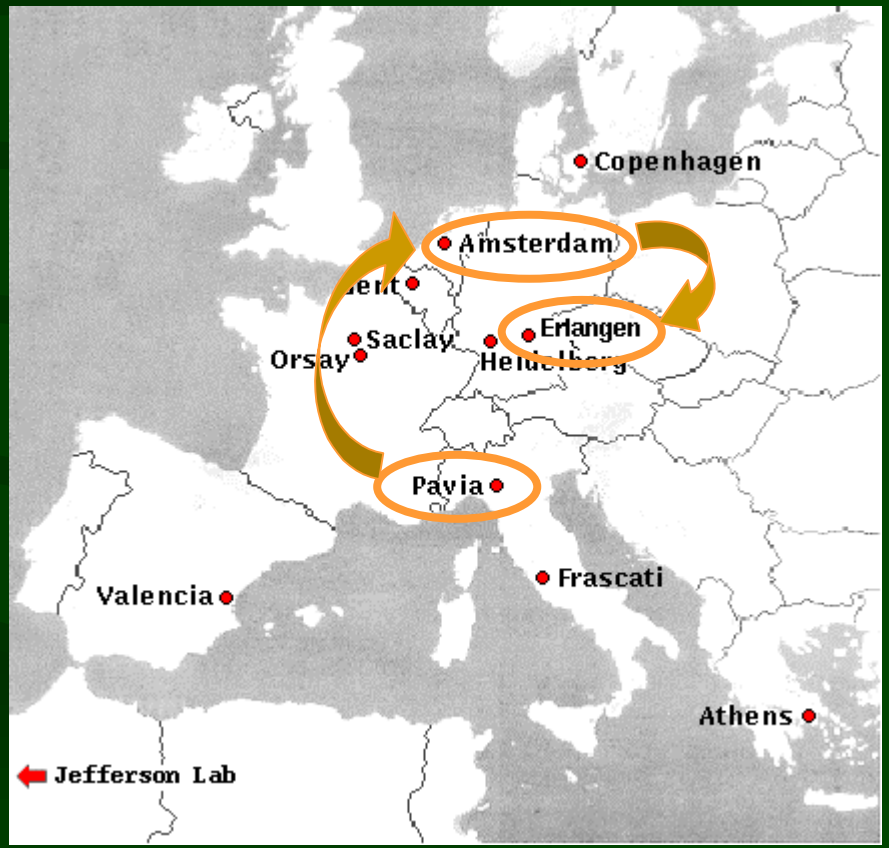
A theorist's contribution to the hunt for transversity

