Muon capture as a probe of double beta decay

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Muon capture

Ordinary muon capture (OMC)

$$(A, Z) + \mu^- \rightarrow (A, Z-1) + \nu_\mu$$

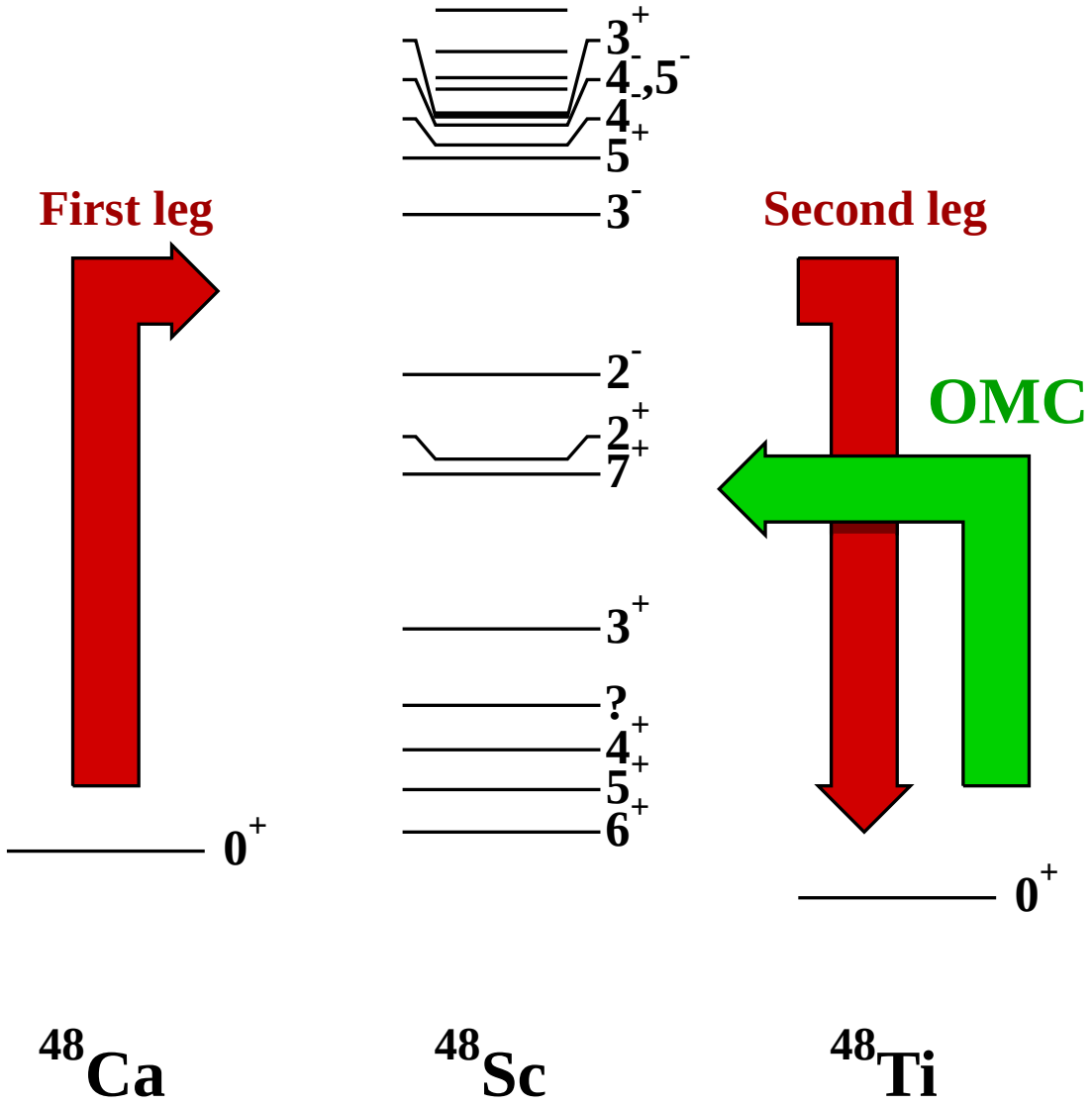
$m_\mu = 106$ MeV $\quad (\approx 200 m_e)$

