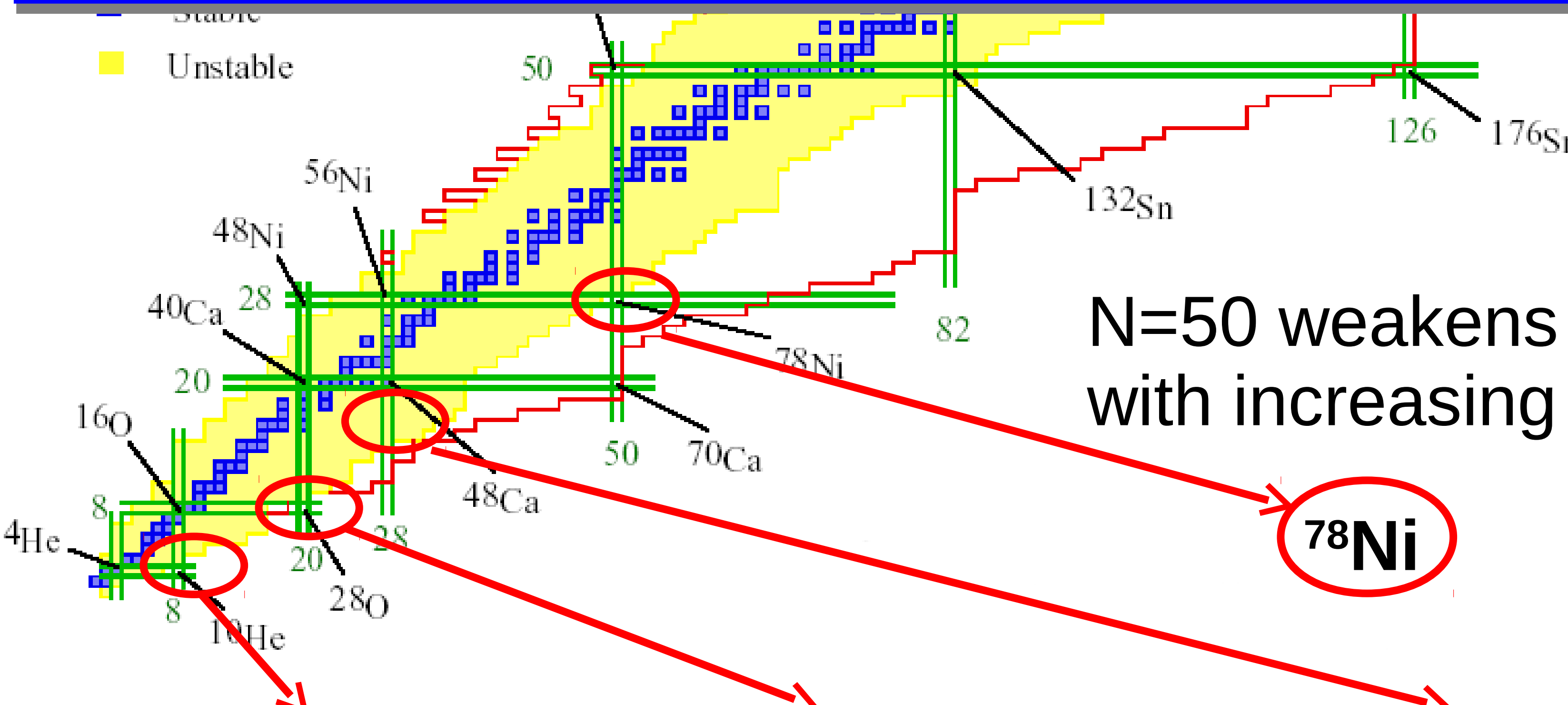
Isomer states in neutron-rich $^{73,75,77}Ni$

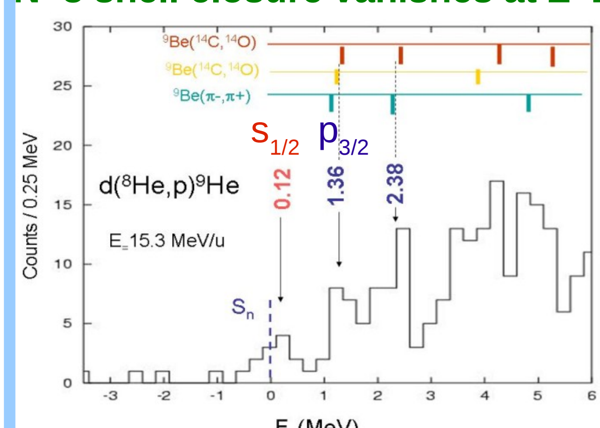
Goal: search for $1/2^-$ isomeric states in neutron-rich odd Ni nuclei next to ^{78}Ni in order to get an estimation on the 2^+ energy of ^{78}Ni.

