

# Nested Iterations for the Overlap Dirac Operator

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# Outline

1. Approximating the matrix sign function
2. Relaxation of iterative methods
3. Recursive preconditioning
4. Some numerical results

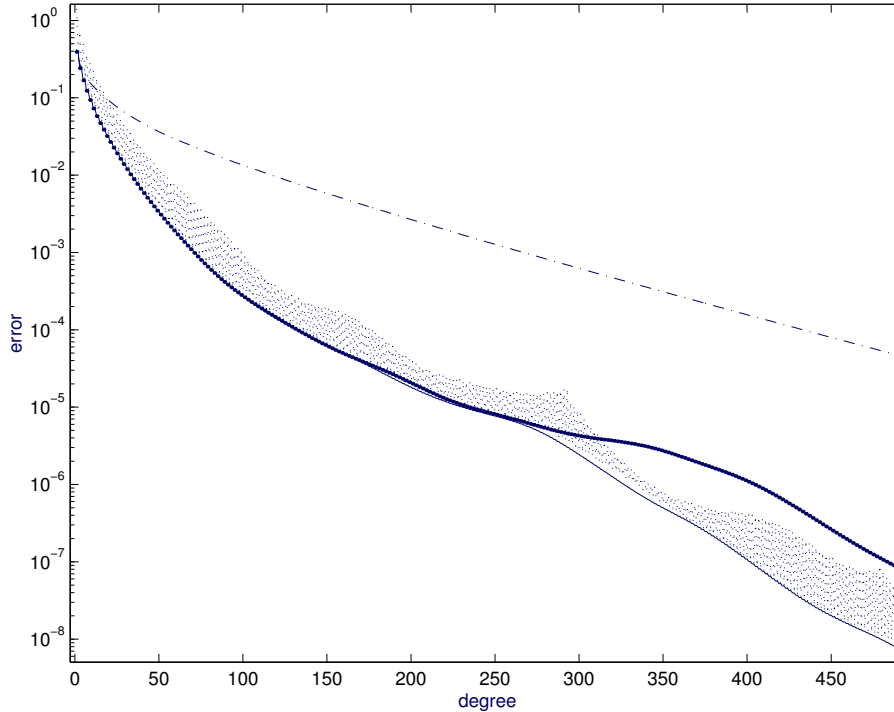


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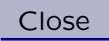
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# Approximating $\text{sign}(Q)b$



$16^4$  lattice,  $\beta = 6$ ,  $\kappa = 0.206$



No of poles for accuracy  $10^{-6}$

$b/a$	PKL	EHN	Zolotarev
200	19	7	5
1000	42	12	6



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## Timings on ALiCE (16<sup>4</sup> configuration)

Conf.	1	2	3	4	5
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### Lanczos/PFE

MVs	2281	1969	1953	1853	1769
time/s	150	131	129	124	118

### PFE/CG Pandey, Kenney, Laub

MVs	×	985	977	929	887
time/s	×	340	362	274	215

### PFE/CG Zolotarev without removal

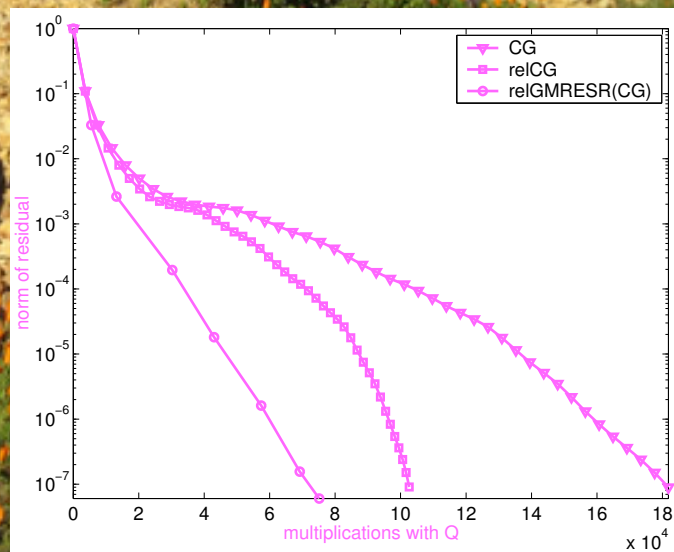
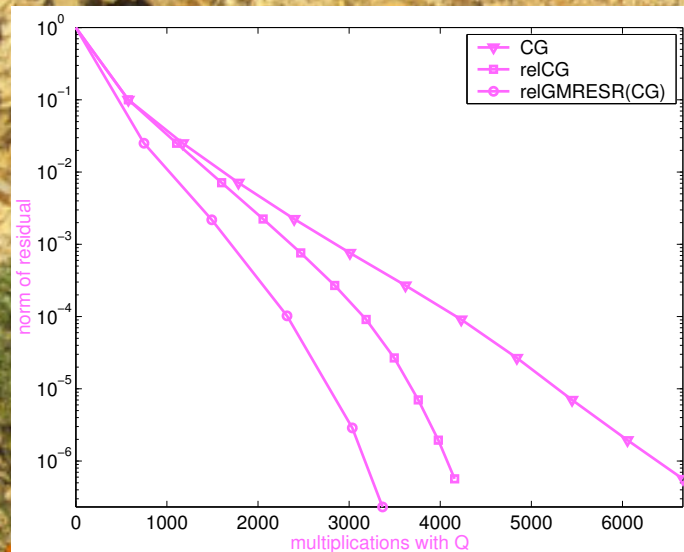
MVs	1141	985	977	927	885
time/s	154	125	125	116	102