Alessandro Bacchetta

Universität Regensburg

Electron Scattering Off confined Partons

My experience with the network



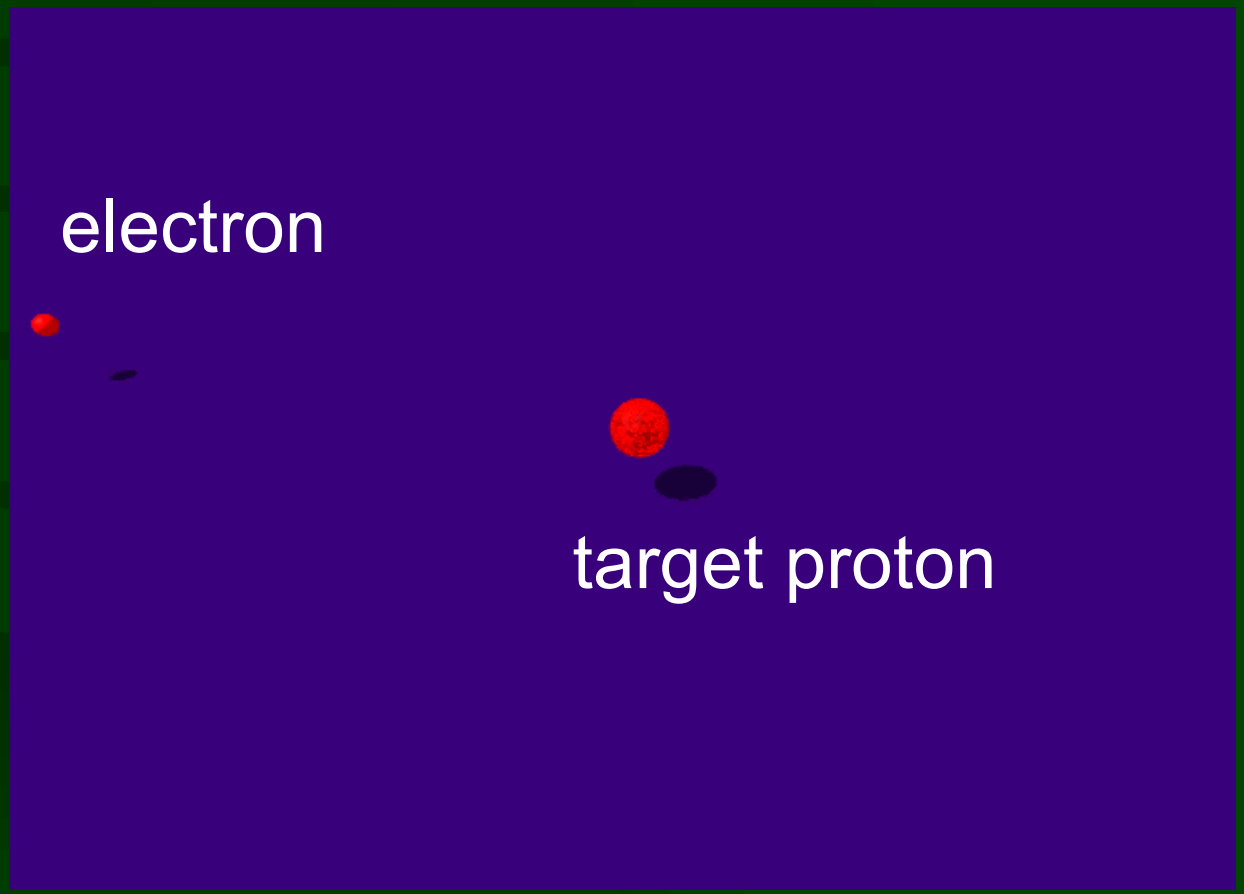
Outline

- Driving questions
- Transversity
- Collins function
- Two-hadron functions

Driving questions

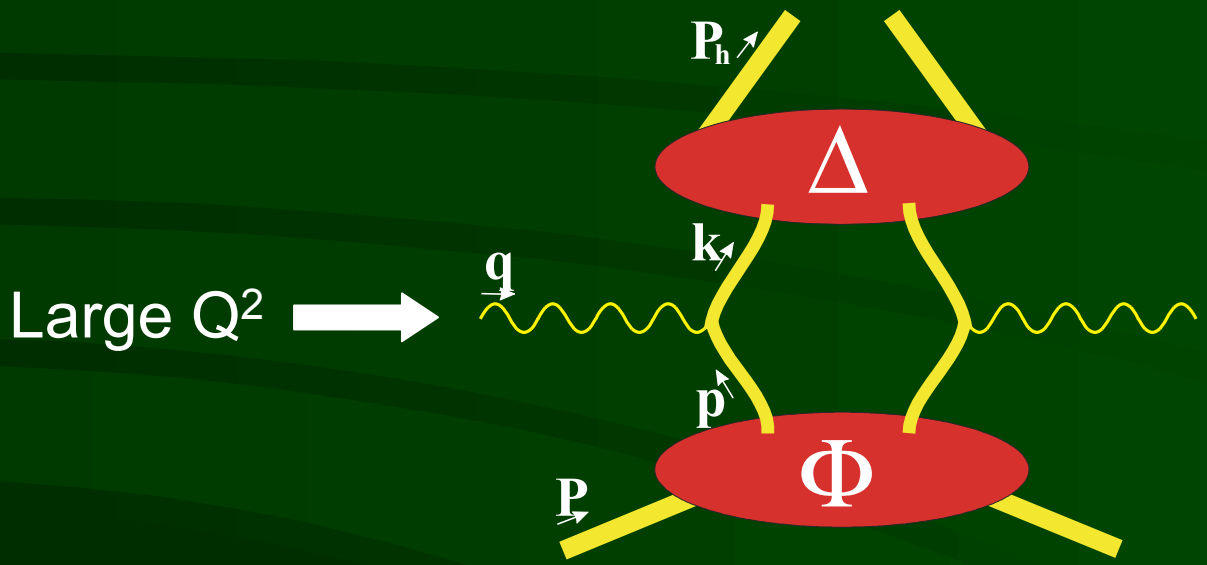
- What is the internal structure of the proton in terms of quarks and gluons?
- Where does the spin of the proton come from?

Deep inelastic scattering



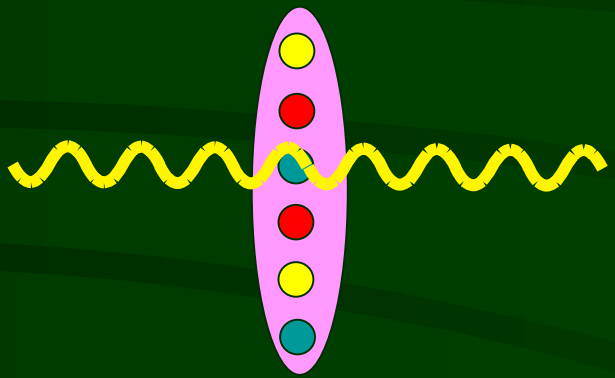
Semi-inclusive DIS

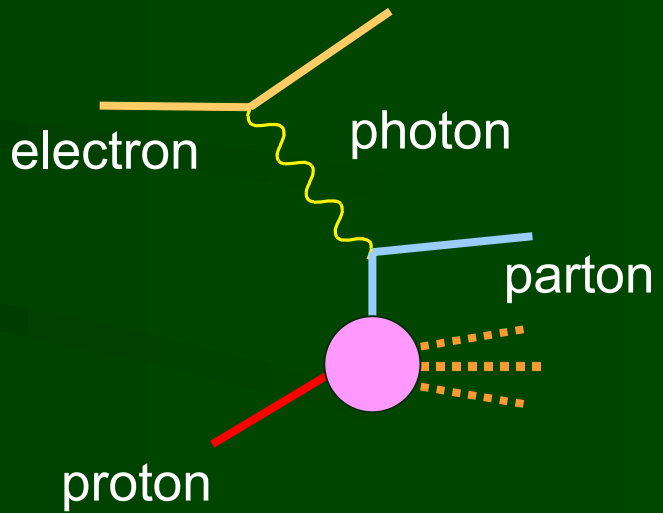
$$\mathrm{d}\sigma\,(l + H \rightarrow l' + h + X) \propto L_{\mu\nu} W^{\mu\nu}$$