$\Downarrow$

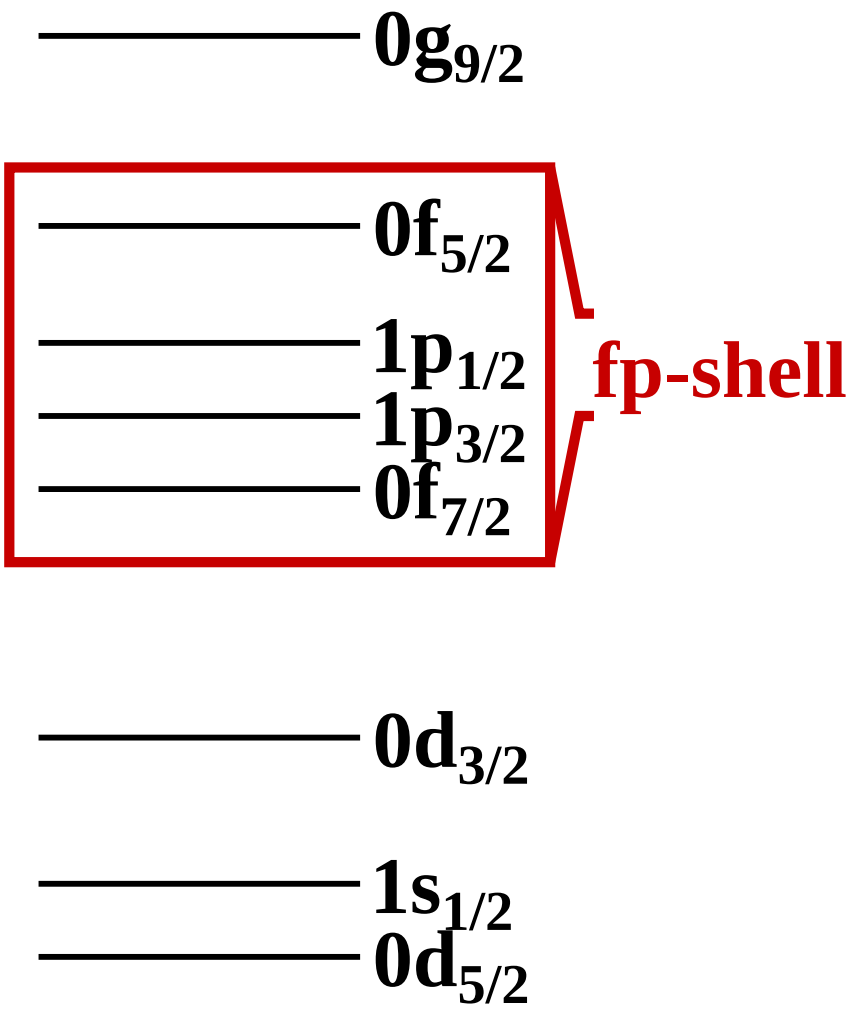
- the final state can be (highly) exited
- forbidden transitions are not as suppressed as in β-decay

