Wavelet Analysis and Characteristic Scales of Dipole und Quadrupole Giant Resonances in ^{28}Si, ^{40}Ca, ^{48}Ca und ^{166}Er *

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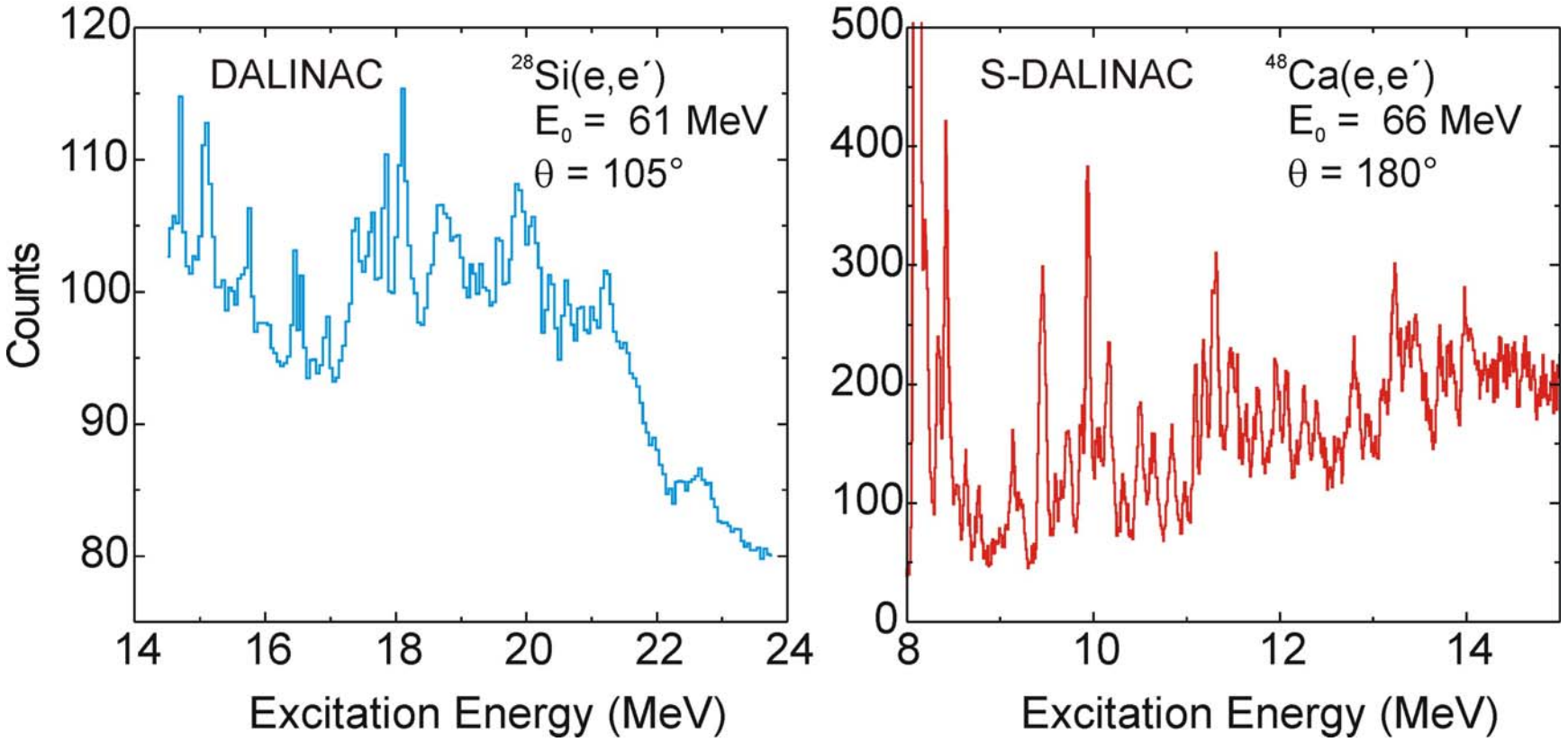
- Motivation
- Continuous Wavelet Transform
- Discrete Wavelet Transform
- Summary and Outlook

SFB 634

*Supported by the DFG within SFB 634

Evidence of Fine Structure in Different Nuclei



ISGQR

M2

Motivation

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- Quantitative analysis of fine structure
  of dipole and quadrupole resonances
- Characteristic scales determined by wavelet analysis
- Interpretation through comparison with microscopic
  calculations including the coupling to complex states
- Model-independent extraction of level densities

