One nucleon transfer reaction

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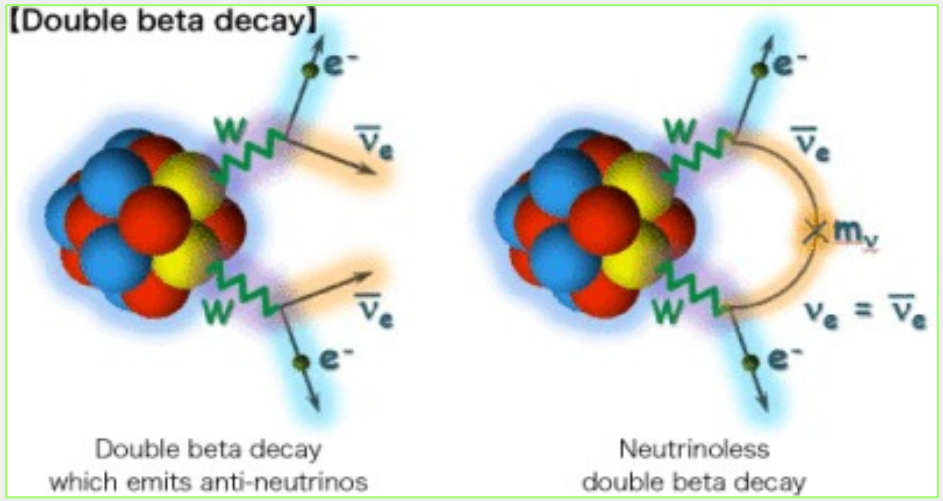
Double beta decay



Double beta decay with neutrinos (observed).

These decay are usually ground state to ground state transitions.

Quenching of g_A

Neutrinoless double beta decay

Lepton number symmetry is broken.

The neutrino is a Majorana particle?

