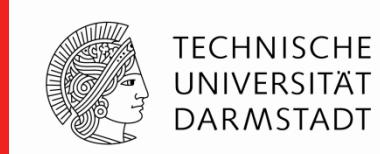


Study of the effect of shell stabilization of the collective isovector valence-shell excitations along the N=80 isotonic chain



Christopher Bauer – TU Darmstadt

Norbert Pietralla – TU Darmstadt
Georgi Rainovski – Uni Sofia

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C. Bauer, N. Pietralla, S. Bönig, S. Illeva, Th. Kröll,
O. Möller, T. Möller, M. Scheck, C. Stahl, R. Stegmann,
M. Thürauf

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A. Blazhev, H. Duckwitz, C. Fransen, J. Jolie, N. Warr

Uni Sofia

G. Rainovski, M. Danchev, K. Gladnishki,
V. Karayonchev

TU Munich

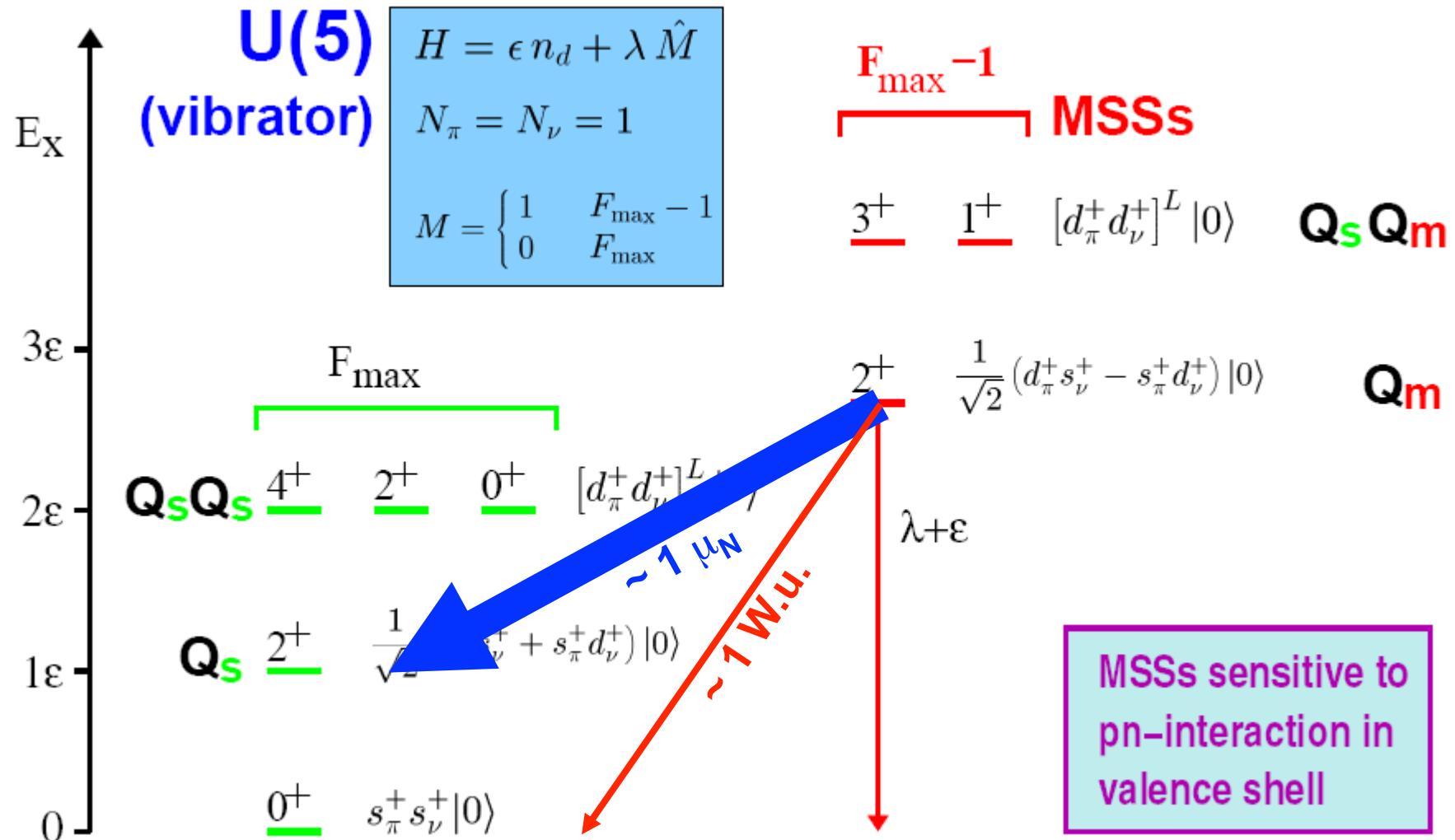
D. Mücher

Physics case – what are the MSSs?

Simple Example: Harmonic Oscillator, N=2



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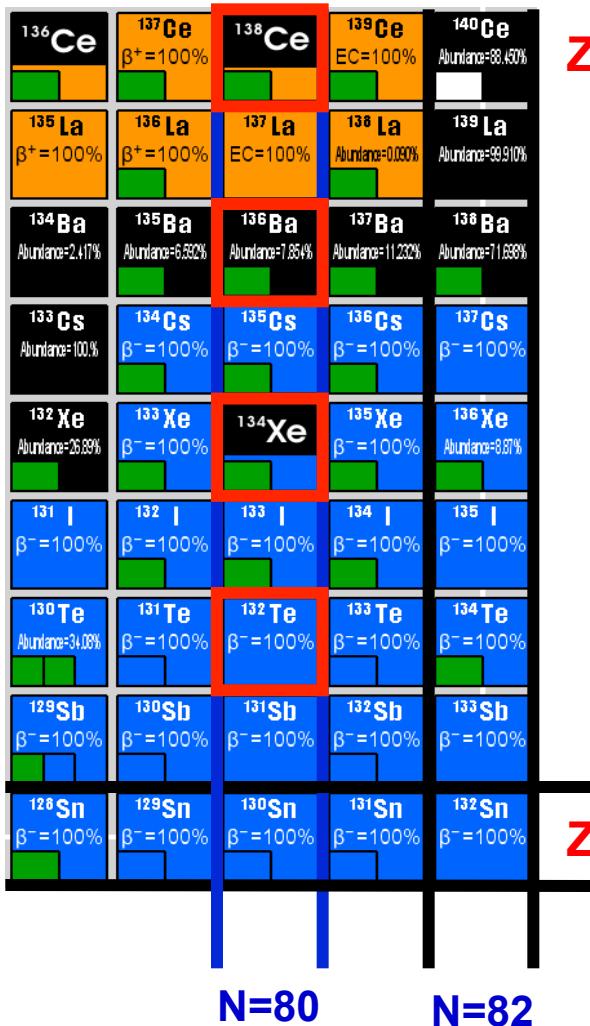


ANL program

Coulomb excitation reactions in inverse kinematics with stable beams and GAMASPHERE



