Static and dynamic moments of exotic nuclei with fragmented and post-accelerated beams

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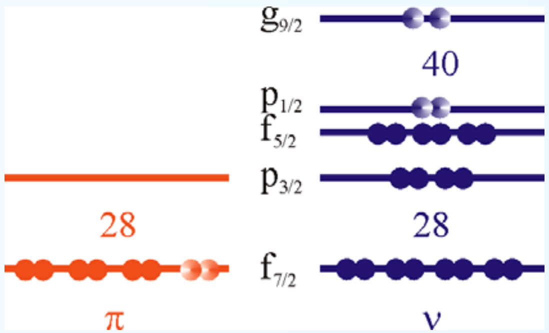
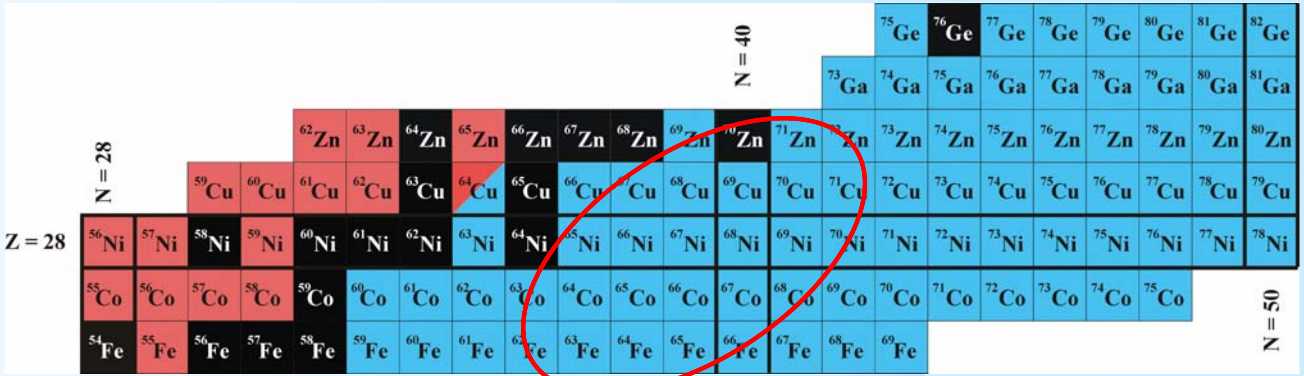
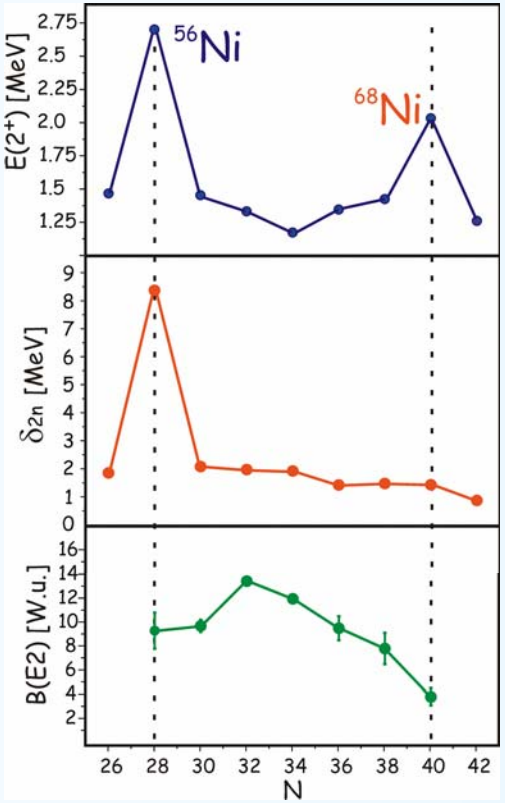
Nuclear electromagnetic moments and nuclear structure

