*M*1 and *M*2 modes in 180° electron scattering at the S-DALINAC

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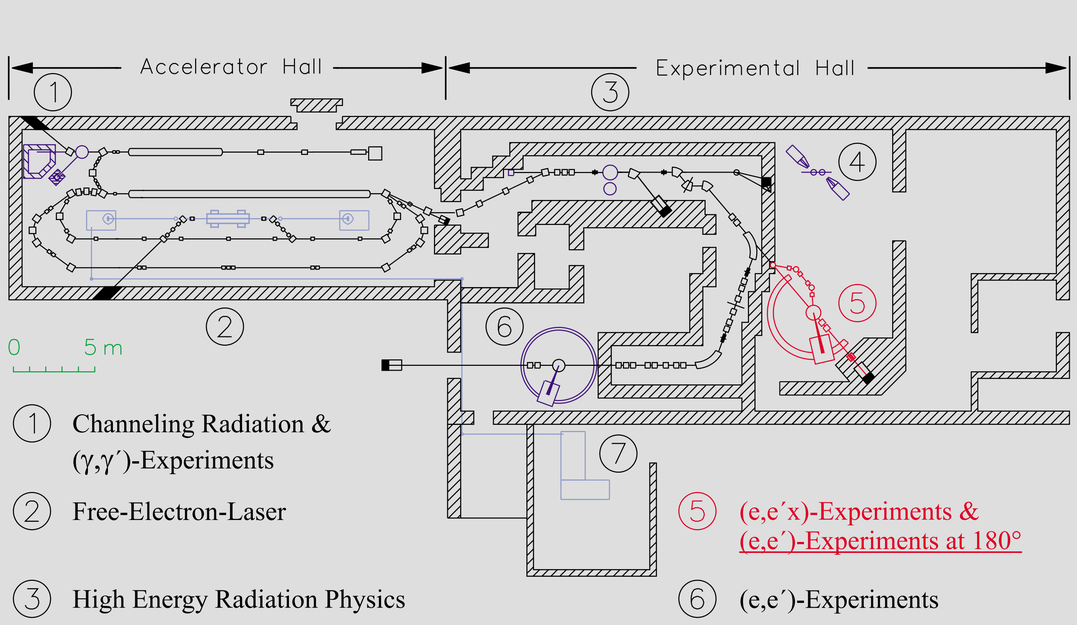
S-DALINAC AND EXPERIMENTAL FACILITIES



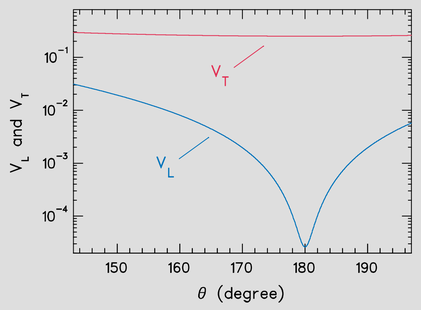
① Channeling Radiation & (γ,γ′)-Experiments
② Free-Electron-Laser
③ High Energy Radiation Physics
④ Compton Scattering off Nucleons
⑤ (e,e′x)-Experiments & (e,e′)-Experiments at 180°
⑥ (e,e′)-Experiments
⑦ Optics Experiments

WHY 180°?

☛ Inelastic cross section for inclusive electron scattering

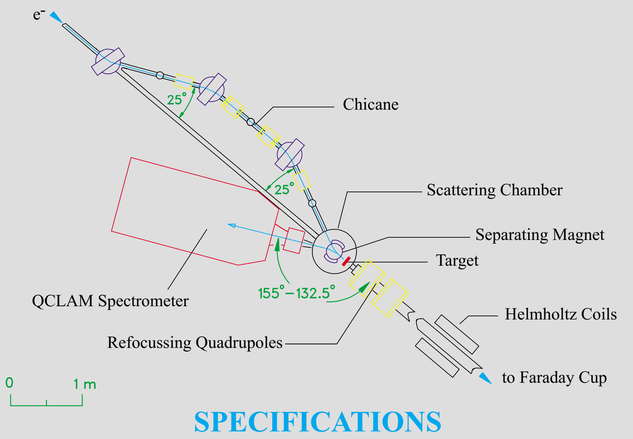
$$\left(\frac{d\sigma}{d\Omega}\right) = \left(\frac{d\sigma}{d\Omega}\right)_L + \left(\frac{d\sigma}{d\Omega}\right)_T$$

$$\left(\frac{d\sigma}{d\Omega}\right)_L \propto V_L \times |F_L(q)|^2 \qquad \left(\frac{d\sigma}{d\Omega}\right)_T \propto V_T \times |F_T(q)|^2$$



☛ Scattering at 180° is ideal for measurements of transverse excitations

180° SYSTEM AT THE S-DALINAC



SPECIFICATIONS

		Full solid angle	Limited solid angle
Central energy range	MeV	25 ÷ 85	25 ÷ 85
Momentum acceptance	%	[- 10 ; + 10]	[- 6 ; + 8]
Effective scattering angle	deg	ca. 177.5	ca. 178
Acceptance of the horizontal scattering angle	mrad	± 60	± 40
Acceptance of the vertical scattering angle	mrad	± 40	± 40
Solid angle acceptance	msr	9.6	6.4
Momentum transfer	fm^{-1}	0.2 ÷ 0.85	0.2 ÷ 0.85
Intrinsic energy resolution		$2 \cdot 10^{-4}$	$2 \cdot 10^{-4}$

*M*1 AND *M*2 TRANSITIONS IN SELF-CONJUGATE NUCLEI ^{28}Si AND ^{32}S

1. Strength distributions and form factors ➪ test of microscopic calculations .
2. Weak *M*1 transitions ➪ subtle structure aspects ?
3. Interpretation of *M*2 strength ?

