Systematic calculation of electric dipole mode with fully self-consistent Skyrme-HF+RPA

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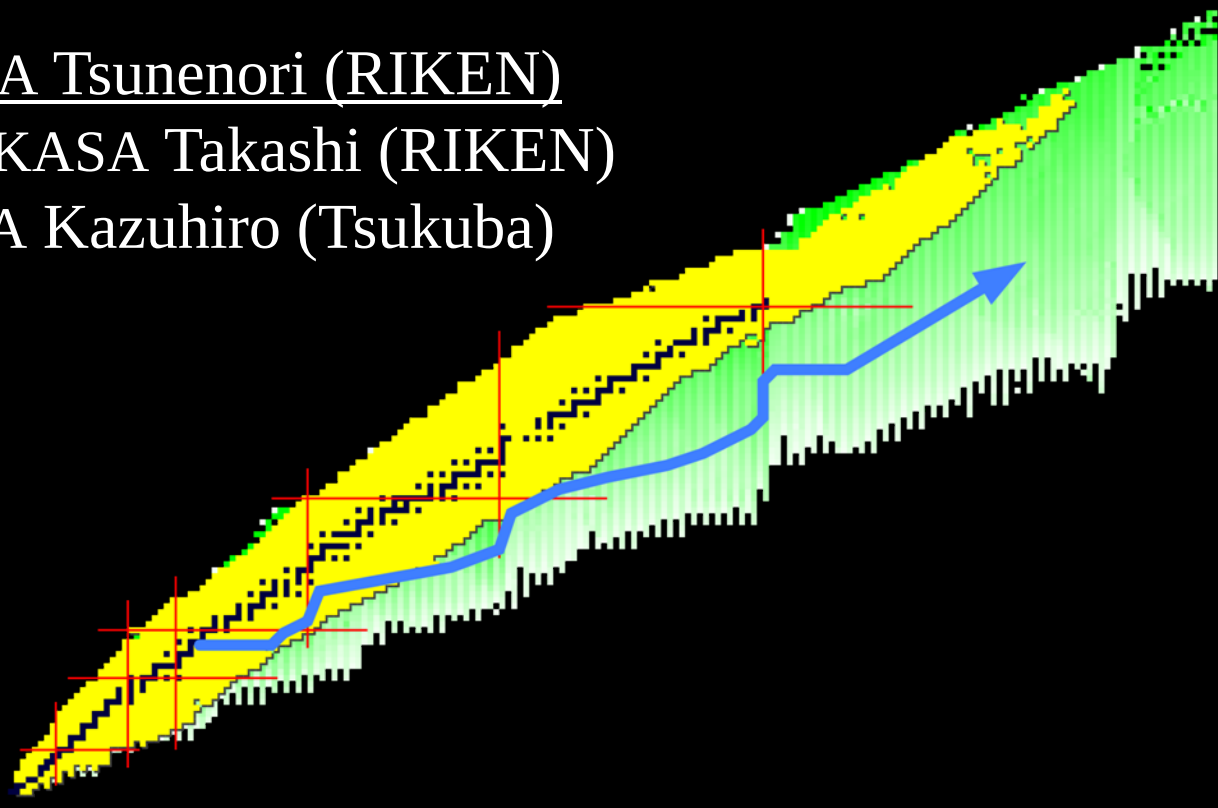
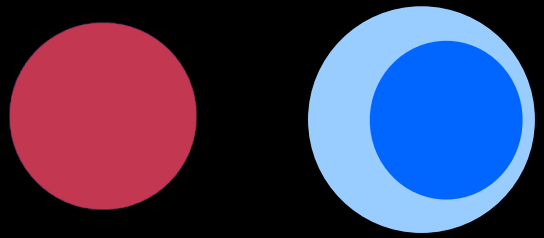


