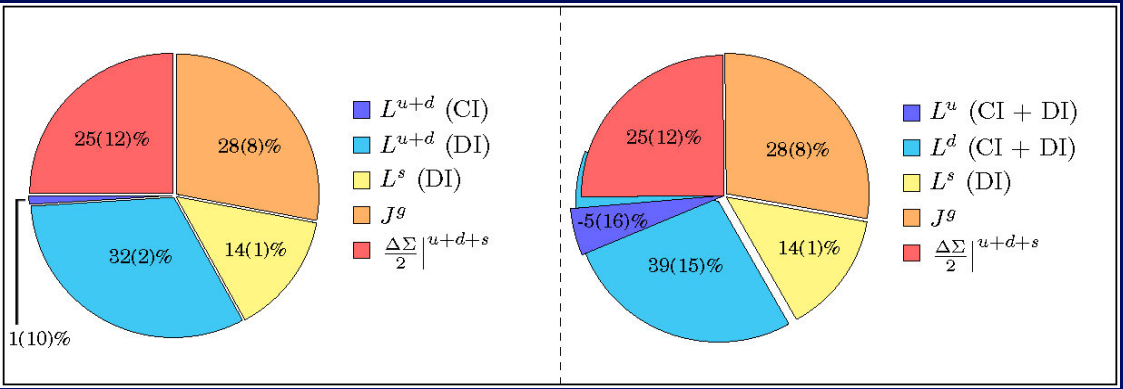
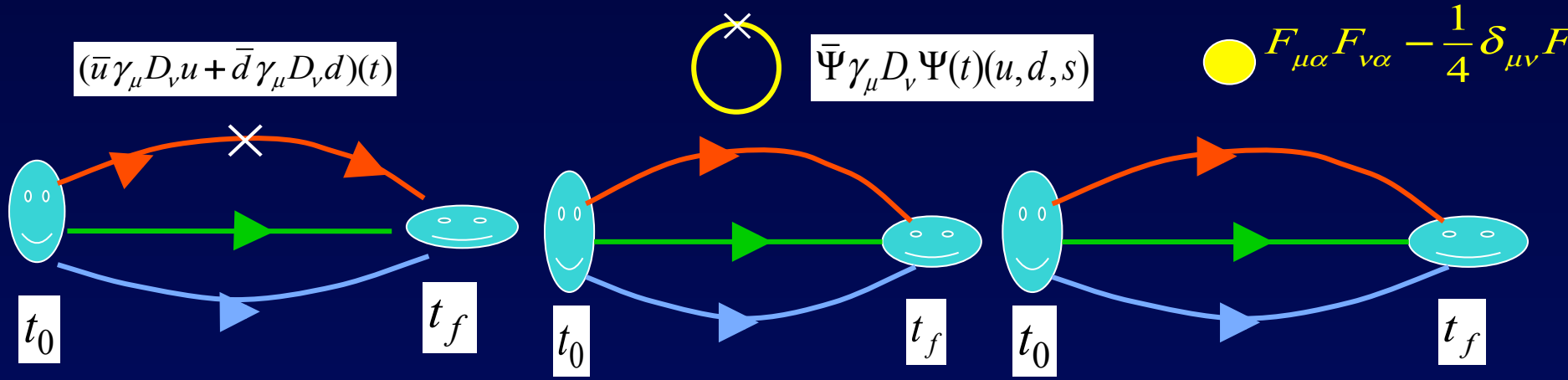


# Nucleon Structure with Quarks and Glue



## Experiments:

- Quark Spin (DIS, SIDIS)
- Gluon Helicity (STAR, COMPASS)
- Orbital AM (TMD, JLAB)
- NEDM (nEDM, Oak Ridge)
- Proton Charge Radius (JLAB)
- Strange EM FF (JLAB)