- Nuclear magnetic moments - very sensitive to the single-particle properties of the nuclear state
  - verification of the spin/parity assignments
  - probes the purity of the nuclear wave function - close to new or disappearing (sub) shell closures
- Nuclear quadrupole moments – information on the collectivity and the deformation of the nucleus
- Static vs. dynamic moments – information on an single state vs. transition (mixing) between two states

An example: physics around N=40







- ✓ **high E(2+) in ^{68}Ni** (R. Broda *et al.*, PRL **74** (95) 868)
  → **proposed new magic number N=40**
- ✓ **NO effect in the S_{2n}** (H.Seifert *et al.*, ZPA 349(94) 25)
  → **explained by quadrupole shape correlations**
  (P.G. Reinhard et al., RIKEN Review 26 (2000) 23)
- ✓ **B(E2) in ^{68}Ni**
  → **shell closure washed-out by pair scattering**
  (O. Sorlin *et al.*, PRL **88**(01) 92501)
  →**main strength above 4 MeV**
  (K.H. Langanke et al. PRC 67 (03) 44314)
- ✓ **collectivity in the Zn** (S. Leenhardt *et al.*, EPJ **A14** (02) 1)
  and Fe isotopes (M.Hannawald et al., PRL **82**(99) 1391)

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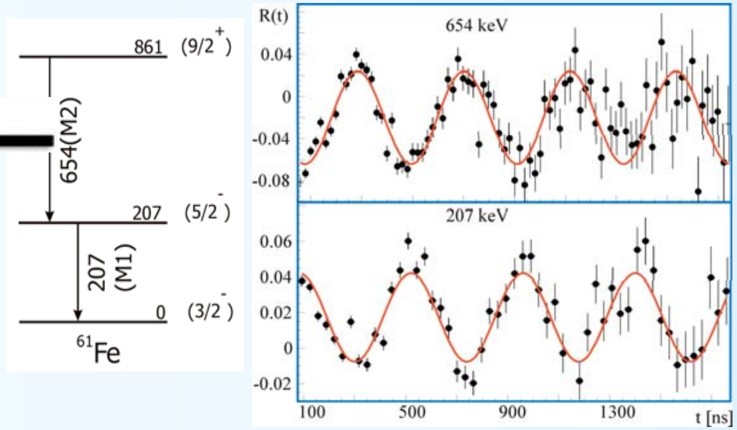
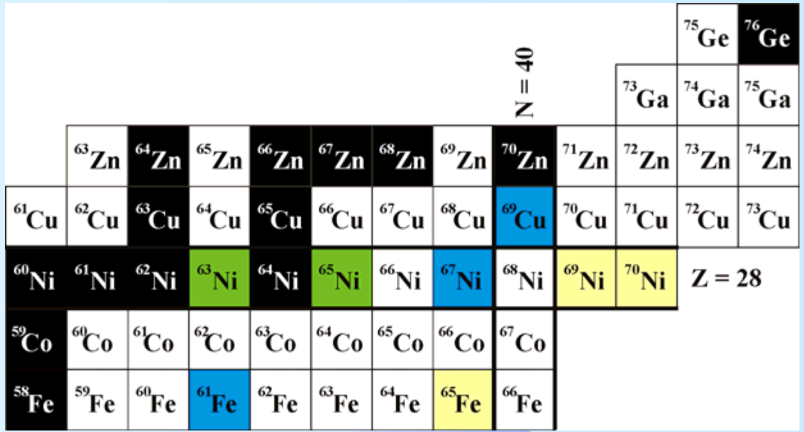
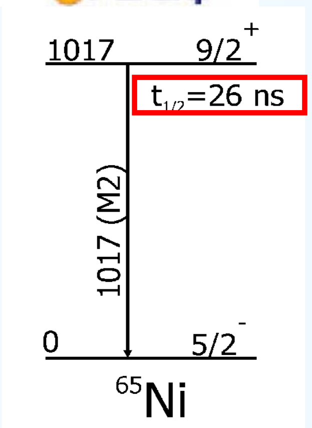
Experimental results – static nuclear moments in fragmentation and in transfer reactions