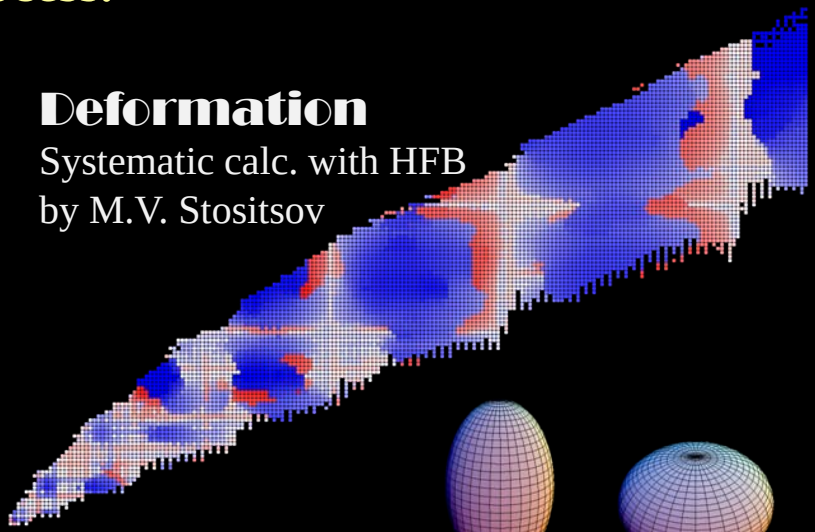
GDR Soft dipole mode



Electric dipole mode

- Simplest collective vibration mode.
- Abundant experiment data in stable nuclei.
- Quite few data in unstable nuclei.
- Low-lying E1 mode is relevant for the r-process.

Deformation
Systematic calc. with HFB
by M.V. Stositsov



prolate oblate

Preceding systematic calc.

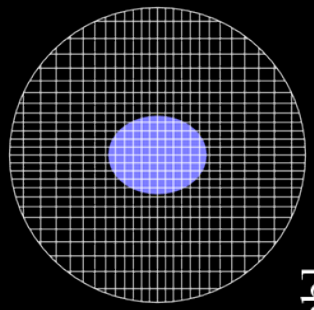
- Spherical nuclei only.
- Phenomenological treatment.

Systematic calculation of E1 mode.

- Self-consistent calculation.
- Including deformed nuclei.
- Systematic analyses of various observables.

RPA in 3D mesh

T. Inakura et al., PRC80, 044301



- **Fully self-consistent Skyrme-RPA**
- **3D mesh representation**
  - suitable to describe unstable nuclei.
  - applicable for deformed nuclei.
  - treat particles escaping from nuclei.
- **RPA matrix: Dimension O($10^{6\text{-}7}$)**
- **No pairing correlation**

Technically…

- **Finite Amplitude Method**

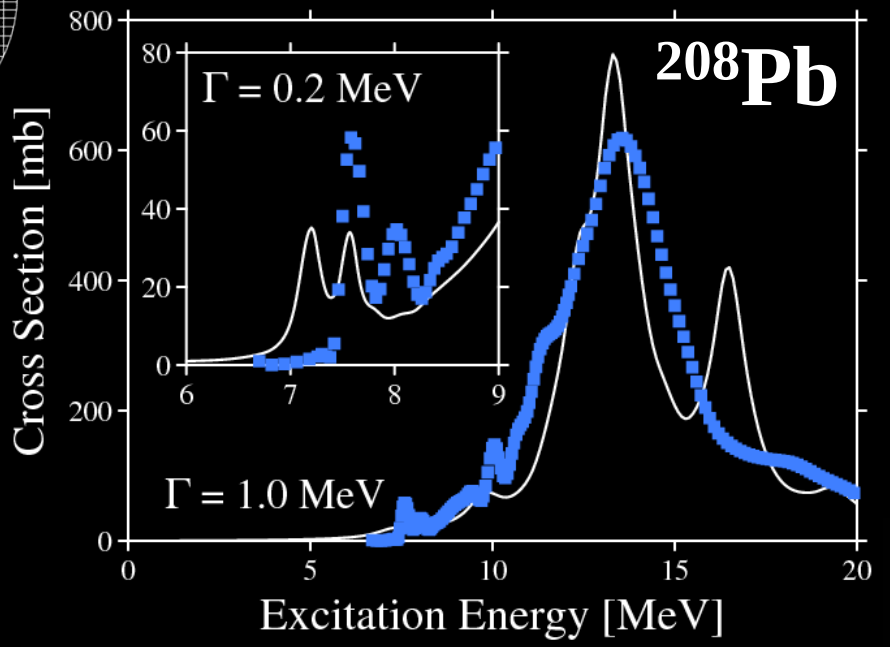
  numerical estimation of residual interaction.
- **Response calculation**