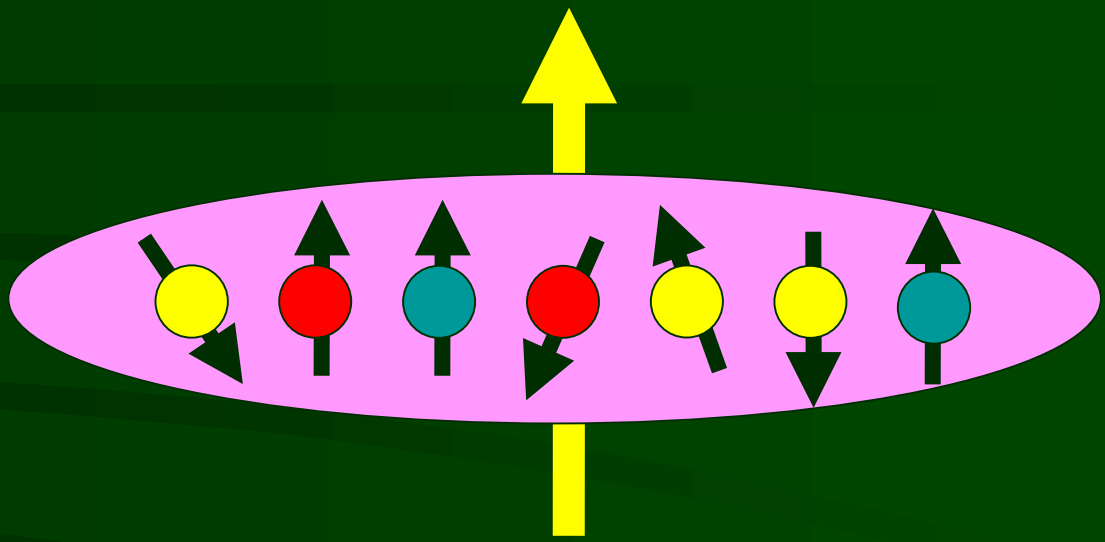
$$2M W^{\mu\nu} \propto \mathrm{Tr}[\Phi(x_B)\gamma^{\mu}\,\Delta(z_h)\gamma^{\nu}]$$