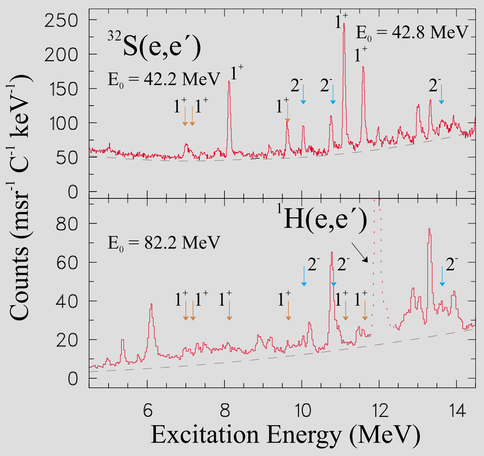
Comparison of isovector *M*1 strengths with the analog *GT* transitions ☛ MEC contribution

Shell-model (USD interaction) and QRPA calculations

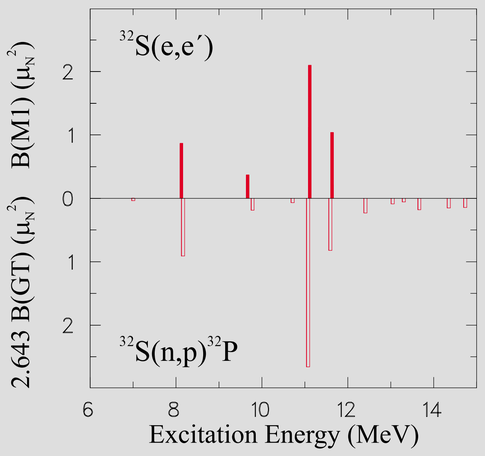
High sensitivity ☛ extremely weak isoscalar *M*1 excitation ⇨ isospin mixing ?

Particle-Core Coupling (PCC) version of the shell model

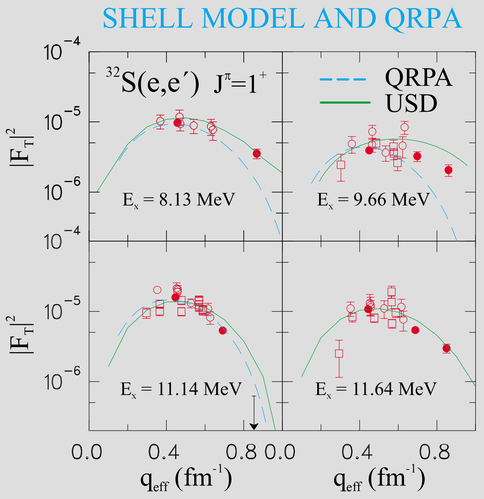
EXPERIMENT



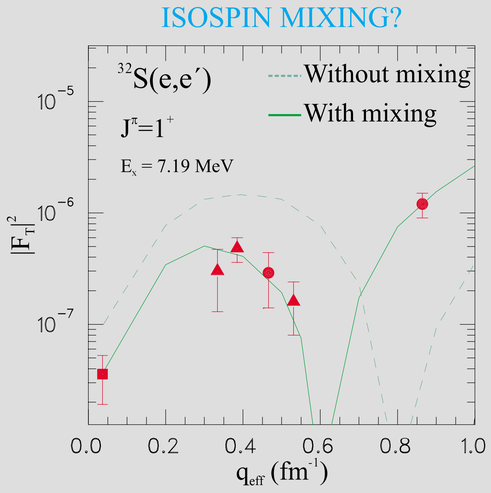
*M*1 vs *GT*



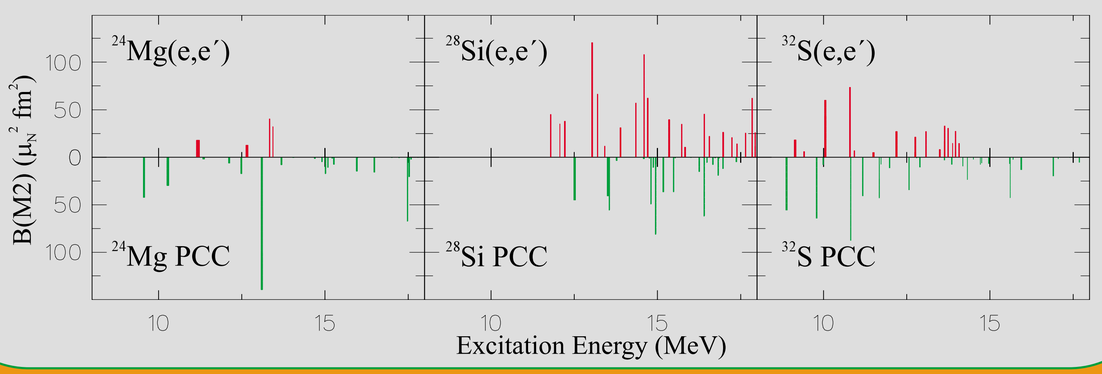
SHELL MODEL AND QRPA



ISOSPIN MIXING?



