State of the EMPIRE

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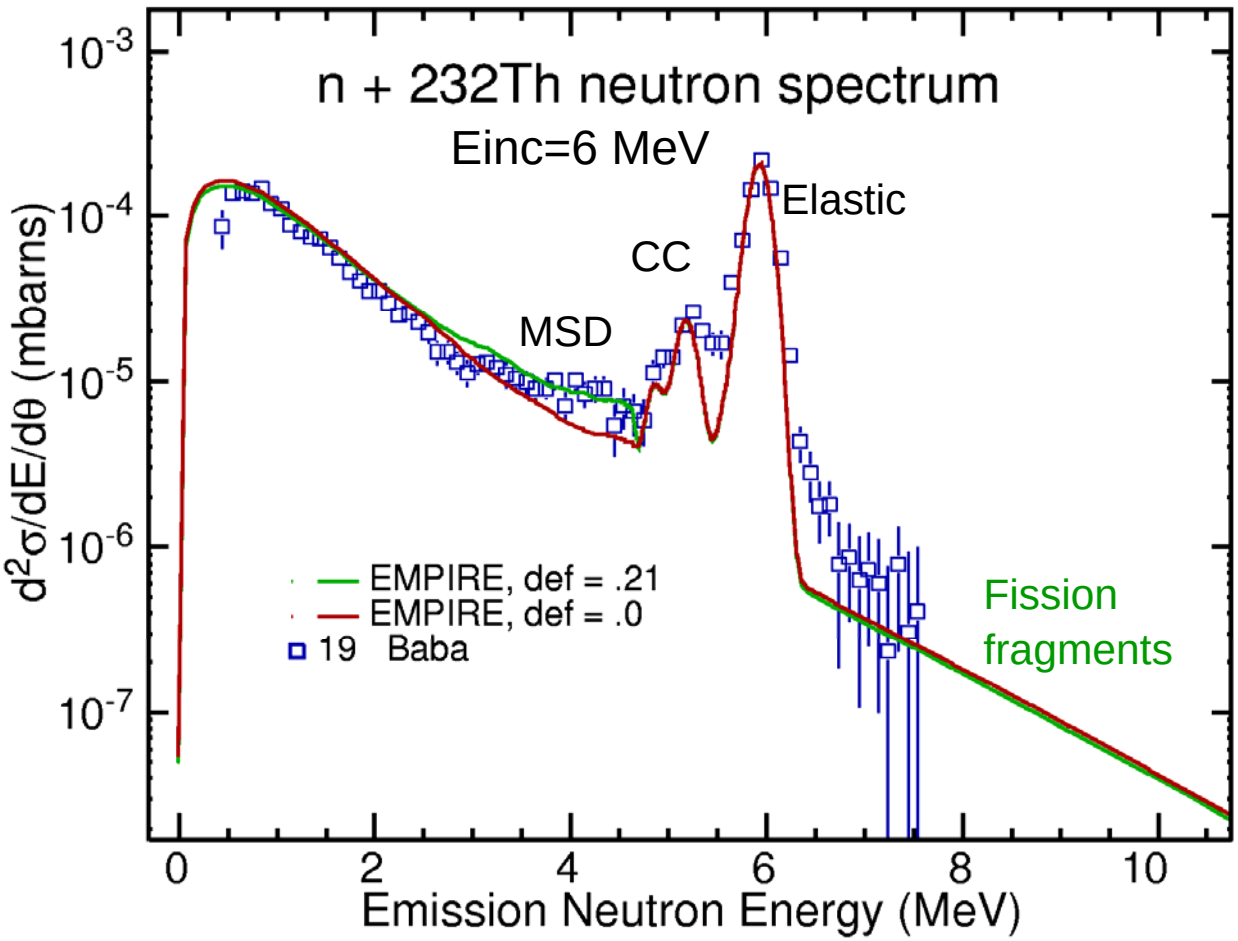
Developers