### PFE/CG Zolotarev with removal

MVs	1205	1033	1033	971	927
time/s	122	93	97	87	79



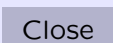
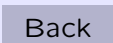
# Relaxation, Recursive Precondit'ng

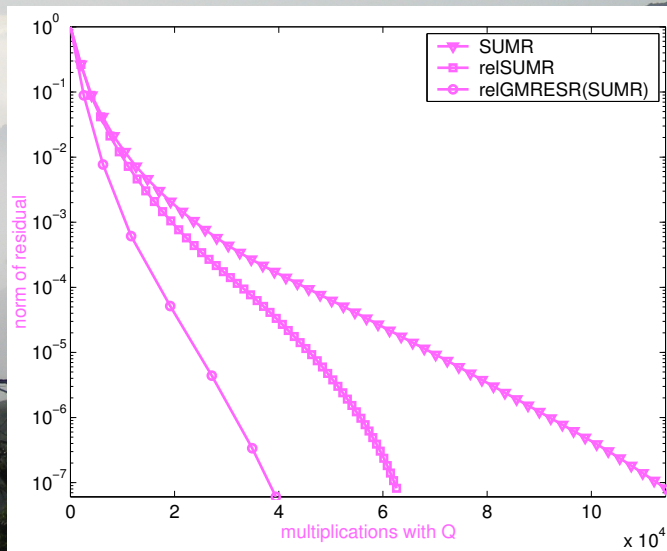


4<sup>4</sup> lattice,  $\mu = 0.3$

8<sup>4</sup> lattice,  $\mu = 0.1$

$$\left(\rho = \frac{1 + \mu}{1 - \mu}\right)$$





$8^4$  lattice,  $\mu = 0.1$



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Method	Conf 1	Conf 2	Conf 3
CG	1965	2052	2039
relCG	1202(1.63)	1250(1.64)	1234(1.65)
relGMRESR(CG)	614(3.20)	567(3.61)	547(3.72)

$$\mu = 0.1$$

Times (in seconds) for one inversion on the three  $8^4$  configurations with  $\beta = 5.6$ , run on 16 processors of ALiCE.



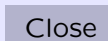
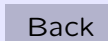
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Method	$\mu = 0.03$	$\mu = 0.1$	$\mu = 0.3$
CG	31430	9022	3493
relCG	18813(1.67)	5981(1.51)	2610(1.34)
relGMRESR(CG)	6642(4.73)	2329(3.87)	1286(2.71)

Times (in seconds) for one inversion on the quenched  $16^4$  configuration at  $\beta = 6.0$ , run on 16 processors of ALICE.



Method	$\mu = 0.03$	$\mu = 0.1$	$\mu = 0.3$
SUMR	31550	8312	3200
relSUMR	18840(1.87)	6038(1.38)	2656(1.20)
relGMRESR(SUMR)	5974(5.82)	2252(3.69)	1382(2.32)

Times (in seconds) for two SUMR inversions on the quenched  $16^4$  configuration, run on 16 processors of ALiCE.



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# Projection of low eigenmodes

$n_p$	Inversion	Calls to Wilson op.	Eigenvalue calculation	Total time
1	9144	1032172	0	9144
10	1269	189514	111	1380
20	796	112862	118	914
30	568	78548	172	740
40	459	63566	274	733
50	387	52758	361	748
60	340	45732	410	750

total time for one relGMRESR(CG) + projection of  $n_p$  eigenmodes,  
 $8^4$  lattice,  $\mu = 0.1$



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