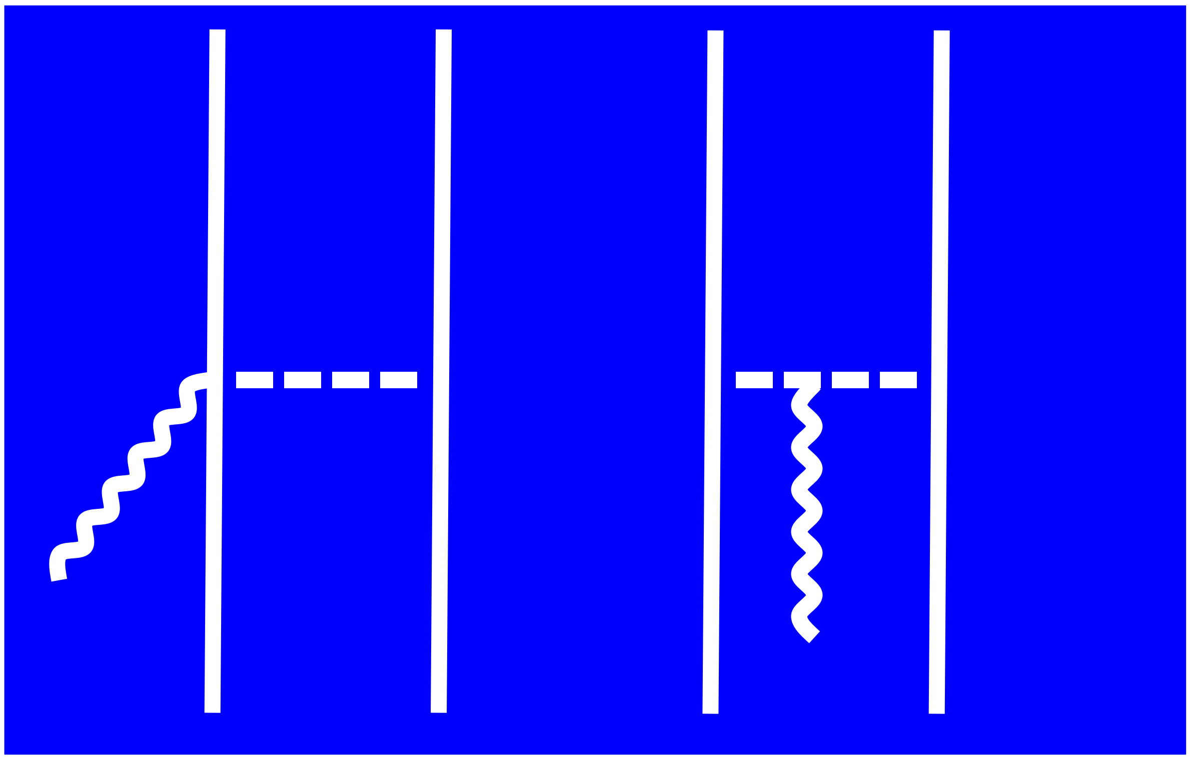
The Two-Body M1 operator in Light Nuclei:



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Two-body currents = Meson exchange currents

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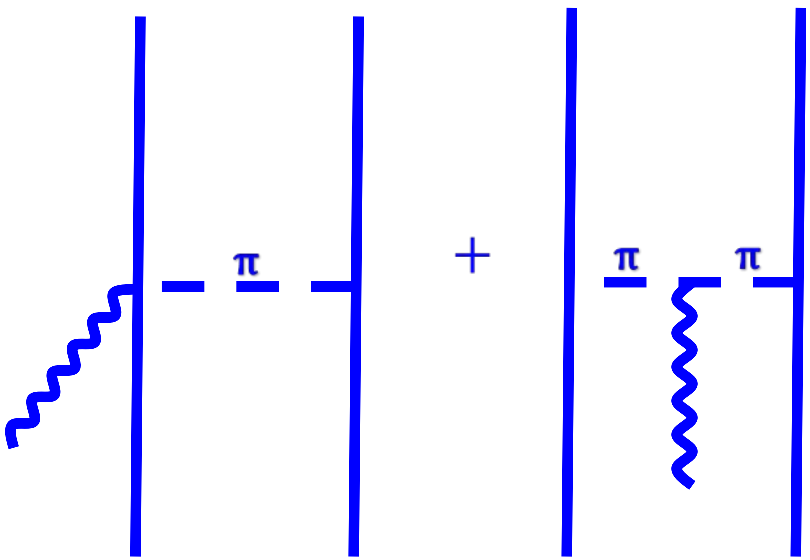
Two-body currents can be ordered via Chiral EFT expansion,

$$J^{[2]}(x) \; = J_{\mathrm{NLO}}(x) + J_{\mathrm{N^2LO}}(x) + J_{\mathrm{N^3LO}}(x)$$

