Spin Physics at hermes

An experiment to study the spin structure of the nucleon

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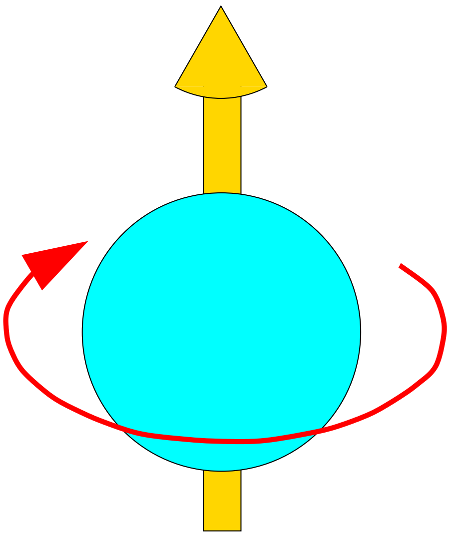
- What is spin ?
- What do we know about the nucleon spin?
- The HERMES experiment
- What to do at HERMES?!

What is spin ?

- Intrinsic spinning of a body around its axis:



Intrinsic property as: m, q, τ

Quantum Mechanics:

$\boxed{\text{Quantized in units of } \hbar/2}$

- Spin is everywhere:
  - Astrophysics: spinning of galaxies as a proof of existence of Dark Matter
  - Solid-State physics: Superconductivity is a consequence of electron pairs with $S_{pair} = 0$
  - Medical physics: MRI-technique based on spin-flip of the proton

Knowledge of the Universe

The study of the Universe requires:

Study of Matter

u c b

d s t

e μ τ

ν_e ν_μ ν_τ

$\Rightarrow$ Spin = 1/2

Study of Forces

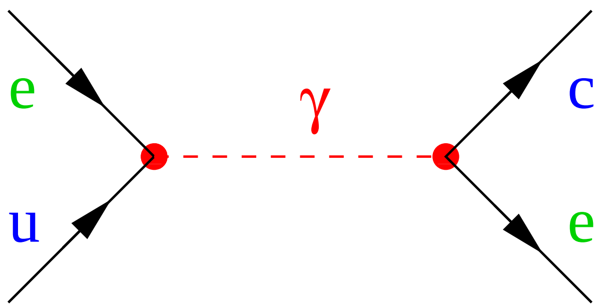
γ $W^{\pm}$

H G

Z_0 g

$\Rightarrow$ Spin = 0,1,2

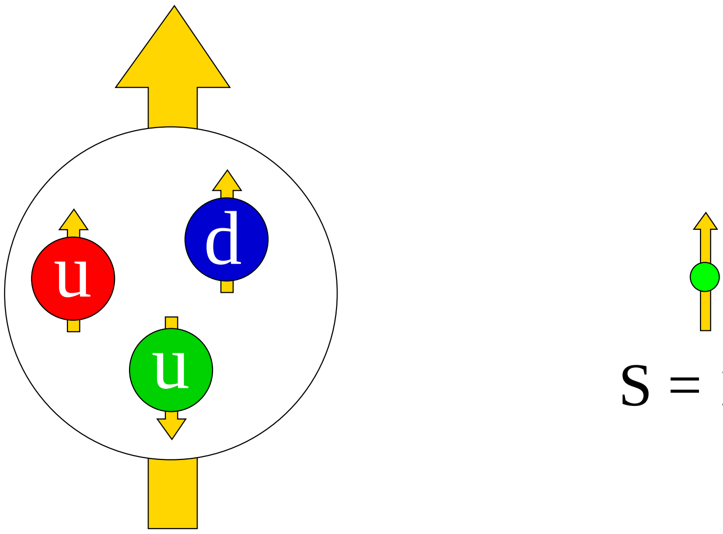
Matter interacts through Forces:



$\Rightarrow$ Spin is conserved in interactions

Spin and Particles

- Proton and electron both have $S = \frac{1}{2}\hbar$:



S = 1/2

S = 1/2

... but the proton is a composite object !