$\Rightarrow$ OMC can be used as a probe of double beta decay

Muon capture as a probe of double beta decay



Nuclear structure calculations

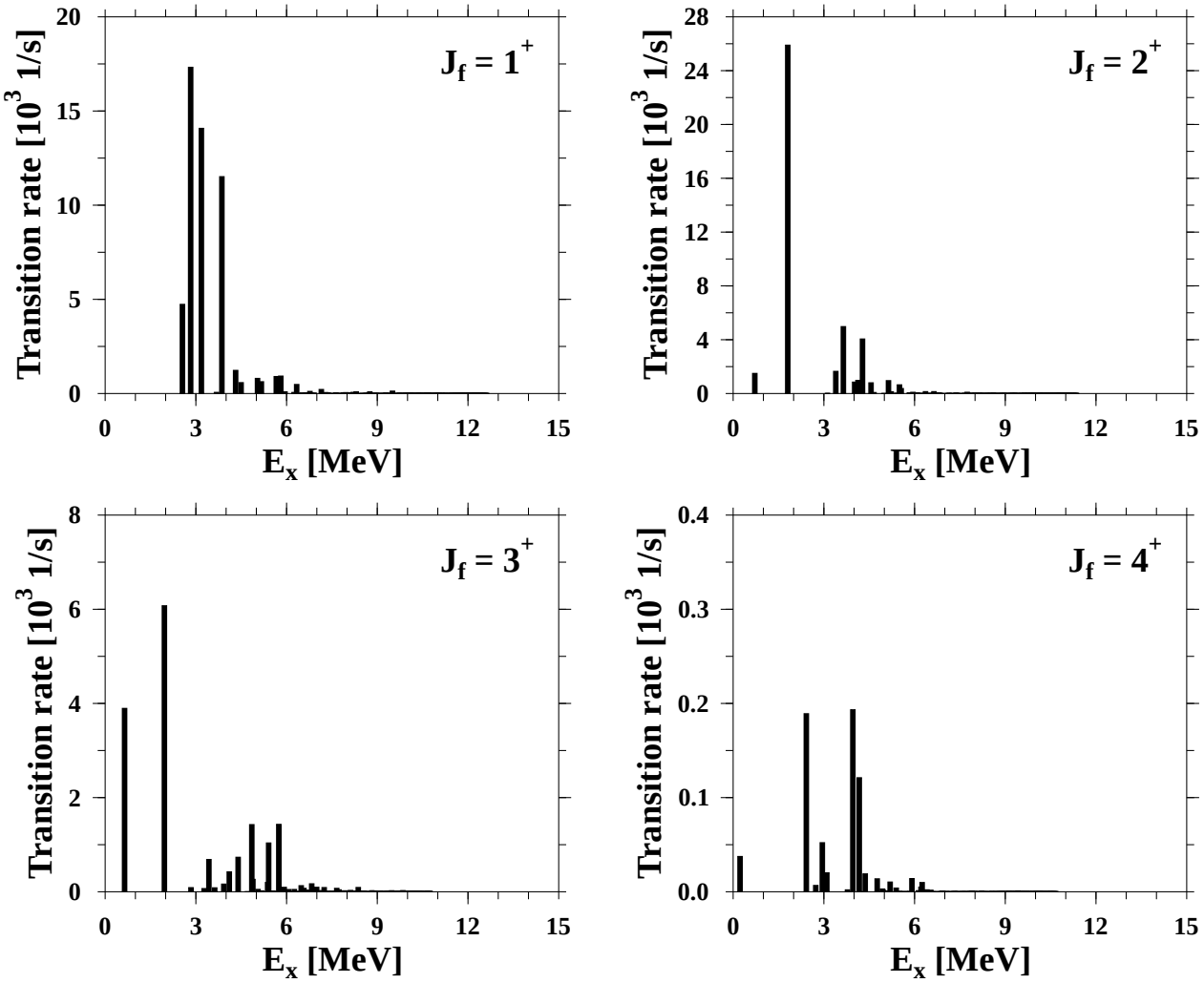


Nuclear structure

- nuclear structure by shell-model calculations
- *fp*-shell used as a model space
- no negative parity states