Physics beyond the Standard model

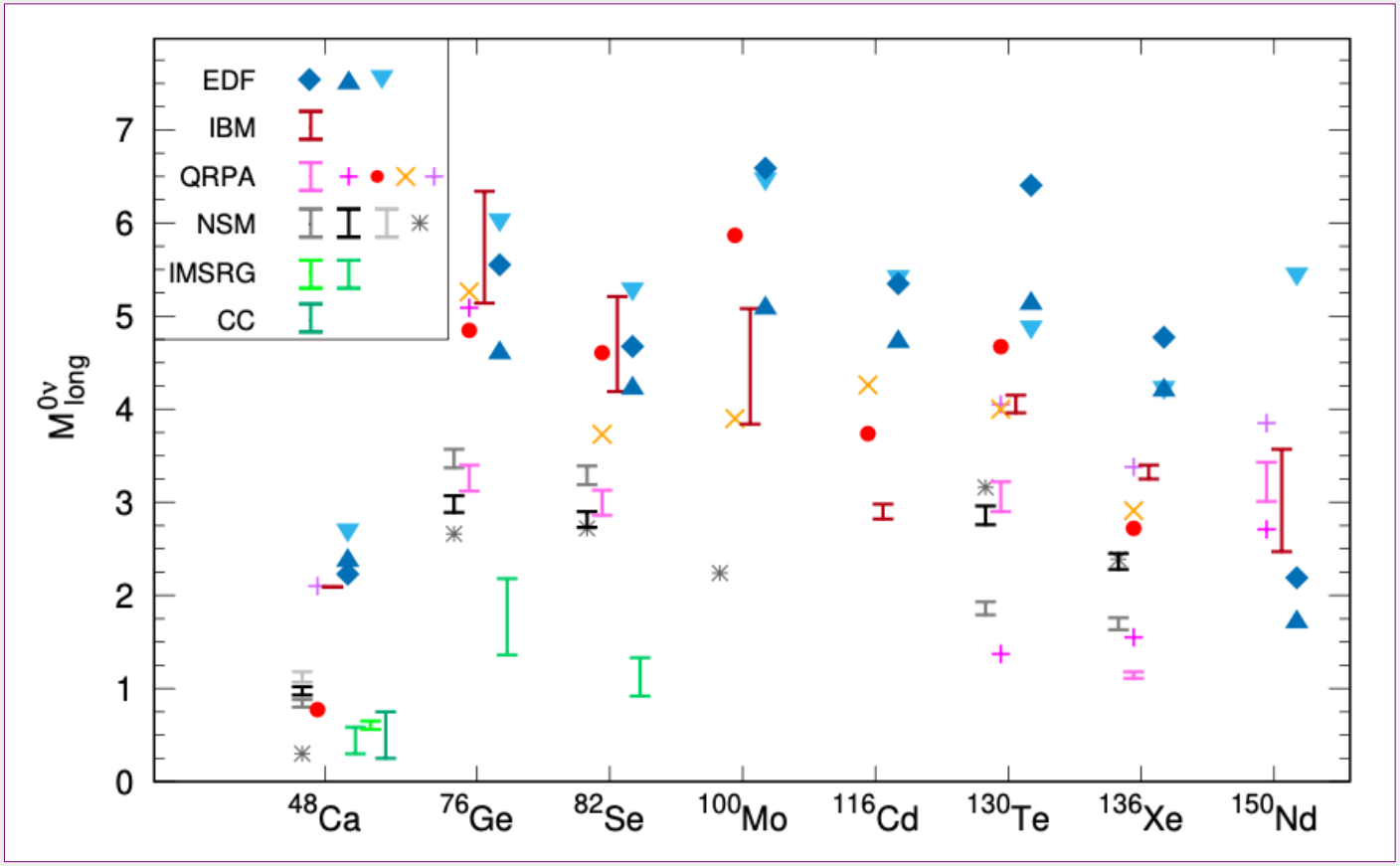
Neutrinoless double beta decay

$$\left[T^{0\nu}_{1/2}\left(0^+ \rightarrow 0^+\right)\right]^{-1} = G^{0\nu}(E_0, Z)\left|M^{0\nu}\right|^2 \langle m_{\nu_e}\rangle^2$$

The nuclear matrix elements are given by $|M_{0\nu}|^2$

The phase space factor and a factor that depend on the neutrino masses and the neutrino mixing coefficients