- A.Shevchenko *et al*., Phys. Rev. Lett. **93** (2004) 122501
- Y.Kalmykov *et al*., Phys. Rev. Lett. **96** (2006) 012502
- A.Shevchenko *et al*., Phys. Rev. C **77** (2008) 024302
- A.Shevchenko *et al*., Phys. Rev. C, in press

Motivation

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- ^{28}Si: ISGQR $\rightarrow$ comparison of data from many different experiments
- ^{40}Ca: IVGDR, ISGQR $\rightarrow$ compare the fine structure from the different resonances in the same nucleus
- ^{48}Ca: IVGDR, M2 $\rightarrow$ comparison of electric/magnetic resonances
- ^{166}Er: ISGQR $\rightarrow$ role of deformation

Motivation

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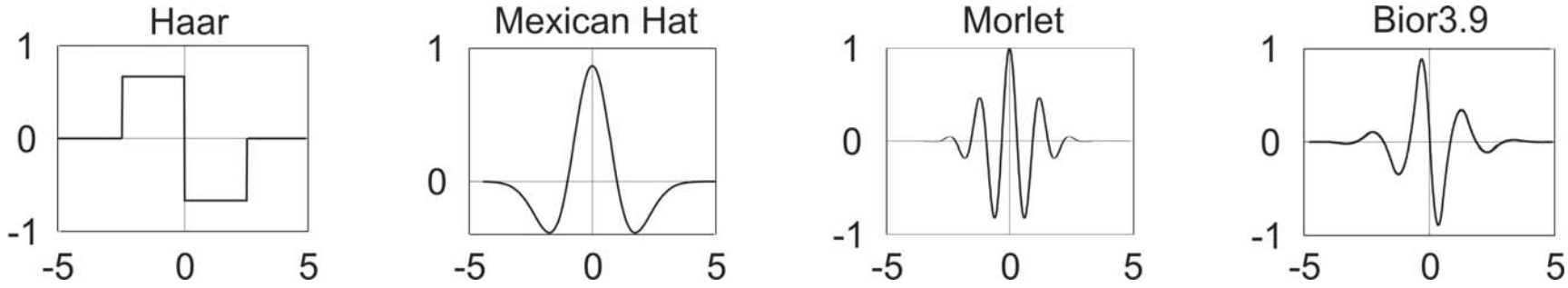
- ✓ ^{28}Si: ISGQR → comparison of data from many different experiments
- ^{40}Ca: IVGDR, ISGQR → compare the fine structure from the different resonances in the same nucleus
- ✓ ^{48}Ca: IVGDR, M2 → comparison of electric/magnetic resonances
- ^{166}Er: ISGQR → role of deformation