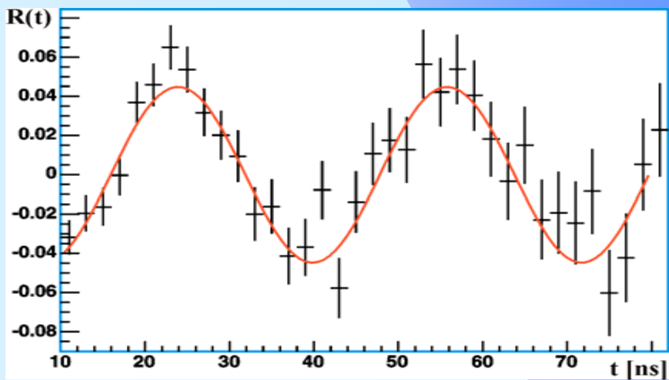
$g_{exp.}$ (^{61m}Fe) = - 0.229(2) I. Matea et al. PRL93 (2004) 142503



transfer (d,p) reaction

pulsed 6 MeV D beam, 1 nA

enriched ^{64}Ni (ferromagnetic) target



$g_{exp.}$ (^{65m}Ni)= -0.298 (4)

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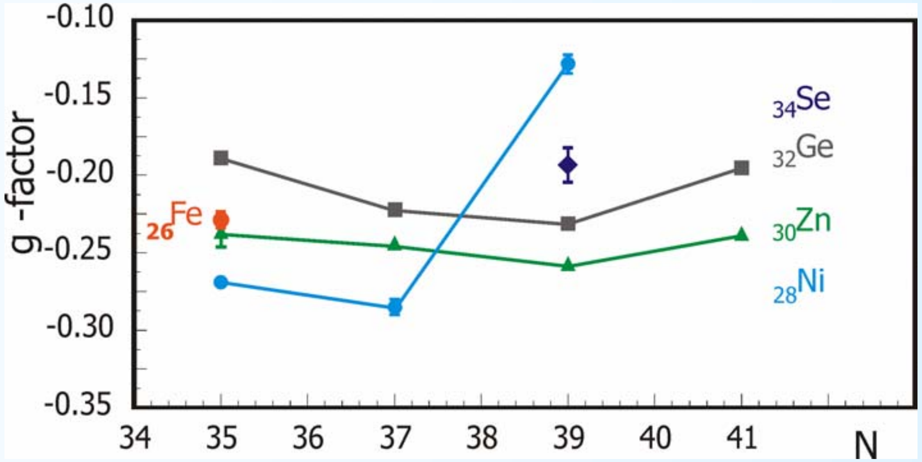
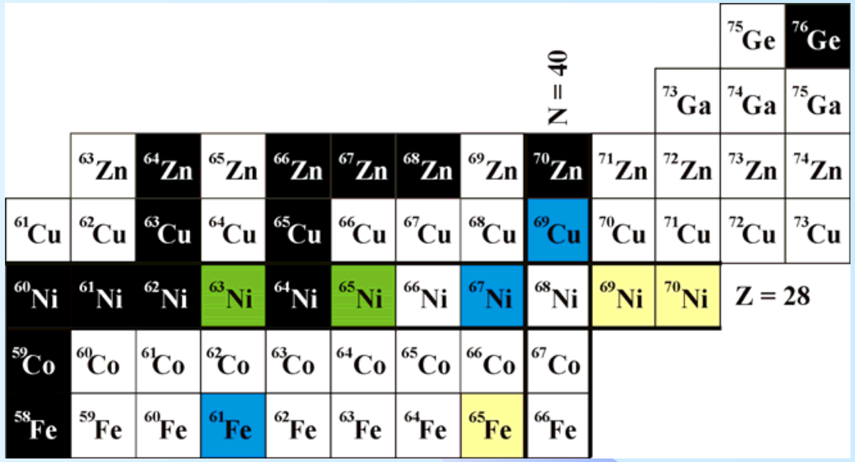
Experiment vs. theory