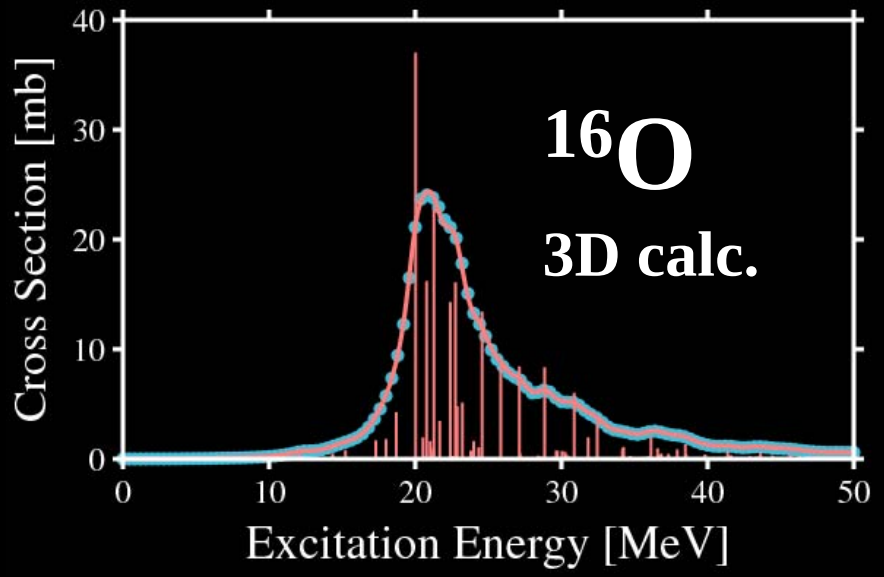
  at fixed complex energies.

  suitable for the paralleled supercomputer.