Physics motivations

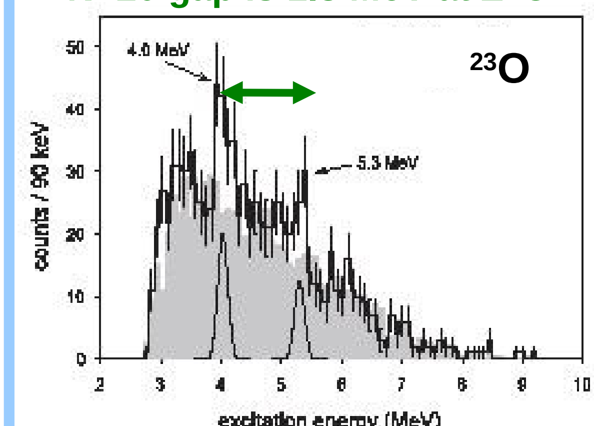


N=50 weakens or not with increasing N/Z?

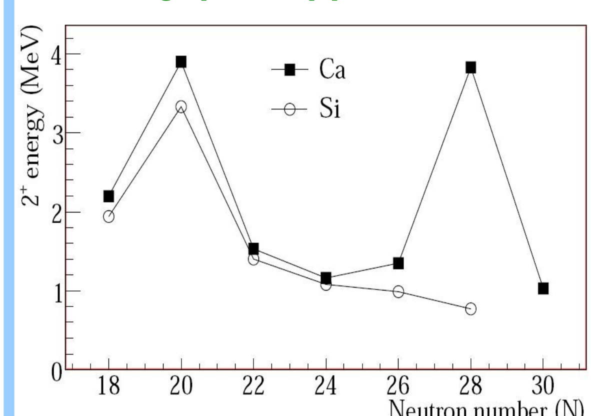
N=8 shell closure vanishes at Z=2



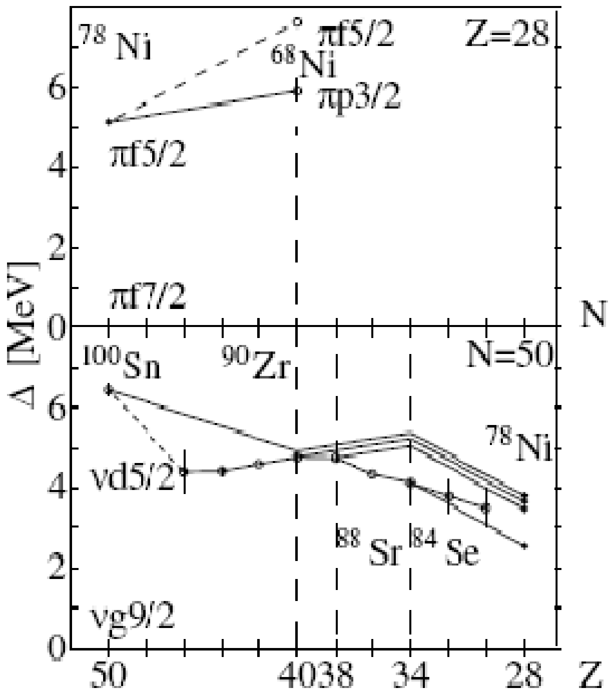
N=20 gap is 1.3 MeV at Z=8

