

Proton, etc. EDM

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Intrinsic EDM

- EDM aligned with spin violates T and P
- Spin precesses in an electric field

$$\frac{\partial \vec{S}}{\partial t} = \vec{d} \times \vec{E} \quad \vec{d} = d \frac{\vec{S}}{S}$$

Orlov EDM Resonance

Modulate velocity with RF at the spin precession frequency

$$\frac{\partial \vec{S}}{\partial t} = \vec{d} \times (c \vec{\beta} \times \vec{B})$$

$$\frac{\partial S_V}{\partial t} = \frac{d S_L c \beta B}{S}$$

Magnetic Moment Precession in Storage Ring Magnetic Field

- ω_c is revolution or “cyclotron frequency”
- Q_{spin} is spin precession per revolution or “spin tune” = $G\gamma$
- Where $G = g/2 - 1$
- $\mu = geS/2m$

$$\frac{\partial(\vec{\beta} \cdot \vec{S})}{\partial t} = \frac{e}{m} G \vec{S}_T \cdot (\vec{\beta} \times \vec{B})$$

$$Q_{\text{syn}} = m \pm G \langle \gamma \rangle$$

	e	p	n	D	He3
S	1/2	1/2	1/2	1	1/2
d (θ_{QCD})	≈ 0	≈ 1	$\approx -2/3$	$\approx 1/3$	$\approx -2/3$
g	2.002	5.586	-3.826	1.715	-4.255
G=g/2-1	.001	1.586	-0.913	-0.143	-1.13
m	NA	2	NA	0	1 or 2

Parameters for $Q_{\text{syn}} = 0.14-0.19$

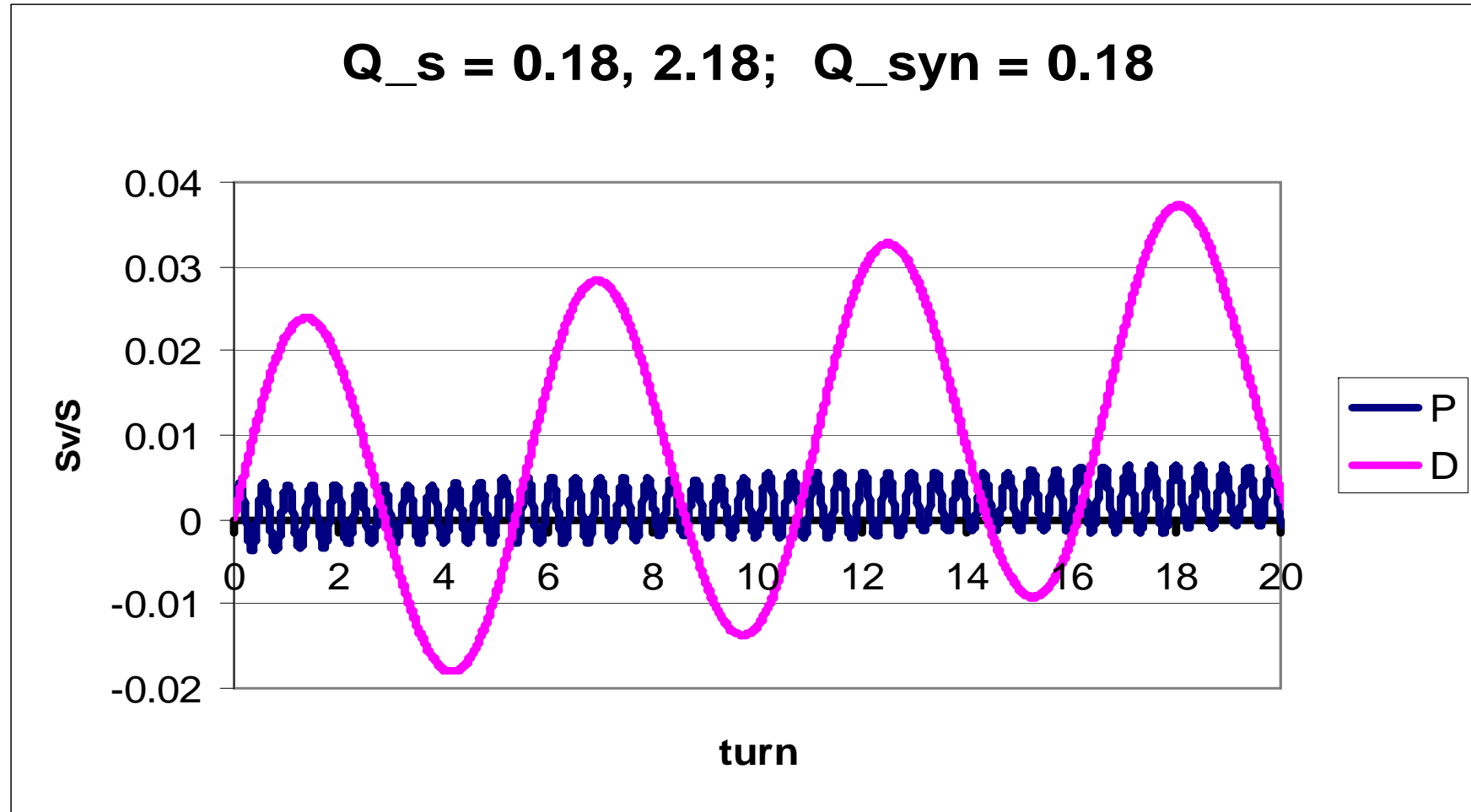
	Proton (m=2)	Deut (m=0)	He3 (m=2)	He3 (m=1)
β	0.67-0.69	0 - 0.66	0.85-0.86	0.13-0.3
P GeV/c	0.85-0.89	0 - 1.6	4.5-4.7	0.4-0.9

Torque due to EDM

$$\frac{\partial \vec{S}}{\partial t} = \vec{d} \times (c \vec{\beta} \times \vec{B})$$

$$\frac{\Delta S_V}{|S|} = \frac{1}{|S|} dc \Delta \beta B T$$

D and P with same B, d, β , $d\beta$, ...
P is $\approx 1/3 \times D$



Same Ring (B, ρ and f_{sync}) Optimized for Both P and D?

D polarimetry has optimum around $\beta \approx 0.6$
 $dE/dx \propto \beta^{-2}$, $E_k \propto \beta^2$

	P (GeV/c)	β	Synchrotron harmonic
D	0.7	0.34	2N
P	0.86	0.68	N

Conclusions

- Can also measure edm of proton with storage ring method
- Physics is complementary to deuteron
- $m = 2$, so less sensitive
- Optimized proton experiment is a different experiment from optimized deuteron exp.
- Reuse much of the ring, but not all