- R. Capote (IAEA, Vienna)
- B. Carlson (ITA, Sao Jose dos Campos, Brazil)
- **M. Herman (BNL, US)**
- T. Kawano (LANL, US)
- P. Oblozinsky (BNL, US)
- M. Sin (Univ. Bucharest, Romania)
- A. Trkov (IAEA, Vienna)
- H. Wienke (Belgonucleaire/EDP)
- V. Zerkin (IAEA, Vienna)

Recent developments (2.19b35 Lodi)

- Prompt fission neutron spectra including post-fission neutrons emitted from fully accelerated fragments (Los Alamos or Kornilov model) (M. Sin, R. Capote)
- DWBA calculations on odd nuclei (discrete levels embedded in the continuum only) (R. Capote)
- ECIS subroutine modified to allow use of dispersive potentials with different geometry of the imaginary and real parts (R. Capote)
- **MSD-model extended to deformed nuclei (H. Wienke)**
- **Modelling of actinides (M. Sin, R. Capote)**
- Library of optical model parameters updated (preliminary RIPL-3)
- Library of discrete levels updated (preliminary RIPL-3)
- Library of neutron resonances updated (ENDF/B-VIIb3)
- Checking codes updated (CHECKR-7.03 FIZCON-7.04)

MSD with nuclear deformation

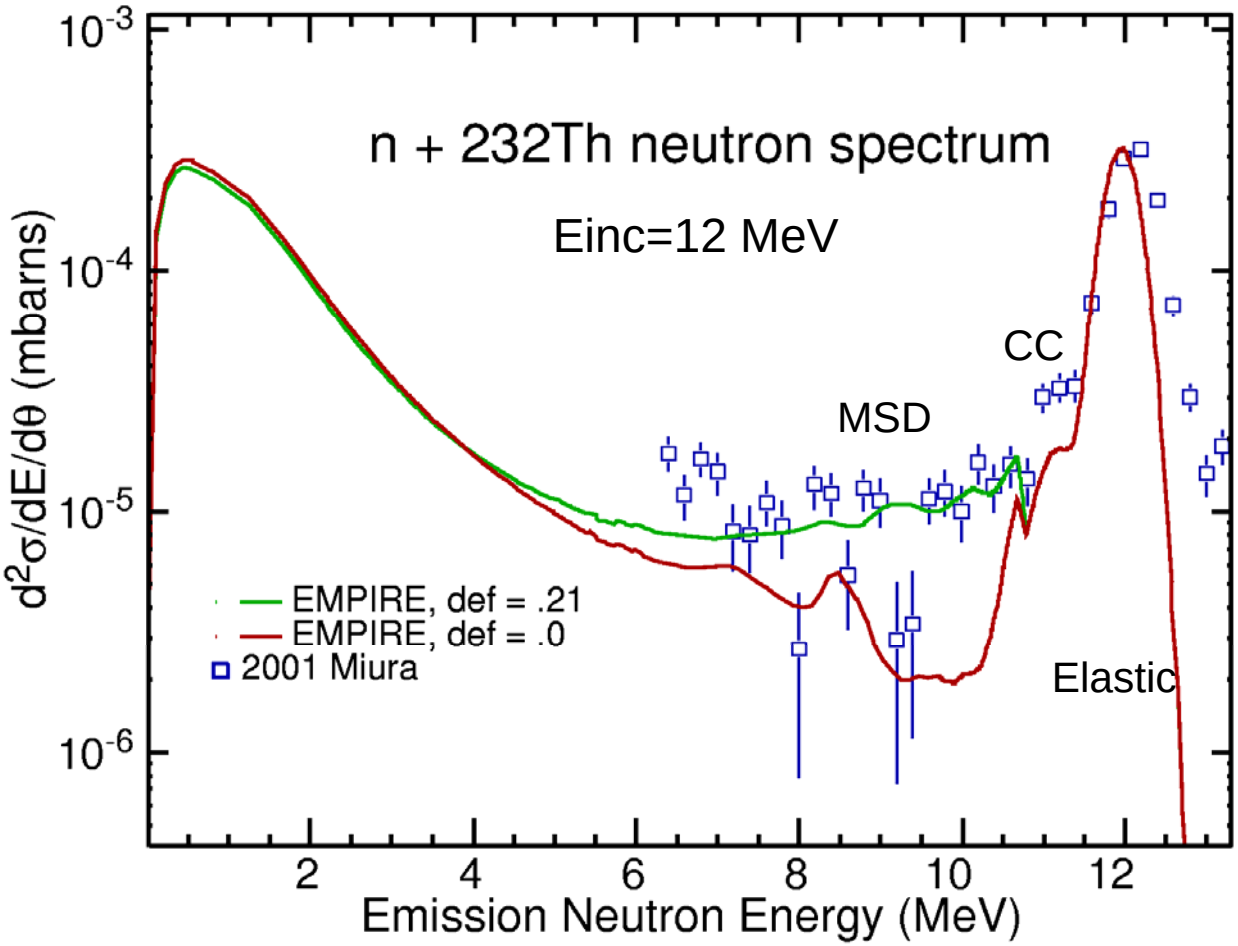


Deformed MSD formalism and calculations by H. Wienke

(fission input: Capote & Sin as for ^{232}Th in ENDF/B-VII.0)

Prompt fission neutron spectrum includes post-fission neutrons emitted from fission fragments and pre-fission neutrons (including subsequent proton-neutron emission)

