Analysis of 2D concentric

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1 Analysis of the 2D concentric rings structure

The second-order dispersion D_2 of the supermodes are analyzed based on data files

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[98]:
```
import numpy as np
import pandas as pd
import re
from Functions import *
```

1.1 Load data files using pandas

[99]:
```
# These CSV files are generated by the "Data_analyzer" class, recording the␣
 ↪dispersion at different wavelengths
filename_D_iso      = "./results/2D concentric rings/Supermodes attributes␣
 ↪using CMT/Dispersion_isolated_WG.csv"
filename_D_coupled  = "./results/2D concentric rings/Supermodes attributes␣
 ↪using CMT/Dispersion_coupled_WG.csv"
```

[100]:
```
df_iso      = pd.read_csv(filename_D_iso)
df_coupled  = pd.read_csv(filename_D_coupled)
```

[101]:
```
# Selecting the range of the gap to be plotted
gap_range = (2.5,3.5)
```

[102]:
```
gap_arr = []
data_arr = []
AD_range_list = []
```

[103]:
```
fold_num = 10           # make a wavl tick every 10 wavl points
wavl_arr        = df_coupled["wavl"]
num_of_wavl_pts = len(wavl_arr)
wavl_ticks      = np.arange(0,num_of_wavl_pts,int(num_of_wavl_pts/fold_num))
wavl_labels     = ["{:.3f}".format(wavl_arr[idx]) for idx in wavl_ticks]
```

[104]:
```
# Regular expression to match the column names
pattern = r'^(\w+)\(\s*(-?\d+\.?\d*)\s*,\s*(-?\d+\.?\d*)\s*\)$'
for column in df_coupled.columns[1:]:
    match = re.match(pattern, column)
    if match:
        label = match.group(1)
        gapx = float(match.group(2))  #
        gapy = float(match.group(3))
    else:
        print("No match for " + label)
        continue
    gap = np.sqrt(gapx**2 + gapy**2)
    if gap < min(gap_range) or gap > max(gap_range):
        continue
    gap_arr.append(gap)
    data_arr.append(df_coupled[column])

data_arr = np.array(data_arr)
```

[105]:
```
# Find the zero dispersion points
data_arr_zero_loc_list = []
for i in range(np.shape(data_arr)[0]):
    line = data_arr[i,:]
    min_zero_idx = len(line)
    max_zero_idx = 0
    for j in range(len(line)-1):
        if line[j] * line[j+1] < 0:
            if j<=min_zero_idx:
                min_zero_idx = j
            if j>=max_zero_idx:
                max_zero_idx = j
            data_arr_zero_loc_list.append([j,i])
    AD_range_list.append([gap_arr[i], max_zero_idx-min_zero_idx,])

AD_range_list = np.array(AD_range_list)
data_arr_zero_loc_list = np.array(data_arr_zero_loc_list)
```

1.2 Finding the gap which can bring the largest Anomalous Dispersion range

[106]:
```
# format: [gap (unit: um), Anomalous Dispersion range (unit: wavl pts)]
AD_range_list
```