The parton model

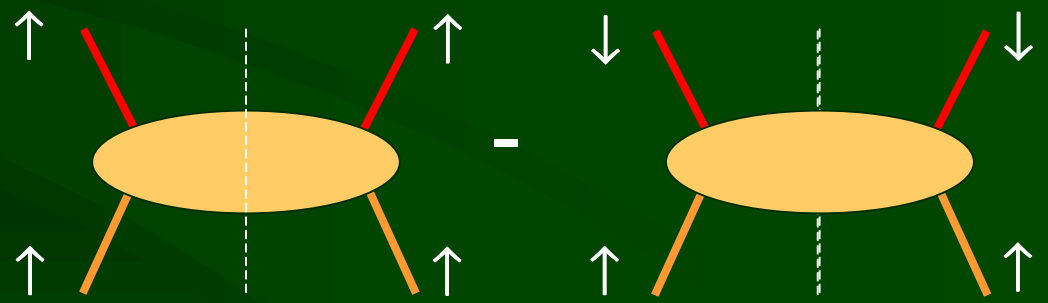




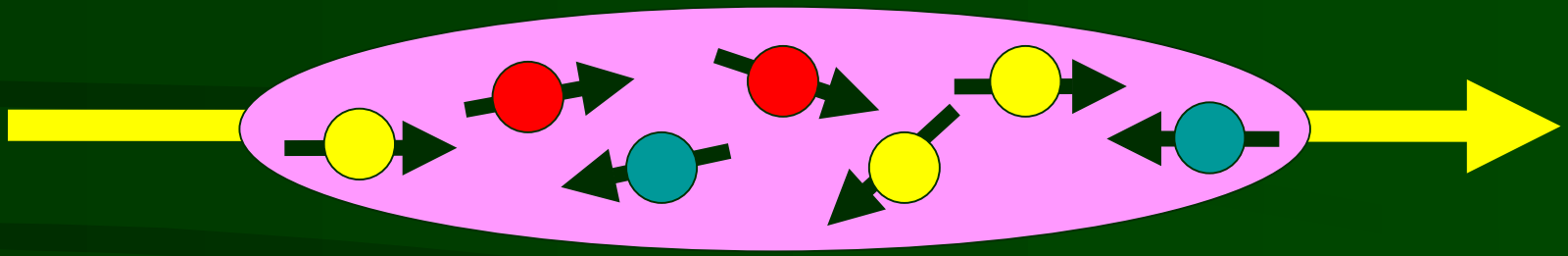
Helicity distribution g_1



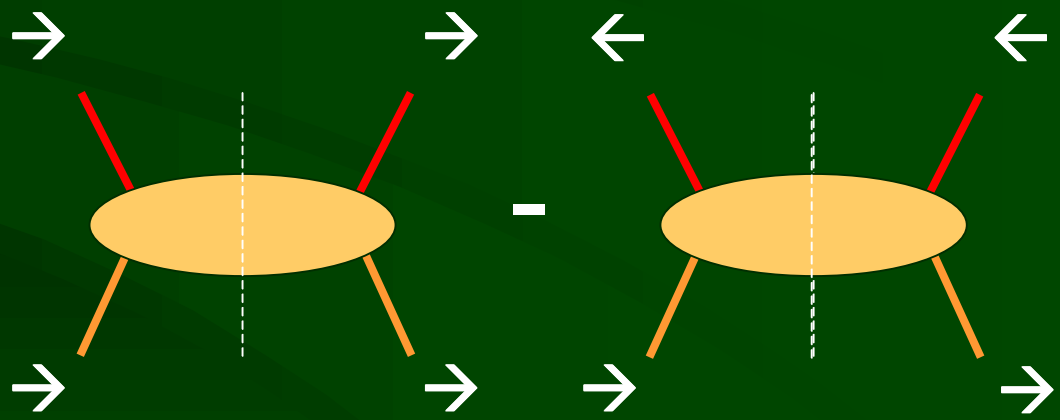
$$g_1 = \Delta q = \frac{1}{2}$$



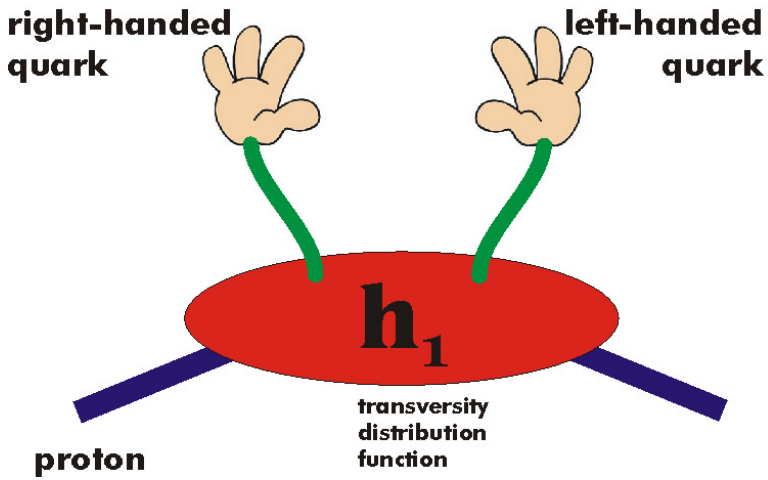
