**Introduction**

**Why heavy atoms?**
- Precise measurements of atomic properties test state-of-the-art multi-valence-electron ab initio atomic theory
- High-Z atoms enhance size of fundamental physics effects in low-energy systems (~ Z^2)

**Why thallium?**
- Existing and planned symmetry violation, standard-model tests
- Tractable atomic theory: single-valence p-electron
- Two abundant isotopes allows measurement of hyperfine anomaly and isotope shift
- Insight into nuclear structure, short-range wavefunction behavior.
- Substantial errors in HFS measurements (U. Giessen, 1990) have been corrected - motivation to continue this work.

**Basic Plan:**
- Use UV laser excitation to Doppler-shift populations of Tl
- EOM probe laser excites 7S level isotope shift (known), which can be used as reference.
- Lock laser parameters (power, relative polarization, oven temperature...)
- Measuring 7p transition frequencies in a supplementary Tl cell
- AOM sidebands (± 250 MHz) sent to a supplementary Tl cell
- Independent calibration via precise FSR determination

**Related experimental work in our group**

- For a 6p/2 (1 - 3/2), measured dipole and quadrupole HFS constants to be in good agreement with all theory estimates.
- Used 67p/2 indium in experiments for frequency calibration.

**Thallium 7S/2, HFS**
- U. Giessen group first measurement (1998)
- U. Giessen group second measurement (1998)
- M. Gieseler group improved measurement (2000)
- Chou et al. [PRA 66, 052518 (2002)] conform result.

**New Results: Thallium 7p/2, HFS**
- U. Giessen group first measurement (1998)
- Repeat control experiment.
- We had a 2.8 MHz systematic error in each value.

**Experimental setup**

**Laser locking: First step transition**
- Nitrogen red dyes laser (1.4 MHz steps) used for scanning Ti cell
- Differential transmission provides stable locking options
- UV laser was frequency doubled

**Midpoint lock: Dual isotope spectra**
- UV laser excites Doppler-shifted populations of 7S1/2 and 7P3/2

**Single Isotope Spectra: HFS Results**

**Summary of data and analysis**
- 3000 scans collected - wide variety of conditions
- Lock to each isotope individually
- Laser powers, relative polarization, oven temperature...
- Independent calibration via precise FP FSR determination

**Follow-up work:**
- Continue to correct/remeasure Ti HFS values
- Move to Ti 8P3/2 state to test accuracy.
- Requires new 671 nm laser system (building, testing now)
- Using existing analog two-step spectroscopy system.

**Single Isotope Spectra: HFS Results**

- Lock UV laser to 7p transition (or 7p3/2)
- UV chopped, IR signal lock-in detection
- Provides zero-background, high S/N spectra
- Frequency scale linearized via EEP cavity
- Absolute calibration using
- FM sidebands @ 6 MHz

**Precise measurement of 7p 1/2 and 8p 1/2 hyperfine splittings and isotope shift in 203TI and 205TI using two-step laser spectroscopy**

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