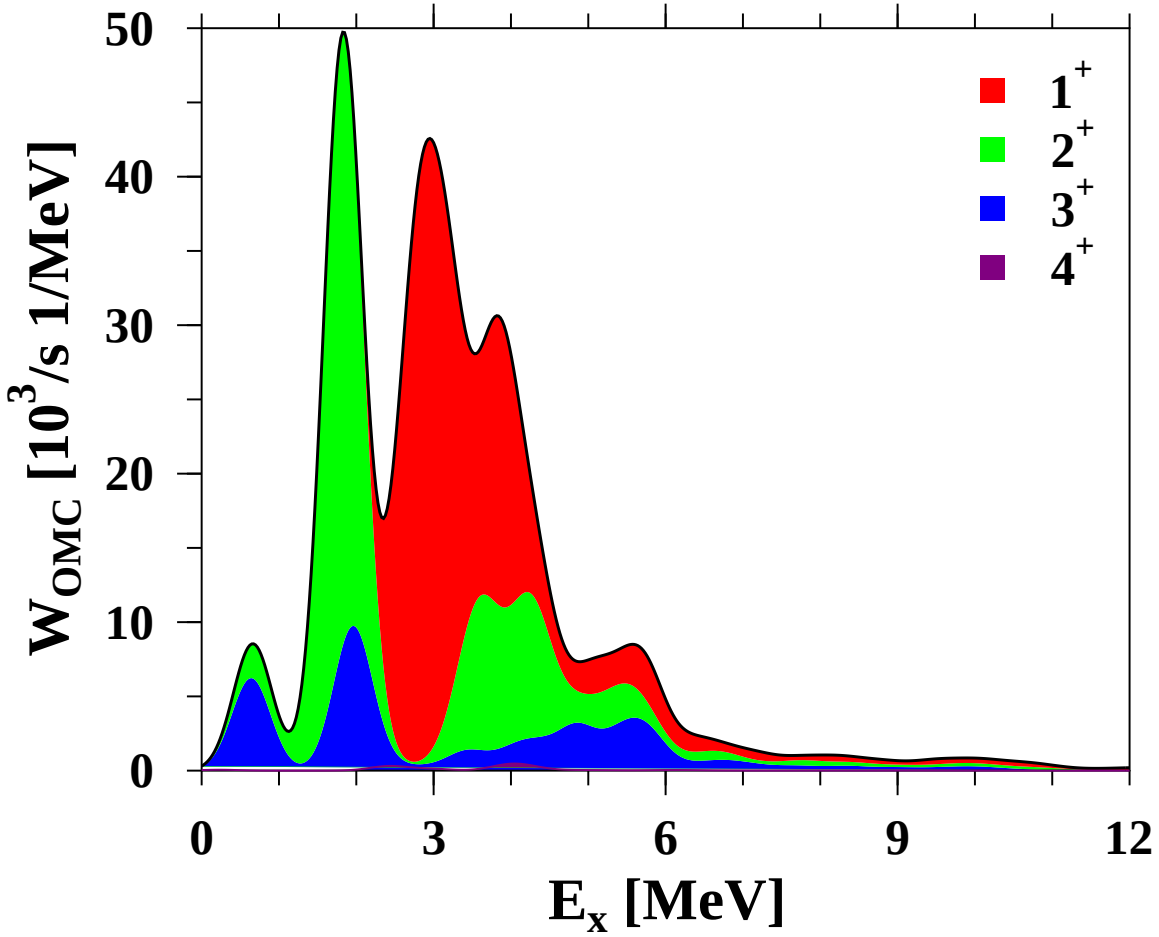
Calculated OMC rates

OMC: ^{48}Ti $\rightarrow$ ^{48}Sc(J^{π})