Transversity distribution h_1



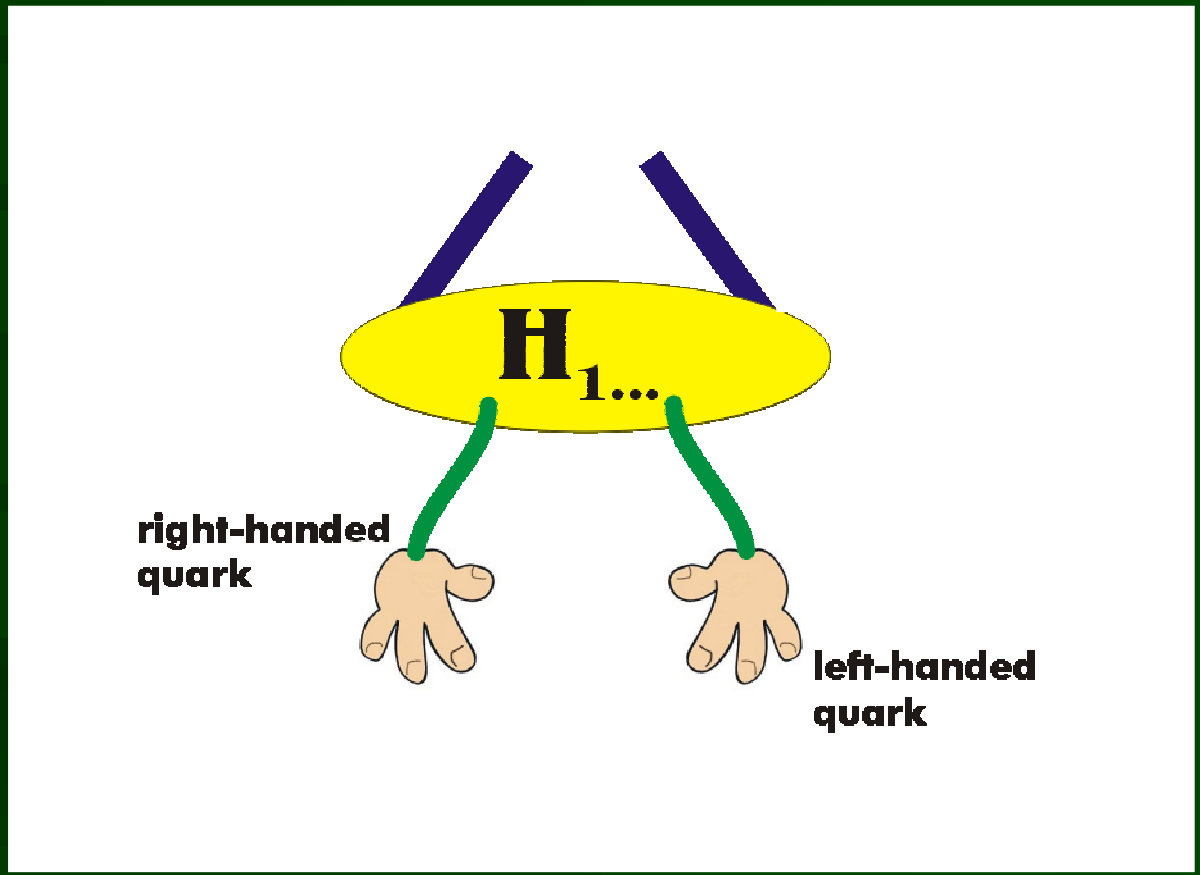
$$h_1 = \delta q = \frac{1}{2}$$



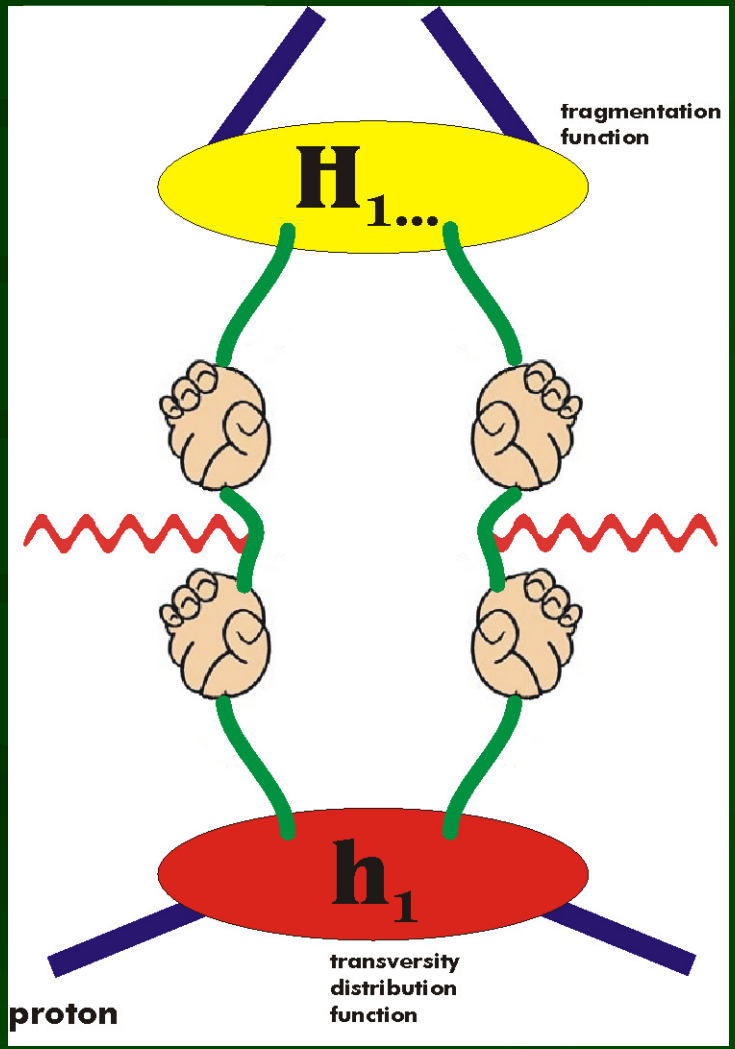
The problem of measuring transversity



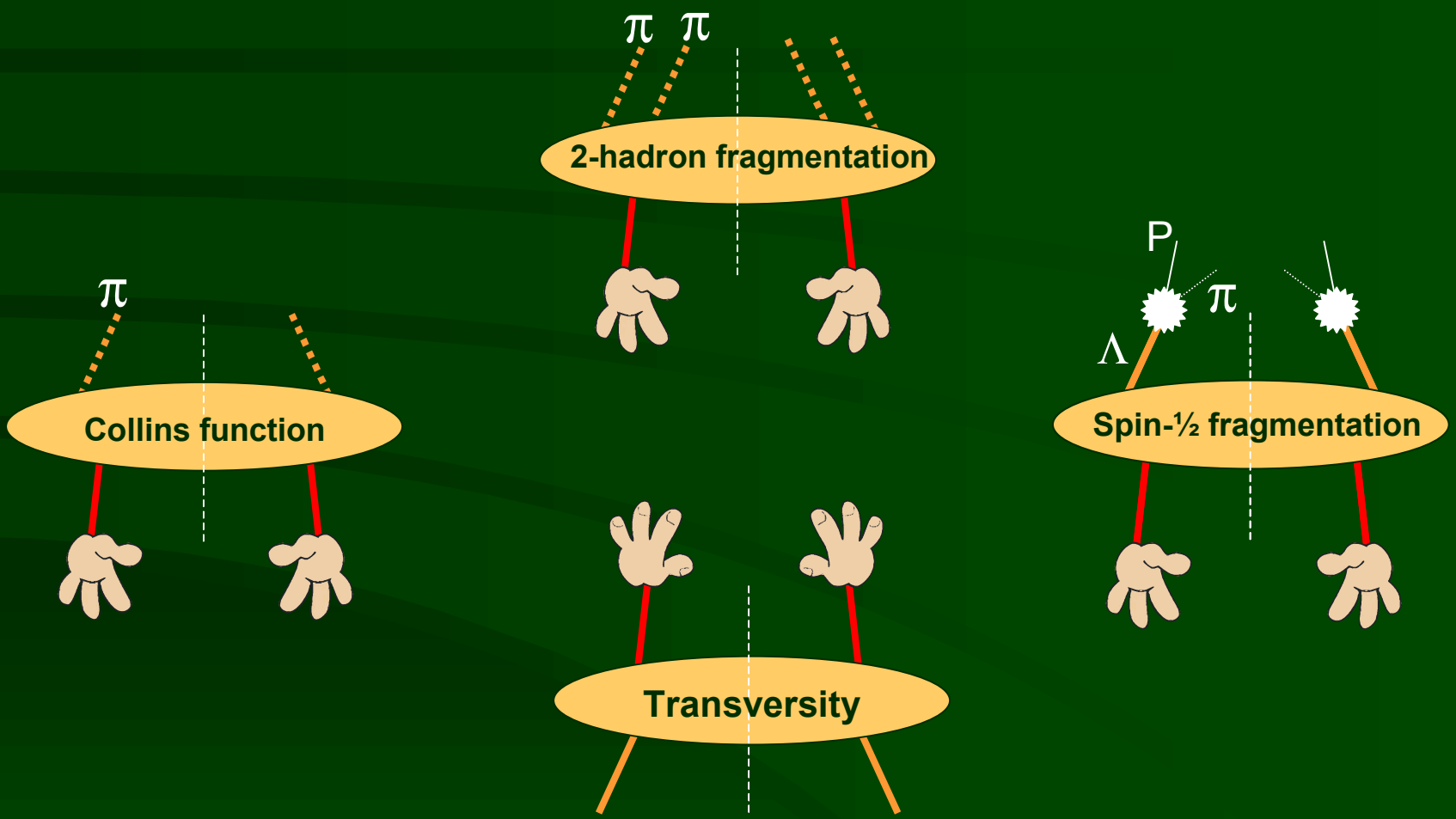
Chiral-odd fragmentation functions



