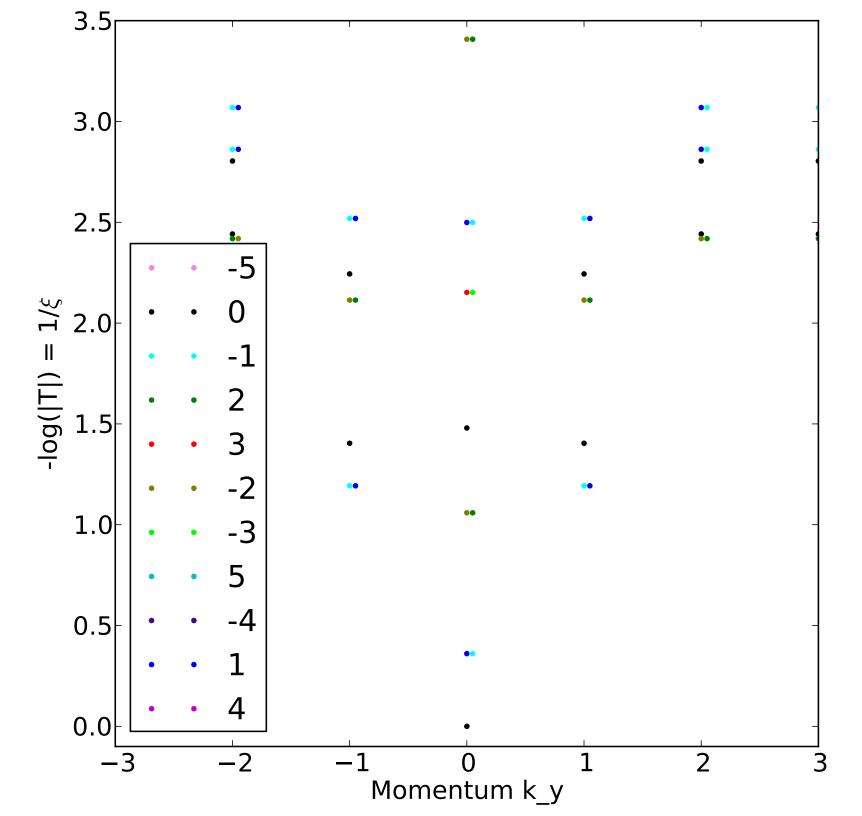
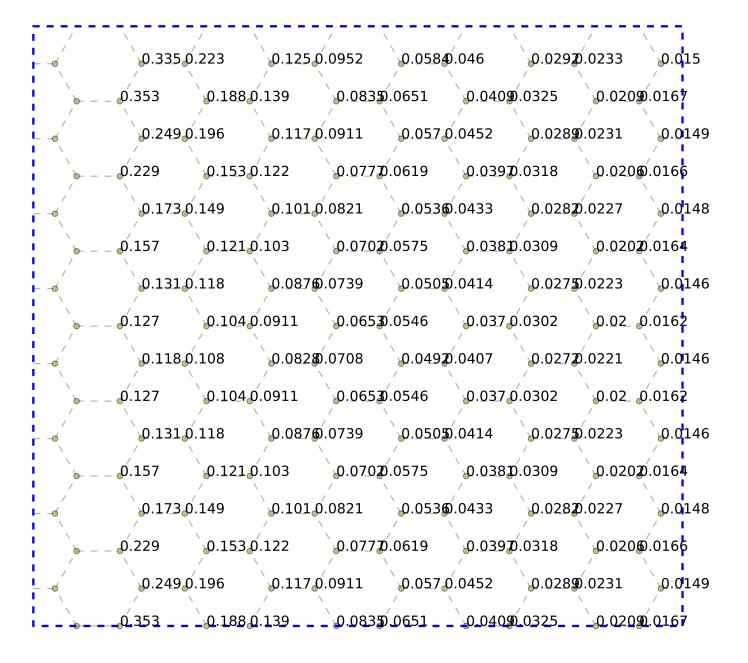
Featureless Boson States with PEPS

