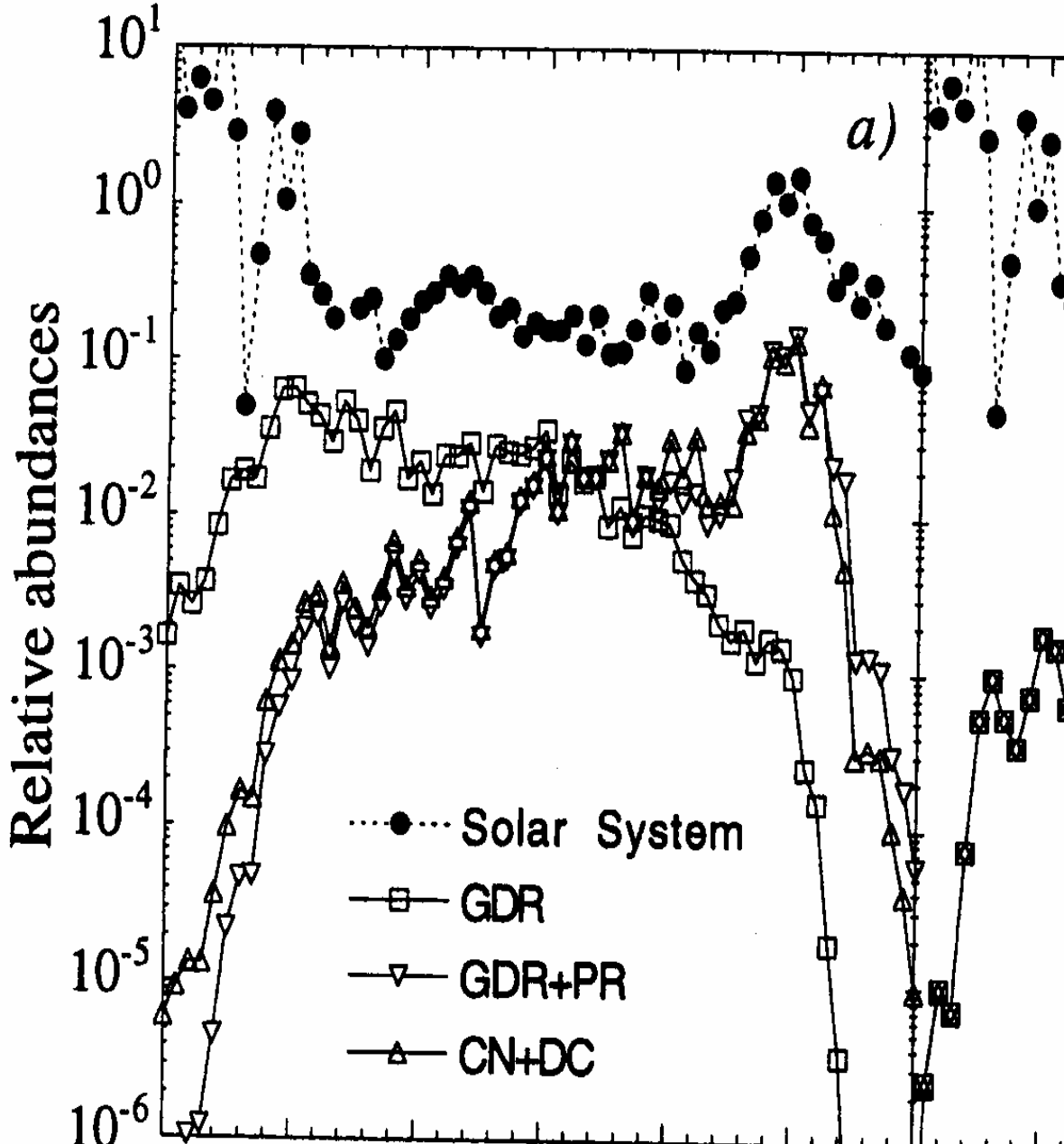

^{124}Sn
σ [мбн]
1x10^{3}
8x10^{2}
6x10^{2}
4x10^{2}
2x10^{2}
0
5
10
15
20
25
30
E[МэВ]