A chiral partnership

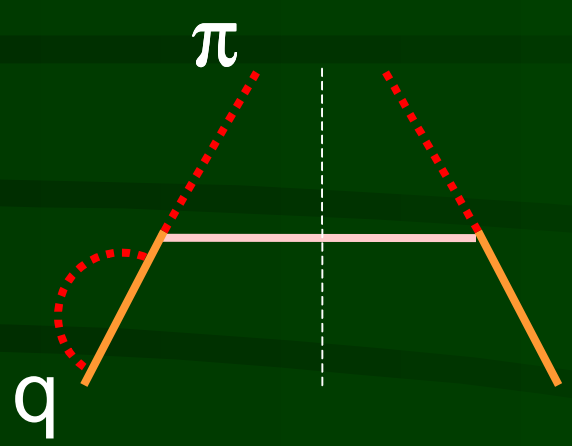


A chiral partner for transversity

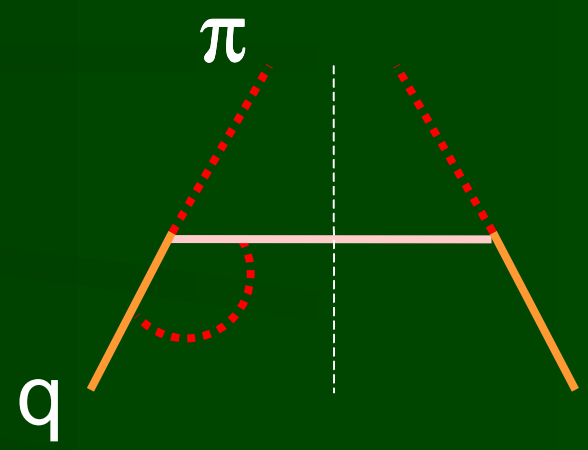


A model for the Collins function

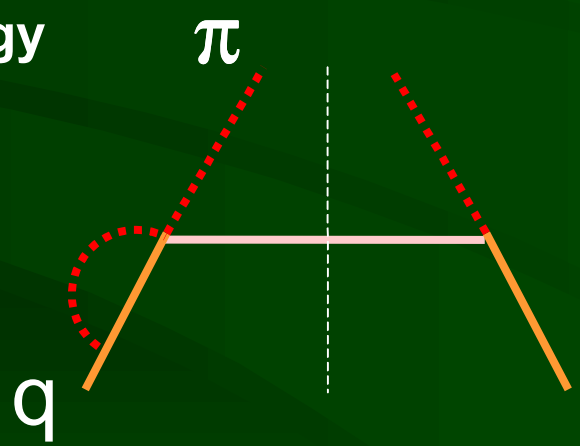
A. B., R. Kundu, A. Metz, P. Mulders, PRD 65 (2002)



