

Nature of One- and Two-Phonon Mixed-Symmetry States in ^{94}Mo from High-Resolution Electron and Proton Scattering*



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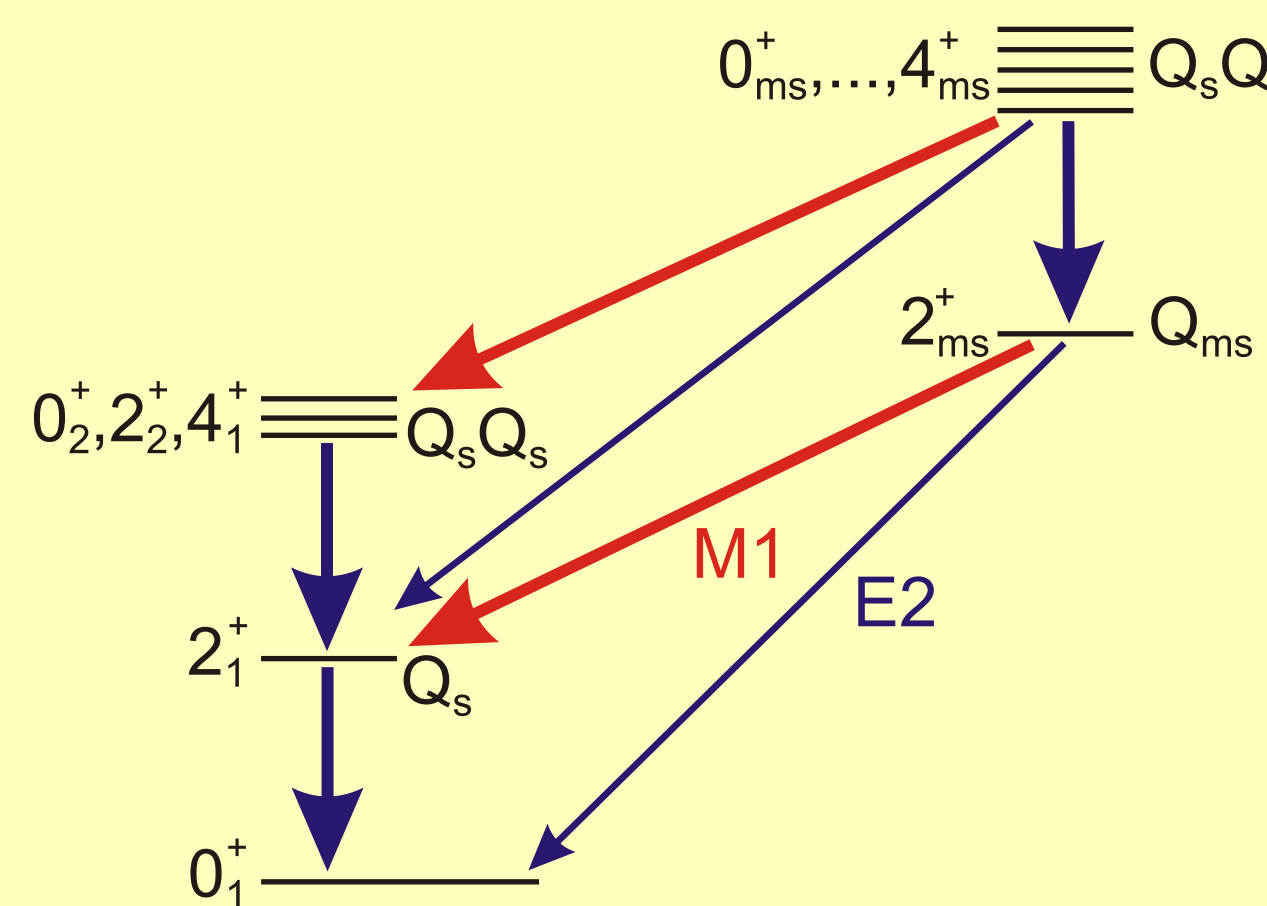