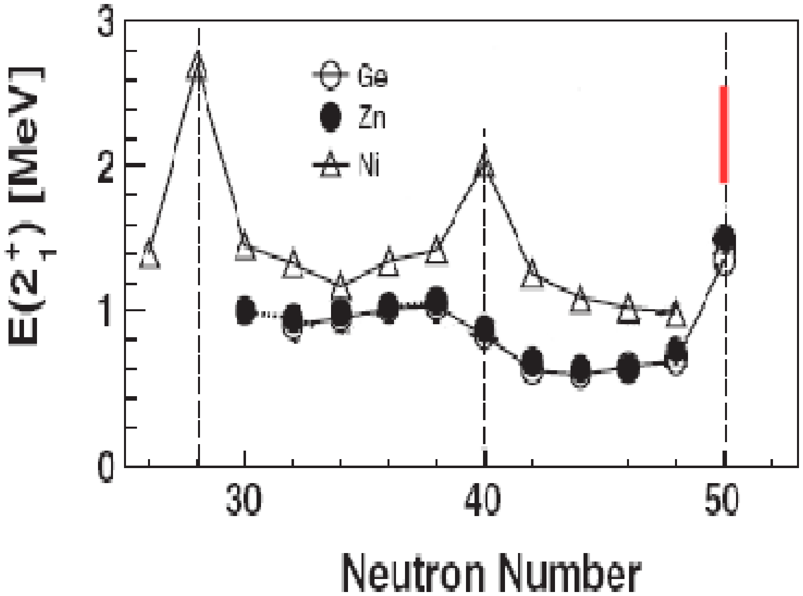


N=28 gap disappears at Z=14



Physics motivations

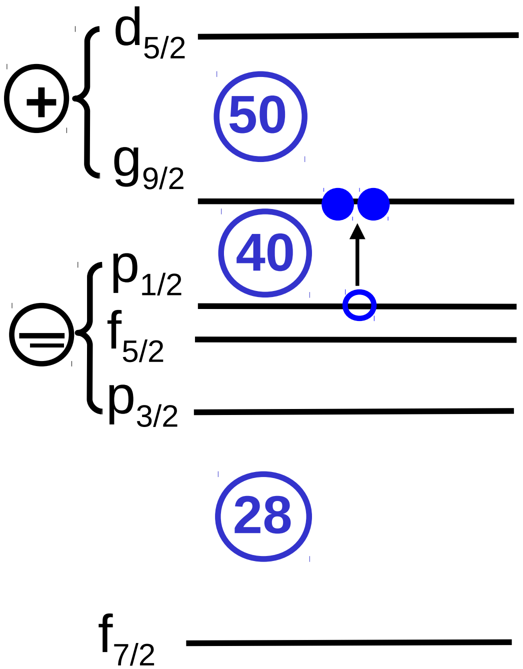




From shell model analysis of N=50 nuclei, the N=50 shell gap at Z=28 is estimated to be reduced by 2-3 MeV relative to ^{100}Sn