✓ ^{61m}Fe and ^{65m}Ni well fitting into the systematics of neutron $g_{9/2}$ states in the region;
✓ g(^{63m}Ni) and g(^{65m}Ni) very well reproduced in LSSM calculations with ^{48}Ca core;
✓ g(^{61m}Fe) slightly differs from the theoretical calculations (using free nucleon g factors)

	$g_{exp.}$	$g_{theor.(free)}$
^{61m}Fe	-0.229(2)	-0.277
^{63m}Ni	-0.269(3)	-0.274
^{65m}Ni	-0.298(4)	-0.303

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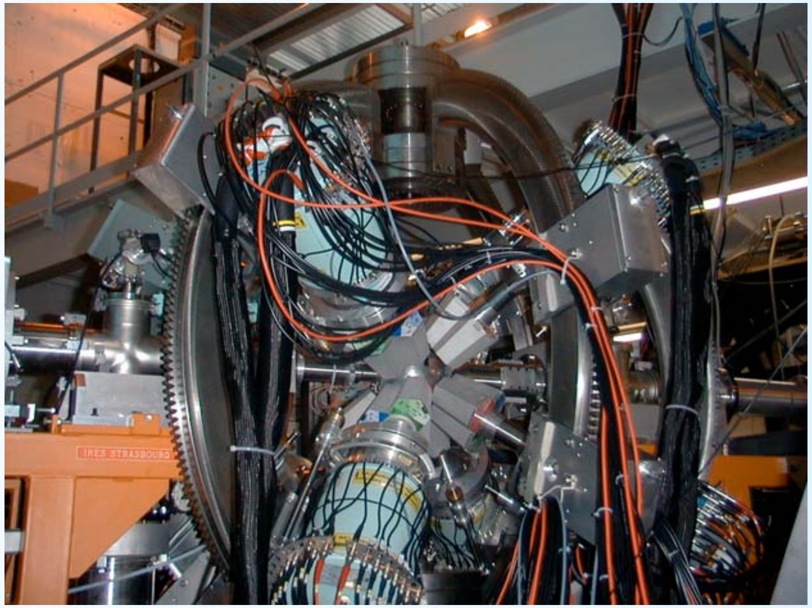
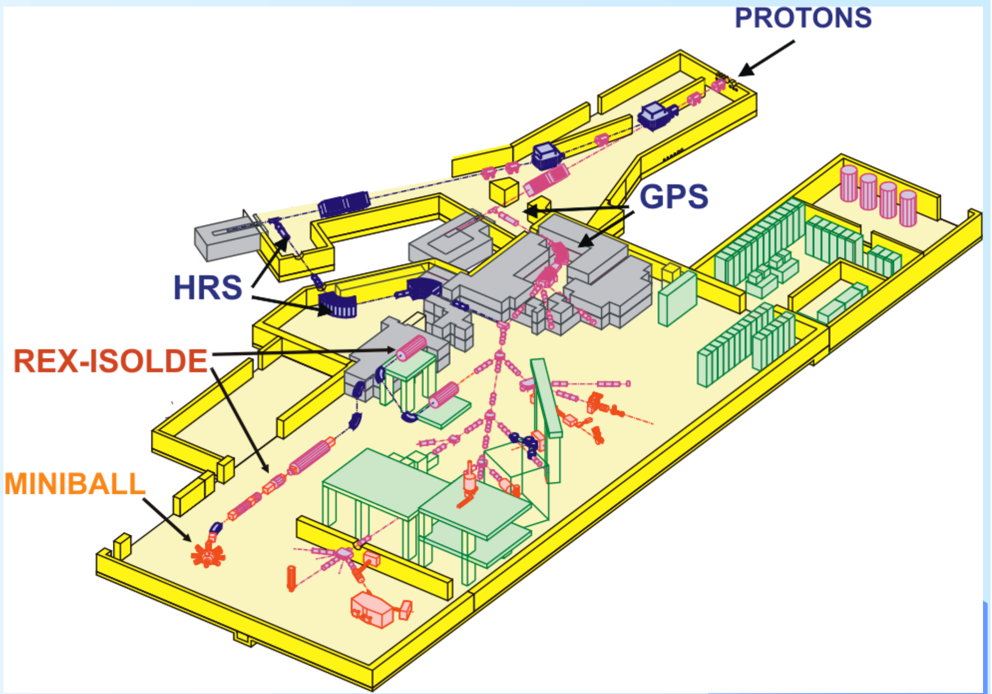
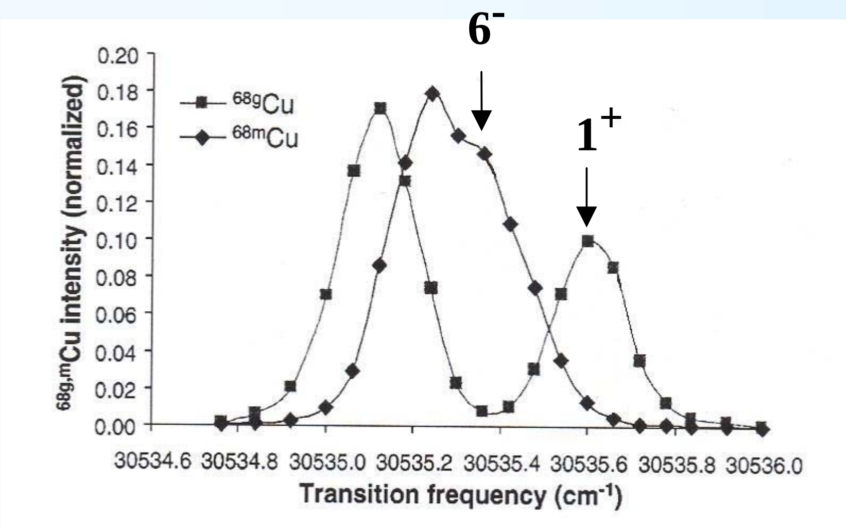
REX-ISOLDE







