Second Harmonic Generation

Chris Corder

Optics Rotation

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Goals of Optics Rotation

- Gain understanding of the optical setup used to achieve the second harmonic generation (SHG)
- Start by making sure the SHG system is working properly
- Move the optical table with the SHG system to a different room
- Get the SHG system running again correcting any problems created by the move

Motivation

- The Rydberg atom experiment requires 389 nm light to create He Rydberg states
- There are no simple lasers that can satisfy this requirement
- This motivates the use of the SHG system

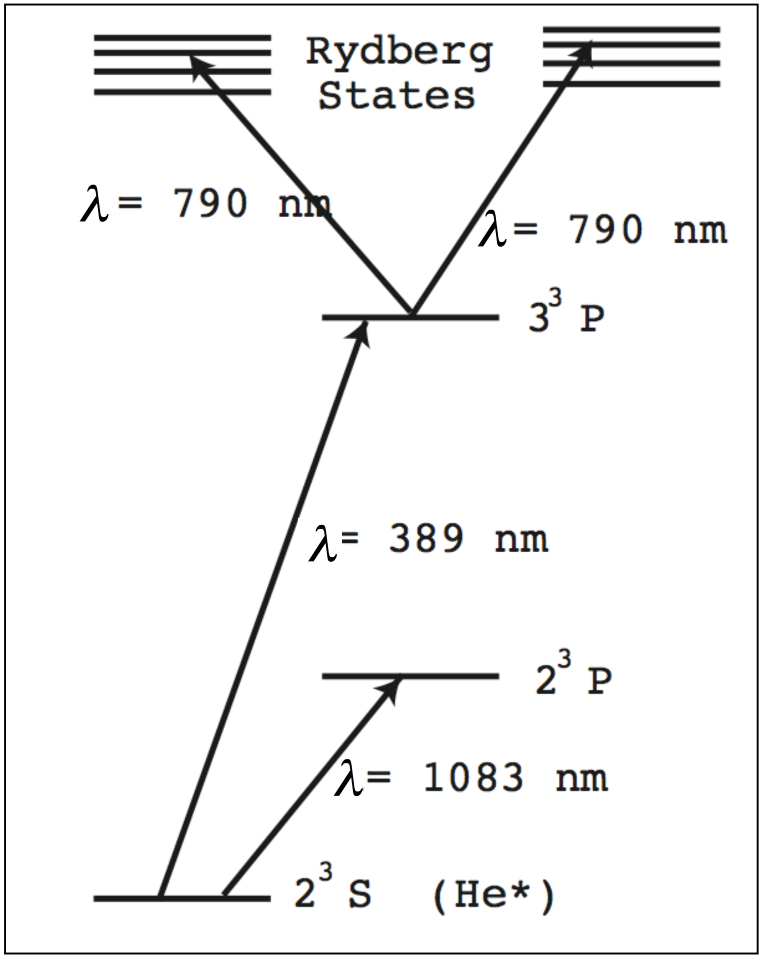


Figure from Hal Metcalf

Laser Systems

- Begins with Verdi V10 with ~10W at 532 nm
- Green light is used to pump the Ti:Sapph producing ~1.5W at 778 nm
- The Ti:Sapph has two locking systems: Fabry Pérot and Saturation Absorption Spectroscopy
- The red light pumps the SHG cavity which is locked to the Ti:Sapph with a Hänsch-Couillaud method producing 389 nm

Second Harmonic Generation

- To create the light SHG is used to double the frequency of light from a Ti:Sapphire laser 778 nm → 389 nm
- A nonlinear LBO (LiB_3O_5) crystal is used to create the second harmonic
- An external SHG cavity is needed to generate the power the experiment requires