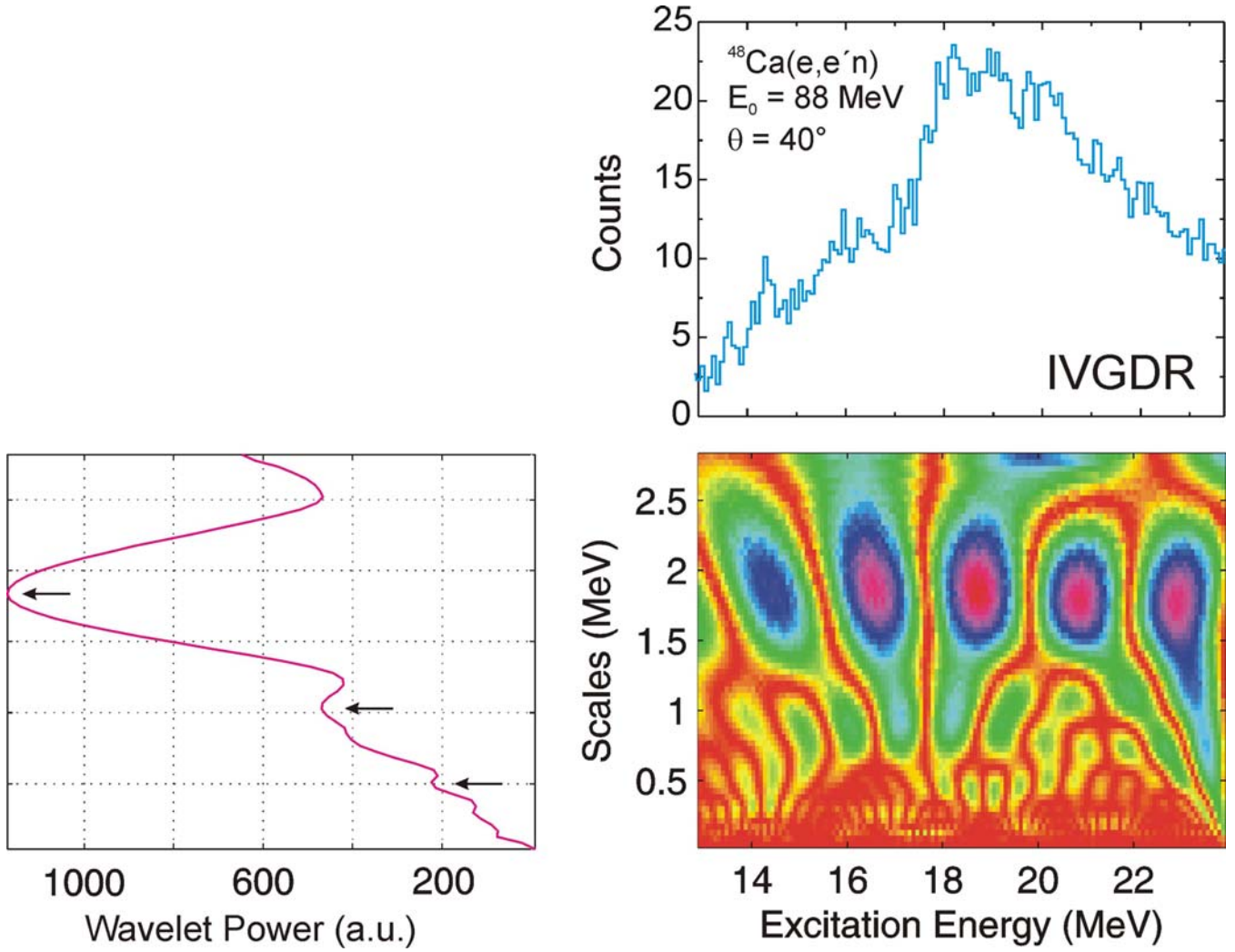
Wavelets and Wavelet Transform



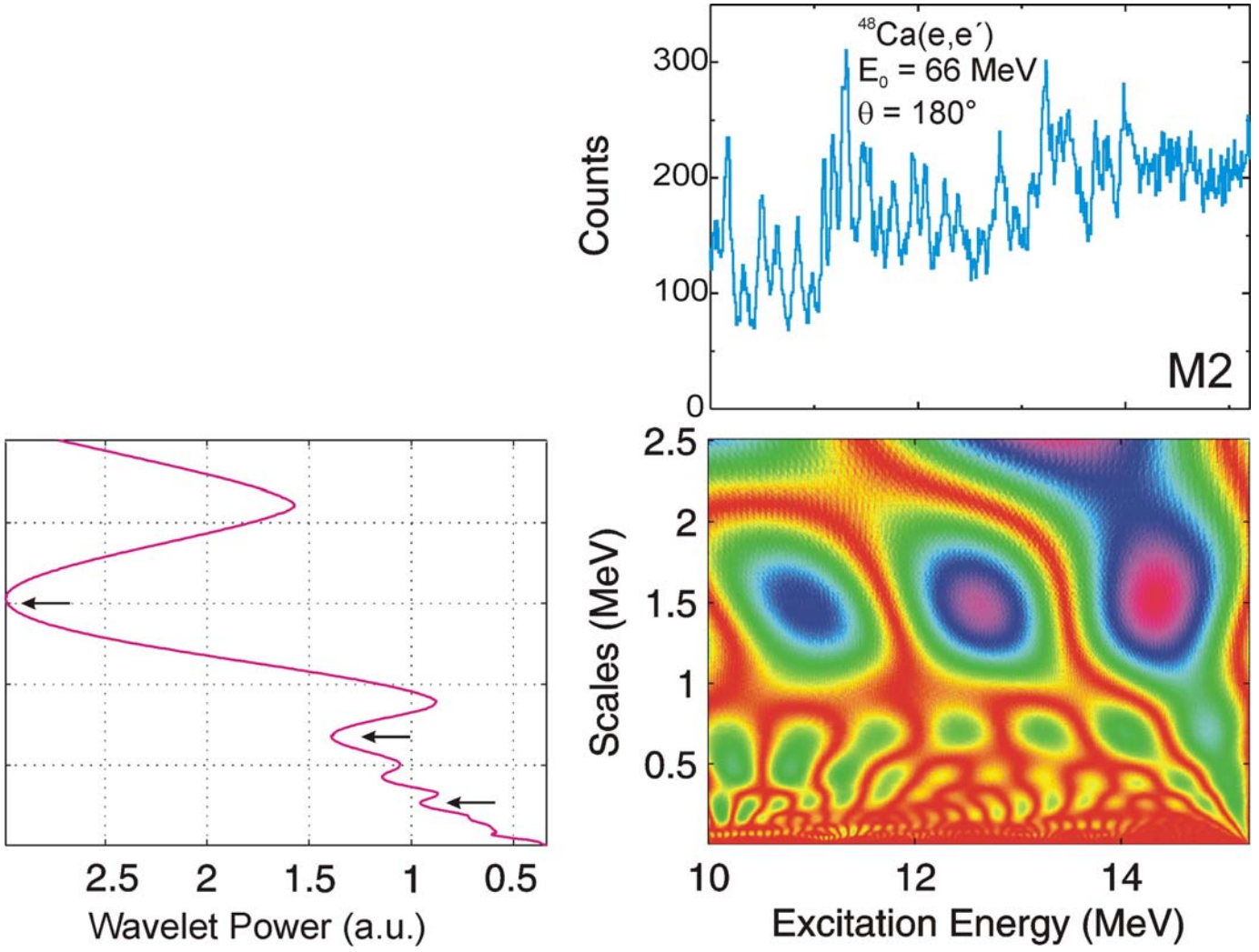
- $\int_{-\infty}^{\infty} \Psi^*(x)\, dx = 0$ wave
- $\int_{-\infty}^{\infty} \left|\Psi^*(x)\right|^2 dx \leq \infty$ finite support
- $C(\delta E, E_x) = \frac{1}{\sqrt{\delta E}} \int \sigma(E)\ \Psi^*\left(\frac{E_x - E}{\delta E}\right) dE$ wavelet coefficients