There are two contributions at NLO

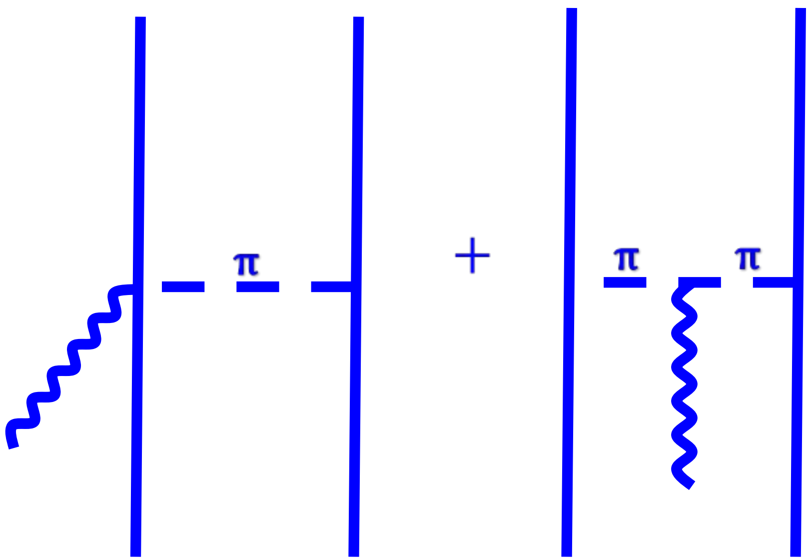


Seagull Pion-in-Flight

$\boldsymbol{q}$ → Photon momentum

$$\boldsymbol{r} = \boldsymbol{r}_1 - \boldsymbol{r}_2 \qquad \boldsymbol{R} = \frac{1}{2}(\boldsymbol{r}_1 + \boldsymbol{r}_2)$$

The NLO currents have been multipole decomposed



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$$\boldsymbol{J}(\boldsymbol{q},\boldsymbol{r},\boldsymbol{R}) = -\frac{ieg_A^2}{F_\pi^2} G_E^V(q^2)(\tau_1 \times \tau_2)_z [\boldsymbol{A}_{Seagull}(\boldsymbol{q},\boldsymbol{r},\boldsymbol{R}) + \boldsymbol{A}_\pi(\boldsymbol{q},\boldsymbol{r},\boldsymbol{R})]$$

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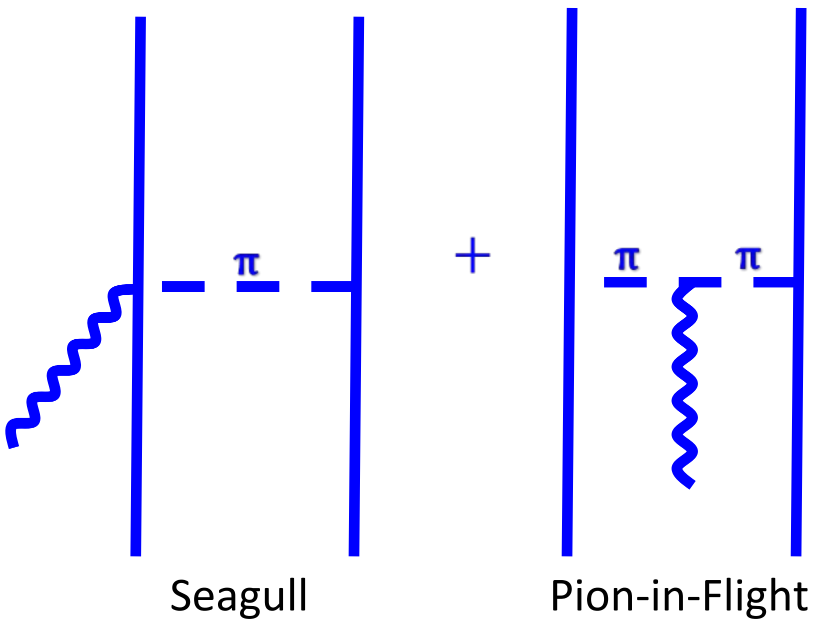