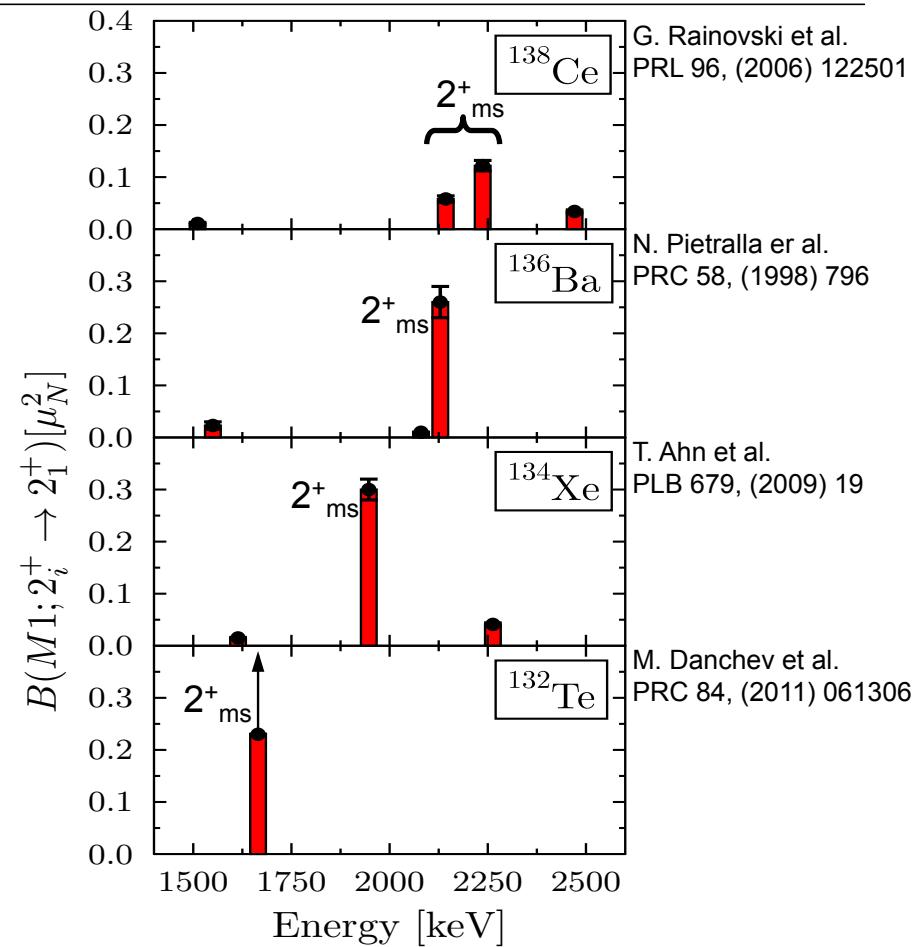
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Z=58

Z=50

$\pi g_{7/2}^{-2}$



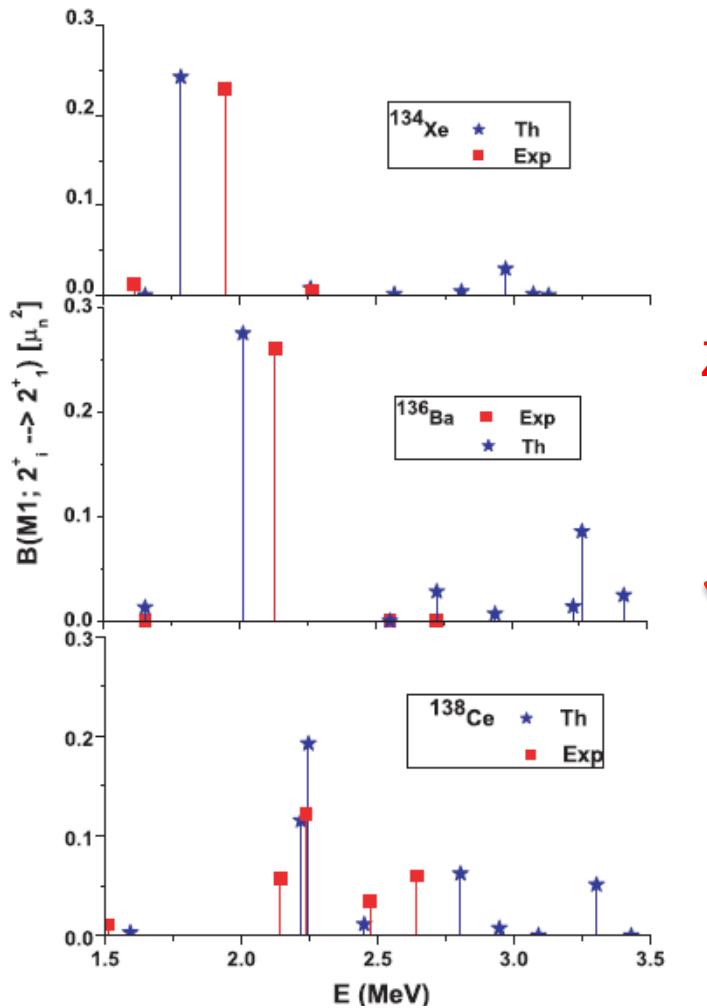
The properties of MSSs are sensitive
to the sub-shell structure!

