Baryshevsky problem:
What would we predict for the Cologne (or KVI) experiment?
(spontaneous appearance of t_{20} polarization going through a target)

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Acceptance of Cologne experiment = 1/3 º
Typical acceptances are about one degree.

Try this for a 1 cm^3 block of carbon and a deuteron energy of 126 MeV.

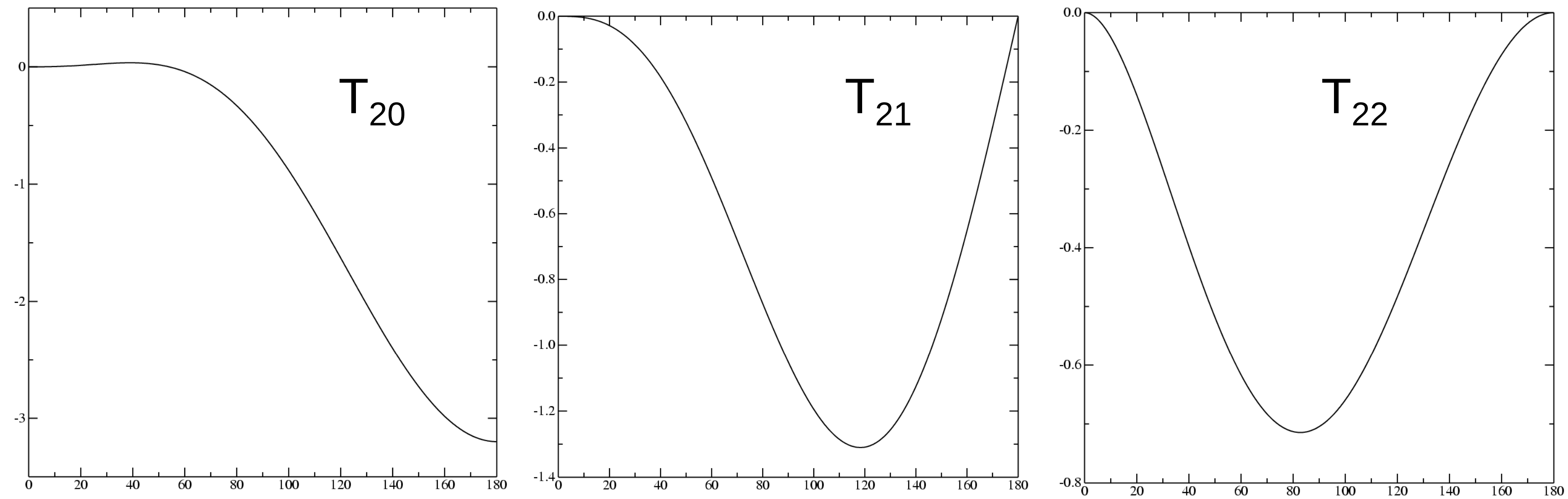
The first calculation involves the static quadrupole moment of the deuteron as it scatters in a Coulomb field. One must couple (QM) small changes to the Coulomb scattering trajectory to reorient the deuteron based on the tensor (T_R) interaction with the field. This calculation is first order in the quadrupole moment.

The interaction is the quadrupole overlapping with the curvature of the Coulomb potential.

(In what appears to be analogous to the fact that the classical and QM formuli for Rutherford scattering are the same, this problem can be solved in closed form, producing a spin-dependent cross section.)

See: Roberts et al. Nucl. Phys. A 584, 362 (95)

pure Coulomb tensor analyzing powers



size is scaled by $\chi = \frac{Q}{8 z_p a^2}$

Q: static quadrupole moment = 2.9×10^{-27} cm^2

a: Coulomb length, half distance to target for point of closest approach in 180º scattering.

Multiply by Coulomb cross section and integrate over acceptance.
This gives induced polarization.

Scatter from carbon nucleus

Small angle approximation yields: $\sigma t_{20} = \frac{Q}{z_p} \frac{3\pi^2}{16} \theta_{\max} = 9.8 \times 10^{-30}\, cm^2$

with maximum angle 1/3 º

To get polarization, divide by appropriate "total" cross section.
Since the Coulomb force is long range, this is size of the atom = 4.3 x 10^{-16} cm^2

But we are no longer in the single scattering limit. This gets multiplied by the number of atoms encountered (~4.8 x 10^{7}) in a 1-cm target.

But multiple scattering dominates at very small angles. A rough estimate yields 1.3º for a 1-cm target. Thus the typical angle is 1.8 x 10^{-4} degrees.

t_{20} = 1.9 x 10^{-9} /1-cm block

What about electrons?

All center-of-mass angles fall within acceptance, so you have to rotate the tensor analyzing powers into the lab frame (T_{20} does not change) and integrate over all angles.

Again, you multiply by the number of atoms along the path and divide by the atomic cross section.

$$t_{20} = 6.2 \times 10^{-6}$$

This is the largest contribution, but it is too small to measure.

Suppose strong interaction mattered maximally, what would that give?

Forward far-side cross section ~ 30 mb/sr. Cologne acceptance ~ 10^{-4} sr. This is single scattering (eff ~ 3×10^{-7}). With usual scaling:

$$|t_{20,max}| = 3.6 \times 10^{-7}$$