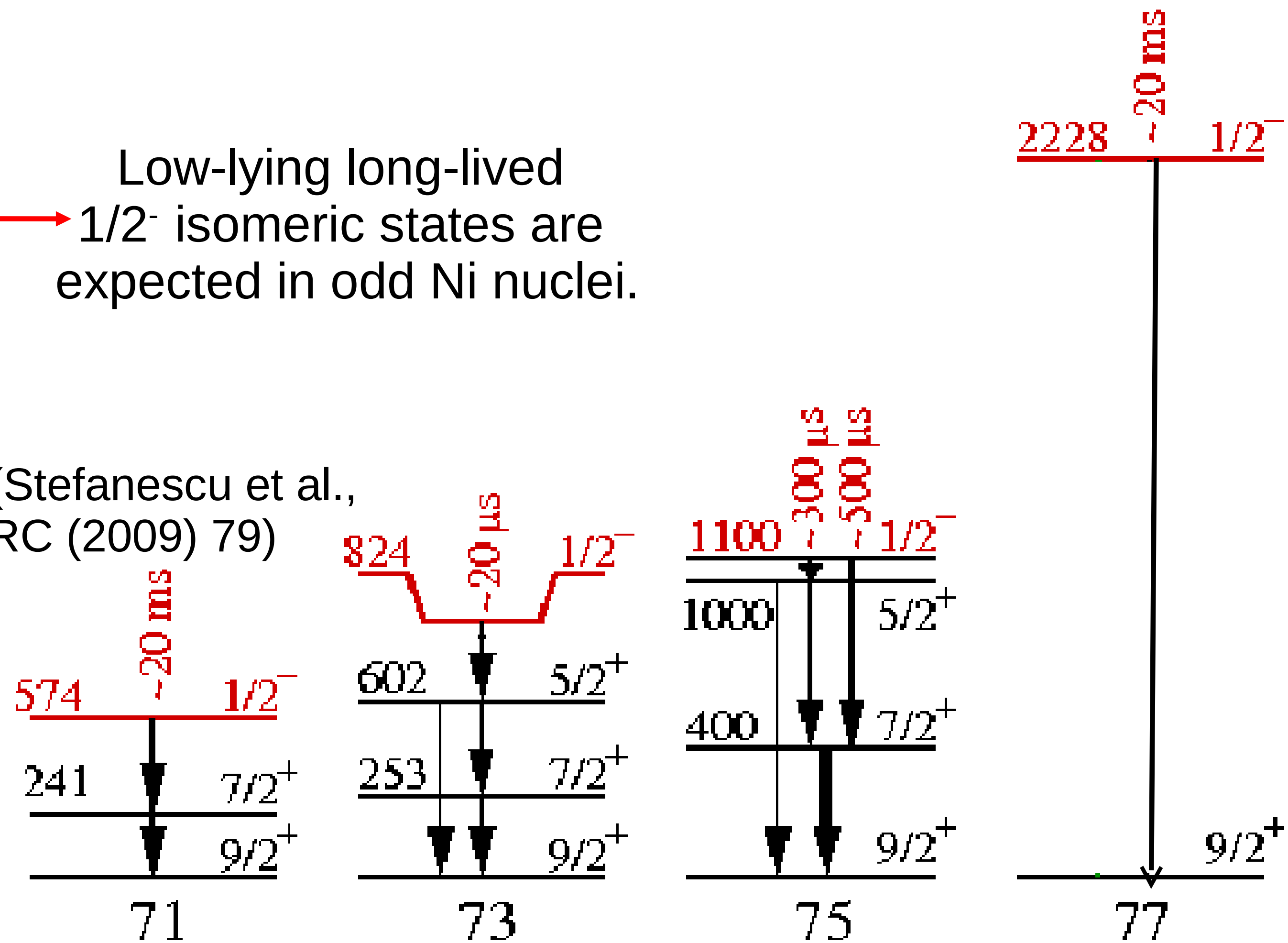
~3.5-4.5 MeV

Long-lived isomers in odd Ni isotopes



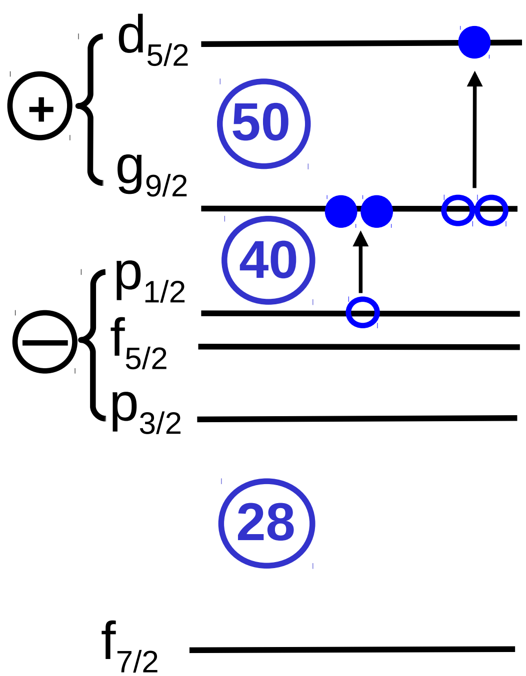
Low-lying long-lived $1/2^-$ isomeric states are expected in odd Ni nuclei.

2.3 s (Stefanescu et al., PRC (2009) 79)



Estimated half lives of the $\nu p_{1/2}$ states in odd Ni nuclei as predicted by the shell model

