EIT Noise Spectroscopy

Anthony Mazzocco  
Dr. Michael Crescimanno
The Basics

What is EIT Noise?

- Electromagnetically Induced Transparency
- “Transparency”
- Noise
Theory

- Two Level System
- Power Broadening
- Resonance

\[ \dot{\rho}_{00} = -\gamma \rho_{00} + iC^* \rho_{01} + c.c \]
\[ \dot{\rho}_{01} = -(i\Delta + \gamma_2)\rho_{01} - iC(1 - 2\rho_{00}) \]
More Theory

- Modeling
- Lorentzian
- Accounting for Noise
A Closer Look
The Experiment

- Laser
- Rubidium Cell
- Fabry-Perot
Raw Data: Off Resonance
Comparison

![Graph showing comparison between two data sets labeled 1 and 2.](image)
Raw Data: Blue Edge (1)

Resonance: Blue Edge
Fabry-Perot Comparison (2)

Fabry-Perot Edge

Noise (mV) vs Time (us)
Analysis

- Difficult form to analyze.
- Easier way?
- RMS!
Off Resonance RMS

Off Resonance RMS

Square of RMS (arb.)

Time (us)
Resonance RMS (1)

Resonance: Blue Edge

Graph showing the square of RMS amplitude over time (us) with peaks indicating resonant behavior.
Resonance RMS (2)
Resonance RMS (3)

Resonance: Bottom

Square of RMS (arb.) vs Time (us)
Comparison
Fabry-Perot Comparison (1)

Fabry-Perot Top

Square of RMS (arb.)

Time (us)
Fabry-Perot Comparison (2)
Fabry-Perot Comparison (3)
<table>
<thead>
<tr>
<th></th>
<th>Square of RMS</th>
<th>RMS</th>
<th>Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off Resonance</td>
<td>4.7240e-7</td>
<td>6.8731e-4</td>
<td>6.850e-9</td>
</tr>
<tr>
<td>Resonance: Blue Edge</td>
<td>3.2682e-5</td>
<td>0.0057</td>
<td>+/- 4.123e-7</td>
</tr>
<tr>
<td>Resonance: Red Edge</td>
<td>2.1449e-5</td>
<td>0.0046</td>
<td>+/- 3.311e-7</td>
</tr>
<tr>
<td>Resonance: Bottom</td>
<td>3.1015e-6</td>
<td>0.0018</td>
<td>+/- 4.725e-8</td>
</tr>
<tr>
<td>Fabry-Perot: Top</td>
<td>1.1487e-7</td>
<td>3.3892e-4</td>
<td>+/- 2.492e-9</td>
</tr>
<tr>
<td>Fabry-Perot: Edge</td>
<td>2.8006e-7</td>
<td>5.2921e-4</td>
<td>+/- 4.894e-9</td>
</tr>
<tr>
<td>Fabry-Perot: Bottom</td>
<td>9.6189e-8</td>
<td>3.1014e-4</td>
<td>+/- 1.536e-9</td>
</tr>
</tbody>
</table>
Conclusions: Laser

- Ratio of peaks to valley.
- Width of laser.
Conclusions: Laser

- Ratio of peaks to valley.
- Width of laser.
Conclusions: Noise

- Noisier on edges.
- Much noisier on resonance.
- Less noise from Fabry-Perot.
References