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# CHAPTER 1

## SOFTWARE USED FOR THE SPATIAL LIGHT MODULATOR

### 1.1 Phase

*Referenced in Chapter 2*

A GUI for creating and displaying phase masks for a Liquid Crystal on Silicon (LCoS) Spatial Light Modulator (SLM). See directory **Software used for the Spatial Light Modulator**

#### Features

- Can load a multiple image files from a text file or a Hamamatsu .lst file (bitmap images only)
- Phase masks can be modified with Zernike functions (e.g. astigmatism, coma, lens...)
- A bounding box can be selected so the Zernike function is applied only to that area
- Modified masks can be saved for later use or use in other software (bitmap images only)
- The phase function can be displayed on a second monitor to display on the SLM (Windows Only)

## CHAPTER 2

### PYTHON FUNCTIONS USED FOR DATA ANALYSIS

#### 2.1 Common Functions

See `Python Functions for Data Analysis/common_functions.py`

#### 2.2 Functions for Chapter 3

See `Python Functions for Data Analysis/optical_binding_of_driven_nanoparticles.py`

#### 2.3 Functions for Chapter 4

See `Python Functions for Data Analysis/half_nanoplate_functions.py`

#### 2.4 Functions for Chapter 5

See `Python Functions for Data Analysis/passing_event_functions.py`

#### 2.5 Helper Functions for Trackpy Particle Tracking

See `Python Functions for Data Analysis/trackpy_helper_functions.py`

#### 2.6 Helper Functions for Matplotlib

See `Python Functions for Data Analysis/matplotlib_helper_functions.py`

#### 2.7 Particle Tracking Scripts

##### *2.7.1 Gaussian Refinement of Particle Centers*

*Referenced in Chapters 2 and 5*

See `Particle Tracking Scripts/gauss_refine_batch.py`

##### *2.7.2 Linking of Trackpy Trajectories*

See `Particle Tracking Scripts/trackpy_linking_script.py`

## CHAPTER 3

### PYTHON NOTEBOOKS USED FOR DATA ANALYSIS

#### 3.1 Notebooks for Generating Phase Masks and Lookup Tables for the SLM

##### *3.1.1 Extracting the Hamamatsu LUT*

See **Analysis Notebooks/slm\_Ana\_15072301\_Hamamatsu\_LUT\_Generation\_from\_Images.py**

##### *3.1.2 Wavefront Correction from SLM Interferograms*

*Referenced in Chapter 2*

See **Analysis Notebooks/slm\_Ana\_15081301\_SLM\_Wavefront\_Correction.py**

##### *3.1.3 Generate Checkerboard Masks*

See **Analysis Notebooks/slm\_Ana\_07021501\_Generate\_CheckerBoard.py**

##### *3.1.4 GS Algorithm for Optimizing Vortex Beam*

See **Analysis Notebooks/slm\_Ana\_15081801\_GS\_Algorithm\_L1\_vortex.py**

##### *3.1.5 GS Algorithm for Optimizing Vortex Beam*

See **Analysis Notebooks/slm\_Ana\_15082001\_GS\_Algorithm\_Ring.py**

##### *3.1.6 Adaptive-Additive Algorithm for Trapping Arrays*

See **Analysis Notebooks/slm\_Ana\_15101201\_Adaptive-Additive\_Algorithm.py**

#### 3.2 Analysis for Driven Optical Matter (Chapter 3)

##### *3.2.1 Constructing the Database of Trajectories*

See **Analysis Notebooks/ring\_Ana\_15101301\_Add\_Particle\_Data\_to\_HDF5\_Database.py**