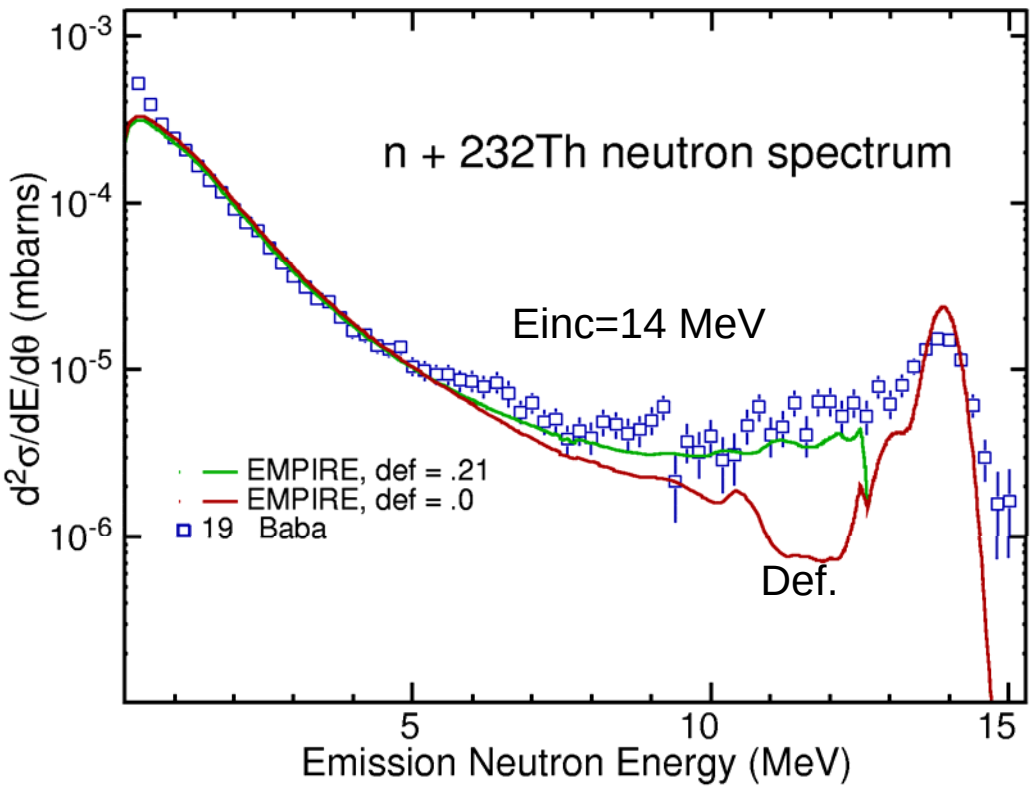
MSD with nuclear deformation

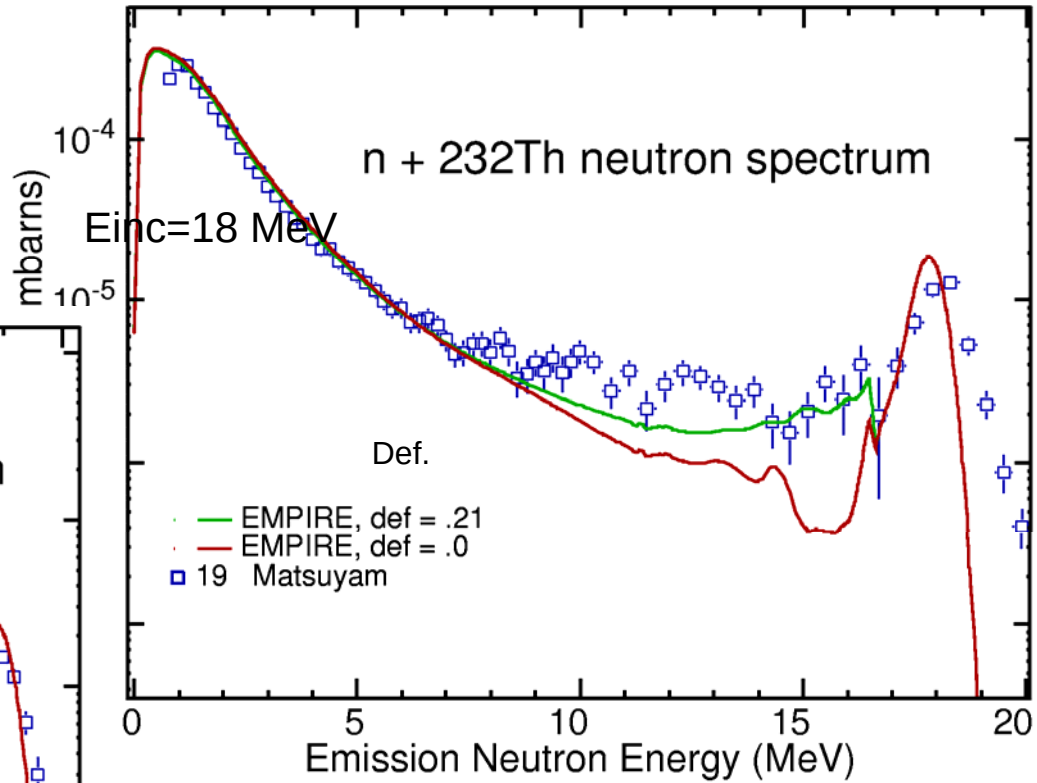


Importance of the deformation effect increases with incident energy

MSD with nuclear deformation

"Deformed MSD" - fills dips in the high energy neutron spectra more efficiently than spherical MSD

