

Interplay among transversity induced asymmetries in hadron leptonproduction (*)

Franco Bradamante

Trieste University and INFN

(*) *C. Adolph et al. [COMPASS Collaboration]
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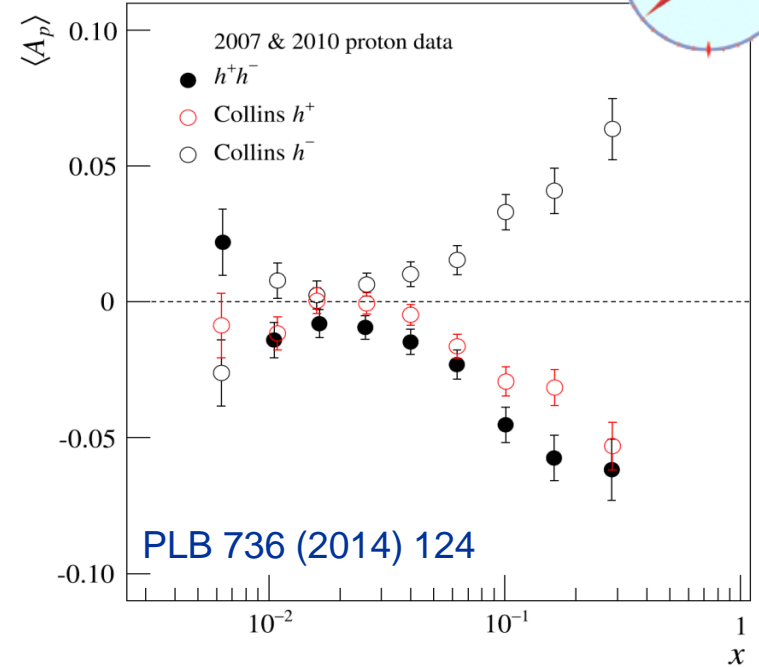


interplay

between Collins and di-hadron asymmetries

known intriguing results

- Collins asymmetry for h^+ and for h^-
“mirror symmetry”
- di-hadron asymmetry
only somewhat larger than h^+ Collins



interplay

between Collins and di-hadron asymmetries

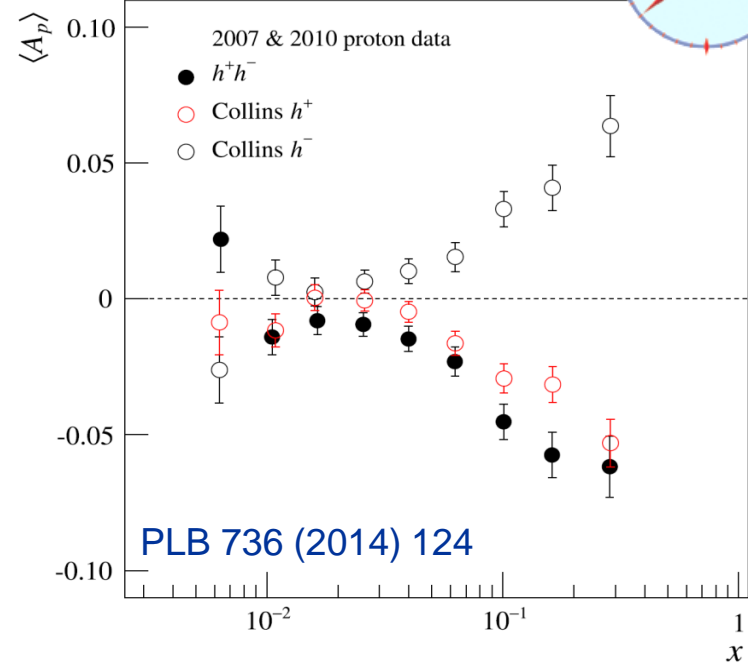
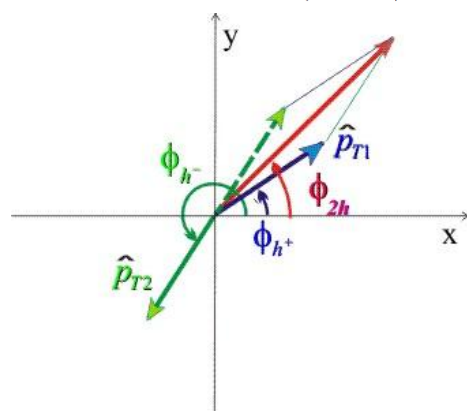
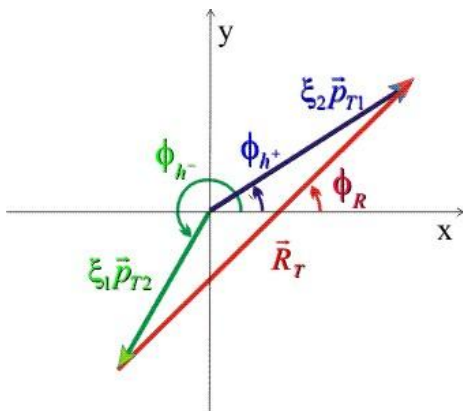
known intriguing results