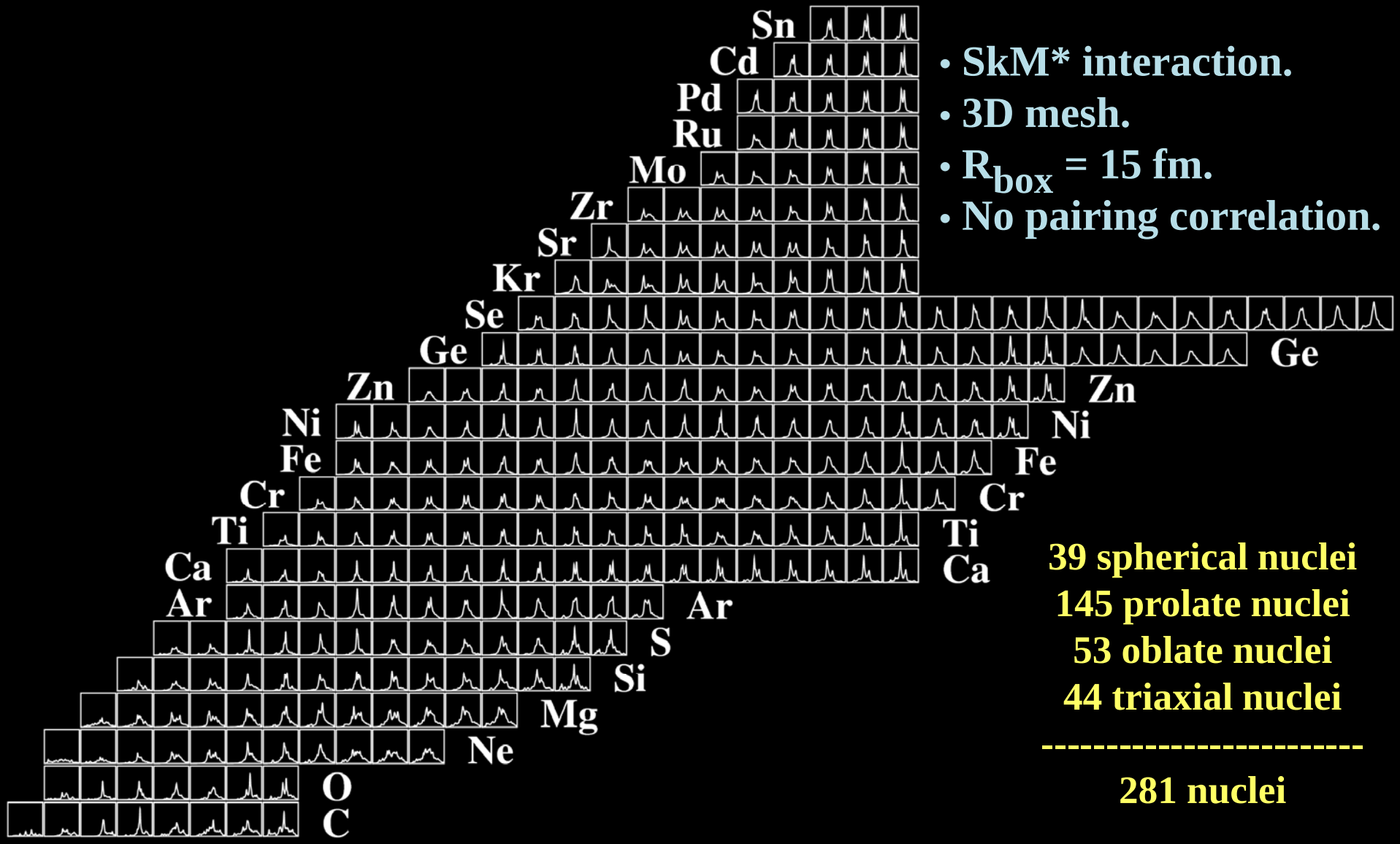
Method	CPU	Time
Diagonalization	1 CPU	3 months
Response calc.	128 CPUs	4 hours

Expt. data : **http://cdfe.sinp.msu.ru/**





Systematic calc. of E1 mode up to mass A=100 region



- SkM* interaction.