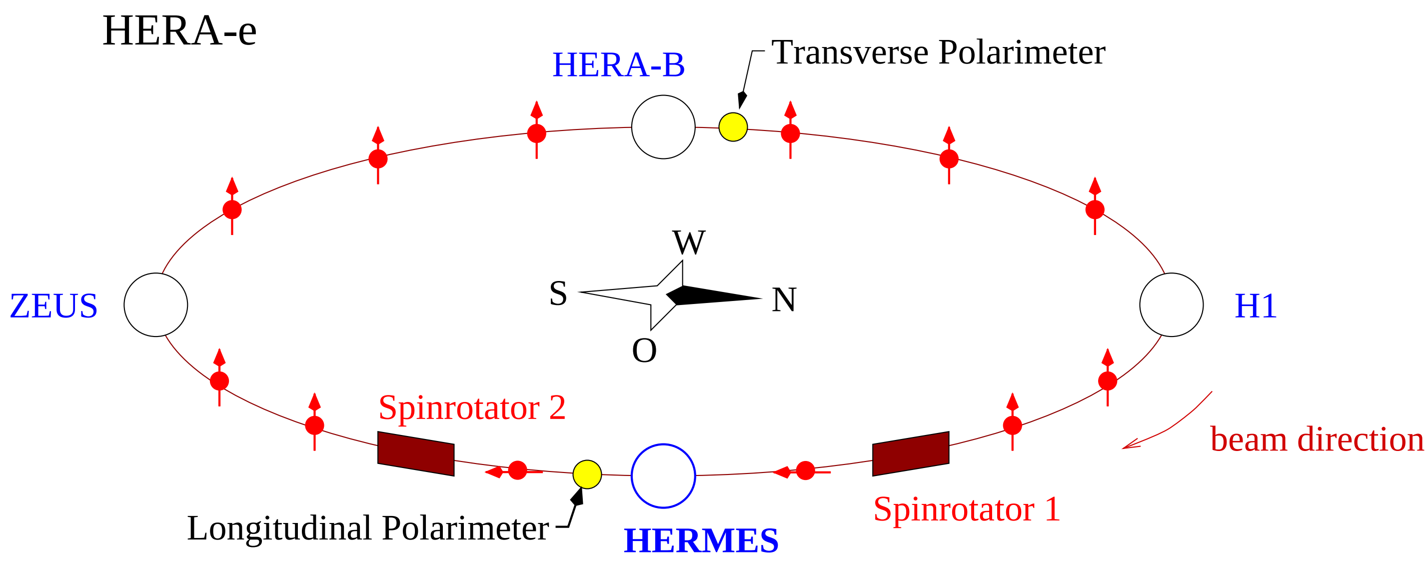
- In the naive model:
  - the proton has a $(\uparrow\downarrow\uparrow)$ structure:

$$S_{proton} = \Sigma\, S_{quarks} = \frac{1}{2} - \frac{1}{2} + \frac{1}{2} = \frac{1}{2}$$