^{150}Sn
QTBA
RPA
S(e^{2}fm^2/Mev)
E(MeV)
0
4
8
12
16
20
24
0
5
10
15
20
25
30

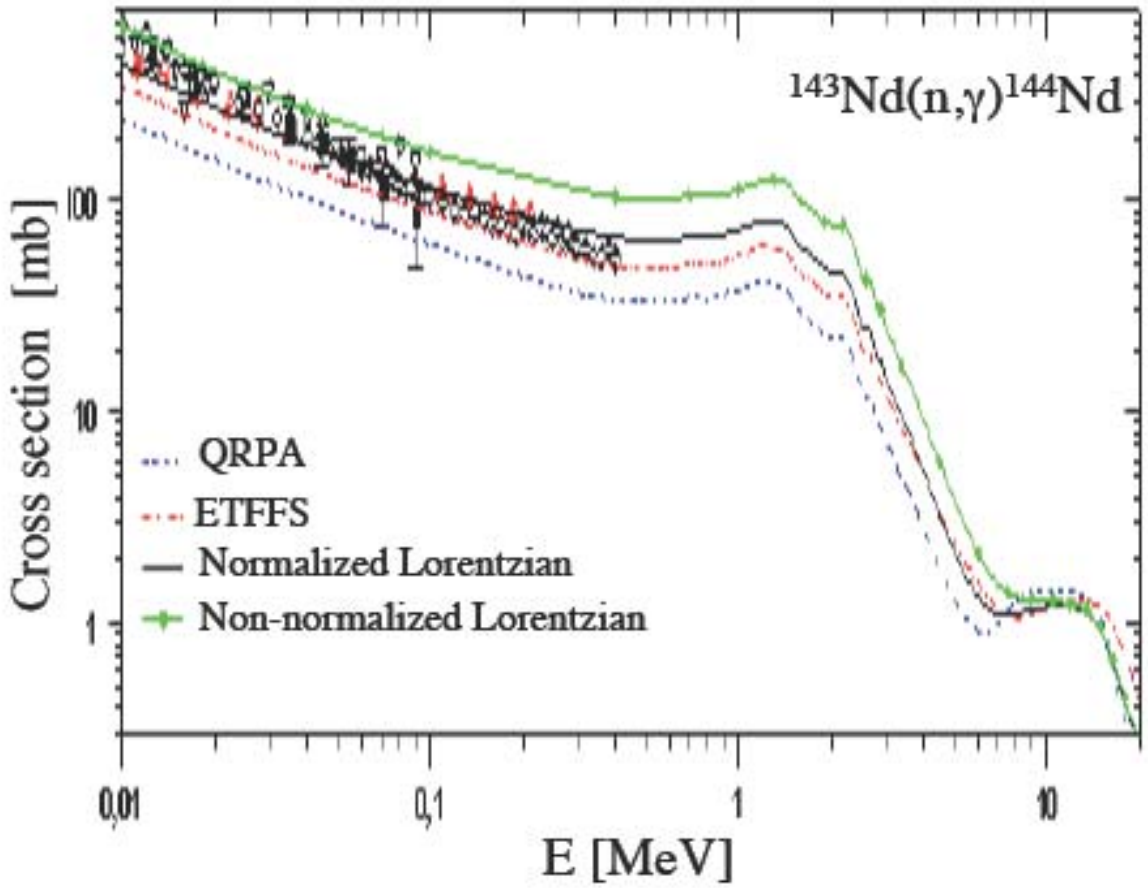


[Goriely,2004]