Self-energy



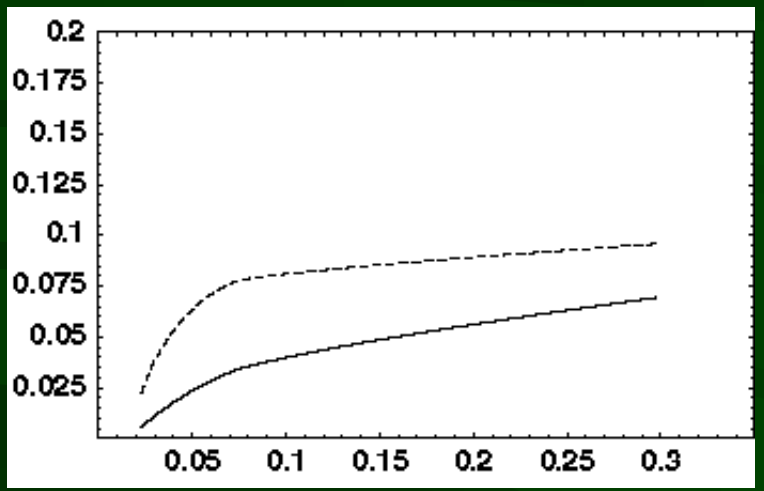
Vertex correction



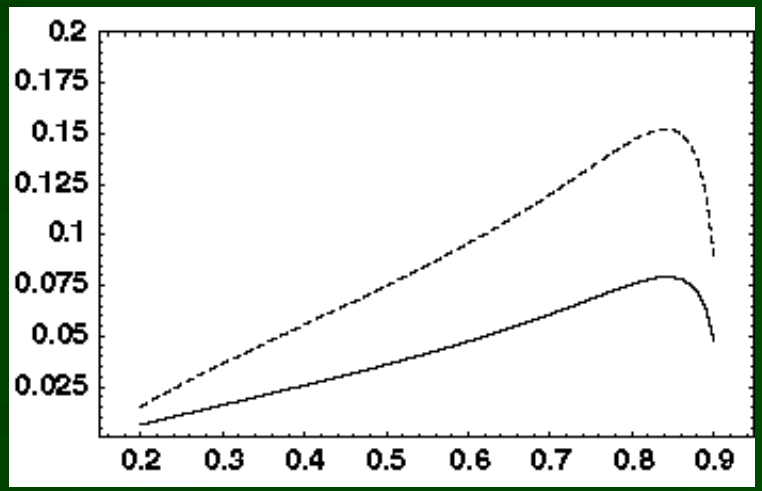
Contact interaction

Predicted asymmetries

$$\langle \sin\phi \rangle_{UT}^{\pi^+}$$



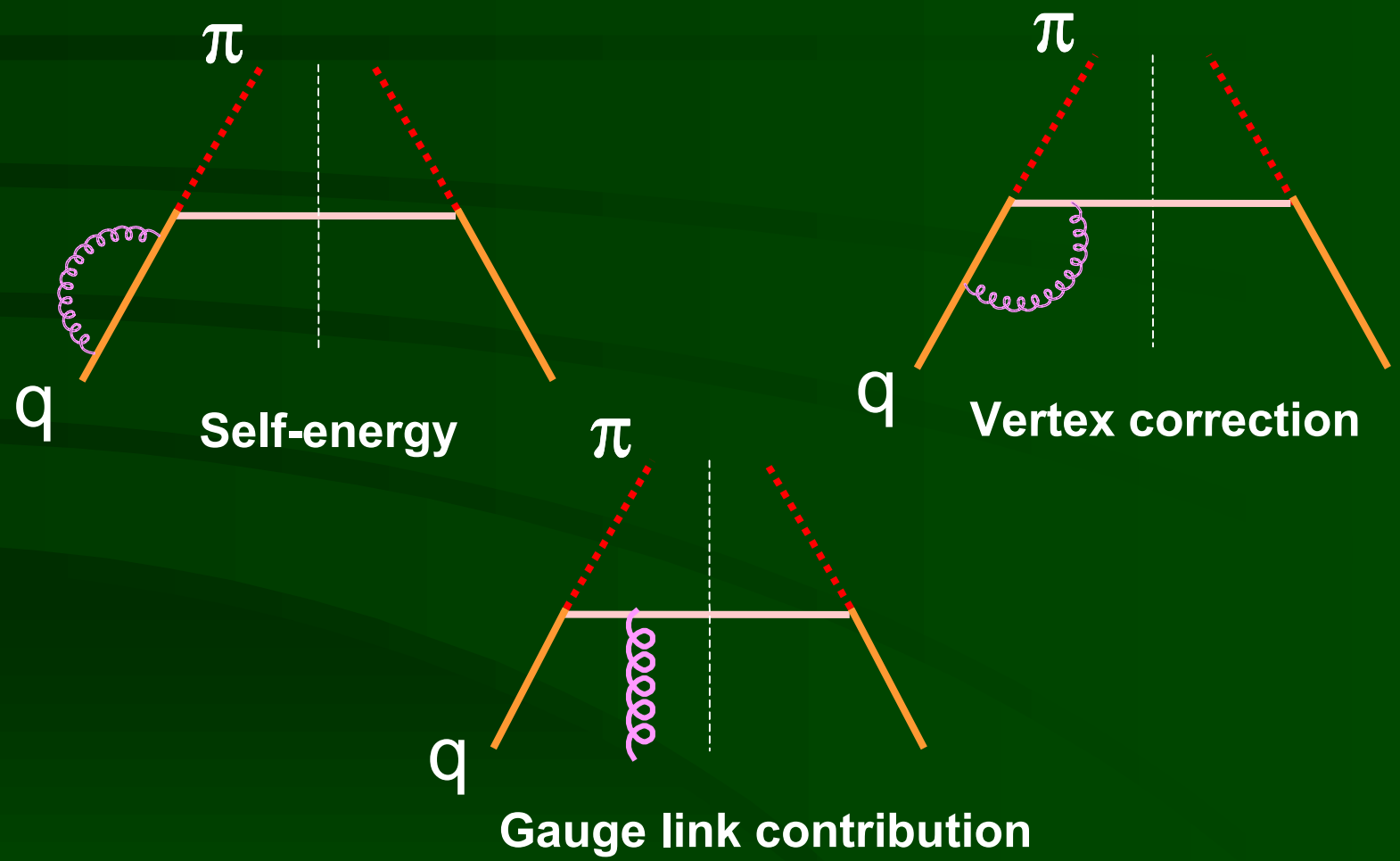
x



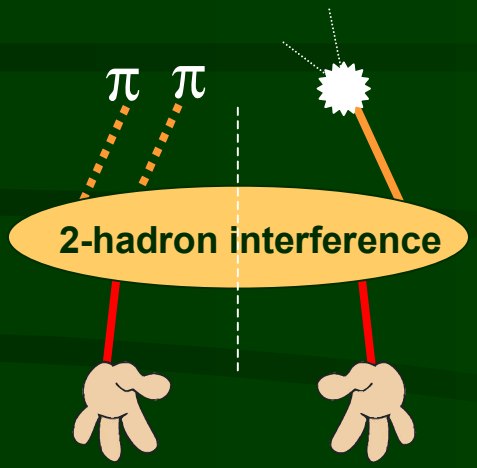
z

Collins function from gluons

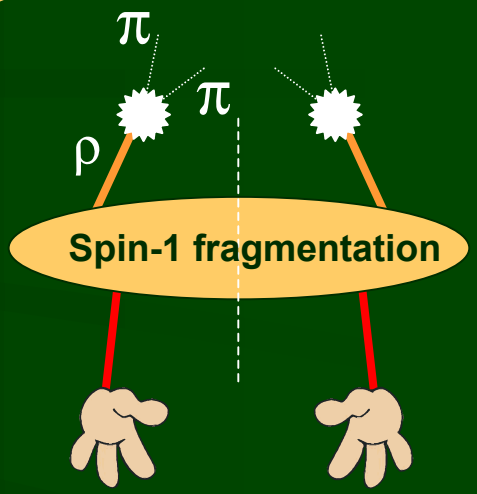
A. B., J. Yang, A. Metz



Two-hadron fragmentation functions



R. Jaffe,X. Jin, J. Tang, PRL 80 (1997)



A. B., P. Mulders, PRD 62 (2000)

$$d\sigma_{UT} \sim \sin(\phi_R + \phi_S)\,\sin\theta\; h_1 \left(H_1^{s-p} + \cos\theta\; H_1^{spin-1} \right)$$

A. B., M. Radici, PRD 67 (2003)

Spin-1 often neglected, but probably very important!