SHG Cavity

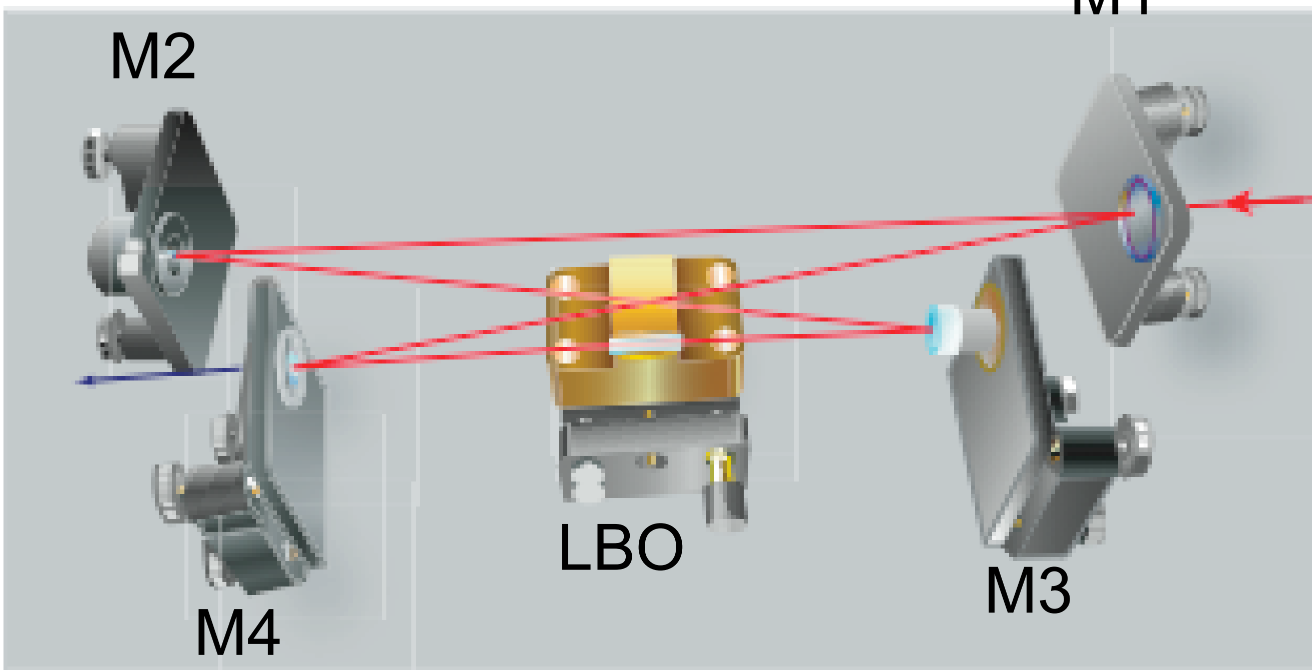


Figure from thesis of Seung Hyun Lee

- M1 has transmission T=1.8~2.4% at 778 nm
- M2, M3, and M4 are coated for high-reflection at 778 nm
- M4 also has a transmission of T>95% at 389 nm
- The cavity needs to be stabilized

Hänsch-Couillaud Locking System

- A $\lambda/2$ is used to rotate the incident beam polarization axis away from the transmission axis of the doubling cavity

