Topological Defect Cavity in Linearly Approximated Ring Resonator

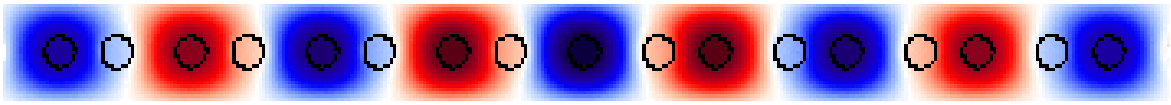
Dimerized Lattice
(Report)

Erin Stigall
Jeffrey Morais

Table of Contents

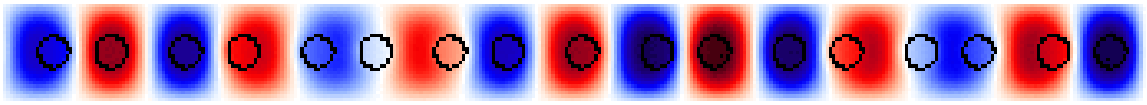
Coupled Cavity Modes

First Cavity Mode



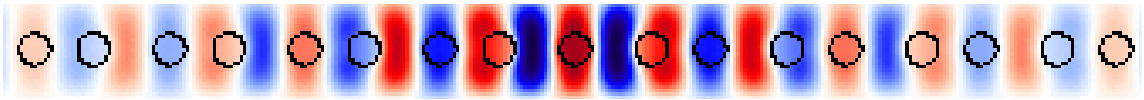
Fcen: 0.143880840001
Df: 0.01
Resolution: 20
Detected Frequencies, Quality Factors, Amplitudes:
{0.143810939048/-3586..96/5.087}
{0.144030156815/60.50/0.2599}
Comments/Errors: None

Second Cavity Mode



Fcen: 0.200000000000
Df: 0.005
Resolution: 20
Detected Frequencies, Quality Factors, Amplitudes:
{0.199396105851/-160.99/0.1017}
{0.200991509668/-171.71/0.0737}
Comments/Errors: None

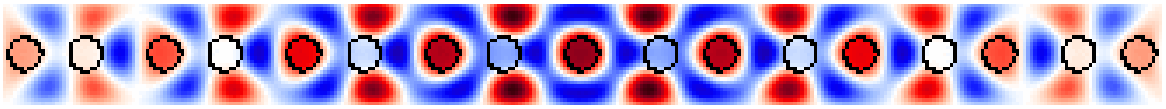
Third Cavity Mode



Fcen: 0.311600000000
Df: 0.008
Resolution: 20
Detected Frequencies, Quality Factors, Amplitudes:
{0.310374417972/848.16/0.0089}
{0.311615003856/299.37/2.8453}

Comments/Errors: None

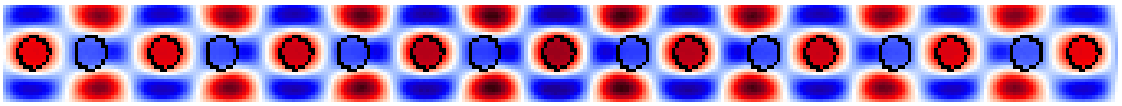
Fourth Cavity Mode



Fcen: 0.380000000000
Df: 0.05
Resolution: 20
Detected Frequencies, Quality Factors, Amplitudes:
{0.380334670727/1115.57/0.0211}
{0.383706672126/1163.52/0.7756}
{0.38602495445/950.70/1.0899}
Comments/Errors: None

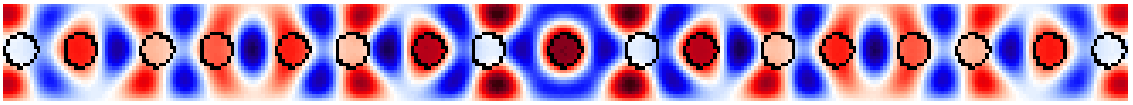
Isolated Cavity Modes

Fourth Cavity Mode (½)