- 3D mesh.
- R_{box} = 15 fm.
- No pairing correlation.

39 spherical nuclei
145 prolate nuclei
53 oblate nuclei
44 triaxial nuclei

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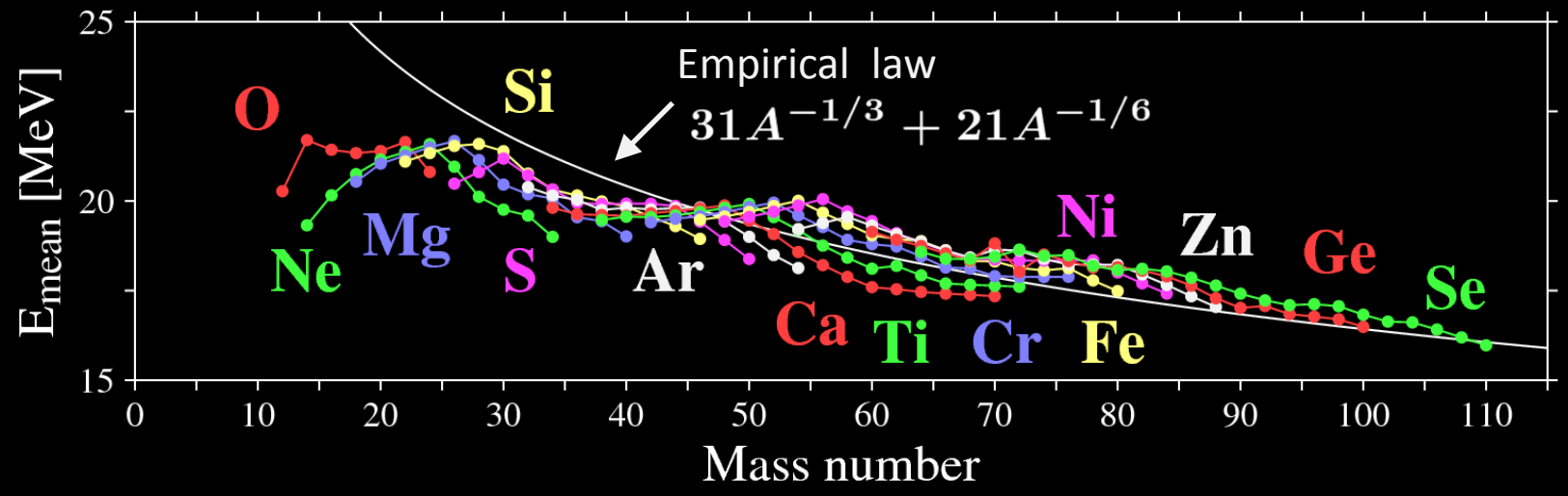
281 nuclei

