Paper Evaluation and Summary

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Paper: Graner et al. (Limit on AEDM measured at UW, 2016)

- Motivation
  Measuring the electric dipole moment of the ^{199}Hg atom is a test of Physics beyond the standard model and can, if no AEDM is found, constrain theories about the baryon asymmetry in the universe and Supersymmertry. If an AEDM is found, this could be evidence for a violation of CP in strong interactions and may as well could explain today's excess of matter.

- What is the main finding of this paper and why is it important?
  The collaboration measures an upper limit for the atomic EDM in the order of $10^{-30}e$cm which is the most precise measurement at this point.

- Describe at a high level the basic technique used. Try a series of "steps" here if necessary, if there is a sequence to be followed (like a recipe).
  Four stacked vapor cells made of fused silica are filled with a small amount of CO buffer gas and ^{199}Hg and are placed in an external magnetic field. The atoms are transverse polarized and precess. An electric field with 10 kV is applied for the inner two cells. The two outer cells don't have an electric field and are used as a magnetometer. One pump-probe cycle consists of:

  - Pump period (30 s): Utilizing circularly polarized laser light to coherently polarize atoms
  - Equilibration period (20 s):
  - Initial probe period A (20 s): Probe atoms with linear polarized, detuned, and attenuated laser light
  - Free precession period (170 s): Dark period
  - Final probe period B (30 s): Probe atoms again

  The output beams are rotated and separated into the p and s components, each component is measured with an enhanced UV-photodiode.

- Choose an interesting technical aspect of the experiment and describe its relation and importance to the measurement.
  The experiment is built such that very small disturbances in the magnetic local field can be measured. For this, ^{199}Hg atoms in the two outer cells are used as magnetometers. Knowing the exact magnetic field strength in the vapor chambers is crucial to get high precision and to avoid systematical error.

- Pick one systematic uncertainty issue that you find interesting and describe its importance and the author's method of addressing it.
  Leakage current flowing around the vapor cell increase the magnetic field producing a comparable Larmor shift as the AEDM would do. To monitor this, high sensitive ampere meters where connected to the chamber. An upper limit of flown current of 40 fA was set.

- Where did you get lost? Was there anything you did not understand?:

  - Rotating copper plate for syncing laser with Larmor frequency?
  - Why is probing laser detuned and attenuated?
  - Potential feedthrough of the cell motion