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Identification of Mixed-Symmetry States: Q-Phonon Scheme

Fully symmetric states (FSS) $F = F_{\text{max}}$ Mixed-symmetry states (MSS) $F = F_{\text{max}} - 1$



- Strong E2 transitions for decay of Q_s -phonon
- Weak E2 transitions for decay of Q_{ms} -phonon
- Strong M1 transitions for decay of MSS to FSS

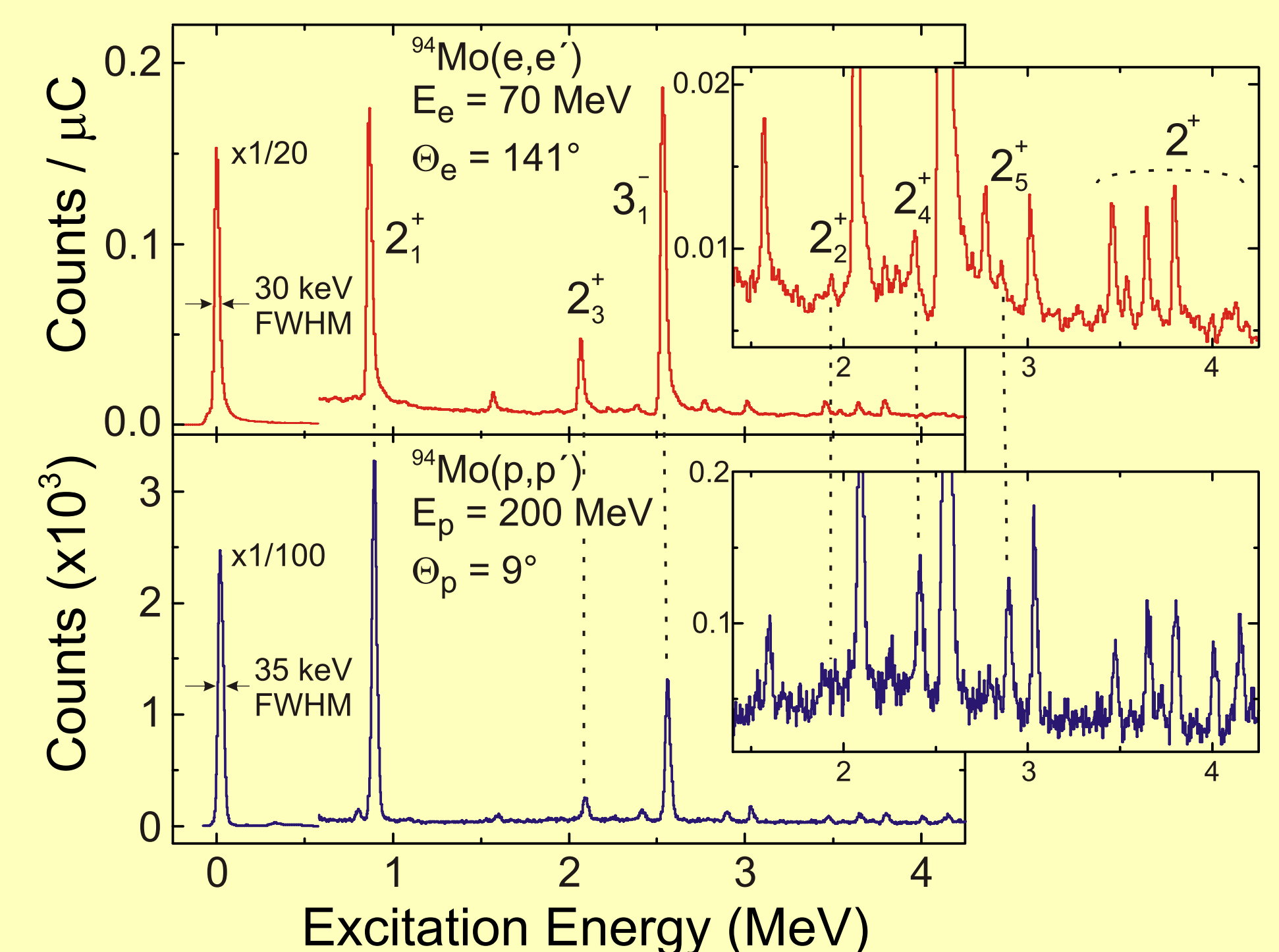
Motivation

- The low-energy spectrum of ^{94}Mo is well studied and most one- and two-phonon 2^+ states have been identified N.Pietralla *et al.*, Phys. Rev. Lett. 83 (1999) 1303; Phys. Rev. Lett. 84 (2000) 3775 C.Fransen *et al.*, Phys. Lett. B 508 (2001) 219; Phys. Rev. C 67 (2003) 024307
- Study of 2^+ states with (e,e') and (p,p')
 - sensitive to one-phonon components of the wave functions
 - test of fundamental phonon character
 - isoscalar / isovector decomposition
 - purity of two-phonon states