The nuclear matrix elements



M. Agostini, et al. Rev. Mod. Phys. 95, 025002 (2023)

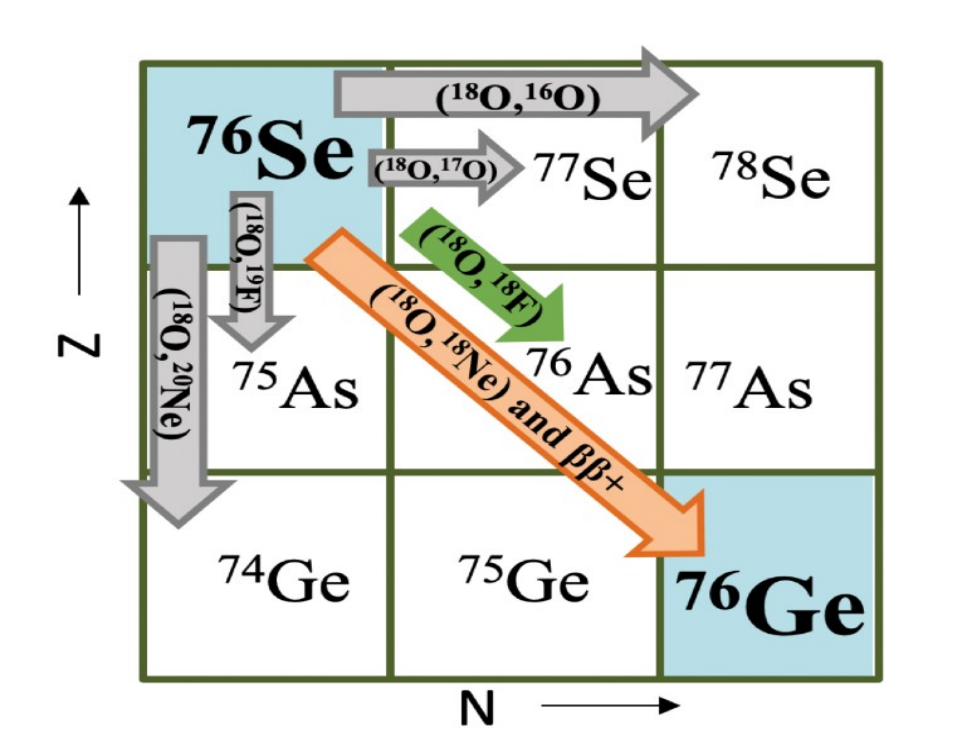
Double charge exchange reactions

- Heavy ion double charge exchange, forthcoming experiments by NUMEN Collaboration

- In heavy ion DCE reactions, we study the nuclear reactions with the exchange of two units of charge between the target and projectile

$$N_{\mathrm{T}}(A,Z)+N_{\mathrm{p}}(a,z)\rightarrow N_{\mathrm{T}}(A,Z+2)+N_{\mathrm{p}}(a,z-2)$$
$$N_{\mathrm{T}}(A,Z)+N_{\mathrm{p}}(a,z)\rightarrow N_{\mathrm{T}}(A,Z-2)+N_{\mathrm{p}}(a,z+2),$$

