READ ME File For 'Dataset for Atomic Scale Dynamics of Thermal and Driven Motion in Photonic Nanostructures'

Dataset DOI: 10.5258/SOTON/D2288

ReadMe Author: Tongjun Liu, University of Southampton ORCID ID: 0000-0003-4931-1734

This dataset supports the Doctoral Thesis:

Tongjun Liu (2023)

Atomic Scale Dynamics of Thermal and Driven Motion in Photonic Nanostructures

AWARDED BY: University of Southampton

DATE OF AWARD: 2023

DESCRIPTION OF THE DATA

The dataset consists of 4 sub-folders containing data presented in Chapters 3, 4, 5 and 6 of the Thesis, respectively.

Each sub-folder contains separate folders with data for each figure in the Thesis. Data files are labelled with the figure number and panel they correspond to as well as a short description.

Chapter3Dataset folder:

File folder Fig. 3.4c: Frequency dispersion of the measured cantilever’s thermal [Brownian] motion transduced to secondary electron signal.

File folder Fig 3.5: Visualizing of cantilever in its second order out-of-plane (OP) mode. Dataset files Fig3\_DC, Fig3\_Phi and Fig3\_R, respectively, represents the mapping of the measured secondary electron in its 0 frequency (in unit of volt), its demodulated amplitude (in unit of volt) mapping at driven frequency and its locked phase mapping.

File folder Fig 3.6: Hyperspectral visualization of driven oscillations of 3 cantilevers with length of 17, 22 and 27μm. Dataset files with ending of DC, Phi, R, respectively, represents the mapping of the measured secondary electron in its 0 frequency (in unit of volt), its demodulated amplitude (in unit of volt) mapping at driven frequency and its locked phase mapping.

File folder Fig 3.7: containing four sub-folders in total. Sub-folder Fig3.7b includes Frequency dispersion of the 15 narrow beams’ thermal [Brownian] motion transduced to secondary electron signal as labelled in the main text corresponding to experimental datasets MMS\_LoStr\_ArrNew\_NB1.txt to MMS\_LoStr\_ArrNew\_NB15.txt. Sub-folders Fig3.7d and Fig3.7e respectively shows SE signal demodulated amplitude (in unit of volt) mapping at driven frequency of 438.2 kHz and 441.6kHz. Sub-folder Fig3.7f includes an SE frequency amplitude spectrum for one of the fingers of a capacitive Si comb within a MEMS accelerometer.

File folder Fig 3.8bcd: Hyperspectral imaging of driven oscillations of flea setae. Dataset files Fig3.8b\_DC, Fig3.8b\_Phi and Fig3.8b\_R, respectively, represents the mapping of the measured secondary electron in its 0 frequency (in unit of volt), its demodulated amplitude (in unit of volt) mapping at driven frequency and its locked phase mapping. Each file contains a matrix of 8790 lines and 1000 columns corresponding to mapping area of 256 micrometres by 256 micrometres. This annotation applies to the other remained text files within this folder.

Chapter4Dataset folder:

Experimental DataFig4.2-4.3 folder: Real time position of cantilever was recorded several times independently at different positions and the data presented in the paper are their statistical results. For displacement calibration: A13: Measured local gradient 8.0mV/nm; A12: Measured local gradient 8.2mV/nm; A11: Measured local gradient 5.6mV/nm

Fig4.4 folder: Real time position of cantilever was recorded several times independently along its horizontal long edge and at its corner.

Chapter5Dataset folder:

Fig5.2a\_Mask1: Binary mask for constructing a cylindric superoscillatory focusing.

Fig5.2b\_electric filed: Calculated complex electric field using angular spectrum method.

Fig5.5 excel file sheet Fig5.5b: Statically measured nanowire position change or the two slits’ width change at a given bias voltage with error bar noted.

Fig5.9: Convolutional neural network predicted nanowire’s position for the unseen scattering patterns.

Fig5.10cd: Simulated intensity and phase profiles of the superoscillatory field in the xz plane.

Fig5.10e: Numerically simulated relative change in scattered superoscillatory light intensity resulting from a λ/1000 displacement of the sample in x-direction along a cross-sectional line through the scattering pattern in the sampling plane as a function of the initial position x0 of the sample relative to the symmetry axis of the light field.

Fig5.10f: Numerically simulated relative change in scattered plane wave light intensity resulting from a λ/1000 displacement of the sample in x-direction along a cross-sectional line through the scattering pattern in the sampling plane as a function of the initial position x0 of the sample relative to the symmetry axis of the light field.

Chapter6Dataset:

Fig6.4c: Experimentally measured optical transmission, reflection and absorption of the fabricated metamaterials sample used in Chapter 6.

Fig6.4d: Numerically calculated optical transmission, reflection and absorption of the fabricated metamaterials sample used in Chapter 6.

Fig6.4e: Numerically calculated out-of-plane optical force with metamaterials sample used in Chapter 6.

Fig6.5a: Numerically calculated metamaterial’s optical properties to the relative displacement of neighbouring beams along z at different levels of displacement.

Fig6.5b: Relative change of the optical transmittance on displacement at the wavelength of 1550 nm.

Fig6.6b: Experimentally measured thermomechanical fluctuation of the metamaterials’ optical transmittance.

Fig6.9: Experimentally measured evolution of the probe transmission spectra [calibrated into displacement power spectral density] with increasing pump laser intensity modulation depth.

Fig6.10: Experimentally measured evolution of the probe transmission spectra [calibrated into displacement power spectral density] with growing parametric pumping frequency.

Fig6.11a: Experimentally measured thermomechanical displacement power spectral density evolution as a function of growing parametric pumping strength while keeping its frequency fixed.

Fig6.11b: Experimentally measured data for the tunable frequency comb generated by tuning parametric pumping frequency or comb separation while keeping the instantaneous optical force driving fixed at mechanical resonance frequency.

Fig6.12c: Experimental measured thermomechanical spectrum evolves with increasing parametric pumping strength at fixed parametric pumping frequency.

Fig6.12d: Experimental measured Spectra evolution with increased parametric pumping frequency while keeping the laser modulation depth fixed.

Data can be viewed using Excel plots, MATLAB plots

Geographic location of data collection: University of Southampton, U.K.

Date of data collection: 2018-2022

Related Funders:

Engineering and Physical Sciences Research Council (EPSRC)

Chinese Scholarship Council (CSC)

Date that the file was created: January, 2023