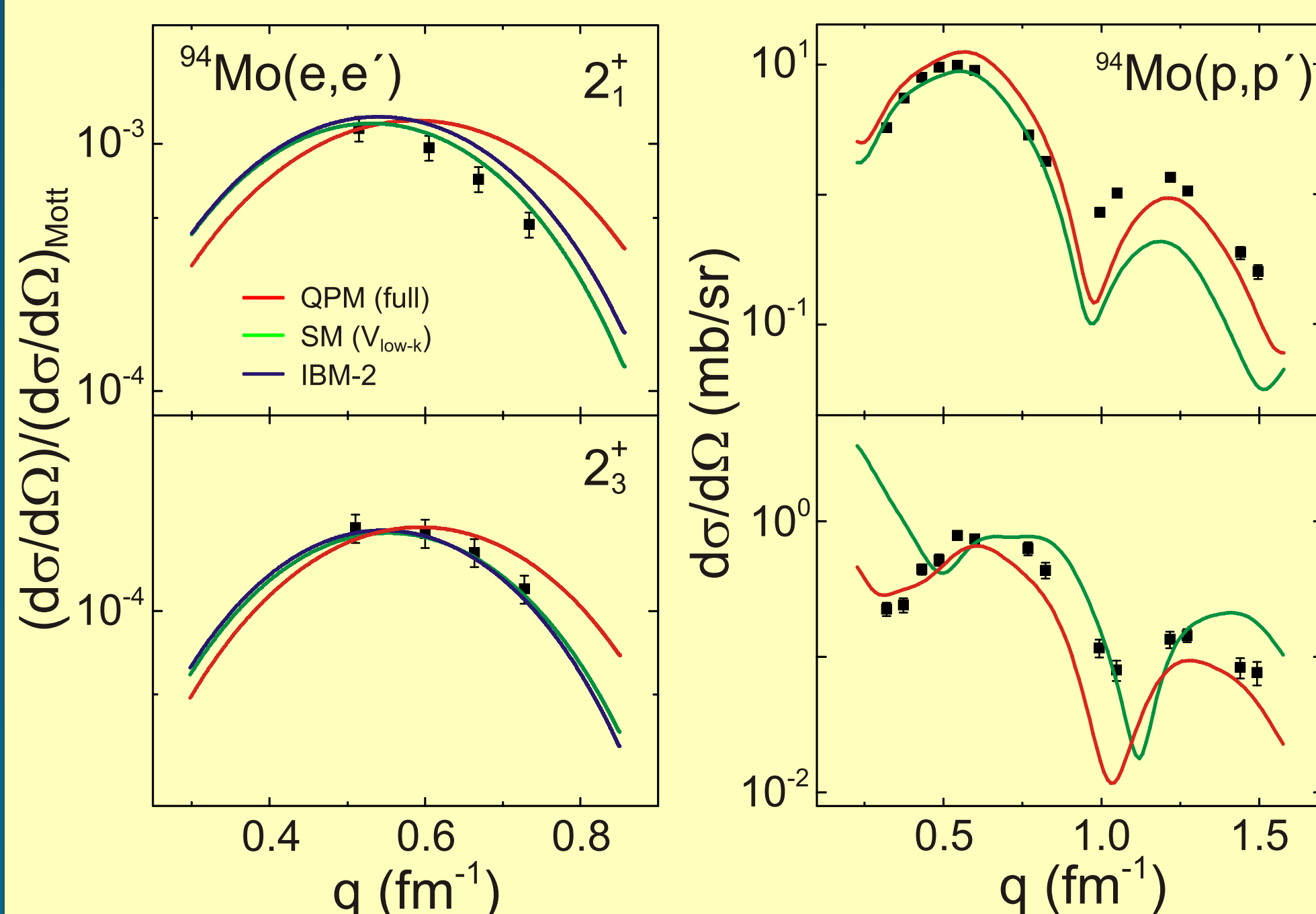
Experiments

- High resolution required to resolve all 2^+ states below 4 MeV
- Use of lateral dispersion matching technique
- (e,e') S-DALINAC, TU Darmstadt $E_e = 70$ MeV $\Theta_e = 93^\circ - 165^\circ$
- (p,p') iThemba LABS $E_p = 200$ MeV $\Theta_p = 4.5^\circ - 26^\circ$