- Collins asymmetry for h^+ and for h^-
“mirror symmetry”
- di-hadron asymmetry
only somewhat larger than h^+ Collins

→ first studies of the correlations between the relevant azimuthal angles and the corresponding asymmetries $\phi_R \sim \phi_{2h}$

$$\phi_{2h} = \frac{1}{2} [\phi_1 + \phi_2 + \text{sign}(\Delta\phi) \cdot \pi]$$

$$\Delta\phi = \phi_1 - \phi_2$$



hints for a common origin of the Collins FF and Di-hFF

Como 2013, DSpin2013, SPIN 2014, CERN-PH-EP/2015-199 → PRL

three issues

1. Dependence of the COLLINS ASYMMETRY on the detection of other hadrons in the jet

$$\mu p \rightarrow \mu' h^+ X$$

h^+ Collins asymmetry

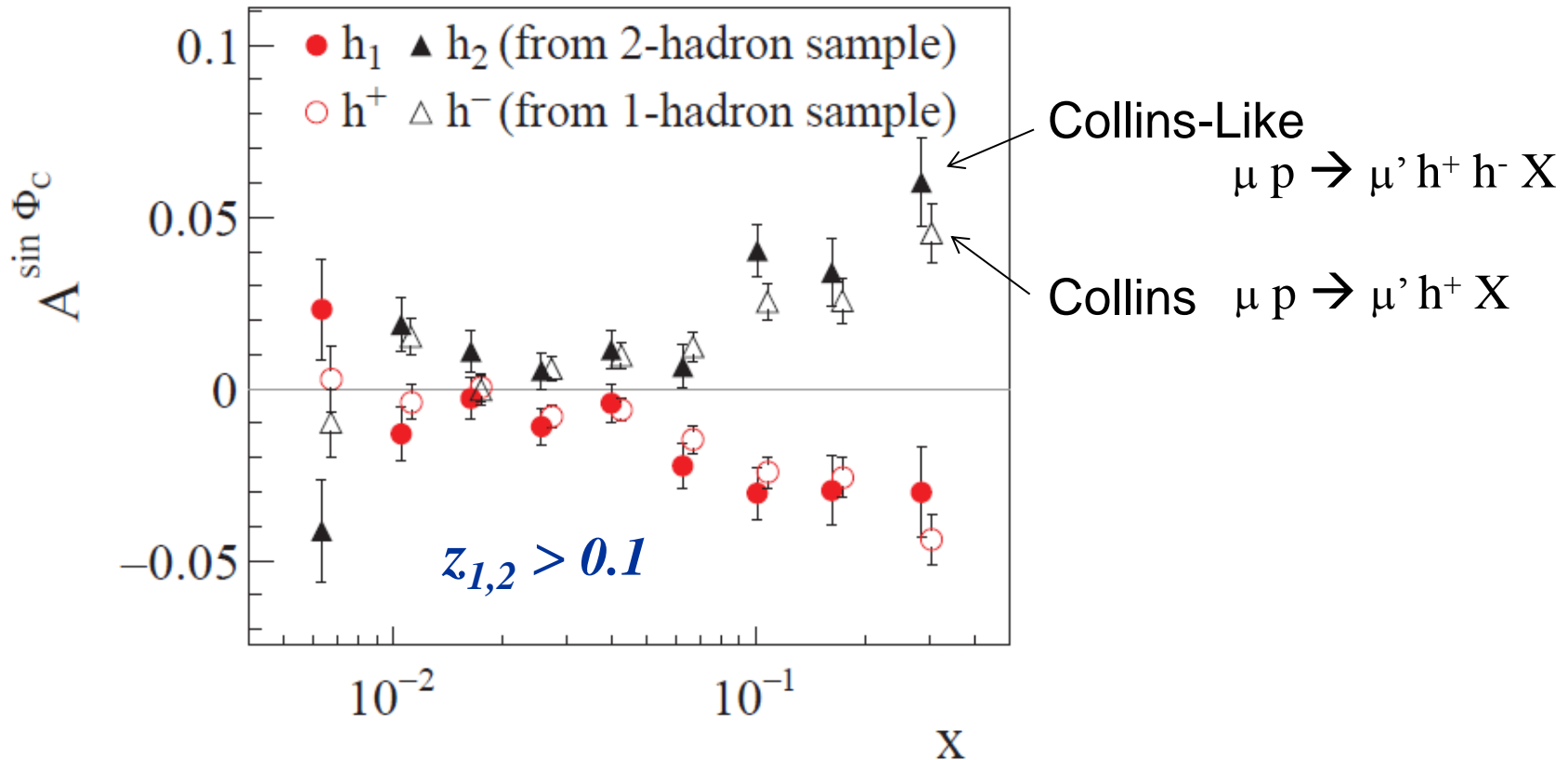
$$\mu p \rightarrow \mu' h^+ h^- X$$

h^+ Collins-Like asymmetry