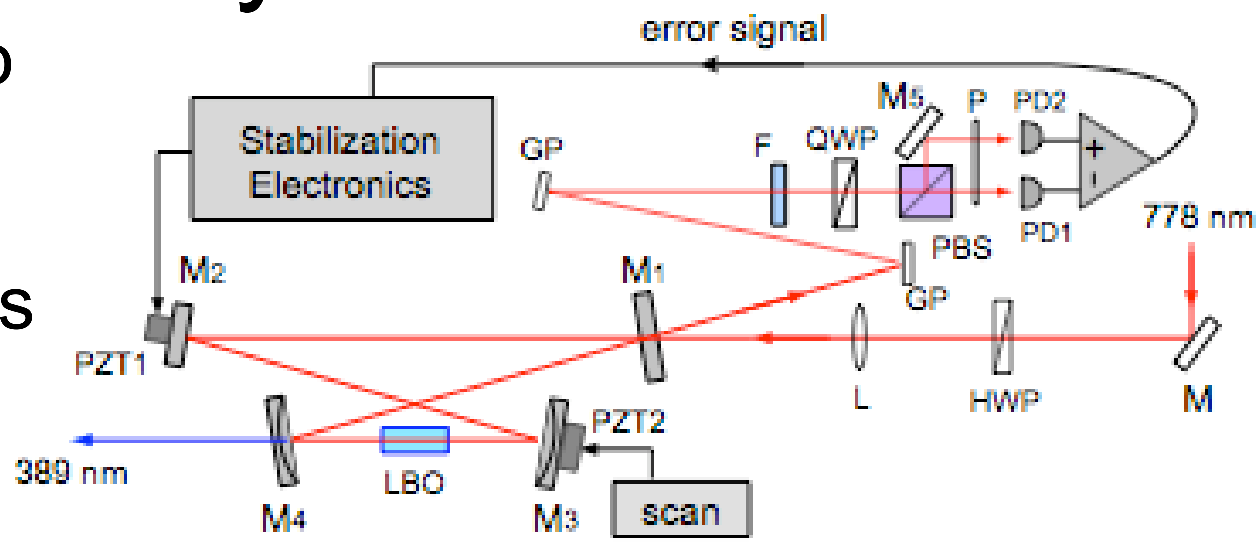


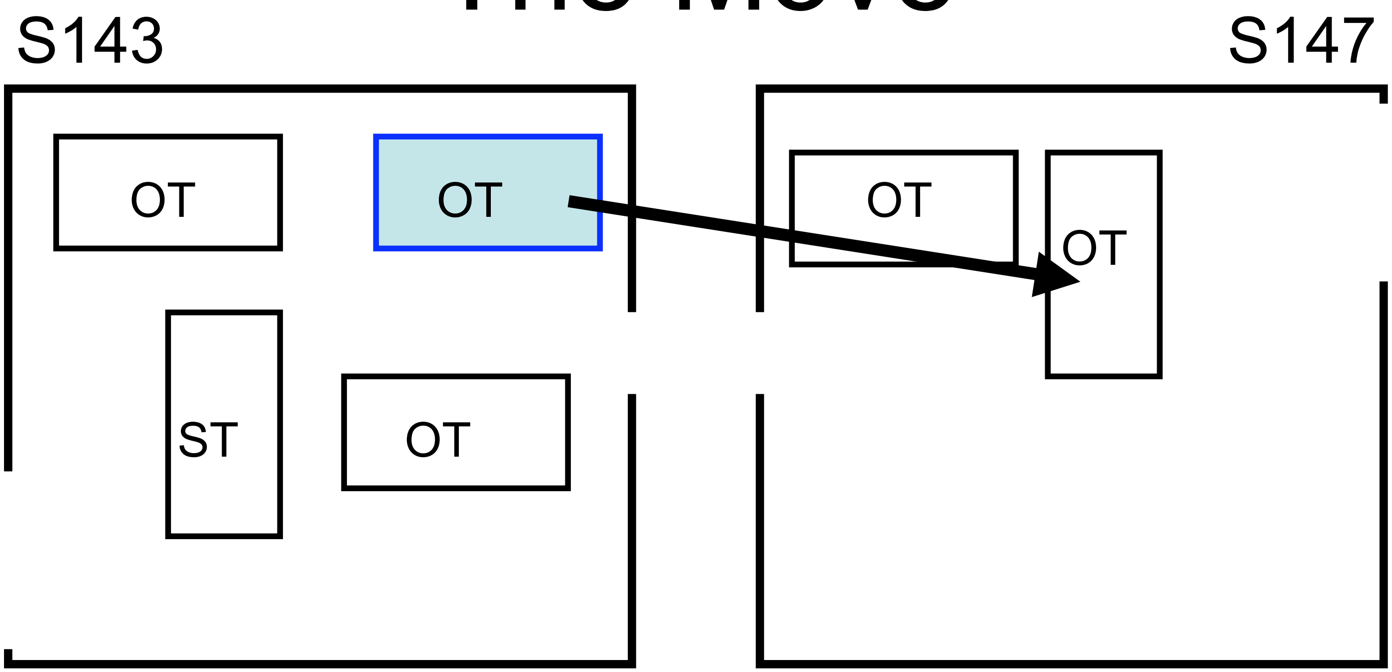
Figure from thesis of Seung Hyun Lee

- The polarization perpendicular to the transmission axis is reflected from M1 and used as a reference
- The parallel component will have a phase shift if the cavity is away from resonance

Hänsch-Couillaud Error Signal

- If the cavity is resonant there will be no reflection of the parallel component giving circularly polarized light out of the $\lambda/4$
- Away from resonance there will be elliptically polarized light from the phase difference between the two polarizations
- The light is split with a PBS cube and the error signal is taken as the difference between the relative intensities of the beams
- The error signal is integrated and amplified and sent to PZT1 to correct the cavity

The Move



- Needed to move the optical table (OT) with the SHG from S143 To S147
- Was complicated by other optical tables as well as a stone table (ST)

Results

- The table was moved to its new position
- As expected, after the move some realignment was needed
- SHG cavity was able to lock producing ~70 mW

Thank You

- A special thanks to Xiaoxu Lu, Jonathan Kaufman, and Hal Metcalf for their help with this project
- Thanks to anybody that helped during the moving of various optical tables and the stone table