Theoretical confirmation

Microscopic description in the framework of the
Quasiparticle-phonon model (QPM)



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- Consistent description of MSS of ^{134}Xe , ^{136}Ba , ^{138}Ce
- Including fragmentation of MSS of ^{138}Ce
- Splitting of M1 strength in ^{138}Ce is a **genuine shell effect** caused by the specific shell structure and pairing correlations
- But predicts **single 2^+ MSS** for ^{140}Nd

Theoretical confirmation

Microscopic description in the framework of the Large Scale Shell Model



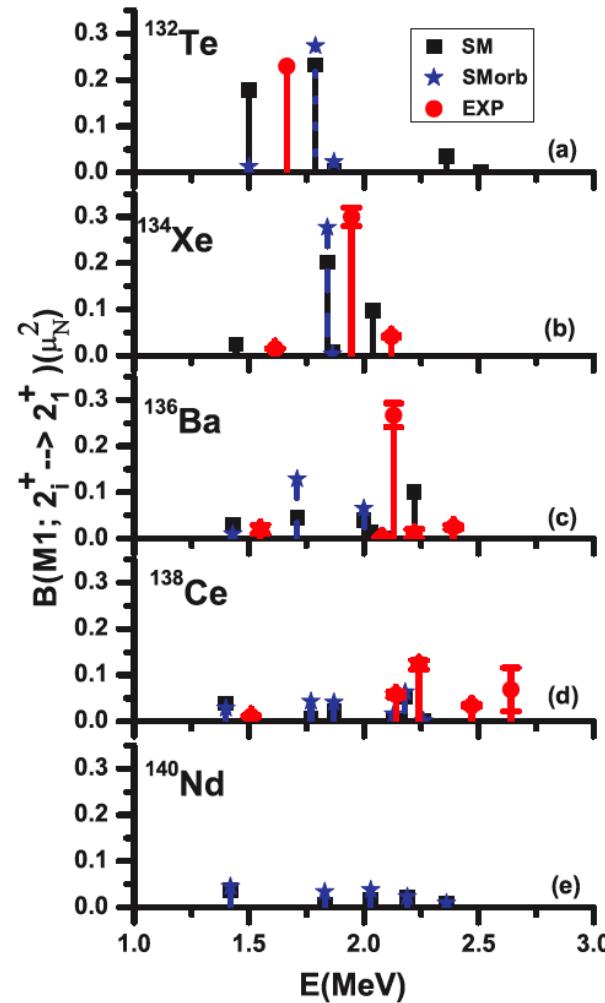
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- First calculations in 2009