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$$\boldsymbol{J}(\boldsymbol{q},\boldsymbol{r},\boldsymbol{R}) = \sum_{J\mu\ell} J_{J\ell}^{\mu}(q,\boldsymbol{r},\boldsymbol{R}) \boldsymbol{Y}_{J\ell}^{\mu*}(\hat{q}) \qquad J_{J\ell}^{\mu}(q,\boldsymbol{r},\boldsymbol{R}) = \int d\hat{q}\, \boldsymbol{J}(\boldsymbol{q},\boldsymbol{r},\boldsymbol{R}) \cdot \boldsymbol{Y}_{J\ell}^{\mu}(\hat{q})$$

The NLO-M1 operator is taken from the decomposition

$$J^{\mu}_{JJ}(q,\boldsymbol{r},\boldsymbol{R}) = 4\pi i^{J} T^{mag}_{J\mu}(q,\boldsymbol{r},\boldsymbol{R})$$

$$\mu^{[2]}_{NLO}(\boldsymbol{r},\boldsymbol{R}) \propto \lim_{q\to 0}\left(\frac{J^{\mu}_{11}(q,\boldsymbol{r},\boldsymbol{R})}{q}\right)$$

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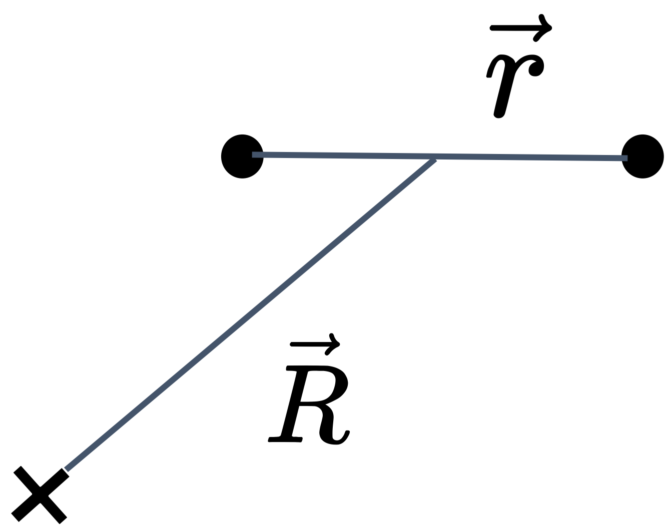
$$\mu^{[2]}_{\text{NLO}}(r,R) = \mu^{[2]}_{\text{intrinsic}}(r) + \mu^{[2]}_{\text{Sachs}}(r,R)$$



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The Sachs term will be tested on A=3 systems

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$$\mu_{\mathrm{NLO}}^{[2]}(r,R) = \boxed{\mu_{\mathrm{intrinsic}}^{[2]}(r)} + \mu_{\mathrm{Sachs}}^{[2]}(r,R)$$

The intrinsic term will be tested on A=2 system

Checks on the Deuteron

$$R_M(\omega) = \frac{1}{2J_0+1} \sum_{N \neq N_0} |\langle N|\mu|N_0\rangle|^2 \delta(E_N - E_0 - \omega)$$

$$\mu = \mu_{\mathrm{LO}}^{[1]} + \mu_{\mathrm{NLO}}^{[2]}$$

$$m_n = \int_0^\infty R_M(\omega)\omega^n d\omega$$

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	$m_{-1}\,[\mathrm{fm}^3]$	$m_0\,[\mathrm{fm}^2]$
$\mu^{[1]}_{\mathrm{LO}}$	14.0	0.245
$\mu^{[1]}_{\mathrm{LO}} + \mu^{[2]}_{\mathrm{Intrinsic}}$	**15.0**	**0.273**

