LASER FARADAY ROTATION IN PLASMAS ON COBRA

Robert Duggan

Professor B. Kusse
Theory

• With a polarized beam propagating parallel to a magnetic field, the polarization angle changes.
• Dispersion for RHCP and LHCP are different due to preferred direction of electron motion

\[ \Delta \varphi = 2.62 \times 10^{-13} \lambda^2 \int n_e \vec{B}(z) \cdot d\vec{z} \quad \text{(mks)} \]

\[
\underbrace{1.59 \times 10^{-25}}
\]

\[ \lambda = 532 \text{ nm} \]
Why do we care?

- Allows B-field measurement without probe in plasma (but we are still limited to the direction of the laser path).

- Gives field data for entire image, not just at localized point.

- Can be effective for loads that set up as 2-dimensional.

- Also lends itself to use with cylindrically symmetric loads.
Diagnostic Setup
Data Analysis

\[ \frac{I_{S \pm}}{I_{B \pm}} = \frac{I_S}{I_B} \frac{\sin^2(\alpha(x, y) \pm \beta)}{\sin^2(\beta)} + \frac{I_{SE}(x, y)}{2I_B \sin^2(\beta)} \]

\[ \alpha(x, y) = \frac{1}{2} \sin^{-1} \left[ \frac{I_B(x, y)}{I_S(x, y)} \left\{ \frac{I_{S+}(x, y)}{I_{B+}(x, y)} - \frac{I_{S-}(x, y)}{I_{B-}(x, y)} \right\} \tan \beta \right] \frac{\tan \beta}{2} \].

- Combine with interferometric density measurements
- Code to be written to perform number crunching
Experimental Setup

- Advantages:
  - Fairly uniform field in x,y,z
  - Good line of site
  - $\frac{dl}{dt}$ reversal $\rightarrow$ significant density between plates

[Image of experimental setup with dimensions 12 mm and 3 mm]
Next Steps

- Collect and process data
- Further improvements/ new test loads to create favorable conditions to observe effect
- Development of data analysis software
- Optimize filters/ attenuators to use full dynamic range of CCDs