Heavy ion DCE and transfer reactions

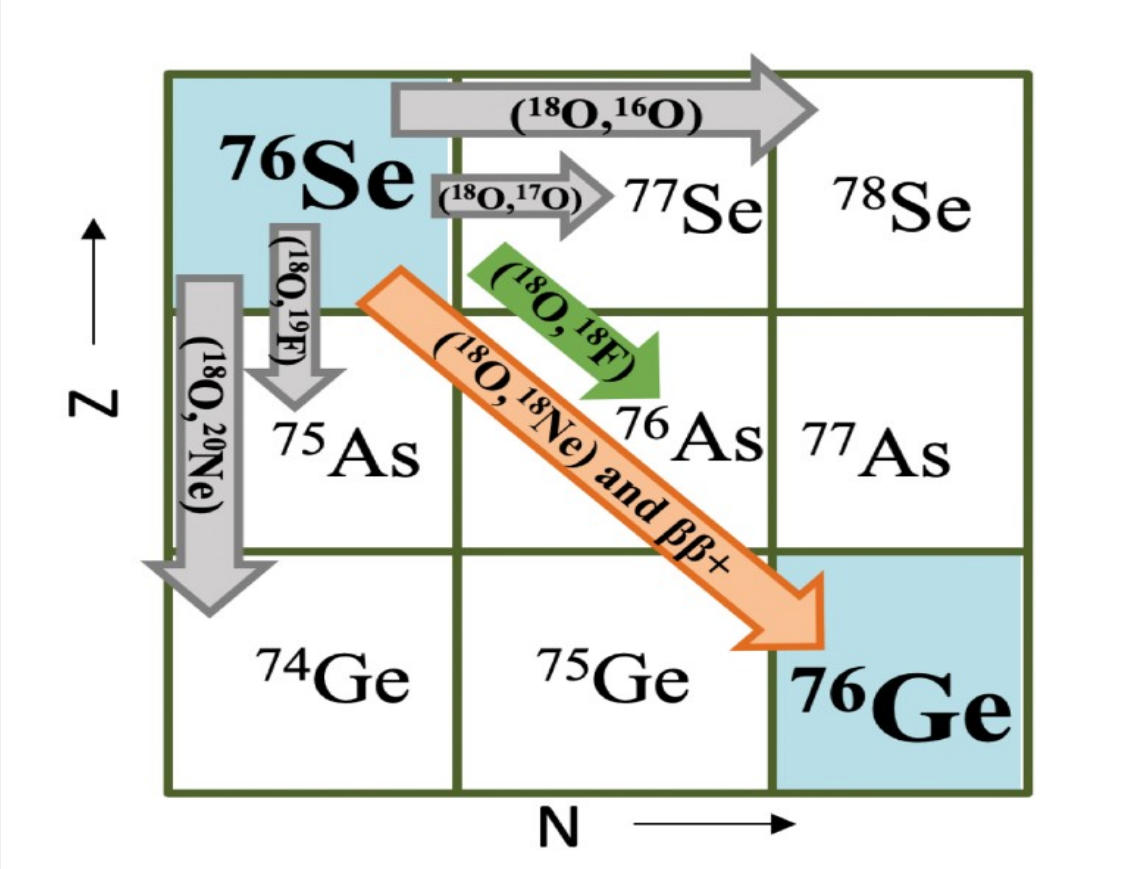


We have to study these competing processes.

One neutron stripping in $^{76}Se(^{18}O,^{17}O)^{77}Se$ reaction

R. Magana and E. Santopinto

- Analysis of the one-neutron transfer reaction in 18O+76Se collisions at 275 MeV, NUMEN Collaboration, I. Ciraldo,…, R. Magana, E. Santopinto et al. PhysRevC 105 044607 (2022)
- Study of $^{76}Se(^{18}O,^{17}O)^{77}Se$ reaction within IBFM



One proton pick up $^{76}Se(^{18}O,^{19}F)^{75}As$ within IBFM

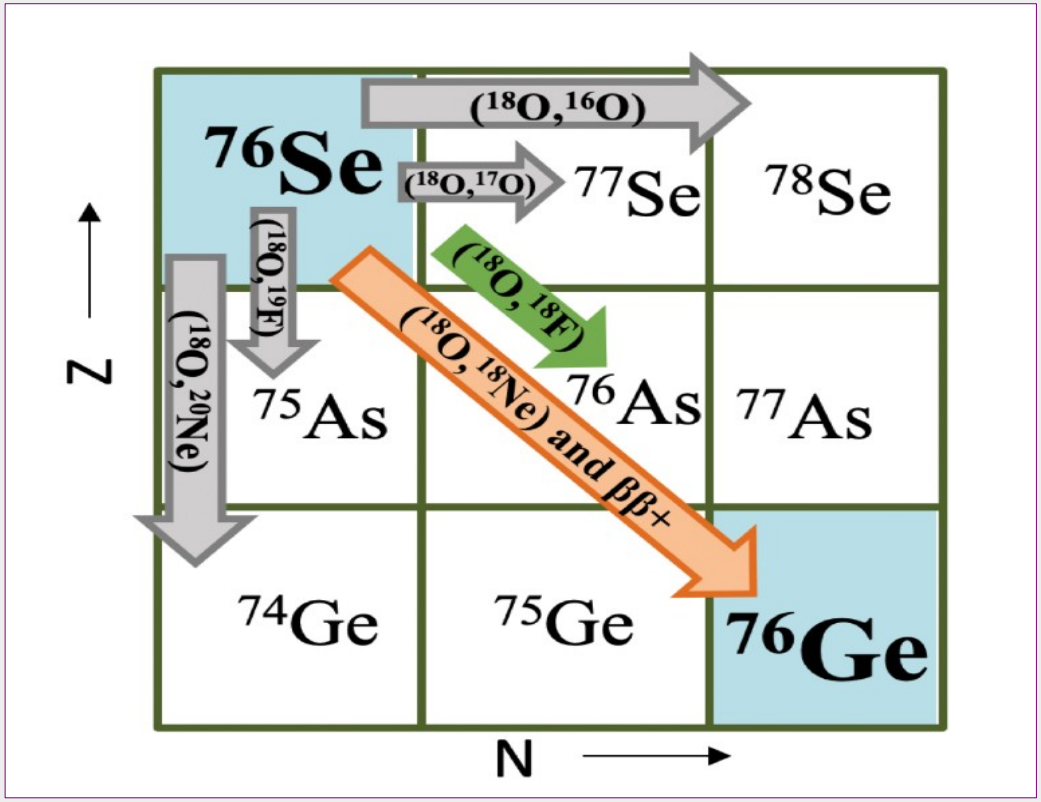
H. Garcia-Tecocoatzi, R. Magana, and E. Santopinto