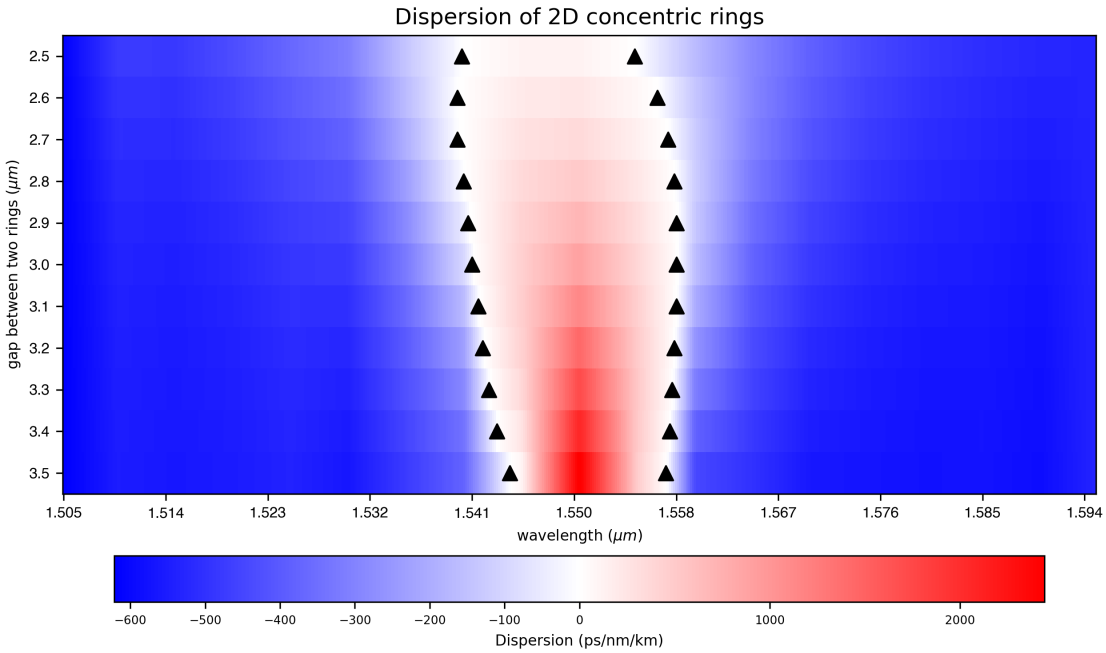
[106]:
```
array([[  2.5,  83. ],
       [  2.6,  96. ],
       [  2.7, 101. ],
       [  2.8, 101. ],
       [  2.9, 100. ],
```

```
       [  3. ,  98. ],
       [  3.1,  95. ],
       [  3.2,  92. ],
       [  3.3,  88. ],
       [  3.4,  83. ],
       [  3.5,  75. ]])
```

[107]:
```
best_gap, best_AD_range = AD_range_list[np.argmax(AD_range_list[:,1]),:]
best_AD_range_in_nm =  (np.max(wavl_arr) - np.min(wavl_arr))/len(wavl_arr) *␣
 ↪best_AD_range * 1e3
print("best gap: {:.2f} um".format(best_gap))
print("best AD range: {:.2f} nm".format(best_AD_range_in_nm))
```

```
best gap: 2.70 um
best AD range: 18.18 nm
```

[108]:
```
param_dict = {
        "figsize"       : [8,8],
        "point_color"   : 'black',
        "point_size"    : 60,
        # "point_marker"  : ".",
        "point_marker"  : "^",
        "norm"          : 'zero_in_center',
        "colormap"      : "bwr",
        "aspect"        : 20,
        "xlabel"        : r"wavelength ($\mu m$)",
        "ylabel"        : r"gap between two rings ($\mu m$)",
        "cbar_label"    : r"Dispersion (ps/nm/km)",
        "cbar_small_ticks" : False,
        "figsize"       : (10,6),
        "title"         : "Dispersion of 2D concentric rings",
        "xticks"        : wavl_ticks,
        "yticks"        : np.arange(0,len(gap_arr),1),
        "xtickslabel"   : wavl_labels,
        "ytickslabel"   : gap_arr,
        "fontsize"      : 8,
        "foldername"    : "./results/"
}
Plot_im(data_arr, point_arr = data_arr_zero_loc_list, **param_dict)
```


Dispersion of 2D concentric rings
gap between two rings (μm)
2.5
2.6
2.7
2.8
2.9
3.0
3.1
3.2
3.3
3.4
3.5
1.505
1.514
1.523
1.532
1.541
1.550
1.558
1.567
1.576
1.585
1.594
wavelength (μm)
−600
−500
−400
−300
−200
−100
0
1000
2000
Dispersion (ps/nm/km)