Fcen: 0.383713333583
Df: 0.002
Resolution: 20
Detected Frequency, Quality Factors, Amplitudes:
{0.383715719639/**129308.77**/17.0588}
Comments/Errors: Decent quality factor

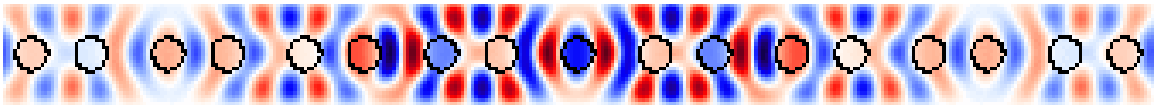
Fourth Cavity Mode (2/2)



Fcen: 0.38602495445
Df: 0.002
Resolution: 20
Detected Frequency, Quality Factors, Amplitudes:
{0.386006873213/2676.87/9.2515}

Comments/Errors: None

Fifth Cavity Mode

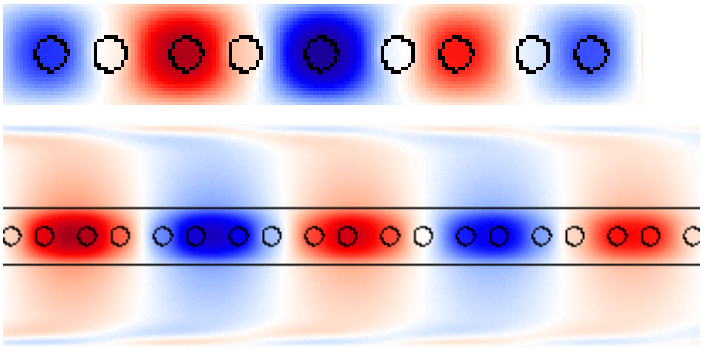


Fcen: 0.542059775082
Df: 0.0024
Resolution: 20
Detected Frequency, Quality Factors, Amplitudes:
{0.542064236699/2950.24/11.6464}
Comments/Errors: Although from the results state it is the fifth mode, based on the larger than normal gap from the fourth cavity mode, it is suspected that the mode is the sixth cavity mode. Also notice how the higher order modes have no issues in being isolated, which will differ when dealing with lower modes in the next section.

Anomalies in Isolated Cavity Modes

Hypothesis: Lower order modes require at least another frequency, no matter how little the amplitude, so that the standing wave can be localized at the center.

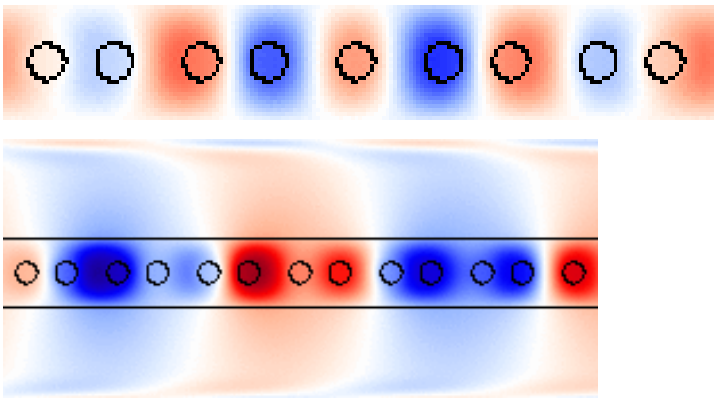
First Cavity Mode



Fcen: 0.143810939048
Df: 0.0016
Resolution: 20
Detected Frequency, Quality Factors, Amplitudes:
{0.14382268053/-3845.73/**49.9267**}