O. J. Hernandez, S. Bacca and K. A. Wendt, Proc. of Science 041 BORMIO2017 (2017).

Checks on A=3

	$^3\mathrm{H}$	$^3\mathrm{He}$	%Diff from Exp
$\mu_{\mathrm{LO}}^{[1]}$	2.622	-1.783	~12-16%
$\mu_{\mathrm{LO}}^{[1]} + \mu_{\mathrm{Intrinsic}}^{[2]}$			
μ_{Exp}	**2.979**	**-2.128**	**-**

with R.Seutin, H. Hebeler, A. Schwenk

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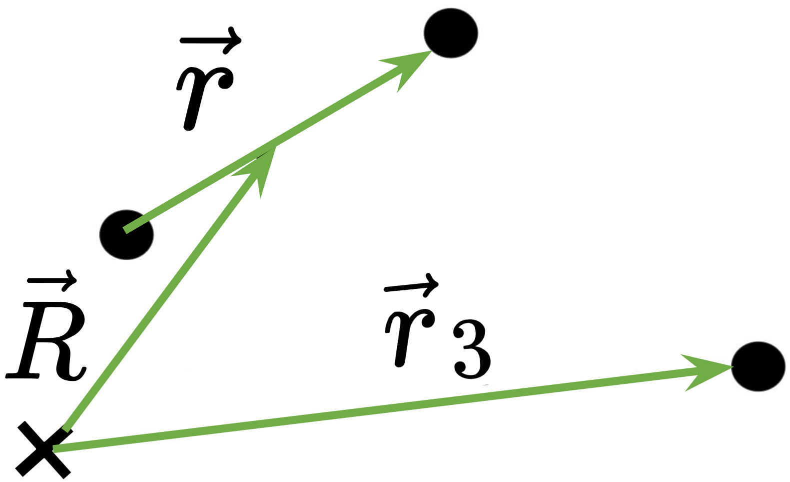
The Sachs term is calculated in two-body frame



$\vec{r}$ two particle relative

$\vec{R}$ two particle COM

$\vec{r}_3$ spectator particle

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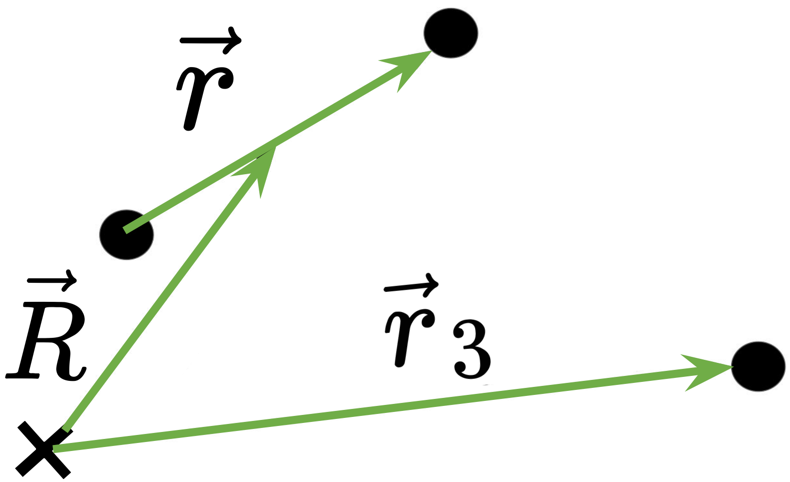

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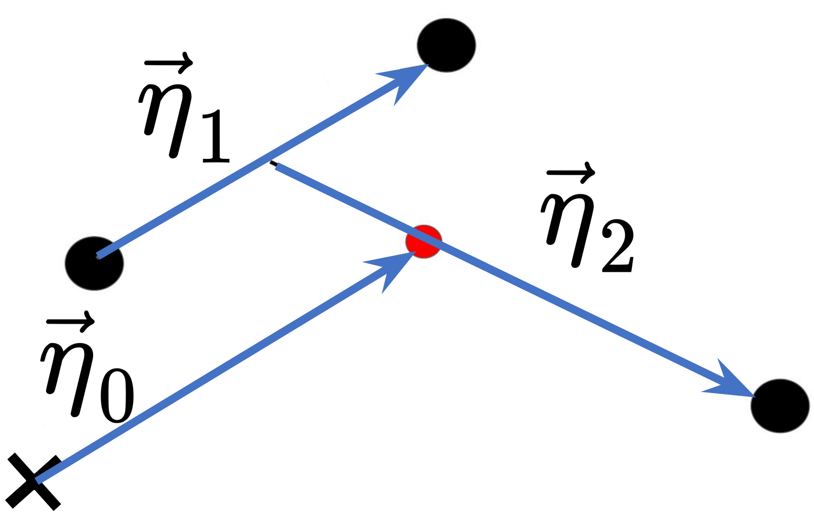
but require matrix elements in the Jacobi Frame



