Spin-spin correlations in $\Lambda\bar{\Lambda}$ pairs production

at NICA SPD

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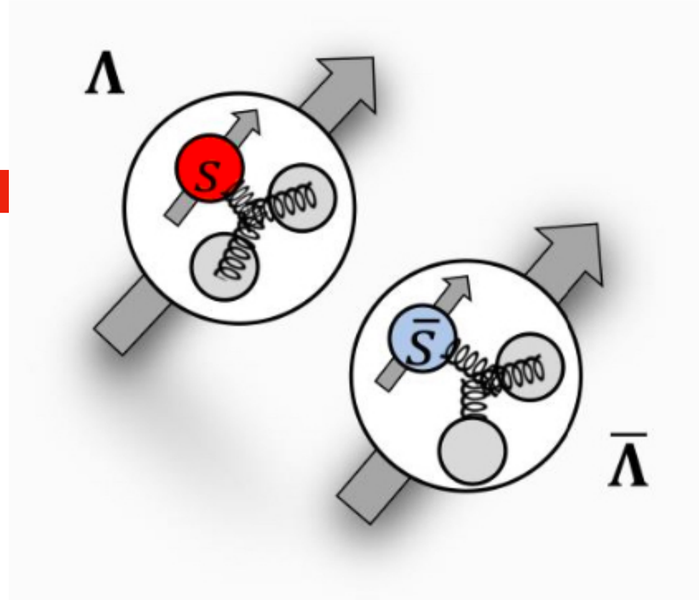
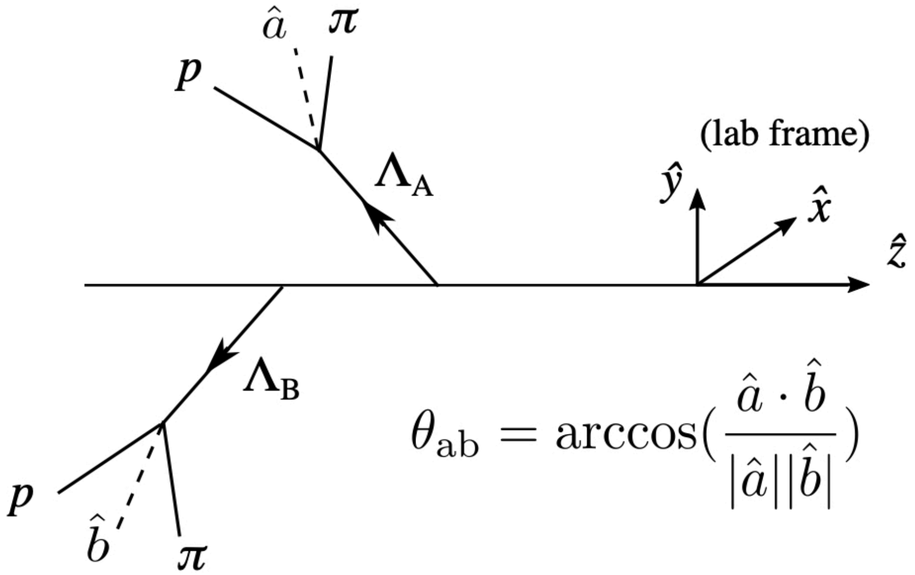
Physics case

Spin correlations of $\Lambda\bar{\Lambda}$ pairs produced in pp and dd collisions can provide unique insight into the locality and entanglement effects in hadronization process.





$$\theta_{ab} = \arccos\left(\frac{\hat{a}\cdot\hat{b}}{|\hat{a}||\hat{b}|}\right)$$

$$\sigma = \sigma_0(1 + \alpha_\Lambda \alpha_{\bar{\Lambda}} P_{\Lambda\bar{\Lambda}} \cos\theta_{ab})$$