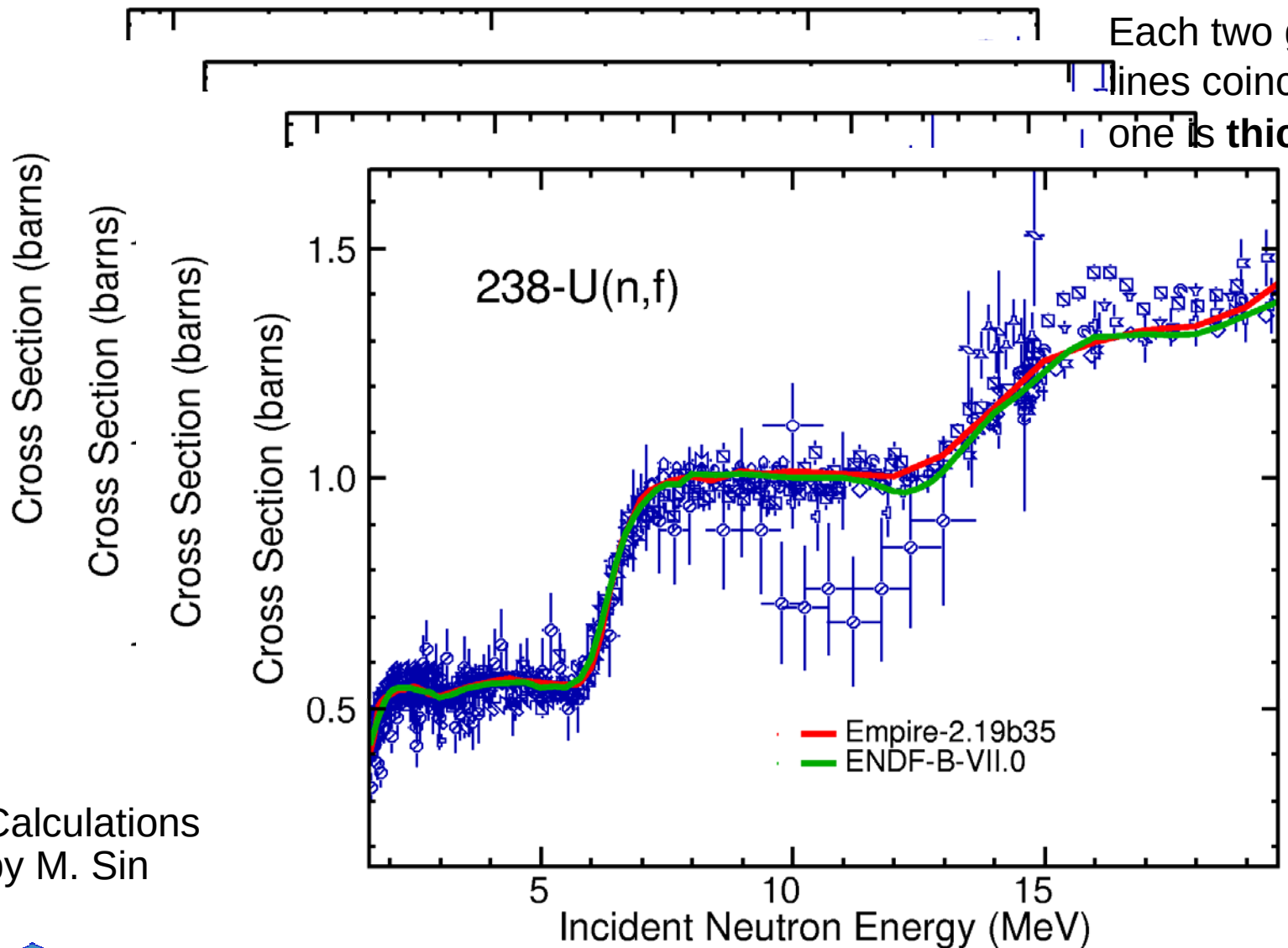




"Deformed MSD" - an alternative approach to the DWBA calculations to the collective states in the continuum

^{238}U(n,f) calculated with EMPIRE

Each two given lines coincide if one is **thick** enough



Calculations by M. Sin

Precise reproduction of fission cross section with model calculations allows consistent:

- neutron and γ spectra
- nu-bar
- covariances

Work in progress

- Resonance module – integration of Atlas of Neutron Resonances and related codes with EMPIRE (in cooperation with Cho (KAERI))
  - link to database with resonance parameters
  - statistical analysis (completeness, random assignment of spins and parities if unknown)
  - ENDF-6 formatting
  - Generation of unresolved parameters
  - Interactive graphical comparison with experiment and other evaluations
- Covariance module in resonance region (Rochman)
- Fission through microscopically calculated (Gorieli) fission barriers (Sin, Capote)
- Covariances (assessment of the methodology)
- Manual and final release of the EMPIRE-2.19 (Lodi)

Conclusions

State of the EMPIRE is improving!

(last year it was… good!)