- One proton pick up transfer reaction: we are studying the $^{76}Se(^{18}O,^{19}F)^{75}As$ reaction
- The IBM assumes that the collective behavior of nucleons can be described by two types of bosons: the S (spin-zero) bosons and the D (spin-two) bosons.
- We describe the ^{76}Se using IBM-2.
- The ^{76}Se

  $N\pi=3$ proton bosons

  $N\nu=4$ neutron bosons (holes)
- The IBM-2 parameters:

  PRC87 014315(2013)



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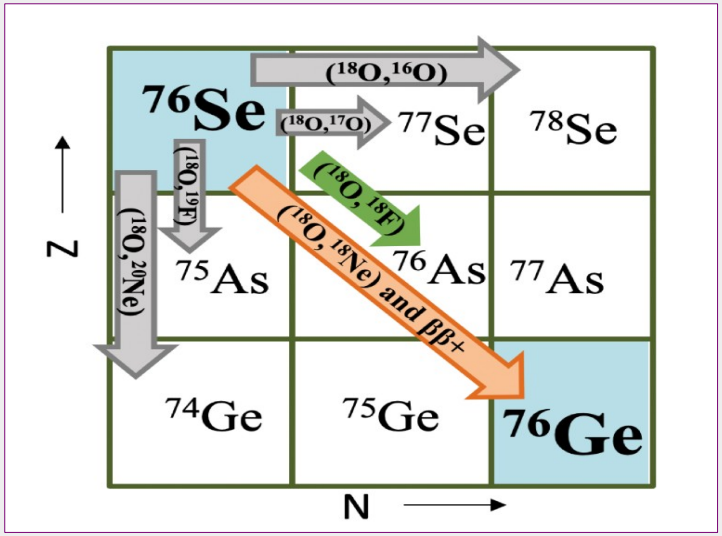
The ^{75}As is described using the IBFM Hamiltonian:

$$H = H^B + H^F_\rho + V^{BF}_\rho$$

The ^{75}As is seen as ^{74}Ge+p in the IBFM scheme:



Nπ=2 proton bosons

Nν=4 neutron bosons (holes)

The single particle hamiltonian is

$$H^F_\rho = \sum_{j_\rho} \epsilon_{j_\rho} \hat{n}_{j_\rho}$$

Orbit j_π	E_{j_π}(MeV)	$Qspe$ (MeV)	v^2
$0f_{5/2}$	1.0280	1.5747	0.2624
$0g_{9/2}$	3.0090	3.0608	0.0542
$1p_{3/2}$	0.0000	1.4136	0.5990
$1p_{1/2}$	1.1060	1.6133	0.2439

