November 9, 1999

POSTMORTEM: ^{193}Hg experiment with the gap target (GS120:Aug. 1997)

I have finally come to the conclusion that, in spite of heroic attempts at making a better target and later extracting some useful information out of the measurements we did take, we have to give up.

1. The targets.

There were two targets. Target I, we didn't modify. There were many things wrong with target II.

a. Target II lost its ^{150}Nd layer. We evaporated more at Berkeley.

b. The Nd was deposited on the up stream side of the "stretched" gold foil, so the recoils had to traverse this foil before entering the gap and the gadolinium.

c. The thickness of the gold foil was quoted as being nominally 2 mg/cm^2 instead of the 1 mg/cm^2 that was requested. Several determinations of this thickness were carried out.

- The shift in the SD lines was determined. It yielded an exit velocity of v/c = 1.55% into the gap.
- The energy shift of normal lines in ^{193}Hg and ^{194}Hg was determined resulting in a velocity of v/c = 1.3%.
- The thickness of the gold layer was determined from Rutherford backscattering of α's at 4.0 MeV resulting in a thickness of 2.8 mg/cm^2, in agreeement with a recoil velocity for the Hg ions of v/c = 1.3%.

d. The size of the gap was crudely determined from the shape of the Nd $8^+ \rightarrow 6^+$ line without benefit from Cyril's careful Coulex analysis. Value of 57.6(103) and 71.5(68) microns were obtained for both targets respectively.

2. Range of ions in the gadolinium foil.

The range of a beam of Hg entering the gadolinium with a velocity of v/c = 1.3% is about 1.6 mg/cm^2. Therefore the ions stop in the ferromagnetic layer where they experience a static field.

3. Effect: ϵ

ALL lines that followed a gating line that was both shifted and stopped were analyzed and thus we hoped to measure the precession of the state that immediately follows such a gating transition. Precessions were measured. Results were obtained for the three main bands in ^{193}Hg and ^{194}Hg.

4. Interpretation.

These data can be analyzed assuming:

- the transient field parametrization applies at all velocities down to 0.
- no static hyperfine field.

The above makes NO SENSE.

Since the Hg ions stop in the gadolinium we must consider static field effects. Assume we know the static hyperfine field. It's probably about + 200kG as determined from the literature.

But, since ALL lines following the "state of interest" were analyzed, and they ALL precess in the static hyperfine field, we must know the integrated lifetime of ALL these subsequent states to determine a precession. Furthermore, since essentially we look at the same low energy transitions for all bands analyzed (even though they were gated by different preceding transitions to select the band), the final precession MUST BE THE SAME FOR ALL THREE CASES.

So what we have measured in the end, is the **average** magnetic moment of the four or five lowest-lying states of these Hg isotopes. No wonder the results were indeed the same for all three bands.

In any case, we can't even determine this value with any degree of certainty because we do not know the static field or the lifetimes of the states. We would also have to correct for the transient field effects on the precession occurring before the ions stop, and the transient field at low velocities.

We also analyzed just the line that follows the gate. However,for this case, we don't have enough statistics to determine a precession with any degree of accuracy.

It's all hopeless.

5. Conclusion

We've learnt something: the target is the most important element in these experiments. It's got to be prepared correctly. We must know thicknesses and magnetizations.

Let's move on. Amen.

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