

# Data set for Topological triple phase transition in non-Hermitian Floquet quasicrystals

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## 1 General Information

Dataset title	Topological triple phase transition in non-Hermitian Floquet quasicrystals
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## 2 Description

This document serves as a guideline for the data repository of the publication [1]. The guideline concerns the acquisition and processing of measurement data as well as information about the deposited files.

## 3 Data Acquisition

The provided experimental data is obtained by time-resolved measurements of light pulse intensities within the coupled optical fiber loops. The pulse intensities have been measured with a photodiode (Thorlabs DET01CFC). The output voltages of the photodiodes are amplified with a logarithmic amplifier (FEMTO HLVA-100) and then sampled by an oscilloscope (RS RTO1104). After reversing the logarithmic scaling and adjusting the zero-voltage baseline, the voltage values are saved in the respective text files. When required, data is accompanied by separate noise measurements, which stem from measuring the temporal evolution of optical noise without the excitation pulse. The noise data is subtracted and an intensity discrimination is applied such that the minimum accepted signal to noise ratio is, depending on the optical noise, at least 1.2 but in most instances 3 or better. Calibration data is provided for obtaining the the time scales of the system and for correct normalizing of the overall optical power. By comparing the power calibration data to the theoretical predictions of the calibration measurement, one obtains the adjustment factor for the overall power

and for the different detection between the u and v loop. Only for the interface measurements, no extra power calibration is required, and only light intensities in the shorter fiber loop used after they are normalized to the maximum value in each time step.

With the characteristic time scales  $dt$  and  $T$  of the fiber loop arrangement, one can map the sampled voltage signals onto the discrete two-dimensional grid  $(m,n)$ , which contains the intensities for the respective propagation steps  $m$  and lattice position  $n$ . The data is then processed as described in publication [1].

## 4 File Format

The data is provided in an ASCII format file, using the delimiter (,) to separate array elements. For example, individual data files can be read out with MATLAB via the command `dmlread('filename')` or `load('filename')`.

## 5 Archive Structure

### Hermitian Localization Transition

Filename	Description
CouplingValues_beta_H.txt	Contains the fourteen different coupling values $\beta$ of the experiments.
LocTransH_1_u.txt, LocTransH_1_v.txt, ... LocTransH_14_u.txt, LocTransH_14_v.txt	Sampling of the logarithmic photodiode voltages of the u-loop and v-loop, respectively. This data contains the light propagation in the Hermitian Floquet AAH lattices with different coupling values. The filename number counts the corresponding coupling value $\beta$ .
LocTransH_PowerCalib_1_u.txt, LocTransH_PowerCalib_1_v.txt, ... LocTransH_PowerCalib_14_u.txt, LocTransH_PowerCalib_14_v.txt	Sampling of the logarithmic photodiode voltages of the u-loop and v-loop, respectively. For each coupling value, a homogeneous system without any modulation is chosen for the power calibration. The number in the filename counts the corresponding coupling value $\beta$ .
LocTransH_TimeCalib_u.txt, LocTransH_TimeCalib_v.txt	Sampling of the logarithmic photodiode voltages of the u-loop and v-loop, respectively. A homogeneous system with symmetric coupling is chosen for the time scale calibration.

### Floquet Hofstadter Butterfly

Filename	Description
Butterfly_1_u.txt, Butterfly_1_v.txt, ... Butterfly_200_u.txt, Butterfly_200_v.txt	Sampling of the logarithmic photodiode voltages of the u-loop and v-loop, respectively. This data contains the light propagation for the different phase gradients in the Hermitian Floquet AAH lattice at symmetric coupling. The filename number counts the corresponding phase gradient.
Butterfly_PowerCalib_u.txt, Butterfly_PowerCalib_v.txt	Sampling of the logarithmic photodiode voltages of the u-loop and v-loop, respectively. A homogeneous system without any modulation is chosen for the power calibration.
Butterfly_TimeCalib_u.txt, Butterfly_TimeCalib_v.txt	Sampling of the logarithmic photodiode voltages of the u-loop and v-loop, respectively. A homogeneous system with symmetric coupling is chosen for the time scale calibration.

## Non-Hermitian Localization and Energy Transition

Filename	Description
CouplingValues_beta_NH.txt	Contains the thirteen different coupling values $\beta$ of the experiments.
LocTransNH_1_u.txt, LocTransNH_1_v.txt, ... LocTransNH_13_u.txt, LocTransNH_13_v.txt	Sampling of the logarithmic photodiode voltages of the u-loop and v-loop, respectively. This data contains the light propagation in the non-Hermitian Floquet AAH lattices with different coupling values. The filename number counts the corresponding coupling value $\beta$ .
LocTransNH_PowerCalib_1_u.txt, LocTransNH_PowerCalib_1_v.txt, ... LocTransNH_PowerCalib_13_u.txt, LocTransNH_PowerCalib_13_v.txt	Sampling of the logarithmic photodiode voltages of the u-loop and v-loop, respectively. For each coupling value, a homogeneous system without any modulation is chosen for the power calibration. The number in the filename counts the corresponding coupling value $\beta$ .
LocTransNH_PowerCalibII_1_u.txt, LocTransNH_PowerCalibII_1_v.txt, ... LocTransNH_PowerCalibII_13_u.txt, LocTransNH_PowerCalibII_13_v.txt	Sampling of the logarithmic photodiode voltages of the u-loop and v-loop, respectively. For each coupling value, a homogeneous system without any modulation is chosen for the second power calibration. In contrast to the first power calibration, this data allows to extract the power growth in the broken PT phase (see publication [1] for details). The number in the filename counts the corresponding coupling value $\beta$ .
LocTransNH_TimeCalib_u.txt, LocTransNH_TimeCalib_v.txt	Sampling of the logarithmic photodiode voltages of the u-loop and v-loop, respectively. A homogeneous system with symmetric coupling is chosen for the time scale calibration.

## Non-Hermitian Trivial and Topological Interfaces

Filename	Description
CouplingValues_beta_LHS.txt CouplingValues_beta_RHS.txt	Contains the different coupling values $\beta$ on the left-hand side (LHS) and right-hand side (RHS) of the interface.
Interface_exp_1_u.txt, Interface_noise_1_u.txt ... Interface_exp_6_u.txt, Interface_noise_6_u.txt	Sampling of the logarithmic photodiode voltages of the u-loop. This data contains the light propagation in two different non-Hermitian Floquet AAH lattices that interface. The filename number counts the respective setting of coupling values. An additional noise measurement is added.
Interface_TimeCalib_u.txt, Interface_TimeCalib_v.txt	Sampling of the logarithmic photodiode voltages of the u-loop and v-loop, respectively. A homogeneous system with symmetric coupling is chosen for the time scale calibration.

## 6 References

- [1] Weidemann, S., Kremer, M., Longhi, S. & Szameit, A. Topological triple phase transition in non-Hermitian Floquet quasicrystals. *Nature* **601**, 354-359 (2022).