$\Delta q \approx 0.25;$

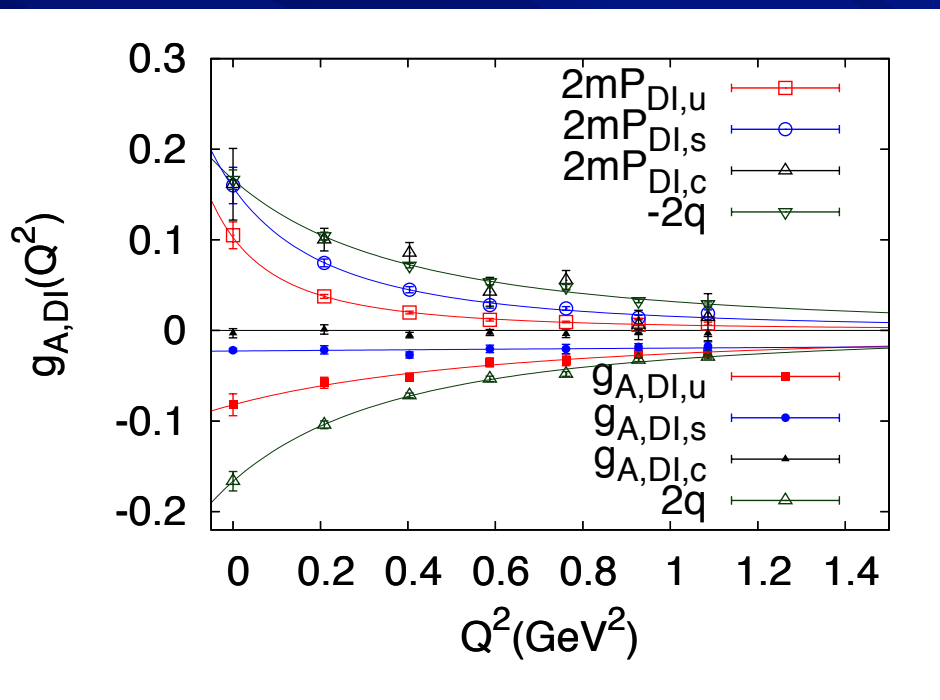
$2 L_q \approx 0.47$  (0.01(valence)+0.46(sea));

$2 J_g \approx 0.28$

M. Deka et al. ( $\chi QCD$ ), 1312.4816

# Quark Spin from Anomalous Ward Identity

$$Z_A \partial_\mu A_\mu = 2mP + 2N_f q$$



$24^3 \times 64$  2+1-flavor DWF Conf.  
 $m_\pi \sim 330$  MeV ( $L = 2.8$  fm)