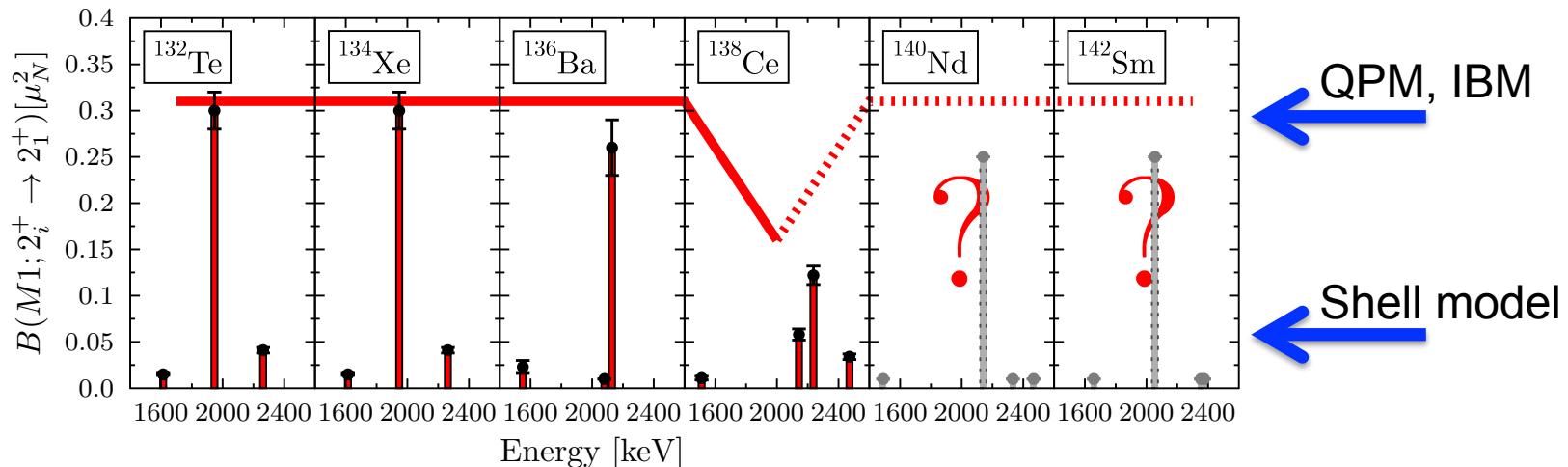
K. Sieja et al. PRC 80, (2009) 054311

- Very recent SM calculation
(importance sampling method)
also predicts fragmentation for
 ^{140}Nd

D. Bianco et al. PRC 85, (2012) 034332



Present situation & Predictions



- Single 2^+ MSS of ^{132}Te , ^{134}Xe , ^{136}Ba
- Fragmented 2^+ MSS of ^{138}Ce
- QPM and SM reproduce situation in N=80

What is the predictive power?

- QPM: **single** 2^+ MSS of ^{140}Nd
- SM: **fragmented** 2^+ MSS of ^{140}Nd

Need to identify and quantitatively study MSSs of ^{140}Nd and ^{142}Sm

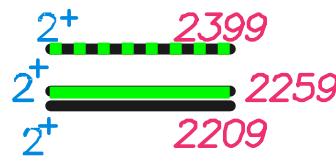
Experiment: ^{140}Nd status



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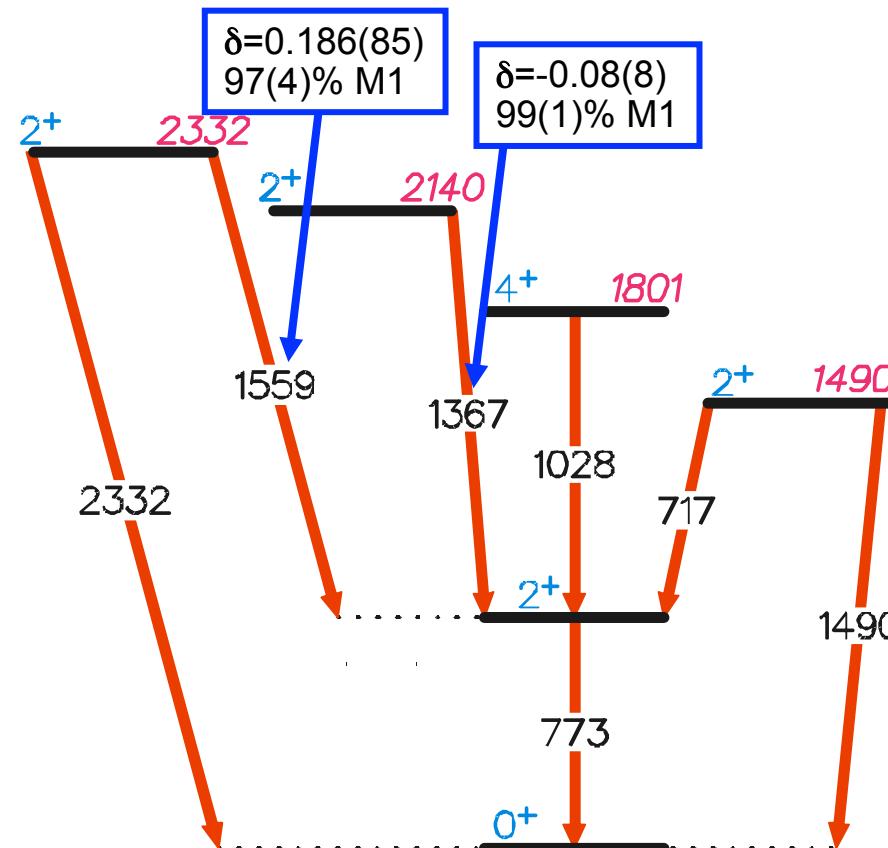
QPM predictions