scale, position, spectrum, wavelet

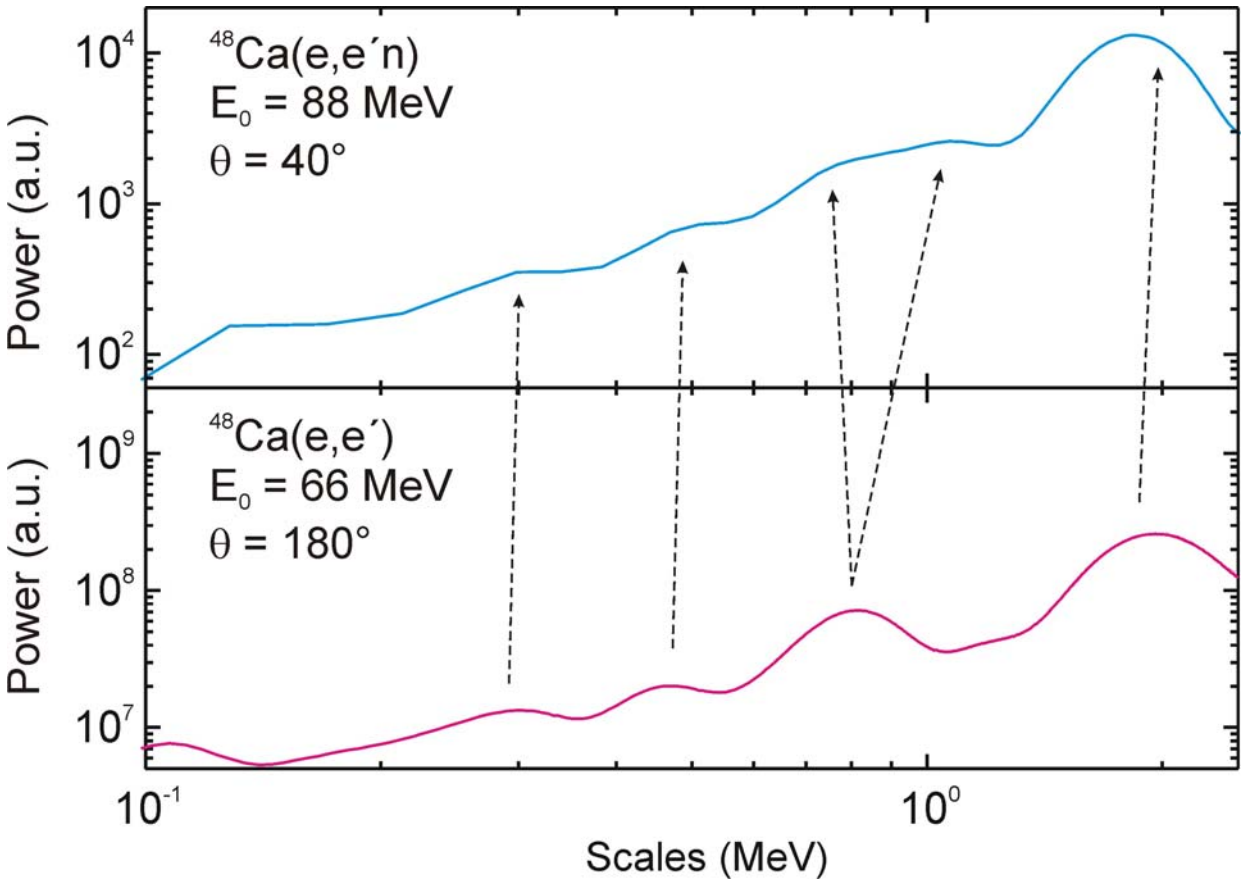
^{48}Ca(e,e´n) at S-DALINAC



^{48}Ca(e,e´) at 180° at S-DALINAC