Long-lived isomers in odd Ni isotopes

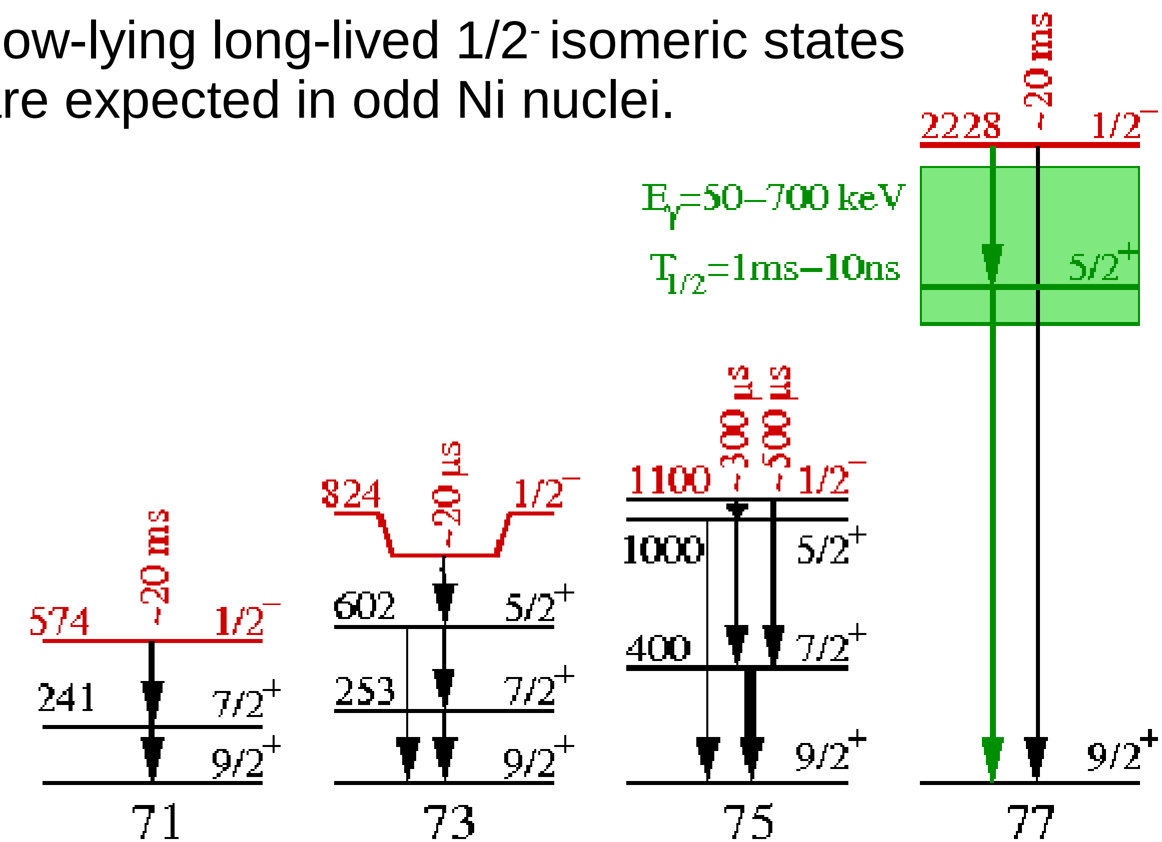


An intruder $5/2^+$ state may appear from cross shell excitations.

Low-lying long-lived $1/2^-$ isomeric states are expected in odd Ni nuclei.

Energy of $d_{5/2}$ state is reduced by:

- strength of pairing interaction in $\nu g_{9/2}$ hole state
- additional bindig from quadrupole correlations



Estimated half lives of the $\nu p_{1/2}$ states in odd Ni nuclei as predicted by the shell model

Long-lived isomers in odd Ni isotopes

- If the $1/2^-$ isomeric state in ^{77}Ni decays by 1 gamma line ⟶ the lowest $5/2^+$ state is above the $1/2^-$ state and the strength of the N=50 shell gap stays strong at Z=28

- If the $1/2^-$ isomeric state in ^{77}Ni decays by 2 gamma lines ⟶ the lowest $5/2^+$ state intrudes below the $1/2^-$ state and the N=50 shell gap weakens at Z=28

- Energy and life time of the $1/2^-$ state in lighter $^{73,75}Ni$ isotopes is needed to reveal the structure of these nuclei from γ-spectroscopy.

Experimental setup

Primary beam: ^{238}U with 345 MeV/nucleon, 2 pnA
Primary target: 1.2 g/cm^2 ^9Be

Expected secondary beam intensities: 200 ion/h ^{77}Ni
5000 ion/h ^{75}Ni
10^5 ion/h ^{73}Ni

We obtained the rates by LISE++ scaled down to experimental production rates reported by Ohnishi et al. (JPSJ 79 (2010) 078201).