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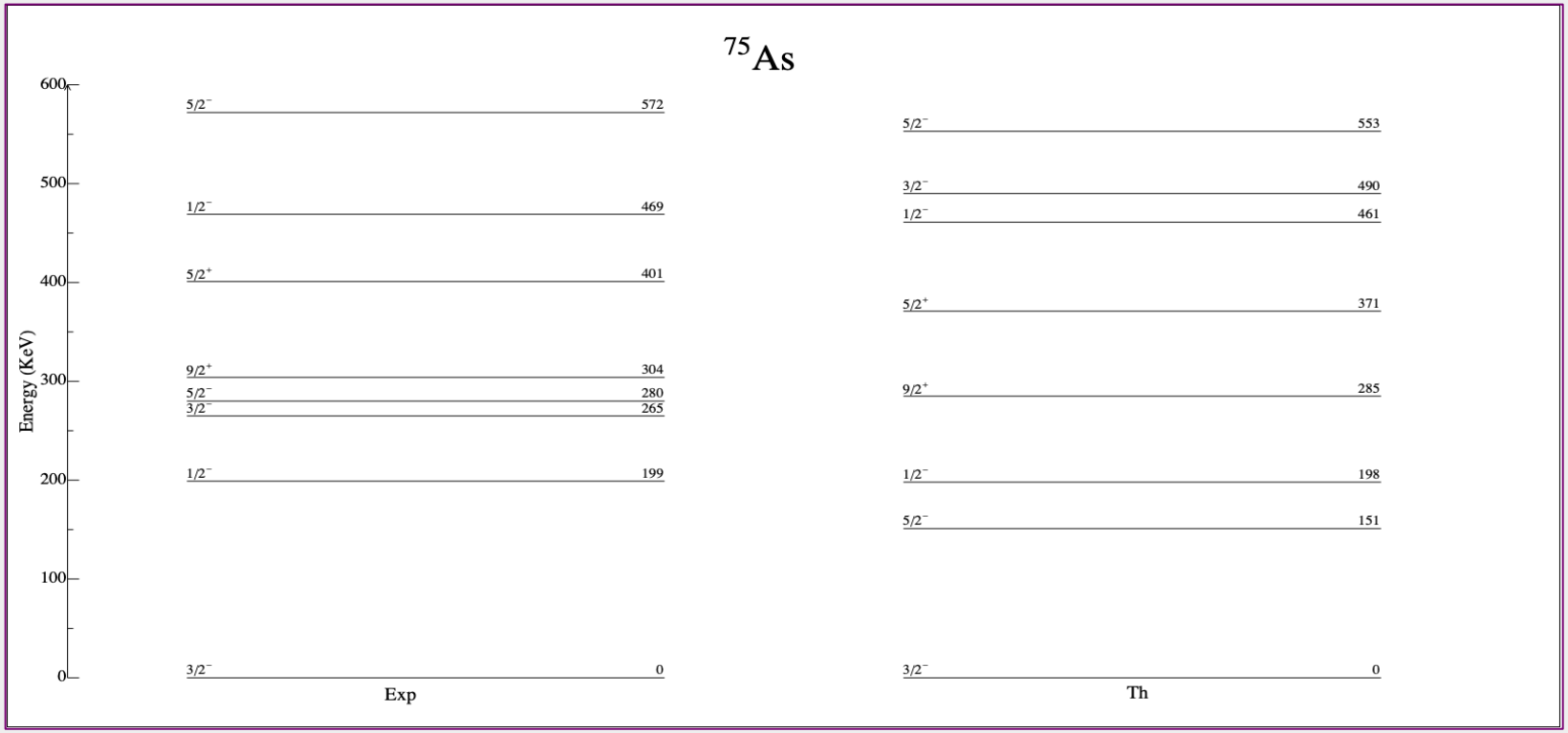
The boson-fermion interaction:

$$V_\rho^{BF} = \Gamma_\rho Q_{\rho'}^{(2)} \cdot q_\rho^{(2)} + \Lambda_\rho F_{\rho'\rho} + A_\rho \hat{n}_{d_{\rho'}} \cdot \hat{n}_\rho$$