*M*2 STRENGTHS



*M*2 STRENGTH IN ^{58}Ni

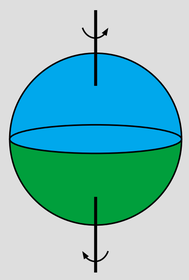
1. Separation of spin and orbital parts ➪ evidence for the twist mode ?
2. Fine structure of magnetic resonances ➪ damping mechanism ?
3. Quenching of *M*2 and *M*3 strengths ➪ same as for *M*1/*GT* ?

^{58}Ni(e,e′) (S-DALINAC, Darmstadt)
Spin-flip *M*2 mode
☛ $J^\pi = 2^-$
⇨ $\Delta S = 1$ and $\Delta T = 1$

^{58}Ni($\vec{p},\vec{p}'$) (KVI, Groningen)
Spin-dipole mode
☛ $J^\pi = 1^-$ and $J^\pi = 0^-, 2^-$
⇨ Spin-flip probability ➜ $\Delta S = 1$
☛ $\Delta T = 0$ and $\Delta T = 1$

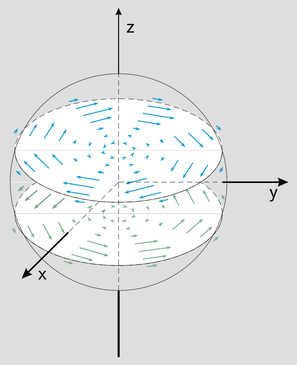
THE $J^\pi = 2^-$ TWIST MODE

SEMICLASSICAL PICTURE

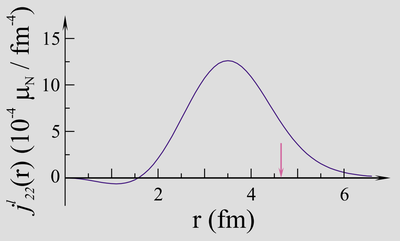


MICROSCOPIC PICTURE

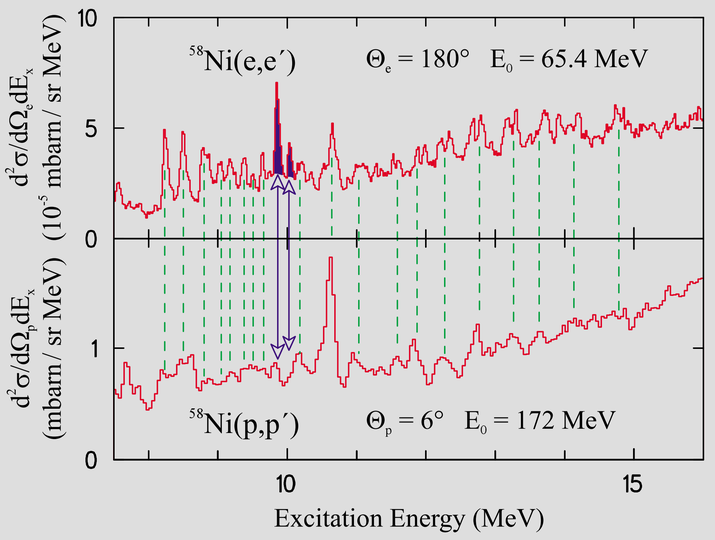
Nuclear current distribution



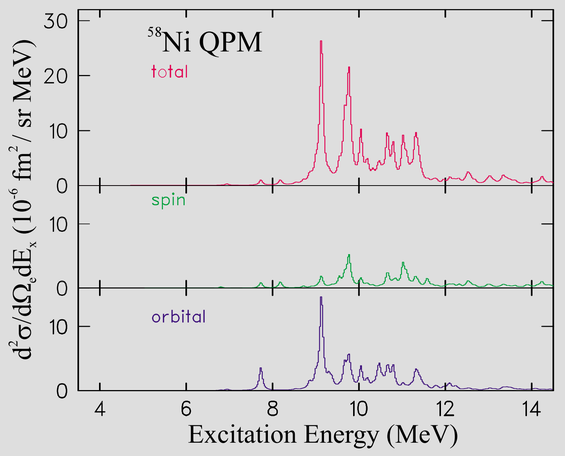
Orbital transition current density



EXPERIMENT



(e,e′) cross section



☛ Dominantly orbital transitions at $E_x = 9.87$, $E_x = 10.04$ MeV - evidence for the twist mode !