2. In the process $\mu p \rightarrow \mu' h^+ h^- X$ investigate the correlations between the h^+ and h^- CL asymmetries as a function of $\Delta\phi = \phi_1 - \phi_2$

3. In the process $\mu p \rightarrow \mu' h^+ h^- X$ investigate the correlation between the CL asymmetries and the 2h asymmetry

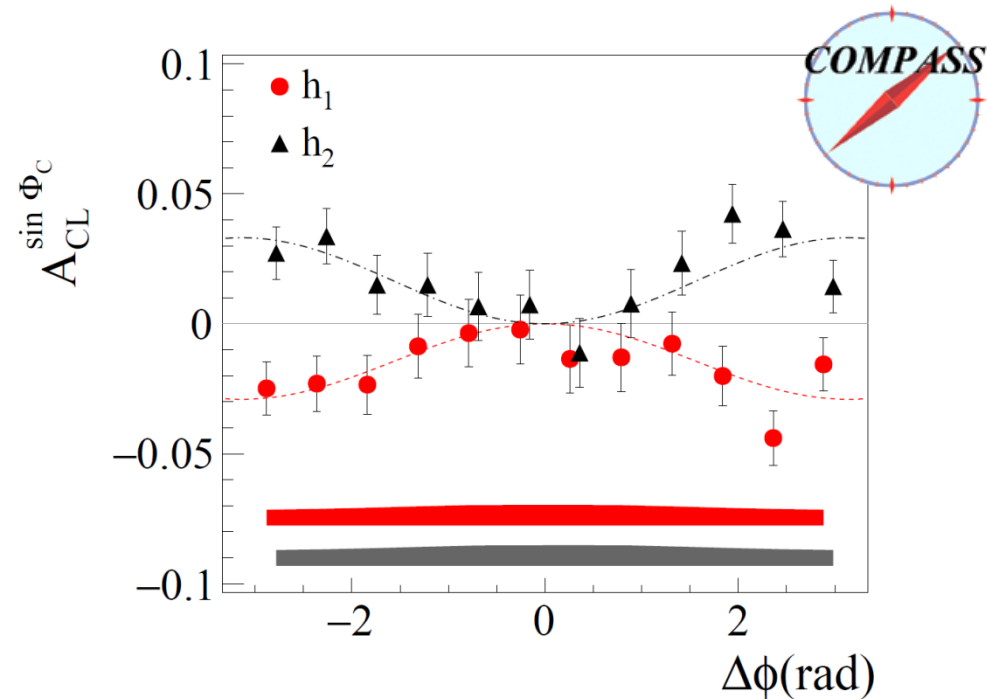
1. comparison of Collins and CL asymmetries



2. correlations between the h^+ and h^- CL asymmetries

Collins Like asymmetries vs $\Delta\phi = \phi_1 - \phi_2$

the asymmetries are expected to be specular and maximum at $\Delta\phi \simeq \pi$
confirmed by data



2. correlations between the h^+ and h^- CL asymmetries

Collins Like asymmetries vs $\Delta\phi = \phi_1 - \phi_2$

the asymmetries are expected to be specular and maximum at $\Delta\phi \simeq \pi$
confirmed by data