Overlap valence fermion

$$\Delta c \sim 0$$

$$\Delta s = -0.6(3)$$

$$\Delta u(\text{DI}) = -0.17(3)$$

$$g_A^0 = \Delta u + \Delta d + \Delta s = 0.17(9)$$

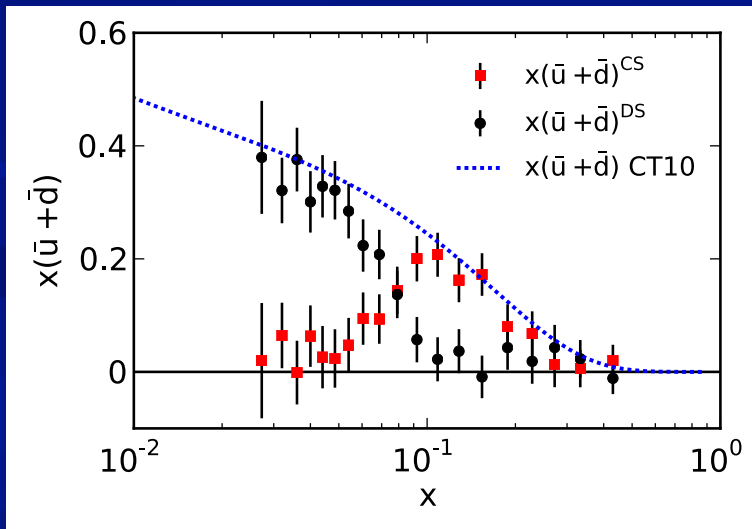
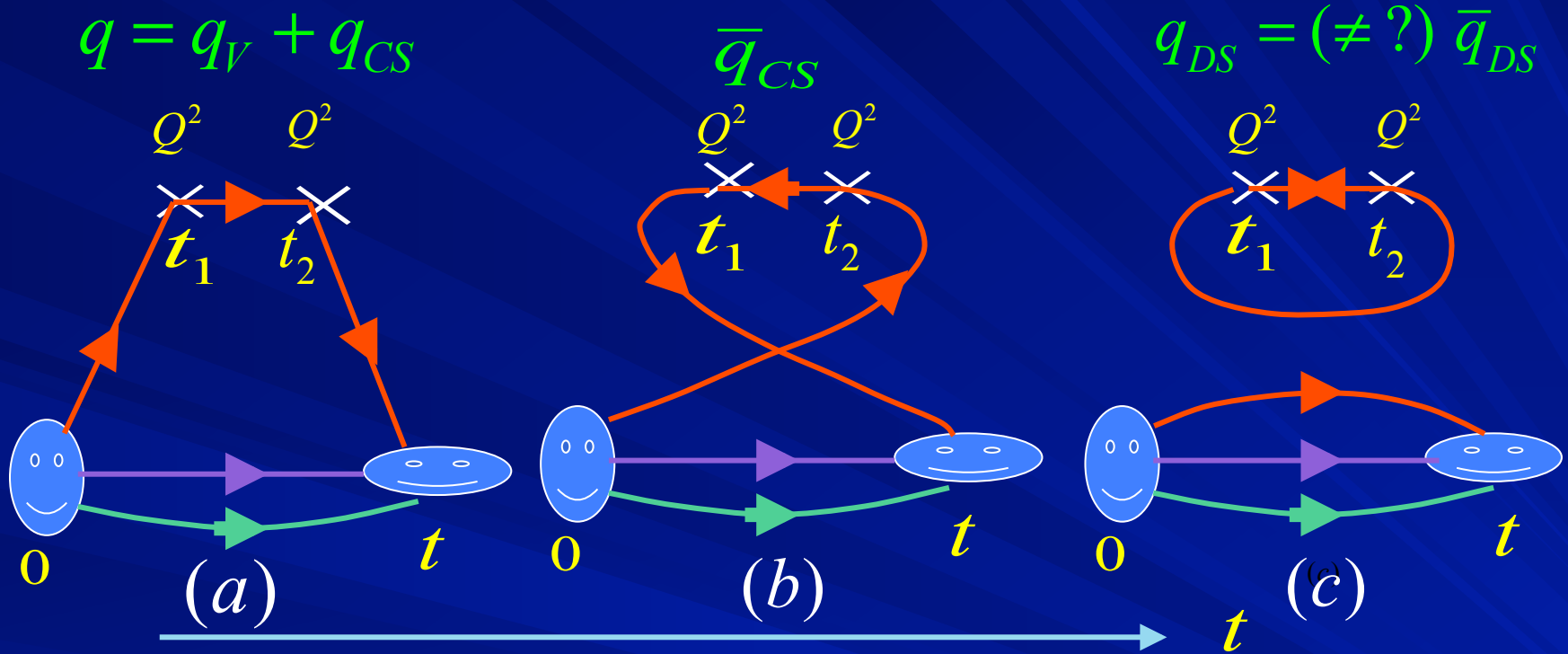
$48^3 \times 96$ ,  $m_\pi = 140$  MeV,  $L = 5.5$  fm  $\Rightarrow$  100 Mhrs

$96^3 \times 128$ ,  $m_\pi = 140$  MeV,  $L = 5.5$  fm  $\Rightarrow$  300 Mhrs

$80^2 \times 96 \times 128$ ,  $m_\pi = 140$  MeV,  $L_x = 5.5$  fm  $\Rightarrow$  700 Mhrs (?)

Human resources

# Hadronic Tensor in DIS



K.F. Liu, PRD 62, 074501 (2000)

- Connected sea from expt + global PDF + lattice;
- Four-point function gives cross-section to be compared with expt directly  $\rightarrow$  PDF;
- Need large fine lattice to accommodate large momentum;
- Test runs need  $\sim 20$  Mhrs.