E1 vs. M2 Resonance in ^{48}Ca



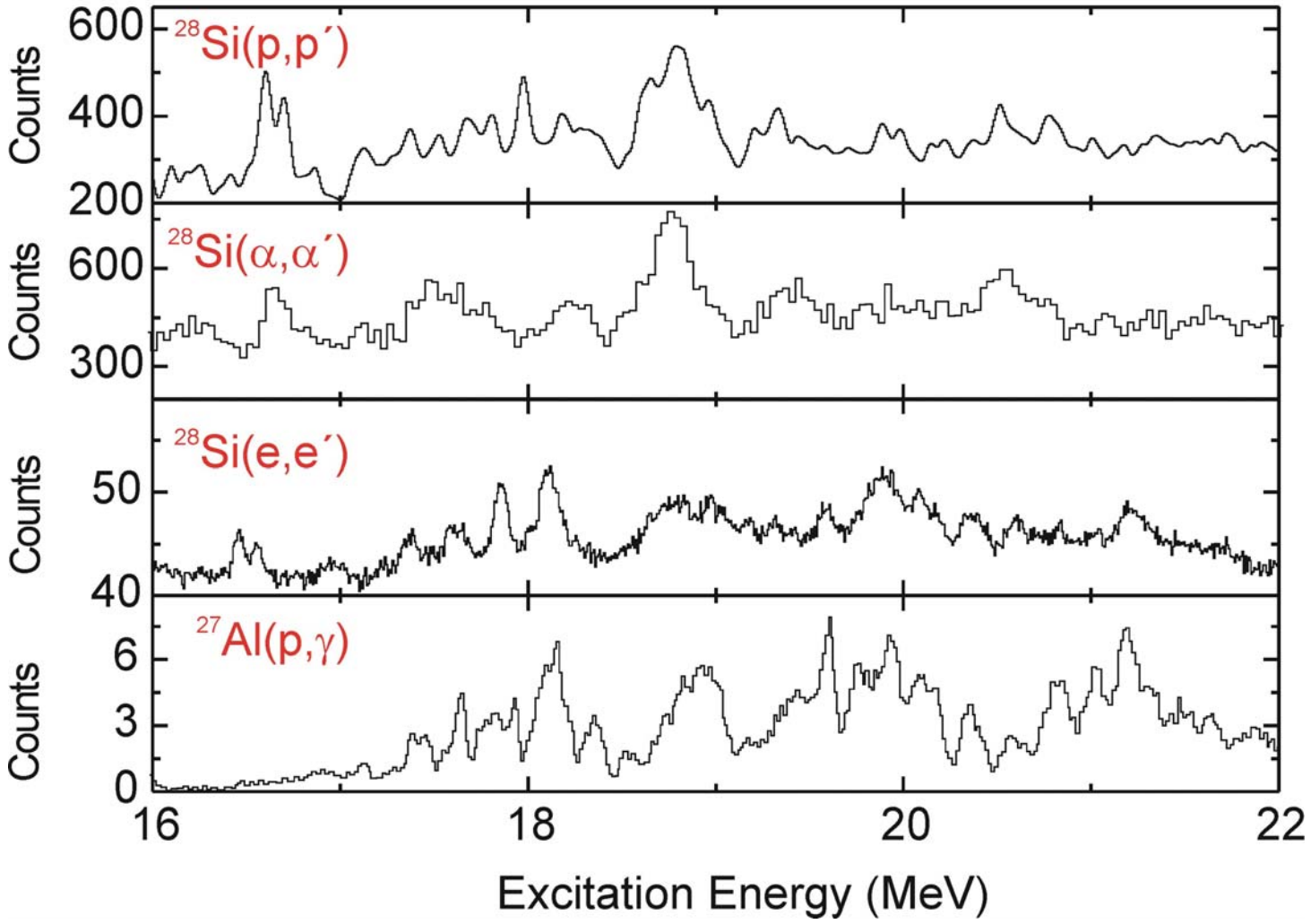
IVGDR

M2

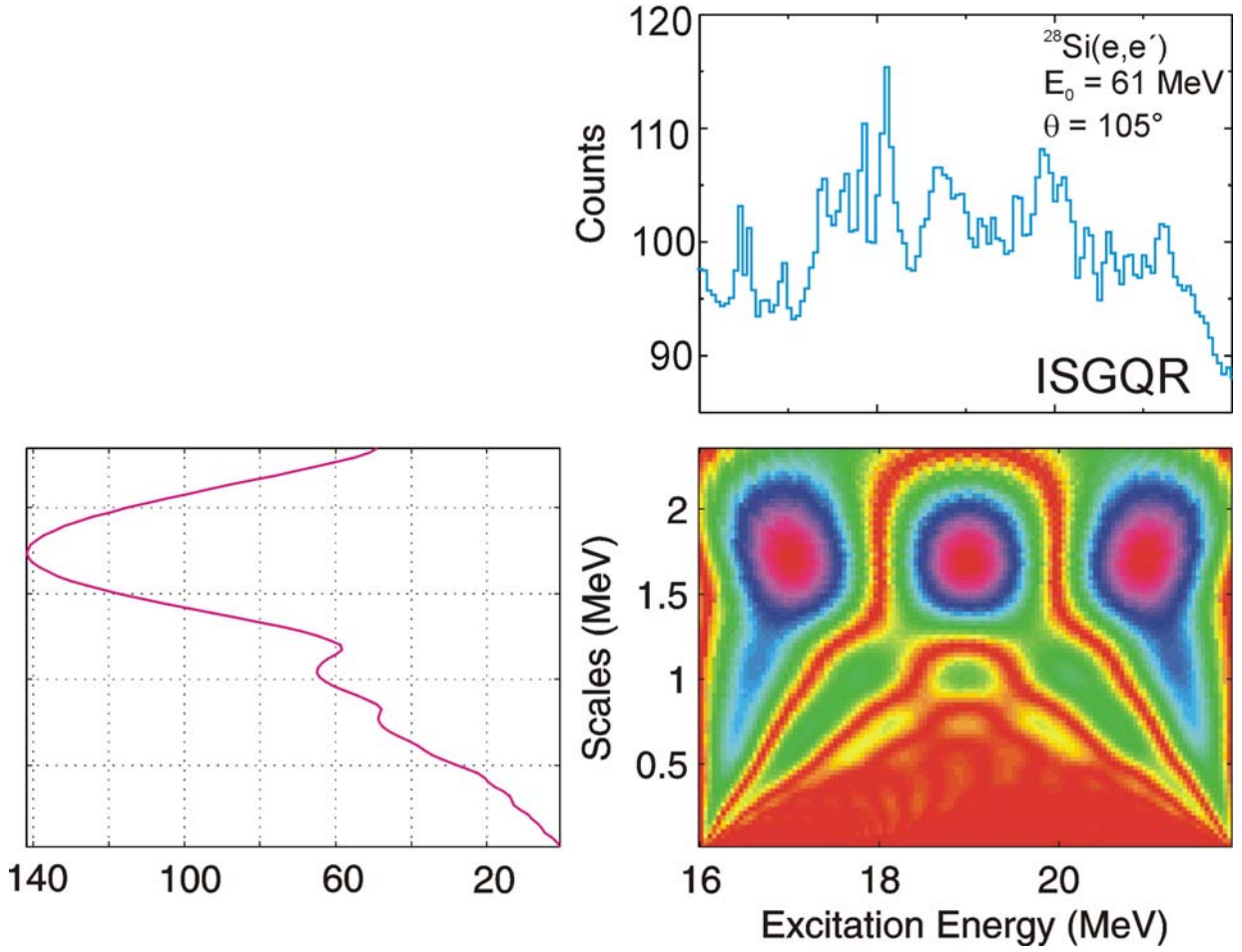
- very similar scales ⟺ same origin ?