$\vec{\eta}_0$ three body CM

$\vec{\eta}_1$ Jacobi coord 1

$\vec{\eta}_2$ Jacobi coord 2

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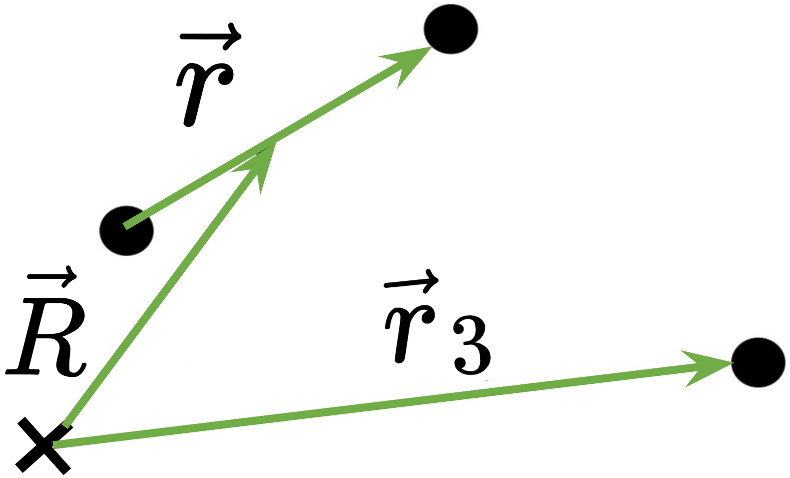

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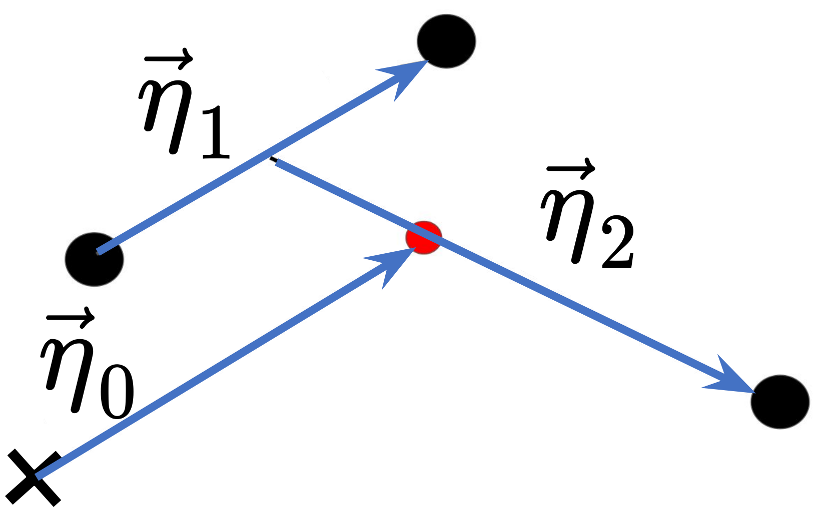

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TM transformation is needed for changing frames