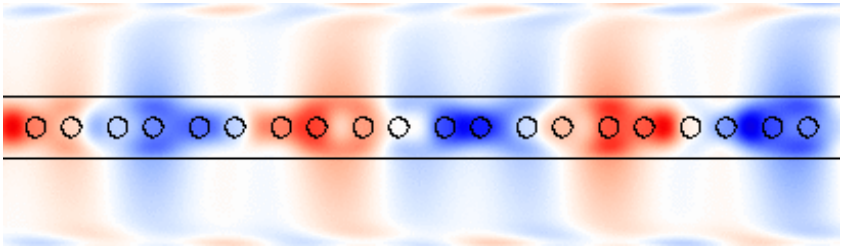
Comments/Errors: The first image is centered on the defect itself whereas the second image is centered at the left edge of the lattice. The right end is the same. Although removing other frequencies with negligible amplitudes in theory shouldn't affect the standing wave produced by the isolated mode, which can be seen in the previous section with higher order modes, the cavity mode was delocalized with a lot of the amplitude leaking through the lattice at the edges. The darkened packets at the edges slide outward without any regard for the lattice.

Second Cavity Mode



Fcen: 0.20035362473
Df: 0.002
Resolution: 20
Detected Frequency, Quality Factors, Amplitudes:
{0.200467161157/-3181.24/0.1989}
Comments/Errors: The anomaly is similar to the first isolated cavity mode, although at the center the standing wave is more faded than the original coupled mode, and the packets at the edges jump from group of holes instead of passing through them.

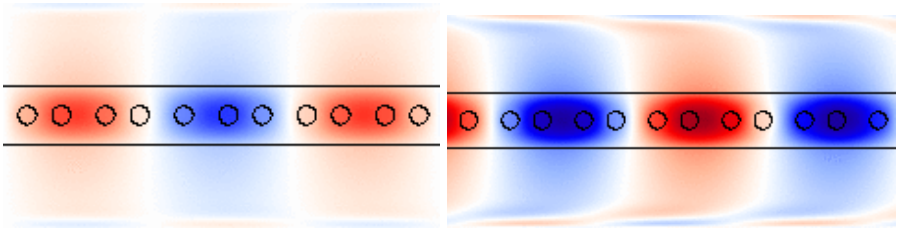
Third Cavity Mode



Fcen: 0.31037441972

Df: 0.0022
Resolution: 20
Detected Frequency, Quality Factors, Amplitudes:
{0.310419018409/654.98/0.0086}
Comments/Errors: There is absolutely no light at the defect or the surrounding lattice structures. The removal of one of the frequencies that had a negligible amplitude in the coupled mode caused a significant drop in the quality factor and amplitude, and focused all the light to the edges where there is a high amount of leaking light.

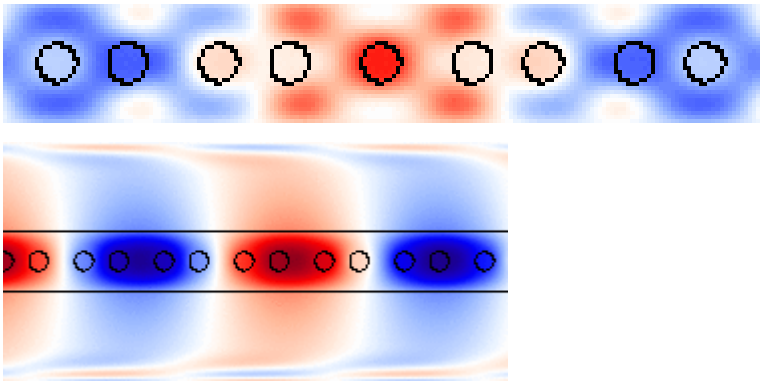
Stationary Mode



Fcen: 0.588468828044
Df: 0.002
Resolution: 20
Detected Frequency, Quality Factors, Amplitudes:
{0.589375716351/461.16/0.0004}
Comments/Errors: Although having a very small amplitude, the light is still pronounced at the center and edges. The light does not move, or flash like it would in a standing wave, instead it darkens and then fades slightly as the gif resets the set of images.