  ⟹ comparison to SRPA calculations

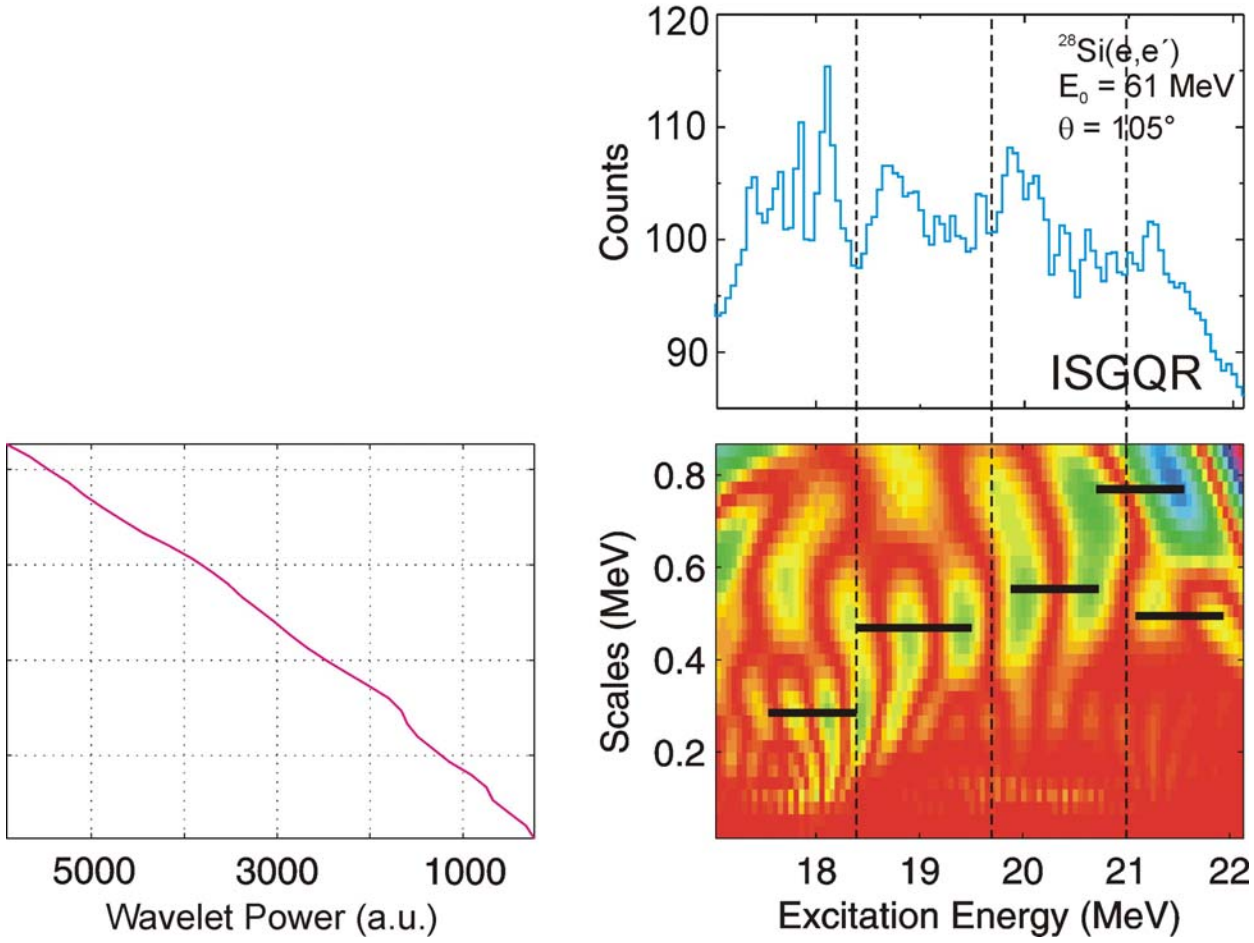
^{28}Si ISGQR


^{28}Si(p,p´)
^{28}Si(α,α´)
^{28}Si(e,e´)
^{27}Al(p,γ)
Counts
600
400
200
600
300
50
40
6
3
0
16
18
20
22
Excitation Energy (MeV)

^{28}Si Results



^{28}Si Results



- Nature of the intermediate structure

Level Densities

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- Vanishing moments $\int_{-\infty}^{\infty} E^n \Psi(E) dE = 0, \quad n = 0, 1 \ldots m-1$