STAR results

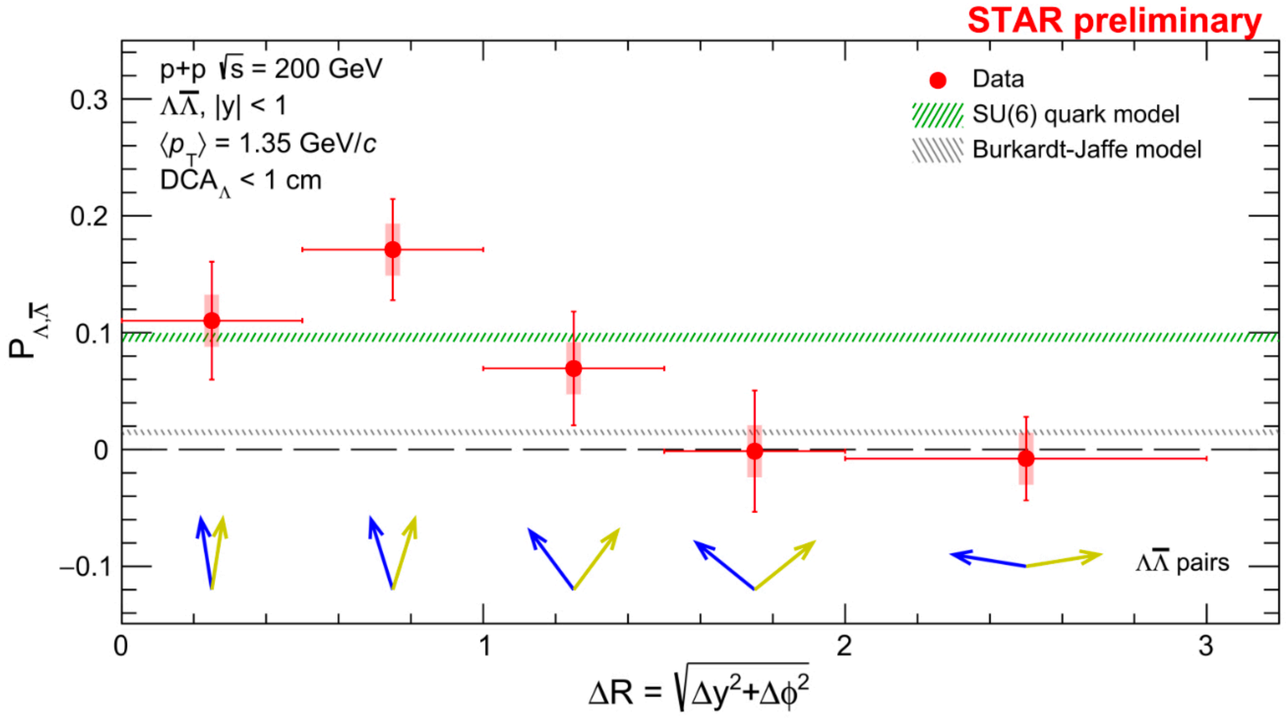
400M of unpolarized MB pp-events at $\sqrt{s}$=200 GeV (2012)