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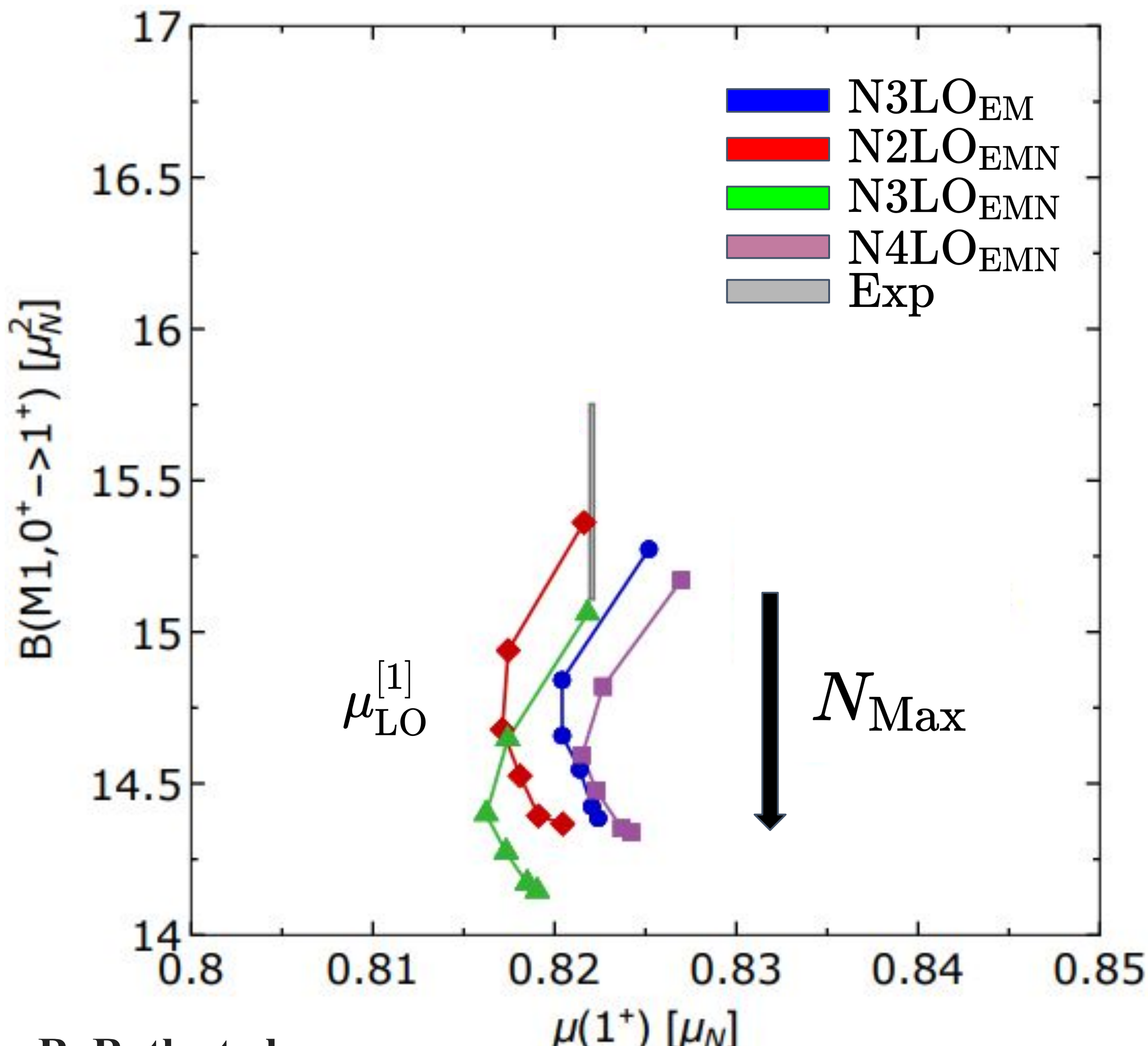
$\mu^{[1]}_{\mathrm{LO}} + \mu^{[2]}_{\mathrm{NLO}}$	**2.849(7)**	**-2.006(6)**	**~4-6%**
μ_{Exp}	**2.979**	**-2.128**	**-**