Ch. Stoyanov, private communication



Experiment

E. Williams et al., PRC 80, (2009) 054309
K. Gladnishki, PRC 82, (2010) 037302



SM predictions

K. Sieja et al.,
PRC 80, (2009) 054311



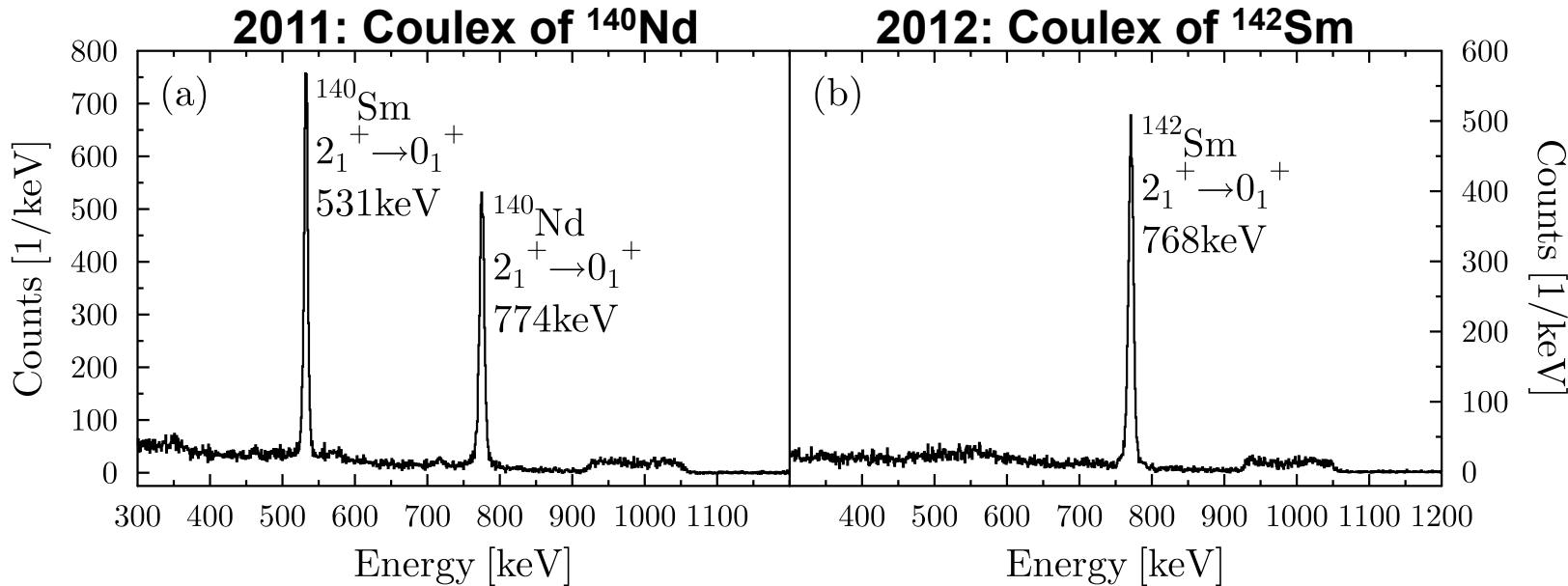
Status of ISOLDE Experiments

B(E2) of first 2⁺ states measured



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- Beams of ^{140}Nd , ^{142}Sm (primary target material: Ta) have been developed, tested and used successfully
- Including RILIS ionization scheme
- 2 experimental runs of IS496