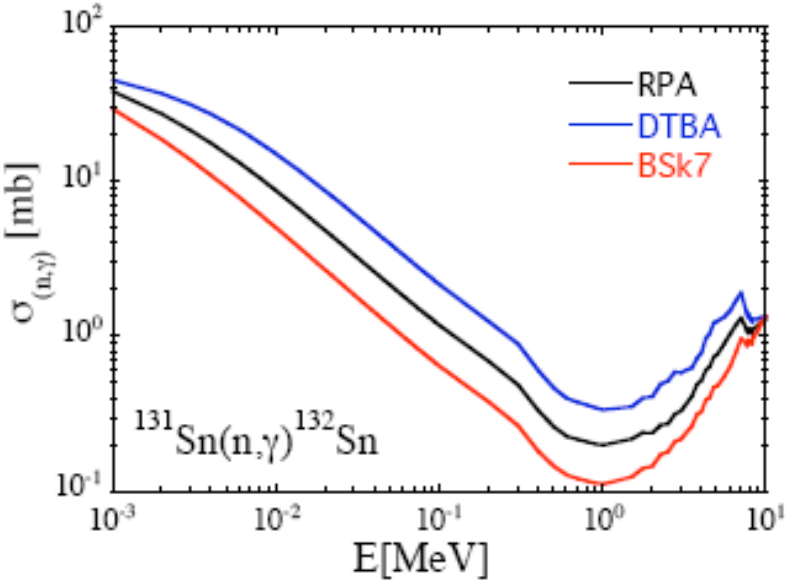
Goriely, 1998

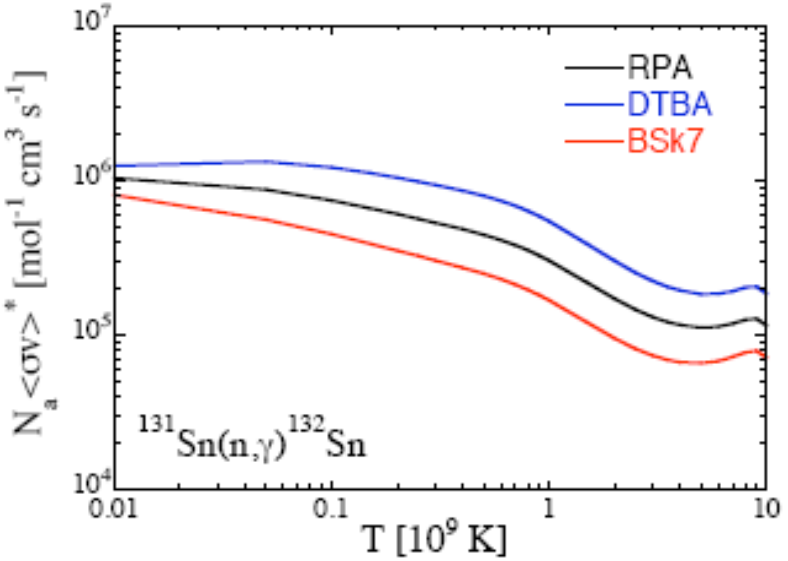


143Nd(n,γ)144Nd **cross sections** calculated with the use of the non-selfconsistent QRPA and ETFFS (QTBA) strength



131Sn(n,γ)132Sn cross sections and reaction rates obtained with the DTBA and RPA strengths





S. Kamerdzhiev[†1], V. Ponomarev[2], G. Tertychny[1], and the ELISe collaboration[3]

[1]IPPE Obninsk, Russia; [2]IKP TU Darmstadt, Germany; [3]GSI Darmstadt, Germany

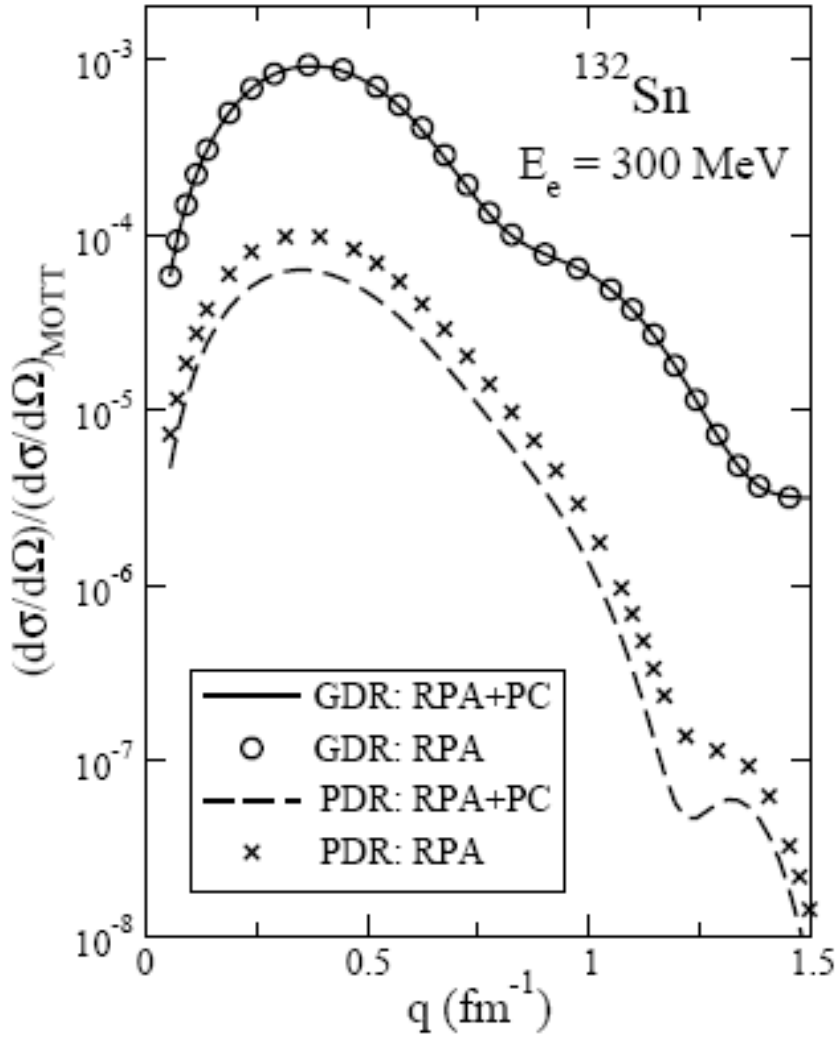


Figure 1: The ^{132}Sn(e,e′) cross section of excitation of the

Проблемы ПДР

- 1. Коллективность
- Не определена даже область энергий
- 2. IS E1 versus IV E1
- 3. В расчетах не учитываются новые эффекты (новые корреляции в основном состоянии, tadpole's effects, зависимость от плотности част.-частичного взаимодействия и др.)

4. Работы чехов = проблемы фотонной силовой функции (PSF) и ПДР [M.Krticka,F.Becvar, J.Phys. G35,vol.1 (2008)]

Заключение

- Исследования ПДР важны для астрофизики , прежде всего эксперименты для нейтронно-обогащенных ядер

- Необходимы последовательные самосогласованные расчеты в теории вне стандартных RPA и QRPA подходов

Dipole strength function and photoabsorption cross section for **132Sn** calculated within the DTBA and RPA with the Skyrme forces SLy4 and within the HFB+RPA model with the BSk7 forces