  ⇒ any polynomial of order up to *n* does not contribute to the wavelet coefficients

  ⇒ background in the spectra can be determined

- Fluctuation analysis

  ⇒ level densities

Level Densities of M2 Resonance in ^{48}Ca

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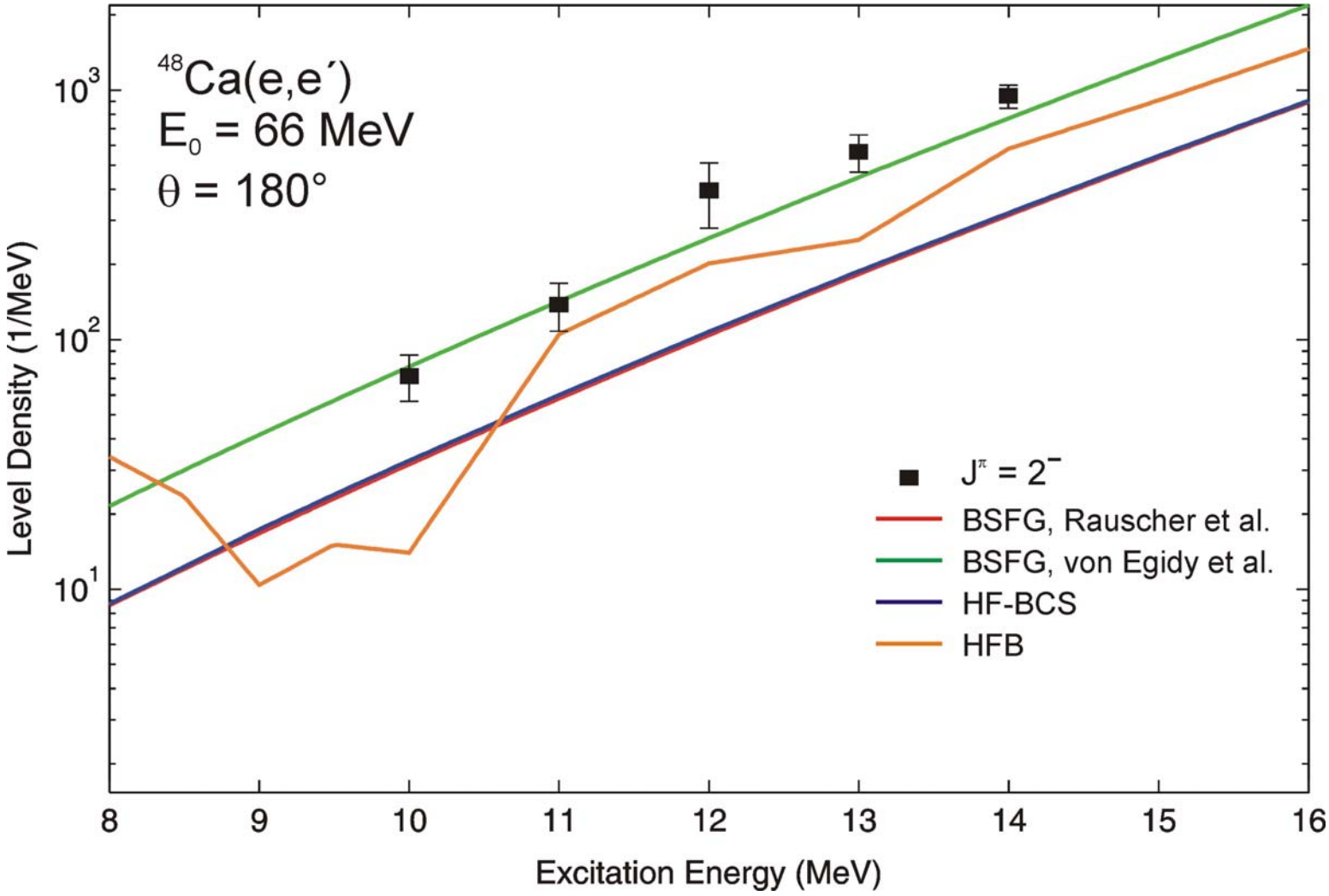

Summary and Outlook

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- Wavelet analysis powerful tool
  - ⇒ extract dominent decay mechanisms
  - ⇒ determine level densities for given spin and parity

- Complete analysis (^{40}Ca, ^{166}Er)

- Comparison to microscopic calculations