The parameters are obtained by fitting the ^{75}As spectrum



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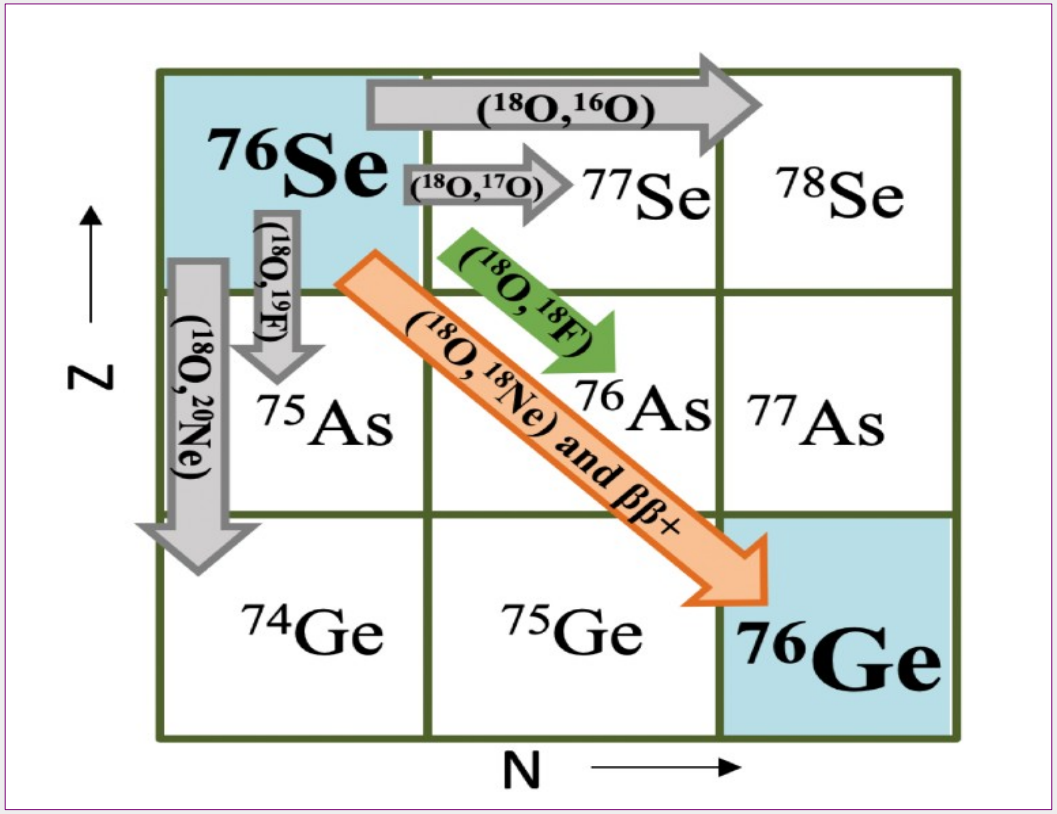
- The transfer operators

$$A_m^{\dagger(j)} = \zeta_j a_{jm}^\dagger + \sum_{j'} \zeta_{jj'} s^\dagger [\tilde{d} \times a_{j'}^\dagger]_m^{(j)},$$

$$\tilde{B}_m^{(j)} = -\theta_j^* s a_{jm}^\dagger - \sum_{j'} \theta_{jj'}^* [\tilde{d} \times a_{j'}^\dagger]_m^{(j)},$$

$$\tilde{A}_m^{(j)} = \zeta_j^* \tilde{a}_{jm} + \sum_{j'} \zeta_{jj'}^* s [d^\dagger \times \tilde{a}_{j'}]_m^{(j)},$$

$$B_m^{\dagger(j)} = \theta_j s^\dagger \tilde{a}_{jm} + \sum_{j'} \theta_{jj'} [d^\dagger \times \tilde{a}_{j'}]_m^{(j)},$$



- We compute the spectroscopic amplitudes for $^{76}Se \rightarrow {}^{75}As$ reaction
- Our results underestimate the experimental data (I.Ciraldo et al. In preparation)

Conclusions and future work

- The IBFM-2 underestimate the experimental data
- We will include ^{76}Se (2+) to ^{75}As(J^P)
- Improve the description of ^{76}Se considering an intruder configuration.
- The NUMEN data can be used to improve the description of even-even nuclei.
- The odd-even information is need for the odd-odd description within IBFFM scheme

Thanks for your attention!