Spin dichroism for deuterons (nuclei) at nonpolarized beam-beam interactions at NICA

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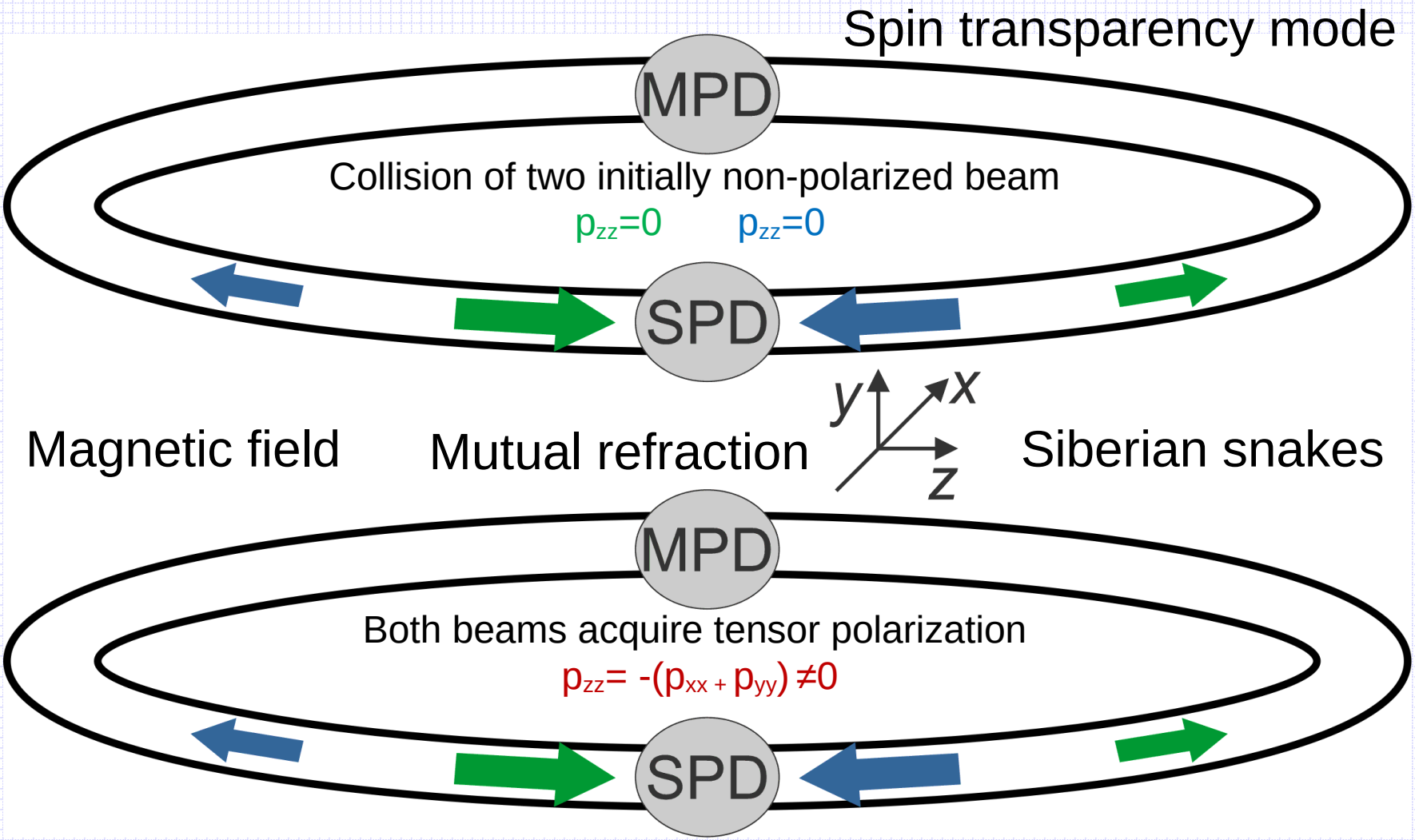
Spin dichroism at collision of two initially non-polarized deuteron beams at NICA



Two collision points at SPD and MPD locations !!!

Statistically reliable effect value

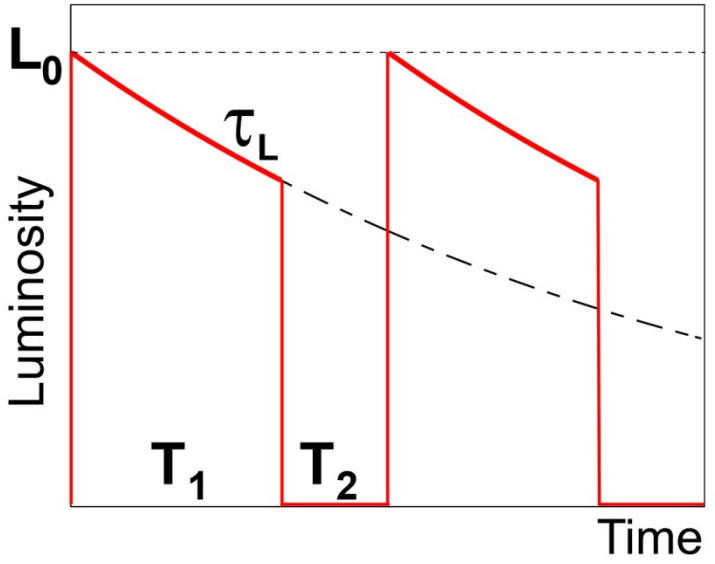
Tensor polarization $\bar{p}_{zz} = \frac{2}{3}\frac{\Delta\sigma}{\sigma}\frac{\sigma LT}{N}$

The number of reactions ($\sigma_r \sim \sigma$) $N_r = \sigma_r LT$

Effect value $N_{diff} \sim A_r N_r p_{zz}$

Statistical error $\Delta N_r \sim \sqrt{\sigma_r LT}$

SPD Technical design report



Observation time: $T_{observation} = N(T_1 + T_2)$, where N is the number of cycles.