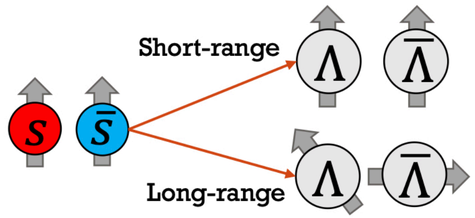
400M MB events

130k $\Lambda-$pairs

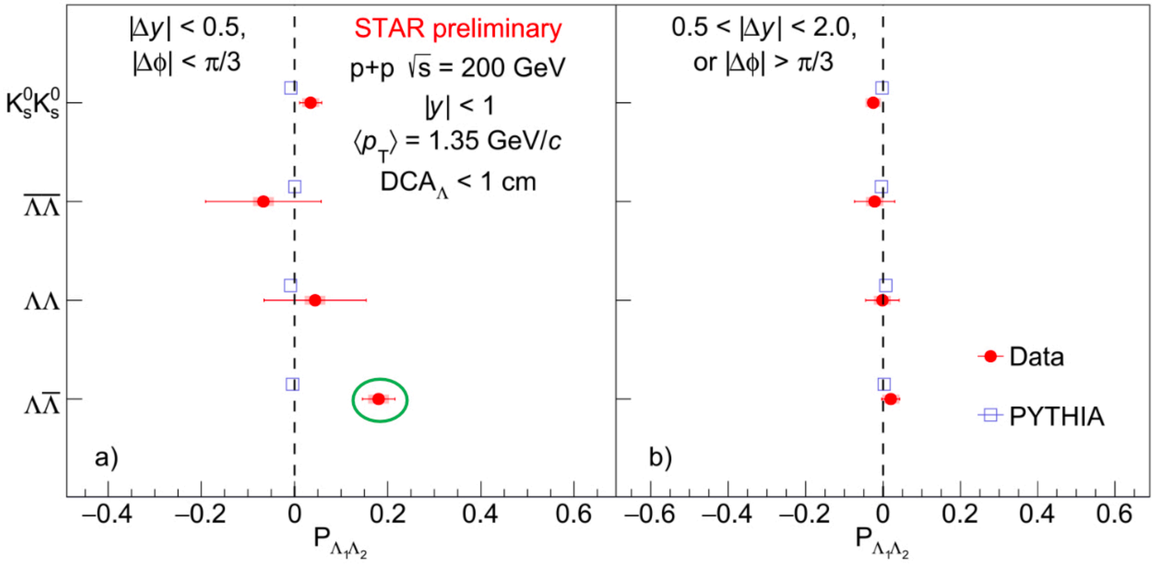
$|y| < 1$

$0.5\ GeV/c < p_T < 5.0\ GeV/c$





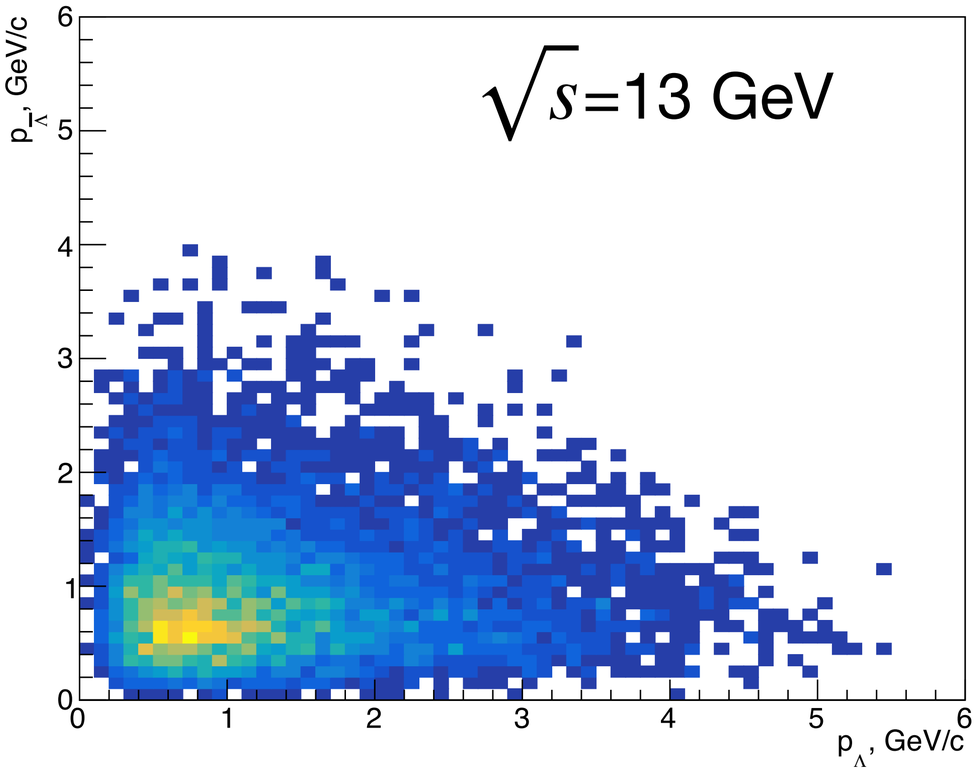
The first evidence of non-zero spin correlations on the hadronic level!



$\Lambda\Lambda$-pairs at SPD

per 1 M of pp interactions	10 GeV	13 GeV	27 GeV
LaL events	5 200	8 800	20 800
LaL pairs	5 900	10 000	25 100
LL events	4 300	5 400	9 600
LL pairs	4 400	5 600	10 200
aLaL events	5	50	900
aLaL pairs	5	50	900

We reach the STAR statistics in 3 hours!



L=10^{31} cm^{-2} s^{-1} , p-p collisions

A_{Λ}=0.2

BF($\Lambda \rightarrow p\pi$) = 0.64

16 $\Lambda\bar{\Lambda}$ pairs decaying into $p\pi$ per second at 13 GeV

General information

Observables: two-particle ($p\bar{p}$) angular correlation function (angle between p and $\bar{p}$ momenta taken in the Λ and $\bar{\Lambda}$ rest frames, respectively
Physics being addressed: possible quantum entanglement and nonlocality effects in hadronization processes
Competitiveness: low-energy collisions at SPD are the optimal tool for the proposed studies
Complementarity: production in e^+e^- , DIS and other hadroproduction experiments
Previous results: STAR
Actuality: actual
Importance: important for understanding hadronization procss

Experimental requirements:

Beam species: **dd**, pp
Collision energy: 5 -13 GeV
Luminosity: 10^{31} cm^{-2} s^{-1} (13 GeV)
Polarization: **preferably** but not necessarily
Involved SPD subsystems: MCT, Straw tracker
Optimal duration of data taking: 1 month
Minimal duration of data taking: 3 days

Expected performance:

Total statistics: 60M pairs for dd collisions at 13 GeV
Statistical accuracy: for - 10^{-3}
Main sources of systematics: incorrectness of the setup description in MC, combinatorial background subtraction