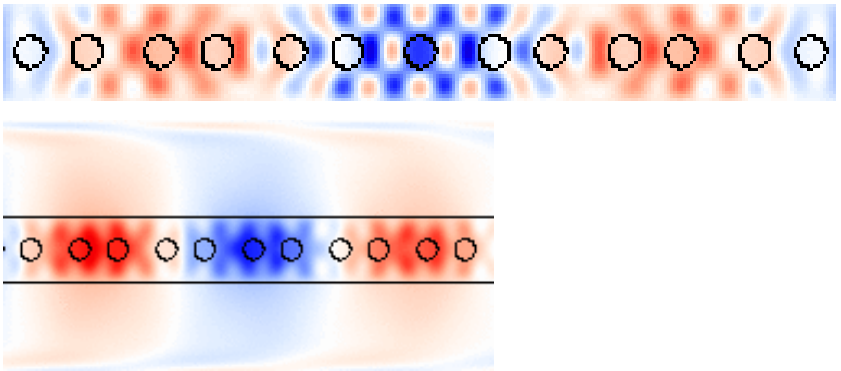
Chaotic Topological Modes

High Quality Factor Leaky Mode



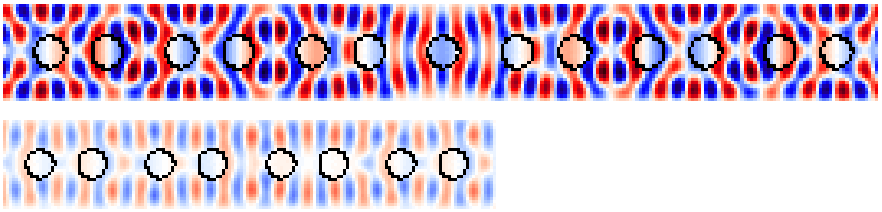
Fcen: 0.383713333583
Df: 0.0015
Resolution: 20
Detected Frequency, Quality Factors, Amplitudes:
{0.383715504677/**2376954.80**/22.6175}
Comments/Errors: The after sources runtime was changed from the default value of 400 to 600.

Flickering Cavity Mode



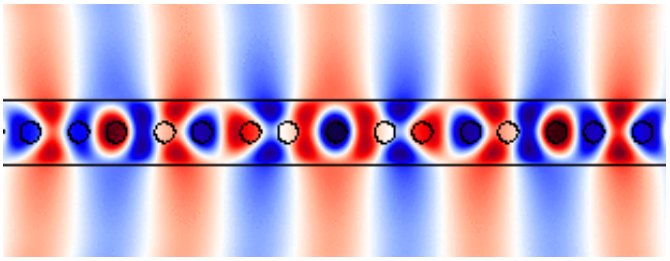
Fcen: 0.588468828044
Df: 0.0025
Resolution: 20
Detected Frequency, Quality Factors, Amplitudes:
{0.588025851833/307.35/0.0006}
{0.589259756963/655.80/0.0002}
Comments/Errors: Instead of flashing between colours like in a regular standing wave, the mode flickers briefly and keeps the same colour.

Higher Order Topological Mode



Fcen: 0.800000000000
Df: 0.05
Resolution: 20
Detected Frequency, Quality Factors, Amplitudes:
{0.785601489422/229.37/0.0011}
{0.785601489422/-152.49/2.0830}
{0.809409808586/208.57/0.0109}
{0.8146372449482/**-20750.46**/0.0136}
{0.815342086385/1155.66/0.0108}
Comments/Errors: The first image is at the defect in the dimerized lattice although the intensity is not dispersed through the defect. The second image is some propagation at the sides. What is most noticeable is the highly negative quality factor of the fourth detected frequency.

Leaky Cavity Mode



Fcen: 0.287761680000
Df: 0.01
Resolution: 20
Detected Frequency, Quality Factors, Amplitudes:
{0.285510053245/-89.98/0.0017}
{0.286526246084/-72.13/0.0030}
{0.288965424199/-56.67/0.0011}
Comments/Errors: Although it is a leaky mode, instead of having the outside intensity of light propagate along the lattice, the leaking seems to be an

extension to the flashing standing wave, in that it doesn’t move in any direction which would suggest leakage, it only flashes.