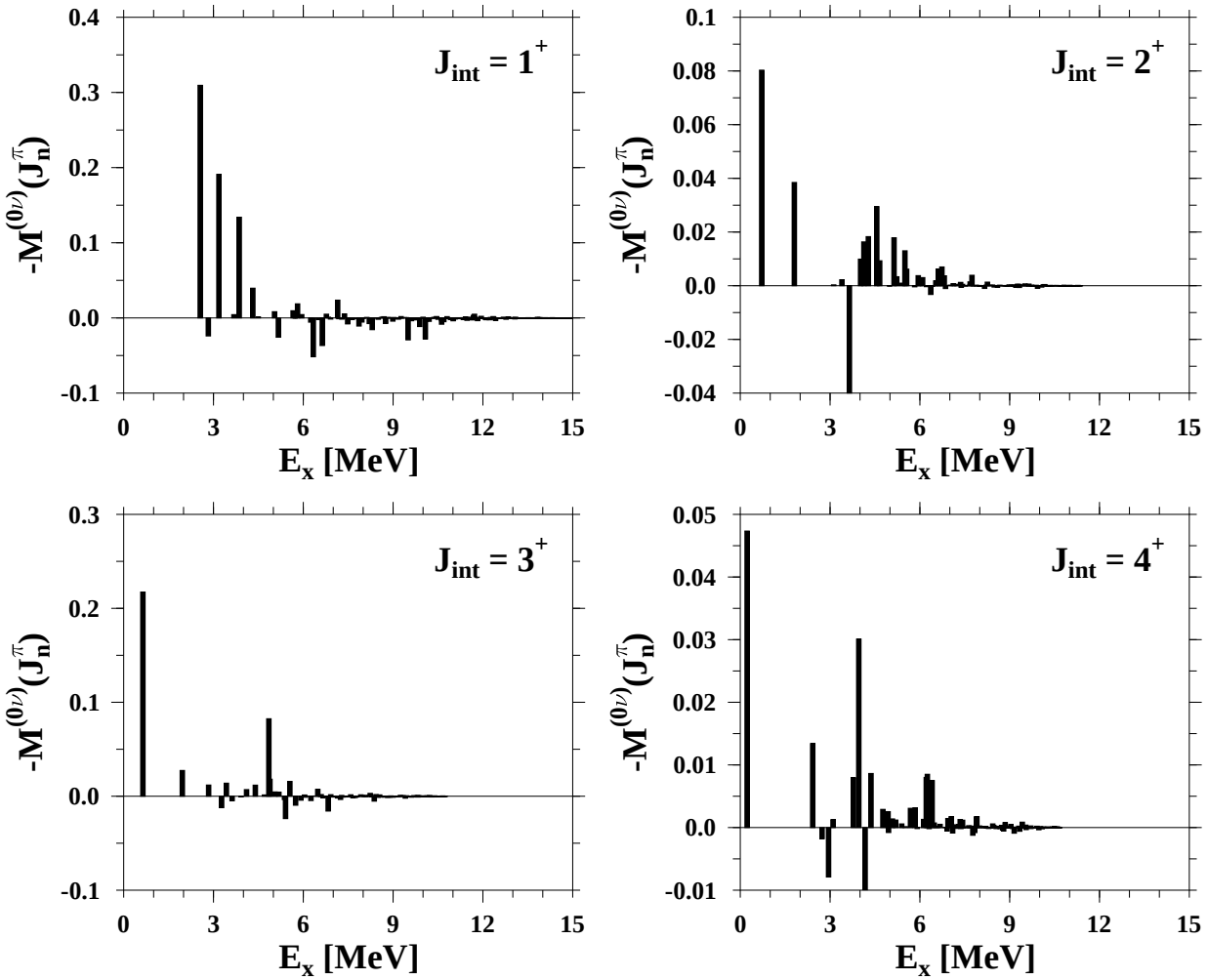
Calculated OMC rates

OMC: $^{48}Ti \rightarrow {}^{48}Sc(J^{\pi})$



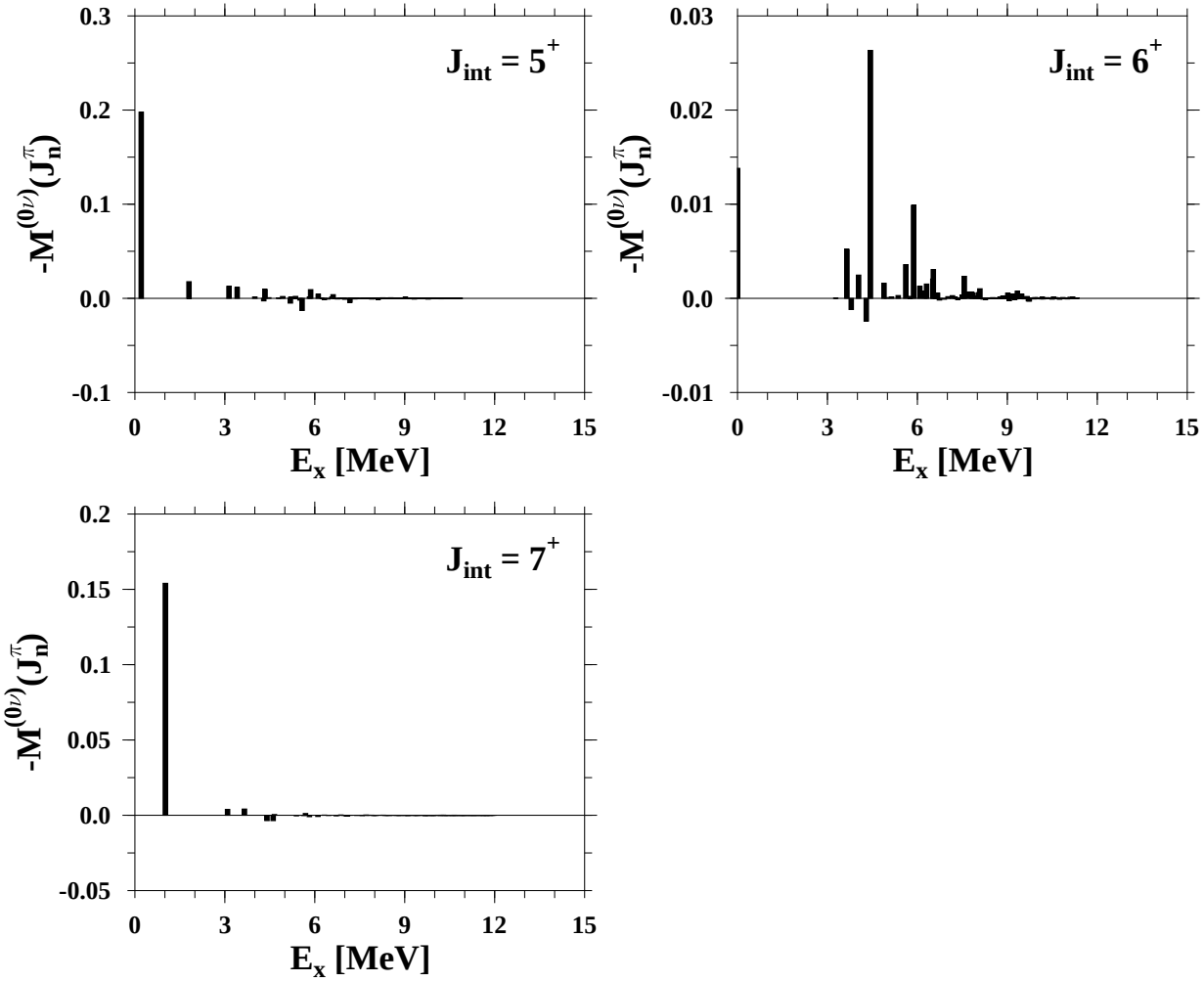
Individual $0\nu\beta\beta$ contributions

$M^{(0\nu)}(J^{\pi}_{\text{int}})$: $^{48}\text{Ca} \rightarrow {}^{48}\text{Ti}$