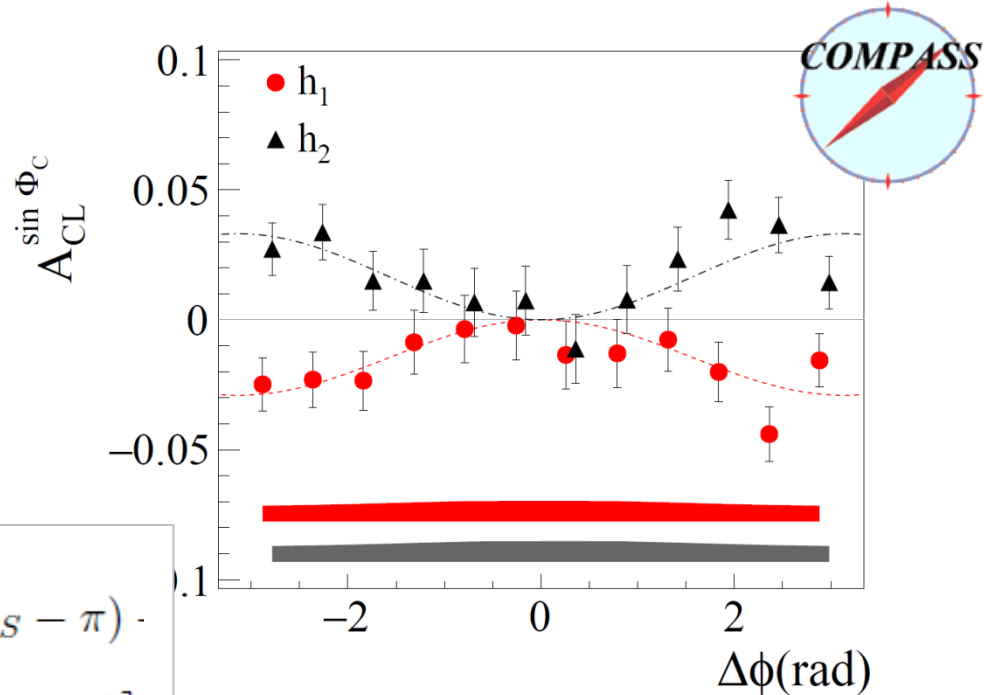
analytical calculations:
A. Kotzionian, PRD91 2015

$$\frac{d\sigma^{h_1 h_2}}{d\phi_1 d\phi_2 d\phi_S} = \sigma_U^{h_1 h_2} + S_T \left[\sigma_{C1}^{h_1 h_2} \sin(\phi_1 + \phi_S - \pi) + \sigma_{C2}^{h_1 h_2} \sin(\phi_2 + \phi_S - \pi) \right]$$



$$A_{CL1}^{\sin(\phi_1 + \phi_S - \pi)} = \frac{1}{D_{NN}} \frac{\sigma_{C1}^{h_1 h_2} + \sigma_{C2}^{h_1 h_2} \cos \Delta\phi}{\sigma_U^{h_1 h_2}}$$

$$A_{CL2}^{\sin(\phi_2 + \phi_S - \pi)} = \frac{1}{D_{NN}} \frac{\sigma_{C2}^{h_1 h_2} + \sigma_{C1}^{h_1 h_2} \cos \Delta\phi}{\sigma_U^{h_1 h_2}}$$