→ radioactive beams post-accelerated up to 3 MeV/u

→ RILIS chemical (and isomeric) selectivity – example ^{68}Cu and ^{70}Cu

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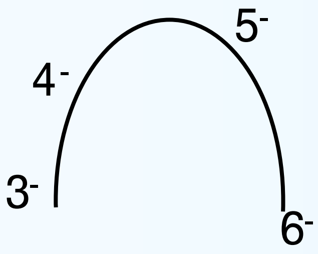
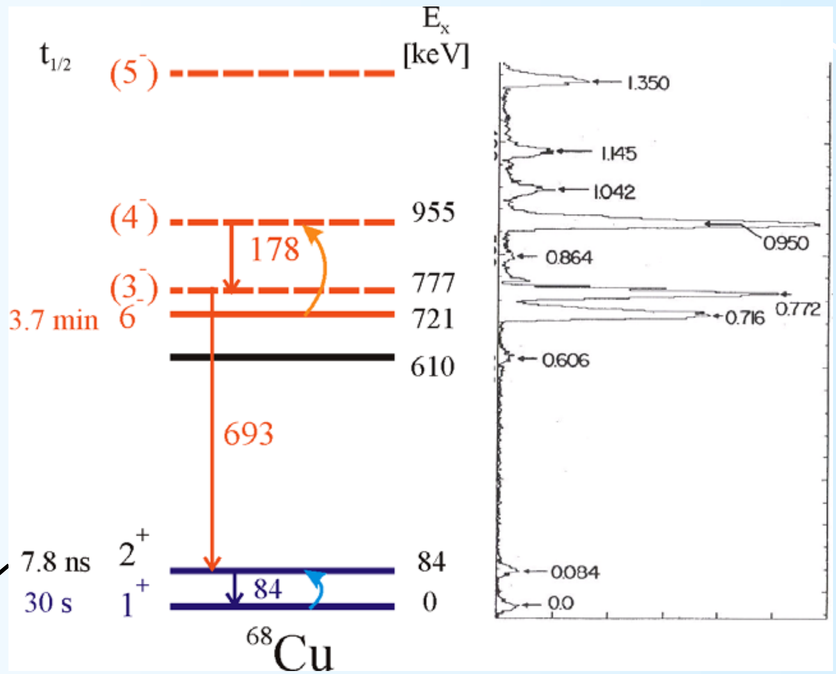
Coulomb excitation of isomeric beams