Subleading-twist analysis of two-hadron functions

A. B., M. Radici

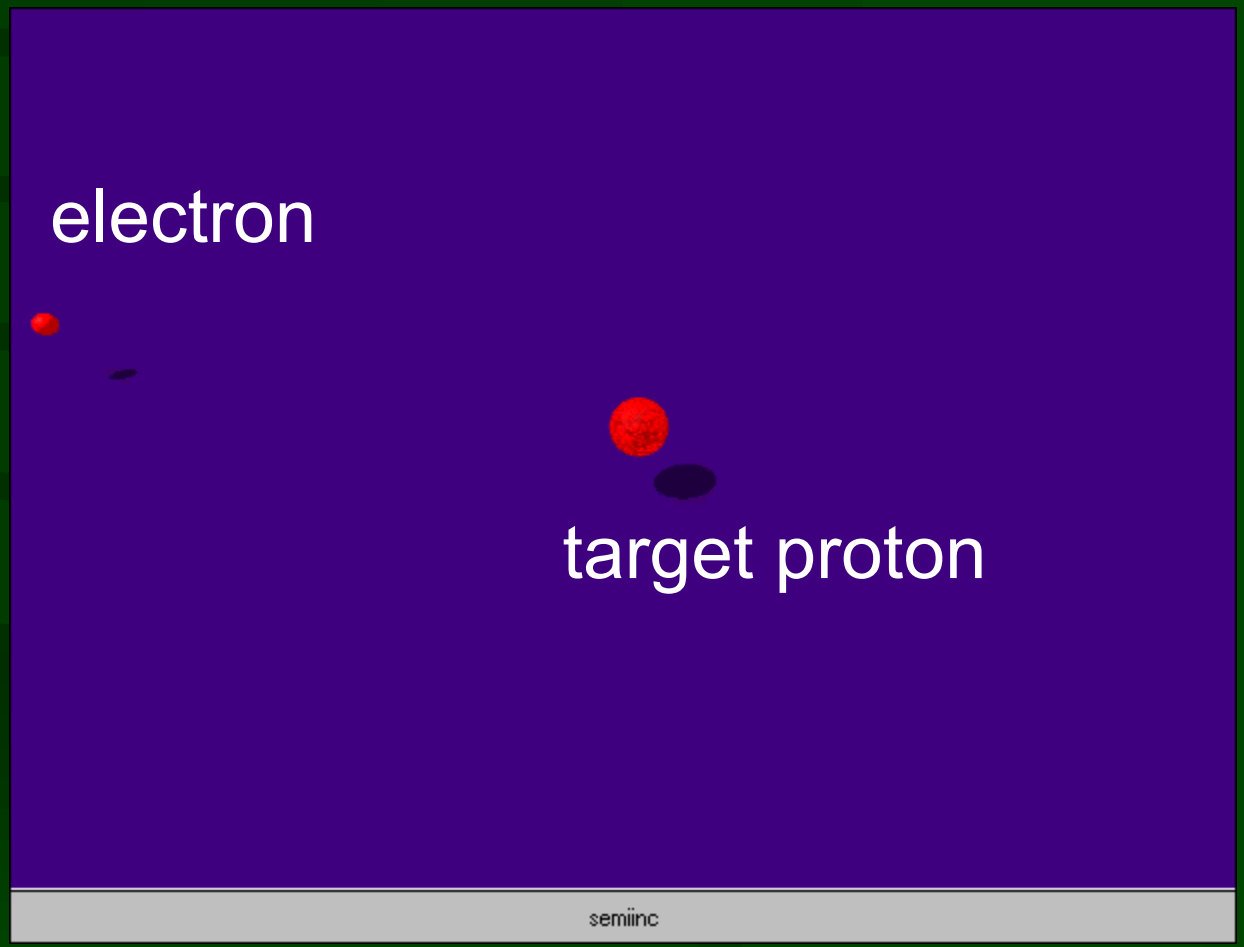
$$d\sigma_{UL} \sim \ldots + \sin\phi_R \ \sin\theta \ h_1 \left(H_1^{s-p} + \cos\theta \ H_1^{spin-1} \right)$$

Conclusions

The hunt for transversity is going on…

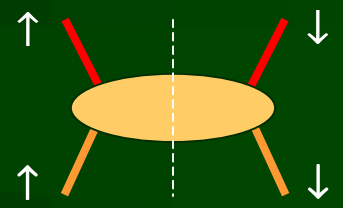
...we are eagerly waiting for experimental data!

Deep inelastic scattering



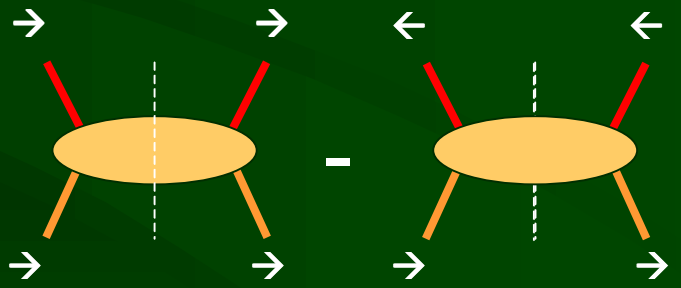
Polarized function h_1

$$h_1 = \delta q = \frac{1}{2}$$



$$|\uparrow\rangle = \frac{1}{\sqrt{2}}\left(|\rightarrow\rangle + |\leftarrow\rangle\right) \qquad |\downarrow\rangle = -\frac{i}{\sqrt{2}}\left(|\rightarrow\rangle - |\leftarrow\rangle\right)$$

$$h_1 = \frac{1}{2}$$



Transversity vs helicity

- Different evolution
- Different integrals (axial and tensor charge of the nucleon) from lattice QCD

$$\delta\Sigma \equiv \int h_1(x)dx \simeq 0.56, \qquad \Delta\Sigma \equiv \int g_1(x)dx \simeq 0.18$$

S. Aoki et al., PRD 56 (1997)

- The difference between transversity and helicity has a dynamical origin

e.g. H. He, X. Ji, PRD 52 (1995)