3D FMM Photonic Crystal Membrane: Band Diagram Convergence and Computation Times

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# Lecamp2007 (PRL)-Structure and Results







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Investigated convergence parameters:

- Lateral Fourier truncation parameter,  $l_x$
- Vertical Fourier truncation parameter,  $l_y$
- Staircase approximation parameter,  $N_{
  m S}$
- Sub- and superstrate heights,  $h_{\rm SS}$

Non-investigated convergence parameters:

- ► Lateral computation domain size, N<sub>Holes</sub>
- All PML-parameters (no PML used here)

s = 0 nm. Vary  $l_x$ ,  $l_y = 10$ .  $\overline{N_{\rm S}} = 33$ .  $h_{\rm SS}/h_{\rm Membrane} = 3$ 



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s=0 nm. Vary  $l_x$ ,  $l_y=10$ .  $\overline{N_{
m S}}=33$ .  $h_{
m SS}/h_{
m Membrane}=1.5$ 



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# s = 0 nm. $l_x = 15$ . Vary $l_y$ . $N_{\rm S} = 33$ . $h_{\rm SS}/h_{\rm Membrane} = 3$



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s = 0 nm.  $l_x = 10$ .  $l_y = 10$ . Vary N<sub>S</sub>.  $h_{SS}/h_{Membrane} = 3$ 



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s = 40 nm. Vary  $l_x$ .  $l_y = 10$ .  $N_{\rm S} = 33$ .  $h_{\rm SS}/h_{\rm Membrane} = 3$ 



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s = 40 nm. Vary  $l_x$ .  $l_y = 10$ .  $N_{\rm S} = 33$ .  $h_{\rm SS}/h_{\rm Membrane} = 3$ 



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# Cluster Computation Times (s = 0 nm)

- Band diagram computed at 100 frequencies
- Computations run on XeonE5-2665 machines (64 GB RAM, Octocore)
- Computation times:

$l_x$	$l_y$	$N_{\rm S}$	Time [h]	Time Per Freq. [min]
10	10	33	12	7
15	10	33	38	23
20	10	33	90	54
10	10	65	23	14
10	10	129	74	44
15	12	33	63	38
15	14	33	110	66

# Convergence in Lecamp2007a (Opt. Express)



"...Typical CPU times for the computation of R in Fig. 6(a) with (my/mx)=(15/15), (25/20) and (20/35) are approximately 30 min, 300 min and 900 min on a PhC computer equipped with a 3-GHz Intel Pentium 4 processor and with Matlab."



- Check s = 40 nm computations; why not qualitative agreement with Lecamp 2007 (PRL)-result?
- Proceed with  $N_{\rm S} = 17$  and  $l_y = 10$ .
- Exploit spatial symmetries (see references)?
- Exploit Redheffer scattering matrix product?