Measured Spectra

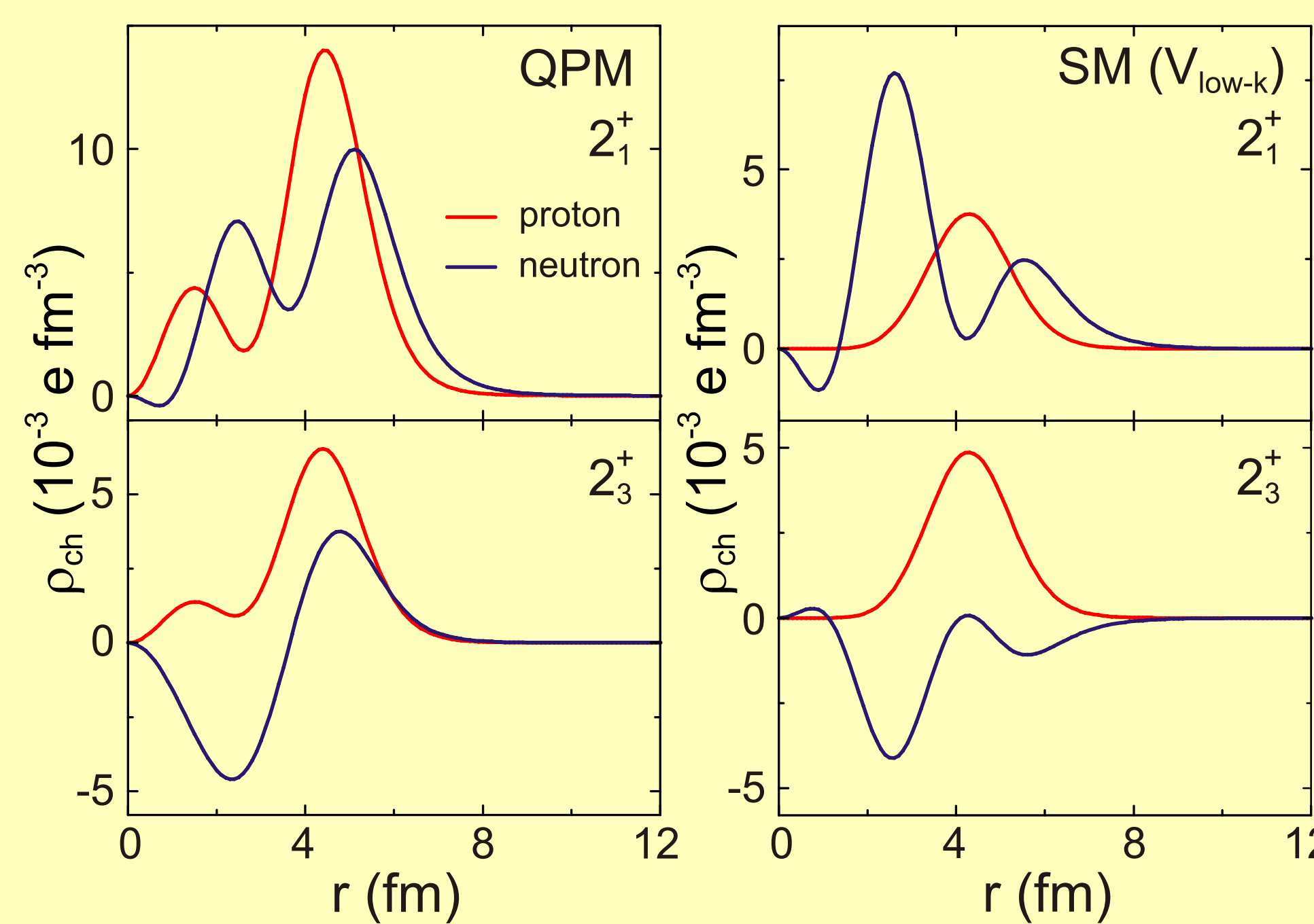


One-Phonon Symmetric and MS States



- One-phonon character confirmed

Radial Transition Charge Densities

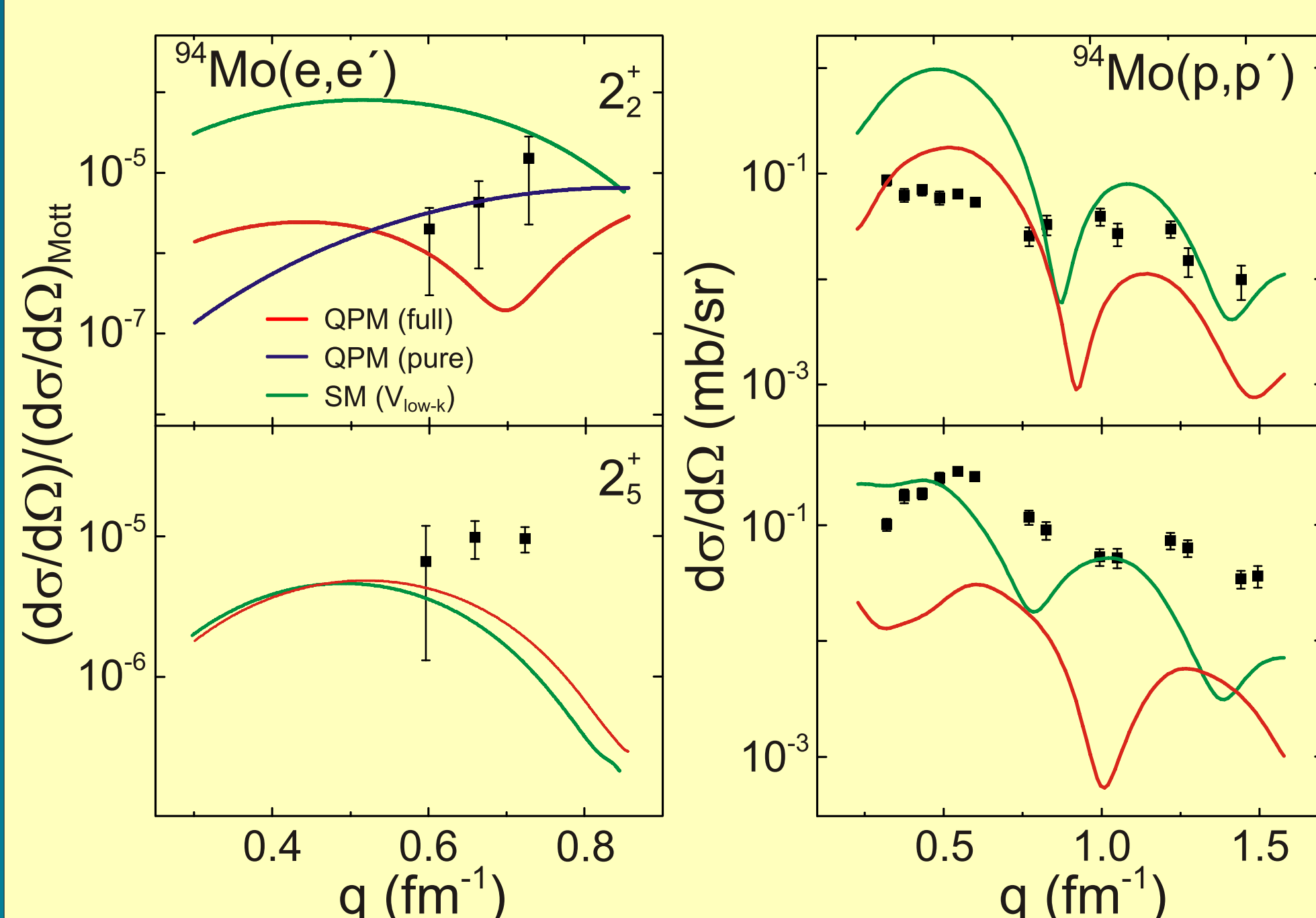


One-Body Transition Densities of One-Phonon Symmetric and MS States

Main configuration	$2_{1,\text{FSS}}^+$		$2_{3,\text{MSS}}^+$	
	QPM	SM	QPM	SM
$\pi(1g_{9/2} 1g_{9/2})$	0.66	0.39	0.64	0.51
$\nu(2d_{5/2} 2d_{5/2})$	0.72	0.55	-0.71	-0.33