with R.Seutin, H. Hebeler, A. Schwenk

Application to ^{6}Li



with T. Hüther, R. Roth et al

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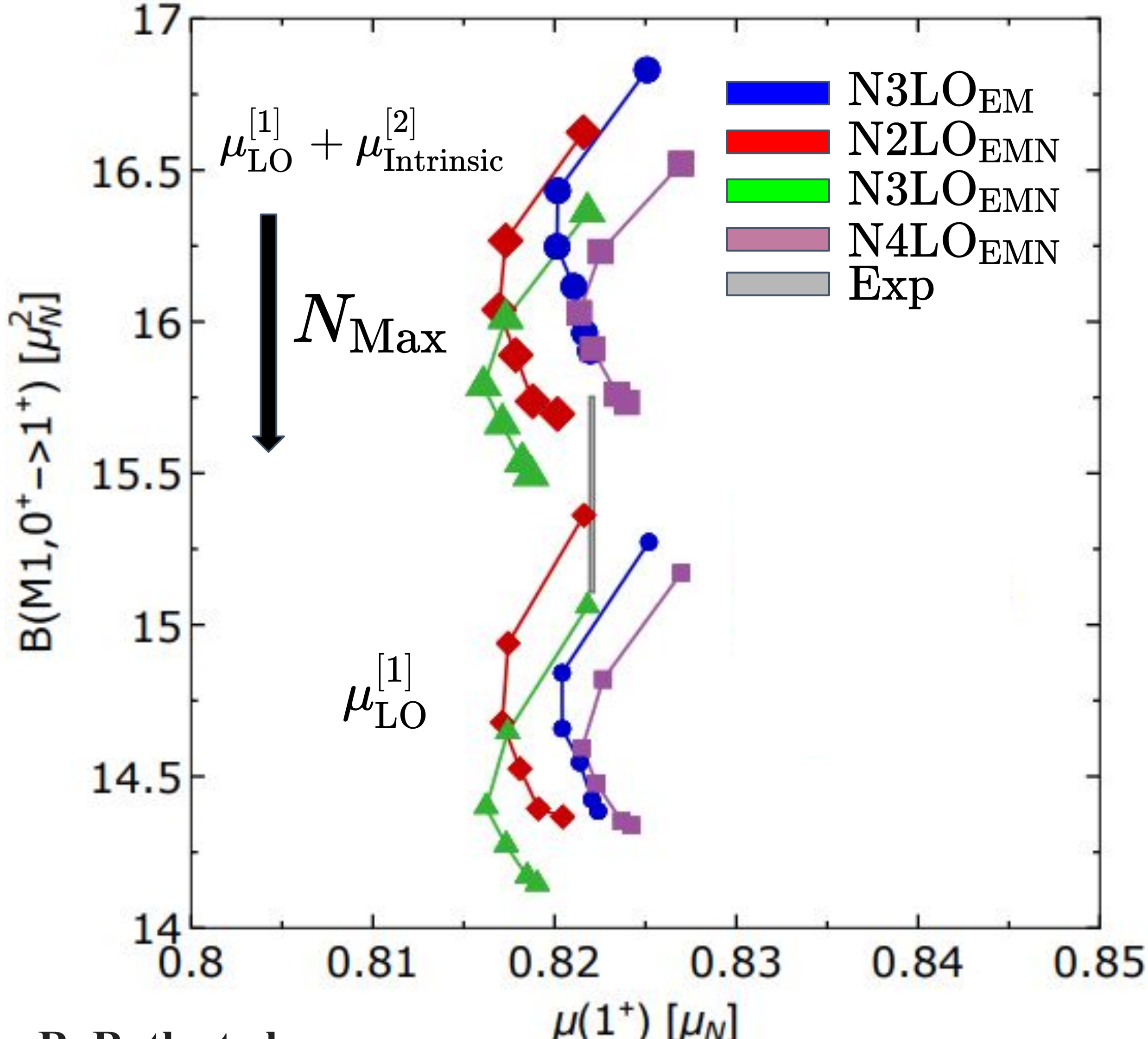

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Thank you!

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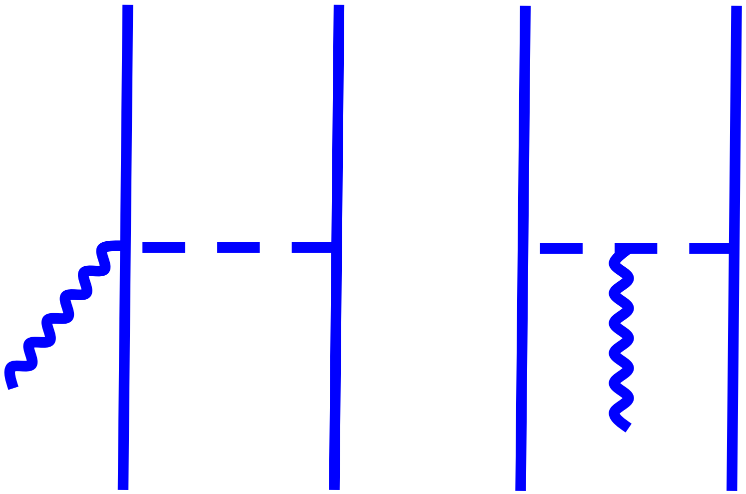

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[1] H. Arenhovel and M. Sanzone, Few Bod. Sys., Photodisintegration of the Deuteron, (1991).
[2] J. Friar and G.L. Payne, Phys. Rev. C 56 619 (1997)