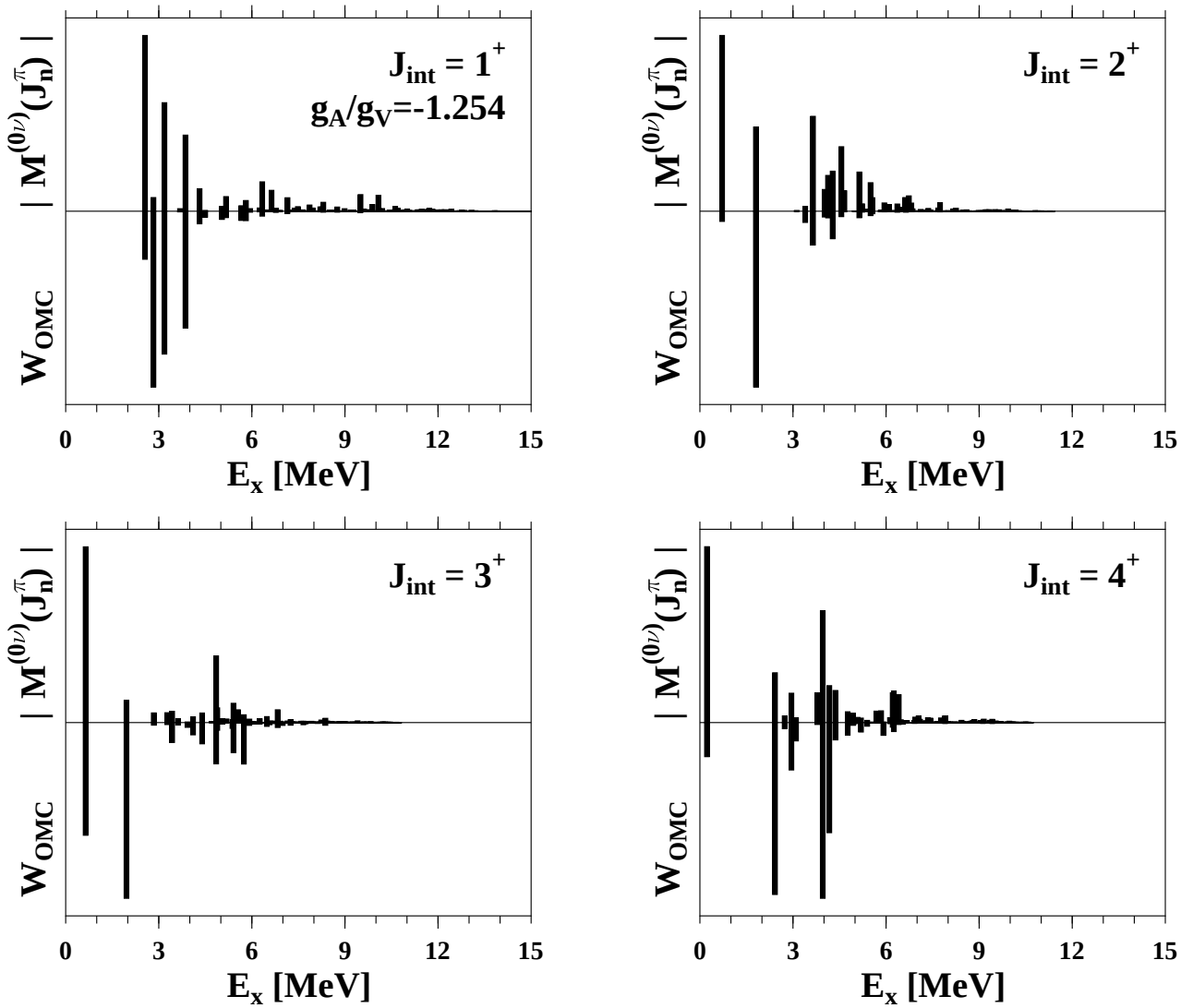
Individual $0\nu\beta\beta$ contributions

$$M^{(0\nu)}(J^{\pi}_{\text{int}}):\ {}^{48}\text{Ca} \rightarrow {}^{48}\text{Ti}$$



$$M^{(0\nu)} \approx -1.6$$

Calculated OMC rates vs. $0\nu\beta\beta$ contributions



Conclusions

- OMC rates in ^{48}Ti and $M^{(0\nu)}$ for ^{48}Ca has been calculated in the shell-model framework
- OMC allows to study transitions of one virtual leg of $\beta\beta$-decay
- biggest OMC transition rates concentrate on the lowest states of ^{48}Sc
- biggest contributions to $0\nu\beta\beta$ matrix element are found among the lowest intermediate states
- Individual $M^{(0\nu)}$ contributions and OMC rates to the intermediate states have a good correspondence