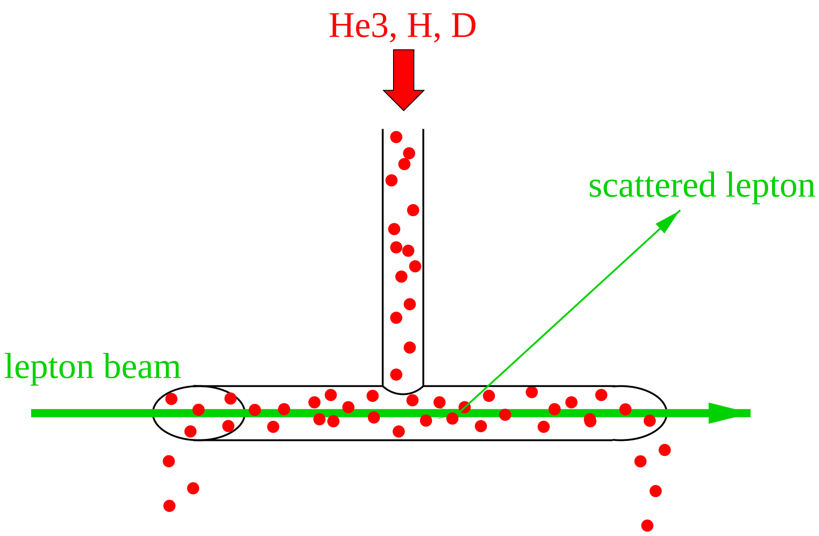
- but we know there is more to it...

Ingredients for the experiment

- Longitudinally polarized lepton beam
  $\sim 40 - 60\%$

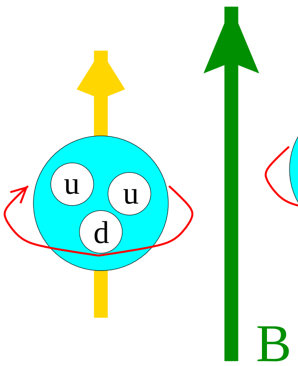


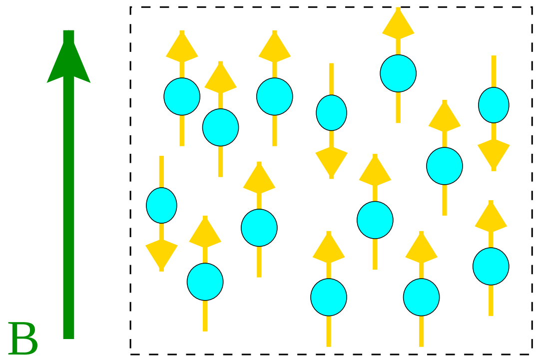
- Polarized internal gas target (H, D, 3He)
  $\sim 80 - 90\%$



Polarization

Given an external magnetic field:

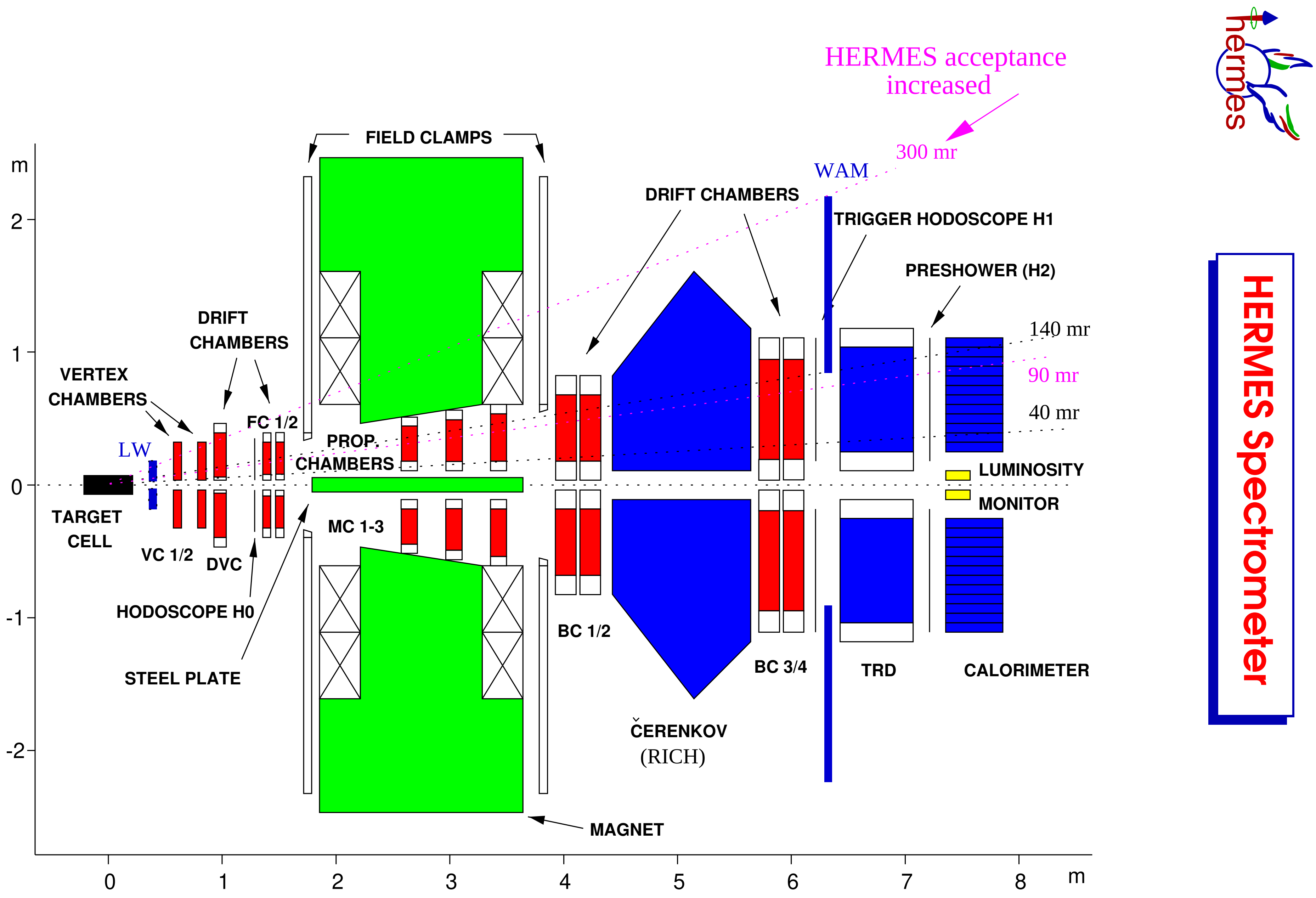




$$P = \frac{N_h^{\overset{\rightarrow}{\Leftarrow}} - N_h^{\overset{\rightarrow}{\Rightarrow}}}{N_h^{\overset{\rightarrow}{\Leftarrow}} + N_h^{\overset{\rightarrow}{\Rightarrow}}}$$

where $\rightarrow$ is the direction of B

and $\Rightarrow$ is the spin direction.



HERMES acceptance
increased
300 mr
WAM
FIELD CLAMPS
DRIFT CHAMBERS
TRIGGER HODOSCOPE H1
PRESHOWER (H2)
140 mr
90 mr
40 mr
DRIFT
CHAMBERS
VERTEX
CHAMBERS
LW
FC 1/2
PROP.
CHAMBERS
LUMINOSITY
MONITOR
TARGET
CELL
VC 1/2
DVC
MC 1-3
HODOSCOPE H0
BC 1/2
STEEL PLATE
BC 3/4
TRD
CALORIMETER
ČERENKOV
(RICH)
MAGNET
m
2
1
0
-1
-2
0
1
2
3
4
5
6
7
8
m
hermes
HERMES Spectrometer

What to do HERMES

2002-2005 Transverse Polarized program

- HARDWARE:
  - New detector development
    - Silicon detector
    - Charm upgrade
  - Tracking challenge with transverse field

- ANALYSIS:
  - First measurement of transverse structure functions
  - Still a lot of longitudinal data to be analyzed!
  - Angular momentum of quarks and gluons...

- UNPOLARIZED PROGRAM:
  - Input measurements for quark-gluon plasma experiments (proton formation time)
  - Nuclear effects on heavy targets: ^{14}N, ^{20}Ne, ^{84}Kr, ^{131}Xe

- THEORY:
  - New ideas always welcome!!!