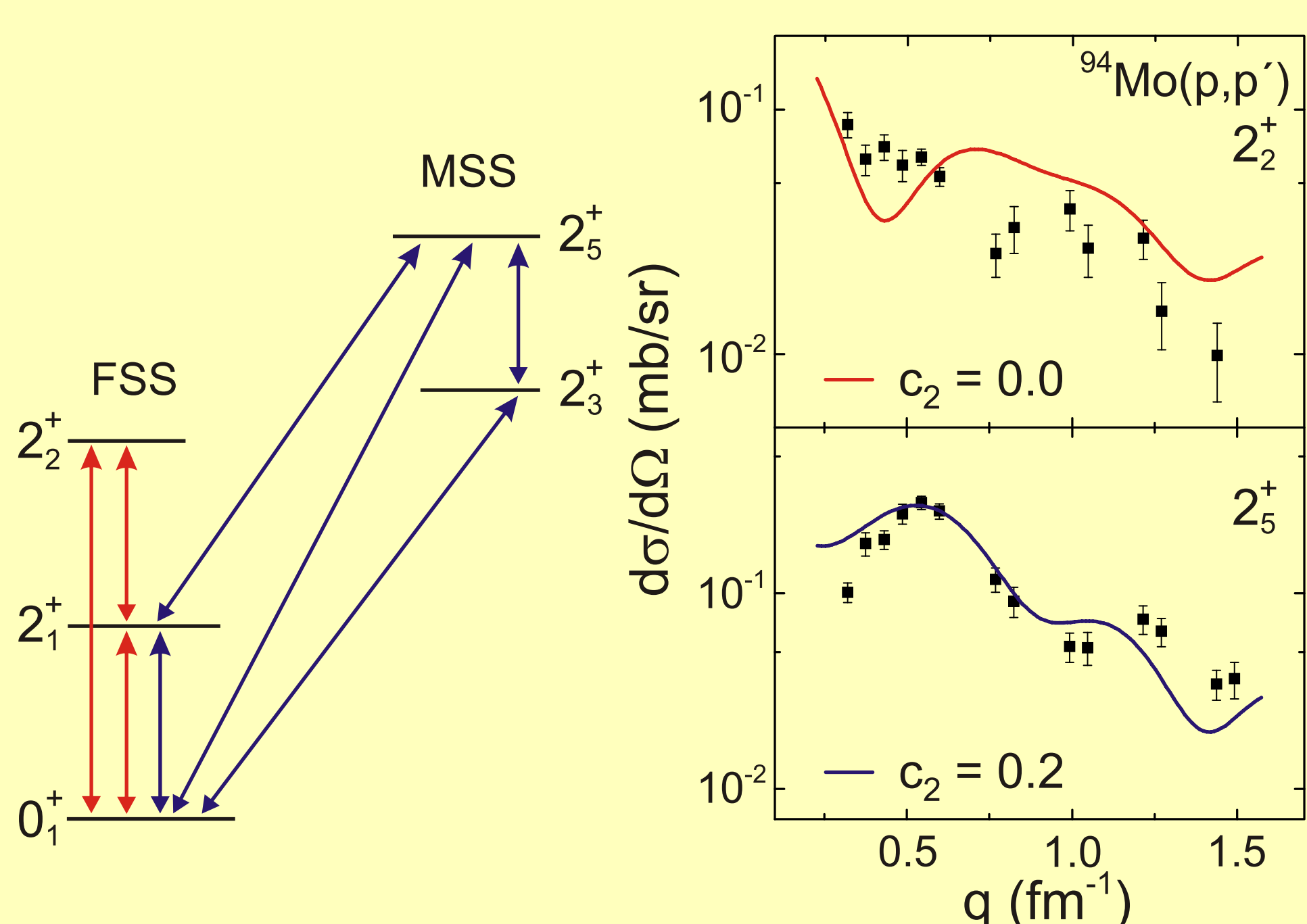
- FSS → isoscalar
 - MSS → isovector
- } in the valence shell

Two-Phonon Symmetric and MS States



- Pure two-phonon FSS
- Two-step contributions?
- About 10% one-phonon admixtures in MSS

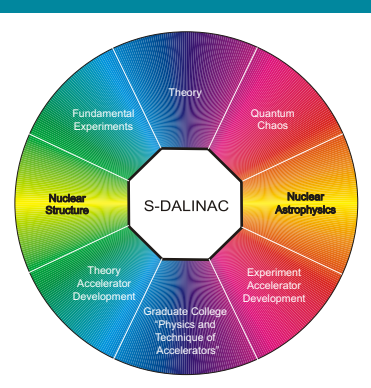
Coupled-Channel Analysis



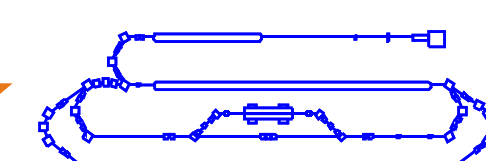
- Pure two-phonon FSS confirmed
- Admixture to two-phonon MSS confirmed

Summary and Outlook

- Study of one- and two-phonon FSS and MSS 2^+ states in ^{94}Mo with high-resolution (e,e') and (p,p') experiments
- Combined analysis with microscopic models reveals
 - dominant one-phonon character of the 2_1^+ and 2_3^+ states
 - isovector character of one-phonon MSS within the valence shell
 - two-phonon FSS quite pure
 - quantitatively consistent conclusions after inclusion of two-step processes in (p,p') cross sections
 - about 10% one-phonon and about 17% three-phonon admixtures in two-phonon MSS
 - but dominant two-phonon character
- The case of ^{92}Zr : Mixed-symmetry concept seems to fail C. Fransen *et al.*, Phys. Rev. C71 (054304) 2005
 - experiments
 - ☑ (p,p') at iThemba LABS
 - ☐ (e,e') at S-DALINAC



SFB 634



S-DALINAC