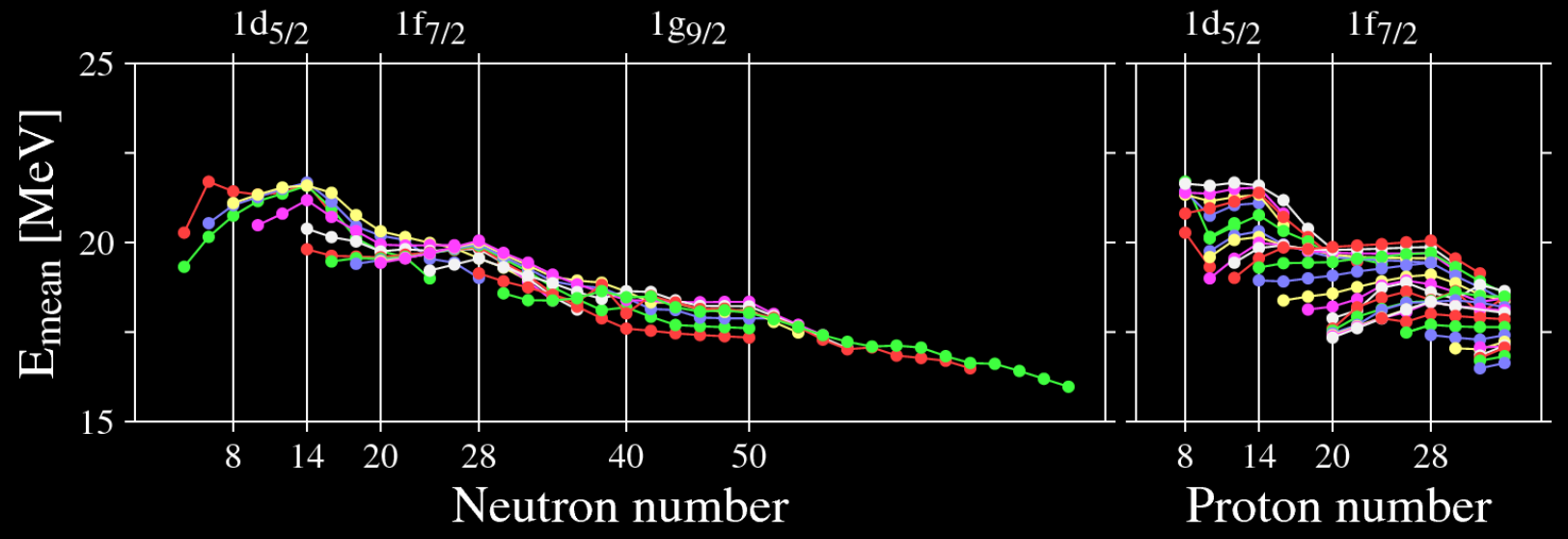
GDR peak (E_{mean})

