FMR Data Processing Application Manual

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INTRODUCTION

This application is designed to help you process FMR data step by step. Each section guides you through a specific part of the analysis process.

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Background Removal

Overview: Background removal is the first step in the FMR data processing. This step helps in eliminating any unwanted noise or background signals from your data.

How to Use:

1. **Load Your S21 Data:** Ensure your data file is ready in a folder.
2. **Run Background Removal:** Click on 'Background Removal' in the first part of the GUI. This will execute the script 'Background_removal.py'.
3. **Check Results:** The processed data will be displayed in the output folder.

Lorentzian Absorption Fit

Overview: Lorentzian absorption fitting is used to model the absorption lines in your FMR data. This step helps in fitting your data to a Lorentzian function. We are fitting the field domain fmr data to Lorentzian function given by:

$$L = -\frac{A}{\pi} \frac{(LW/2)}{[(H - H_{res})^2 + (LW/2)^2]} \tag{1}$$

How to Use:

1. **Load Processed Data:** Use the data obtained after background removal.
2. **Run Lorentzian Fit:** Click on 'Lorentzian Absorption Fit' in the first part of the GUI. This will execute the script 'Lorentzian_Absorption_fit.py'.
3. **Check Fitted Results:** The fitted data will be saved in the output folder, and parameters such as peak positions and widths will be provided.

Skew Lorentzian Absorption Fit

The model function for skew Lorentzian lineshape is given by:

$$L_s(H) = \frac{-A \cdot (LW/2)}{\pi \left[(H - H_{res})^2 + \left[\frac{LW}{2} (1 + \alpha_s (H - H_{res})) \right]^2 \right]} \tag{2}$$

Where α_s is the asymmetry factor, LW is the line-width of FMR spectra. By considering asymmetry we can find out the linewidth more accurately . The derivative of skew Lorentzian function is then given by:

$$\frac{dL_s(H)}{dH} = \frac{-A \cdot LW \left[(H - H_{res})^2 + \frac{LW}{2} (1 + \alpha_s (H - H_{res})) \right]}{\pi \left[(H - H_{res})^2 + \left[\frac{LW}{2} (1 + \alpha_s (H - H_{res})) \right]^2 \right]^2} \tag{3}$$

Derivative Divide Method

Overview: The Derivative Divide Method involves several steps to remove the noise in the FMR signal. This section handles the transformation and fitting of your FMR data. The derivative Lorentzian function is given by:

$$\frac{dL}{dx} = \frac{A \cdot LW \cdot (H - H_{res})}{\pi \left[(H - H_{res})^2 + (LW/2)^2 \right]^2} \tag{4}$$

Steps:

1. **Conversion of Frequency to Field Domain:** Click on 'Conversion of Frequency to Field Domain' in the second part of the GUI. This will execute the script 'conversion_of_freq_to_field_domain.py'.

2. **Run Derivative:** Click on 'Derivative of Field Domain' in the second part of the GUI. This will execute the script 'conversion_to_field_domain_to_ds21_data.py'.

3. **Run Lorentzian Fitting of dS Data:** Click on 'Lorentzian Fitting of dS data' in the second part of the GUI. This will execute the script 'Curve_Fitting_field_domain_ds21_data.py'.

4. **Run Skew Lorentzian Fitting of dS Data:** Click on 'Skew Lorentzian Fitting of dS data' in the second part of the GUI. This will execute the script 'Curve_Fitting_field_domain_ds21_data_to_skew_lorentzian_function.py'.

5. **Run Derivative Spectra:** Click on 'Derivative FMR Spectra' in the second part of the GUI. This will execute the script 'FMR_Spectra.py'.

Magnetic Properties

Overview: This section involves analyzing magnetic properties using Kittel fit, Linewidth fitting, and Asymptotic Analysis of the g-factor.

Steps:

1. **Run Kittel Fit:** Click on 'Kittel Fit' in the third part of the GUI. This will execute the script 'Kittel_fit_from_field_domain_data.py'.

$$f_{res} = \frac{\gamma}{2\pi}\sqrt{\left[H_0 + H_k + M_{eff}\right]\left[H_0 + H_k\right]} \tag{5}$$

2. **Run Linewidth Fitting:** Click on 'Linewidth Fitting' in the third part of the GUI. This will execute the script 'Linewidth_Fit.py'.

$$\mu_0 \Delta H = \mu_0 \Delta H_0 + \left(\frac{4\pi\alpha}{\gamma}\right) f \tag{6}$$

3. **Run Asymptotic Analysis of g Factor:** Click on 'Asymptotic Analysis of g factor' in the third part of the GUI. This will execute the script 'Asymptotic_Analysis_of_g_factor.py'.

Contact Support

If you need any assistance, please contact at:

- **Email**: joshisuraj472@gmail.com
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