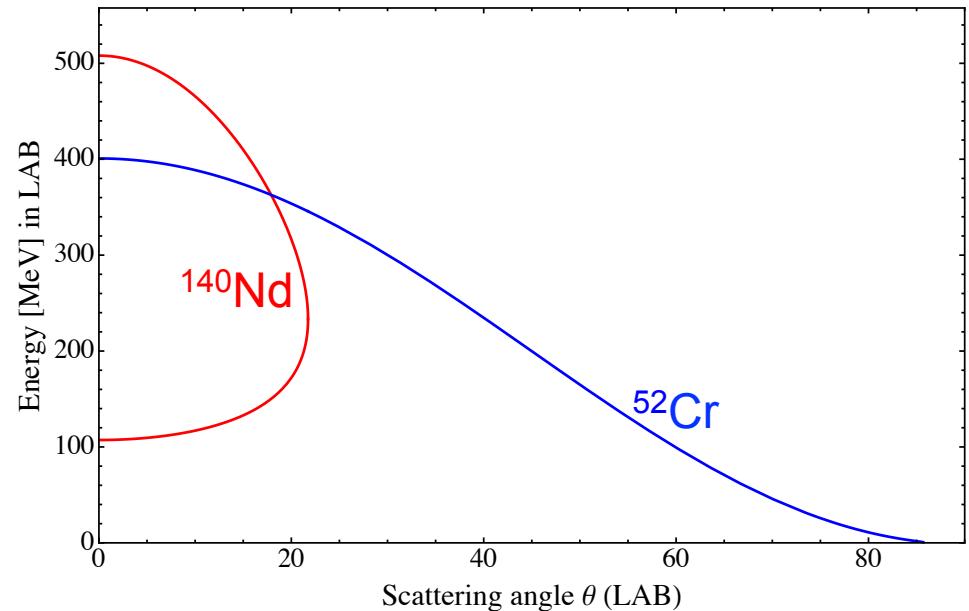
Proposal & Setup



- Identification of 2^+ MSS via measurement of $B(M1)$ strength
- Relative population with respect to first 2^+ state in Coulex

- MINIBALL + particle detector (CD or T-REX)
- Beam: $^{140}\text{Nd} + ^{142}\text{Sm}$ at 3.62 MeV/u ($\sim 5 \times 10^5$ ions/s on target)
- Target: ^{52}Cr , no interfering γ -rays, proper kinematics
(alternative choice: ^{208}Pb , need 4.5 MeV/u beam energy)

- Only possible at HIE-ISOLDE
(isotopes, beam energy & intensity)



Yield estimate



- Normalization of measured yields to excitation of first 2^+ state (measured in IS496)
 - Do not rely on target excitation
 - Beam purity is minor issue
 - RILIS: can measure solely in laser ON mode

Table: Estimated yields for ^{140}Nd excitation with 2.0 mg/cm^2 ^{52}Cr target from CLX, 3 shifts laser ON (24h)

E_{level} (keV)	J^π	σ (mb)*	γ -ray yields
774	2^+_1	714	17228
1490	2^+_2	14	328
2140	2^+_3	0.3	7
2267*	2^+_4	6.1	147
2468*	2^+_5	0.4	9

Beam time request



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- **18 shifts** for CE yield measurements of ^{140}Nd beam at 3.62 MeV/u in laser on mode
- **24 shifts** for CE yield measurements of ^{142}Sm beam at 3.62 MeV/u in laser on mode
- **Total Request: 42 shifts (+ 3 shifts setup)**

Yield estimate

Alternative target choice: ^{208}Pb



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- Same approach for normalization
- 30% higher σ for state of interest, but more 2-step excitation
- Need perfectly collimated beam at higher energy
(is above fusion/fission barrier for Al/Fe, could result in high count rates)

Table: Estimated yields for ^{140}Nd excitation with 2.0 mg/cm^2 ^{208}Pb target from CLX, 3 shifts laser ON (24h)

E_{level} (keV)	J^π	σ (mb)*	γ -ray yields
774	2^+_1	2242	54114
1490	2^+_2	100	2421
2140	2^+_3	2.8	68
2267*	2^+_4	8.1	196
2468*	2^+_5	3.0	27

* QPM predictions