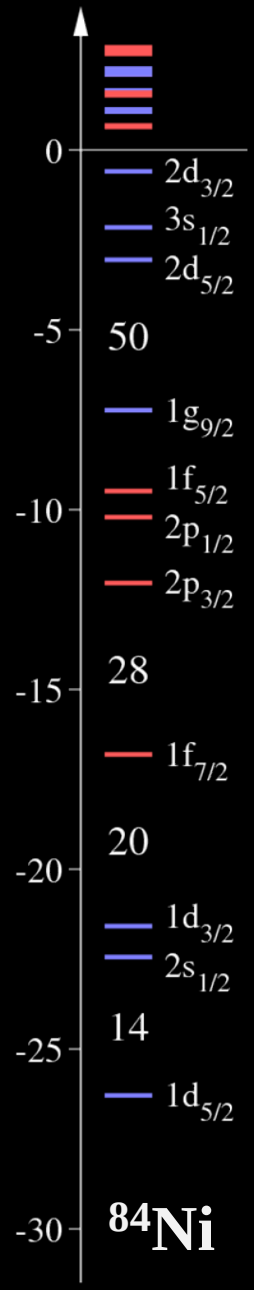
Mean Energy

$$E_{\mathrm{mean}} = m_1/m_0$$

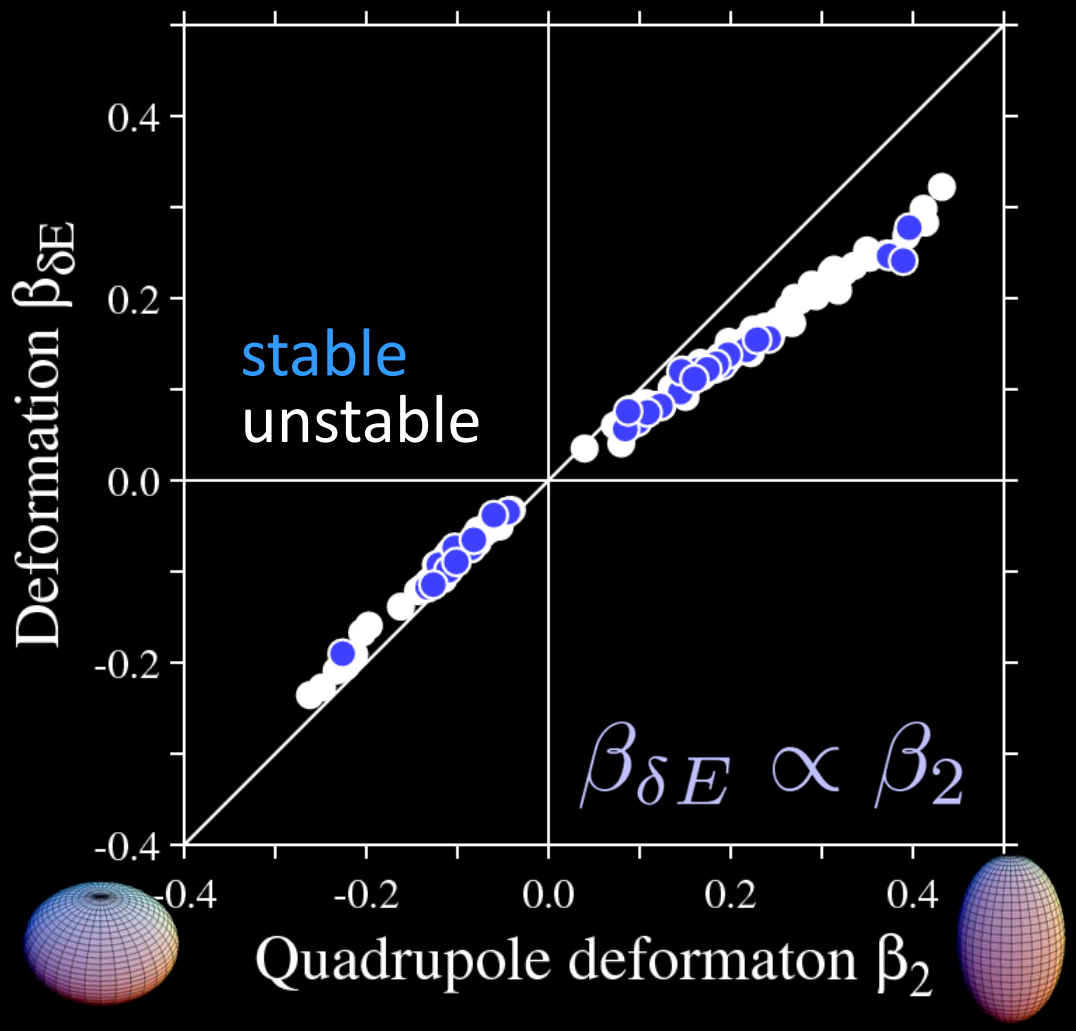
$$m_k \equiv \int \mathrm{d}E\, E^k \sigma(E)$$