##### *3.2.2 Velocity vs Theta Analysis*

See **Analysis Notebooks/ring\_Ana\_16080301\_Velocity\_vs\_Theta.py**

##### *3.2.3 Polar Plot of Velocity vs Theta*

See **Analysis Notebooks/ring\_Ana\_16010501\_Velocity\_Polar\_Plot.py**

### *3.2.4 Nearest Neighbor Separation Grouped by $l$ 's*

See **Analysis Notebooks/ring\_Ana\_15102801\_NN\_Separation\_Grouped\_Ls.py**

### *3.2.5 Creation of Figures for Chapter 3*

See **Analysis Notebooks/ring\_Figs\_15111701.py**

## **3.3 Analysis for Half Nanoplate Experiments (Chapter 4)**

### *3.3.1 Background Subtraction of Nanoplate*

See **Analysis Notebooks/halfnp\_Ana\_16052401\_Background\_Subtraction.py**

### *3.3.2 Cleanup of Trajectories*

See **Analysis Notebooks/halfnp\_Ana\_16053001\_Processed\_Images\_Cleanup.py**

### *3.3.3 Survey of Particle Trajectory Properties*

See **Analysis Notebooks/halfnp\_Ana\_16061201\_Survey\_of\_Analysis\_from\_Database.py**

### *3.3.4 Calculation of Force from Stokes' Law*

See **Analysis Notebooks/halfnp\_Ana\_16101701\_Stoke's\_Force\_Different\_Methods.py**

### *3.3.5 Dudko-Hummer-Szabo Model Fit*

See **Analysis Notebooks/halfnp\_Ana\_16101702\_Hummer\_Szabo\_Fit.py**

### *3.3.6 Particle Distributions Near Barriers*

See **Analysis Notebooks/halfnp\_Ana\_16120101\_Exploring\_Particle\_Positions\_at\_Barrier.py**

### *3.3.7 Determine the Location of Nanoplate Edges Limits*

See **Analysis Notebooks/halfnp\_Ana\_17031302\_Determine\_Location\_Edge\_and\_Spread.py**

### *3.3.8 Determine Barrier Parameters from Derivative of PMF*

See **Analysis Notebooks/halfnp\_Ana\_17032901\_DHS\_fit\_params\_from\_2nd\_Derivative.py**

### *3.3.9 Creation of Figures for Chapter 4*

See **Analysis Notebooks/halfnp\_Figs\_16102501.py**

## 3.4 Analysis for Particle Rearrangements in Driven Optical Matter (Chapter 5)

### *3.4.1 Determining which Particle is in Trap during Passing*

See **Analysis Notebooks/pass\_Ana\_17051001\_Find\_Particle\_in\_Trap\_Passing.py**

### *3.4.2 Scatter Plots of Different Variables of Particle Passing Trajectories*

See **Analysis Notebooks/pass\_Ana\_17041902\_Scatter\_Plots\_Passing\_Data.py**

### *3.4.3 Kinetics of Passing Events*

See **Analysis Notebooks/pass\_Ana\_17050702\_Kinetics\_of\_Trajectories.py**

### *3.4.4 Mean Trajectory of Particle Passing*

See **Analysis Notebooks/pass\_Ana\_17050803\_Mean\_Trajectory\_of\_Passing.py**

### *3.4.5 Optimized Parameters for Trackpy Tracking of Particle Clusters*

*Referenced in Chapter 5*

See **Analysis Notebooks/pass\_Ana\_17041101\_Params\_Trackpy\_Clusters.py**

### *3.4.6 Creation of Figures for Chapter 5*

See **Analysis Notebooks/pass\_Figs\_17050701.py**

## 3.5 Analysis for SPIFF (Chapter 6)

### *3.5.1 SPIFF from Trackpy*

See **Analysis Notebooks/spiff\_Ana\_16041501\_SPIFF\_Dense\_Data.py**

### *3.5.2 SPIFF from Mosaic*

See **Analysis Notebooks/spiff\_Ana\_16042401\_SPIFF\_Mosaic.py**

### *3.5.3 SPIFF from Raghu*

See **Analysis Notebooks/spiff\_Ana\_16042801\_SPIFF\_Raghu.py**

### *3.5.4 Creation of Figures for Chapter 6*

See **Analysis Notebooks/spiff\_Figs\_16051001.py**