good agreement with data if

$$\sigma_{C1}^{h_1 h_2} = -\sigma_{C2}^{h_1 h_2}$$

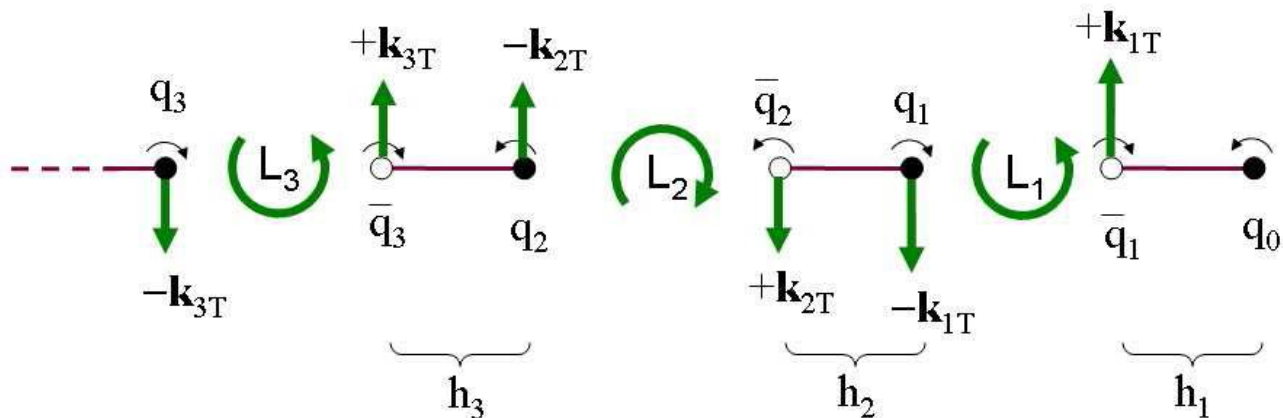
→ *mirror symmetry*

$$A_{CL2}^{\sin(\phi_2 + \phi_S - \pi)} = -A_{CL1}^{\sin(\phi_1 + \phi_S - \pi)}$$

2. correlations between the h^+ and h^- CL asymmetries

Mirror symmetry is just what one expects from the

string fragmentation model + pairs created in 3P_0 state



X. Artru ...

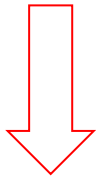
Indeed $\sigma_{C1}^{h_1 h_2} = -\sigma_{C2}^{h_1 h_2}$

means that at every break of the string the quark flips its spin

3. correlation between CL and di-hadron asymmetries



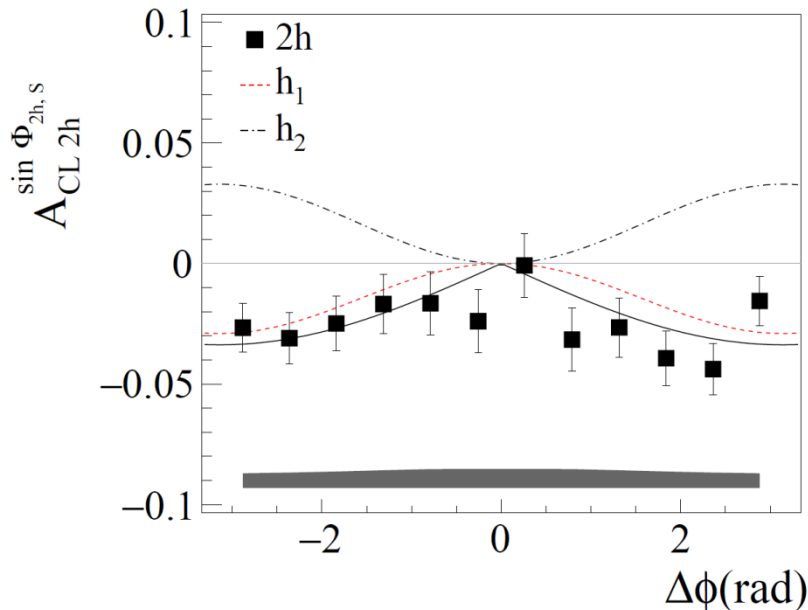
$$\sigma_{C1}^{h_1 h_2} = -\sigma_{C2}^{h_1 h_2}$$



rewriting the cross-section in terms of ϕ_{2h} and $\Delta\phi$ one easily obtains

$$A_{2h,CL}^{\sin(\phi_{2h} + \phi_S - \pi)} = \frac{1}{D_{NN}} \frac{\sigma_{C1}^{h_1 h_2}}{\sigma_U^{h_1 h_2}} \cdot \sqrt{2(1 - \cos \Delta\phi)}$$

a very **simple relationship** between di-hadron and single hadron asymmetries in the 2h sample



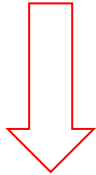
in agreement with data

ratio of the integrals: $4/\pi$

“slightly larger than h^+ ”

3. correlation between CL and di-hadron asymmetries

$$\sigma_{C1}^{h_1 h_2} = -\sigma_{C2}^{h_1 h_2}$$



rewriting the cross-section in terms of ϕ_{2h} and $\Delta\phi$ one easily obtains

$$A_{2h,CL}^{\sin(\phi_{2h} + \phi_S - \pi)} = \frac{1}{D_{NN}} \frac{\sigma_{C1}^{h_1 h_2}}{\sigma_U^{h_1 h_2}} \cdot \sqrt{2(1 - \cos \Delta\phi)}$$

a very **simple relationship** between di-hadron and single hadron asymmetries in the 2h sample



- the analysis of COMPASS data continues:
results from complementary studies of the 2h asymmetries in a short time
some results for Sivers already released
- it would be interesting to perform the corresponding studies in e^+e^-