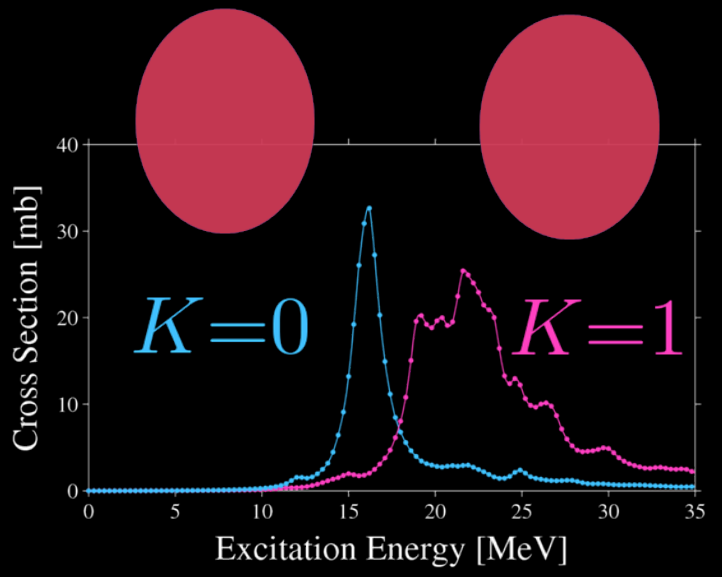


GDR peak splitting by deformation

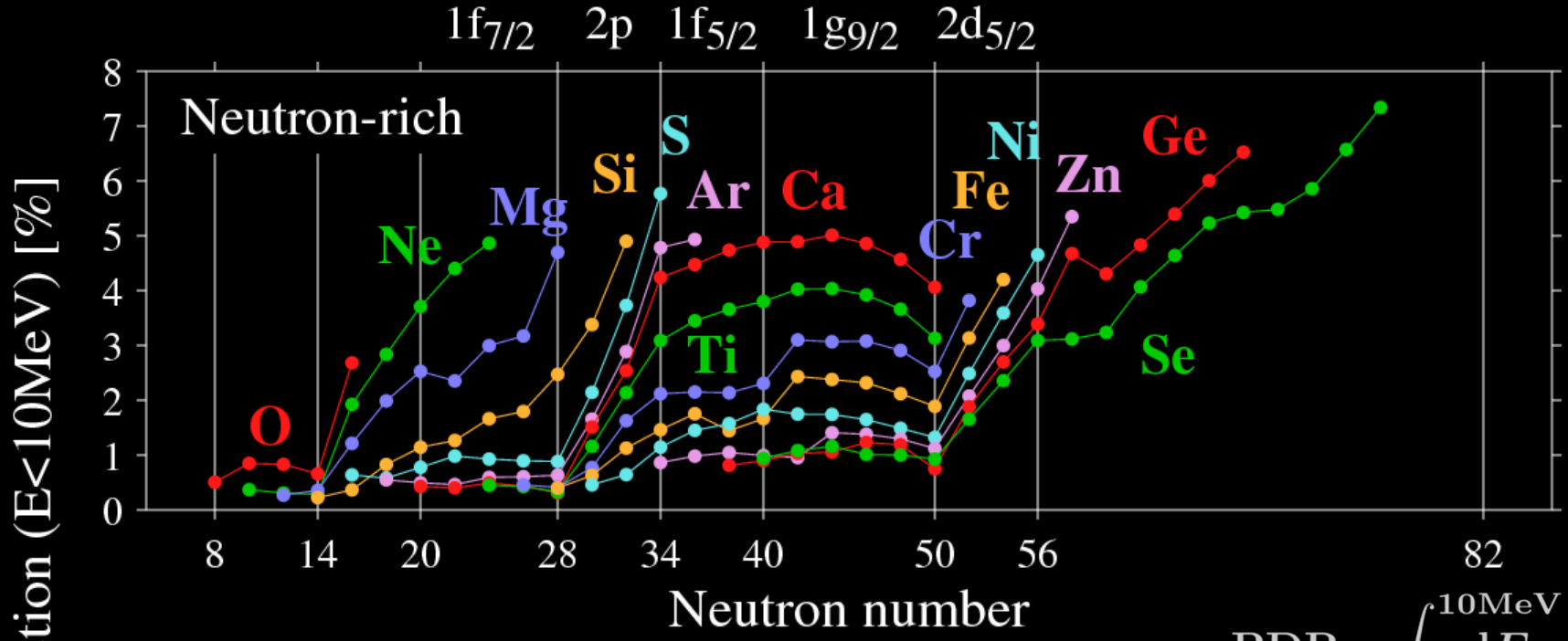


$$\beta_2 = \frac{4\pi}{5}\frac{\langle r^2 Y_{2m}\rangle}{\langle r^2\rangle} \propto \frac{\langle 2z^2 - x^2 - y^2\rangle}{\langle r^2\rangle}$$

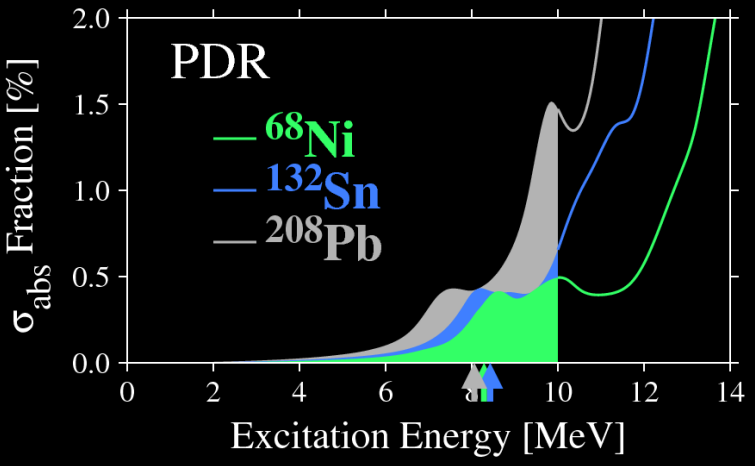
$$\beta_{\delta E} = \frac{E_{\rm mean}^{K=1} - E_{\rm mean}^{K=0}}{E_{\rm mean}^{\rm all}}$$



Growth of pygmy dipole resonance (PDR)



$$\mathrm{PDR} : \int_0^{10\mathrm{MeV}} \mathrm{d}E\ \sigma_{\mathrm{abs}}(E)$$



Summary

We carried out systematic calculation of E1 mode

- up to mass A=100 region.
- including deformed nuclei.
- fully self-consistent calculation.

We found and confirmed …

- ✓ GDR peak is affected by neutron shell structure.
- ✓ GDR peak splitting is strongly correlated with static deformation β_2.
- ✓ PDR is NOT specific in ν-rich nuclei.
- ✓Loosely-bound low-*l* orbit plays important role for emergence of PDR.

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