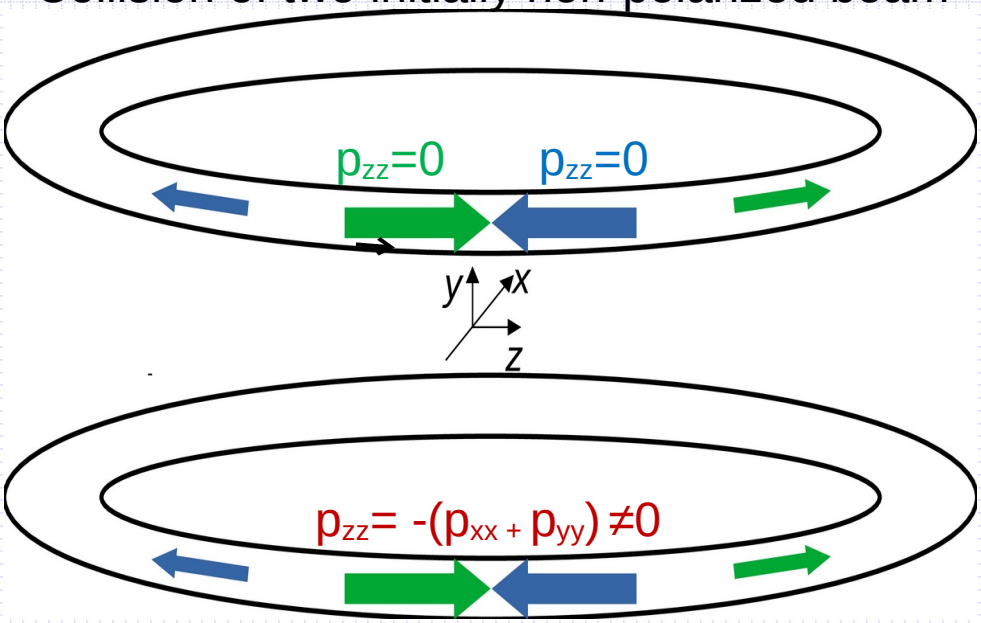
For $T_{observation} = 1000$ **hours**, we have $\Delta N_r/N_{diff} \sim 2\cdot10^{-3}/A_r - 10^{-2}/A_r$

Part.	σ,b	Δσ/σ	N	N_{diff}	ΔN_r	p_{zz}	T_1
d-d	0.2	0.01	$1.3\cdot10^{13}$	$2\cdot10^6 A_r$	$2\cdot10^5$	$3\cdot10^{-5}$	2 hours
d-d	0.2	0.06	$1.3\cdot10^{13}$	$10^7 A_r$	$2\cdot10^5$	$2\cdot10^{-4}$	2 hours

For $p_{zz} \sim 10^{-4}$, the observation time is around 2000 hours and the statistical error is <30%.

Spin dichroism effects: evaluations for NICA

Collision of two initially non-polarized beam



Both beams acquire tensor polarization

NO siberian snakes and
NO spin transparency mode

Nevertheless, the effect could be observed, while its value is 4 times lower

Particles	N per beam	σ, b	L, $cm^{-2}s^{-1}$	Δσ/σ	p_{zz}	$T=T_1$
d-d	$1.3 \cdot 10^{13}$	0.2	$4 \cdot 10^{31}$	**0.01**	$3 \cdot 10^{-5}$ / 4	2 hours
d-d	$1.3 \cdot 10^{13}$	0.2	$4 \cdot 10^{31}$	**0.06**	$2 \cdot 10^{-4}$ / 4	2 hours

Conclusions

- Deuteron spin dichroism could be observed at d-d collisions at NICA
- Deuteron dichroism can be observed at Nuclotron with the use of non-polarized internal target that is important for further experiments at NICA and measuring analyzing powers.

Data required

- Reactions, differential cross-sections, and analyzing powers at the multi-GeV range
- Systematic errors: evaluation, origin/source understanding

Articles and reports @ 2025

- Baryshevsky V.G. High energy nuclear optics of polarized nucleons and nuclei: research at the Nuclotron-M/NICA complex. Nat. Sci. Rev. 3 200607 (2026).
- Baryshevsky V.G. High Energy Nuclear Optics of Polarized Protons and Nuclei: Research at Complex Nuclotron M-NICA // The XVI-th International School-Conference "The Actual Problems of Microworld Physics", Minsk, Belarus, 24 – 31 August, 2025.
- Anishchenko S.V., Baryshevsky V.G., Gurinovich A.A. Possibilities to observe nuclear optical phenomena for protons and nuclei at Nuclotron-M and NICA // The XVI-th International School-Conference "The Actual Problems of Microworld Physics", Minsk, Belarus, 24 – 31 August, 2025.
- Anishchenko S.V., Baryshevsky V.G., Gurinovich A.A. Deuteron dichroism effect: observation possibilities at complex Nuclotron M - NICA. // SPD first stage physics N14, 7 October 2025.

Thank you for the attention!!!