Preliminary

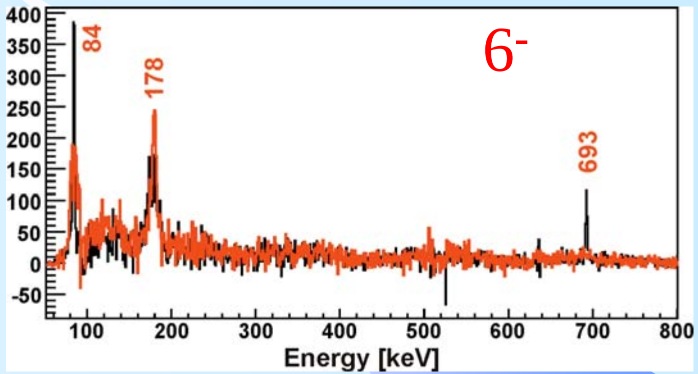


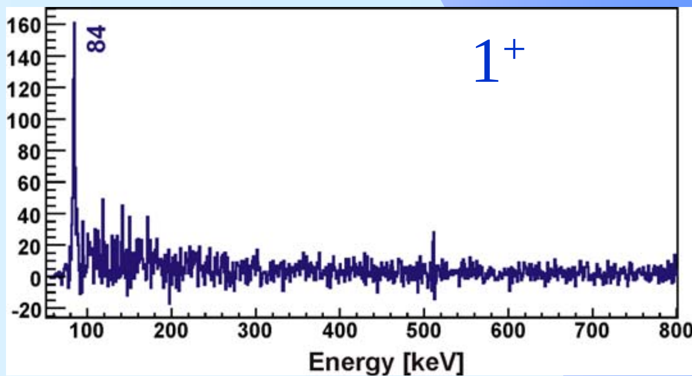
$\pi p_{3/2} \otimes \nu g_{9/2}$

$\pi p_{3/2} \otimes \nu p_{1/2}$



L. Hou et al. PRC68 (2003) 54306





2^+ → pure $\pi p_{3/2} \otimes \nu p_{1/2}$ or admixture with $\nu f_{5/2}$

→ **effective charges**

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Conclusions and perspectives

- Nuclear moments provide indispensable information on the nuclear wave function
  - static and dynamic moments probing different aspects of the nuclear structure
- Studies with fragmented and post-accelerated ISOL beams are complementary and should be used in their strongest points
- Nuclear moments studies with transfer reactions in inverse kinematics – a tool to be developed
  - a project in progress together with the University of Camerino

Collaborations

- **Static moments (fragmentation and transfer)**

  CERN, Geneva, Switzerland
  GANIL, Caen, France
  University of Sofia, Sofia, Bulgaria/University of Camerino, Italy
  IKS, Leuven, Belgium
  The Weizmann Institute, Rehovot, Israel
  FLNR-JINR, Dubna, Russia
  CEA/DIF/DPTA/PN, Bruyères le Châtel, France
  IPN, Orsay, France
  IFD, Warsaw University, Warsaw, Poland

- **Transition probabilities (Coulex)**

  CERN, Switzerland
  IKS Leuven, Belgium
  INRNE &University of Sofia, Bulgaria/ University of Camerino, Italy
  LMU, Munich, Germany
  MPI, Heidelberg, Germany
  University of Köln, Germany
  TU Darmstadt, Germany
  TU Munich, Germany
  Warsaw University, Poland
  IPN Orsay, France
  Lund University, Sweden
  INP, NCSR "Demokritos", Athens, Greece
  University of Gent, Belgium
  REX and MINIBALL collaborations