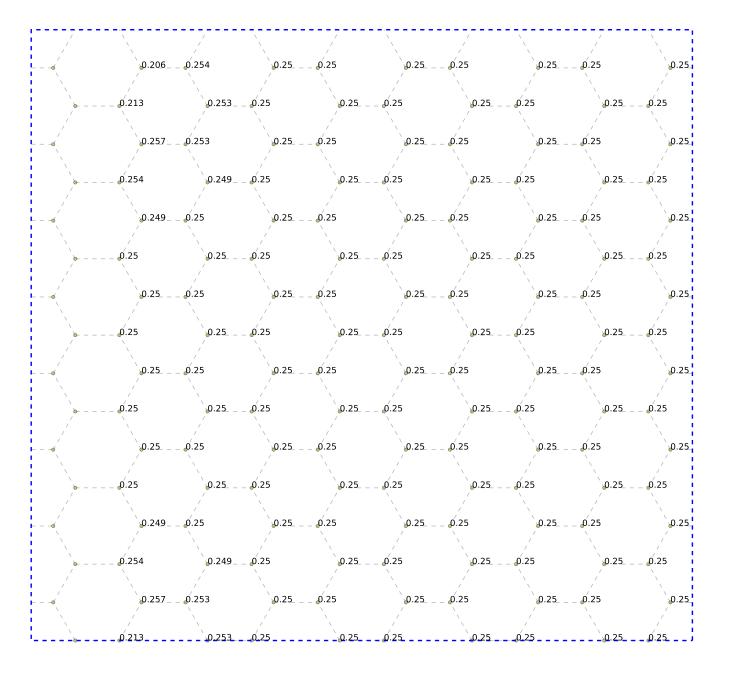
bray den ware

June 2014

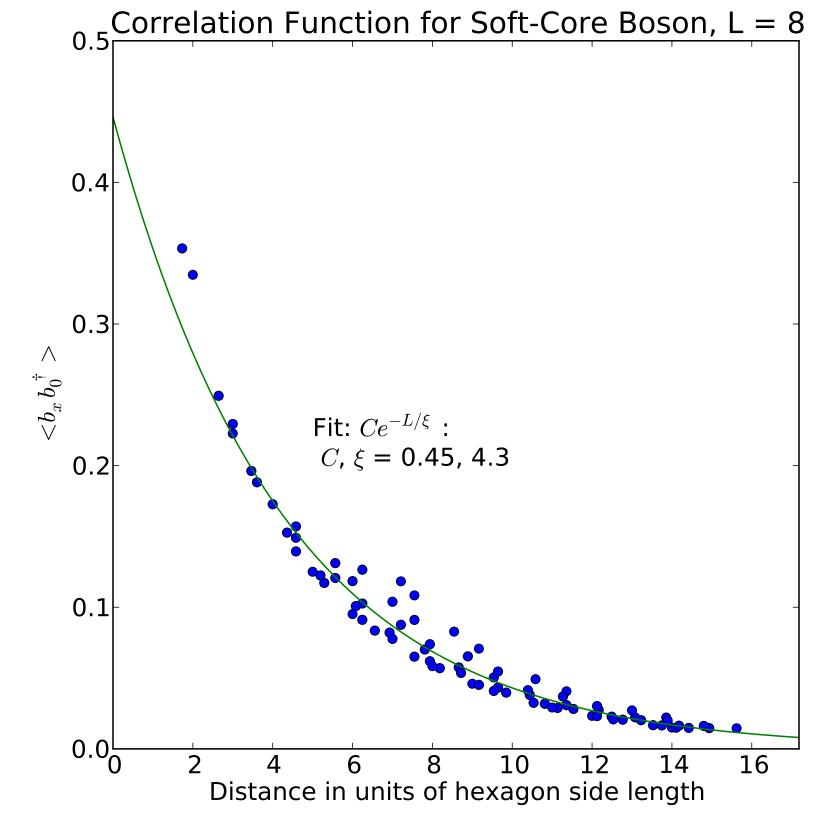
- 1 Introduction
- 2 Appendix
- 2.1 Soft Core Boson Plots

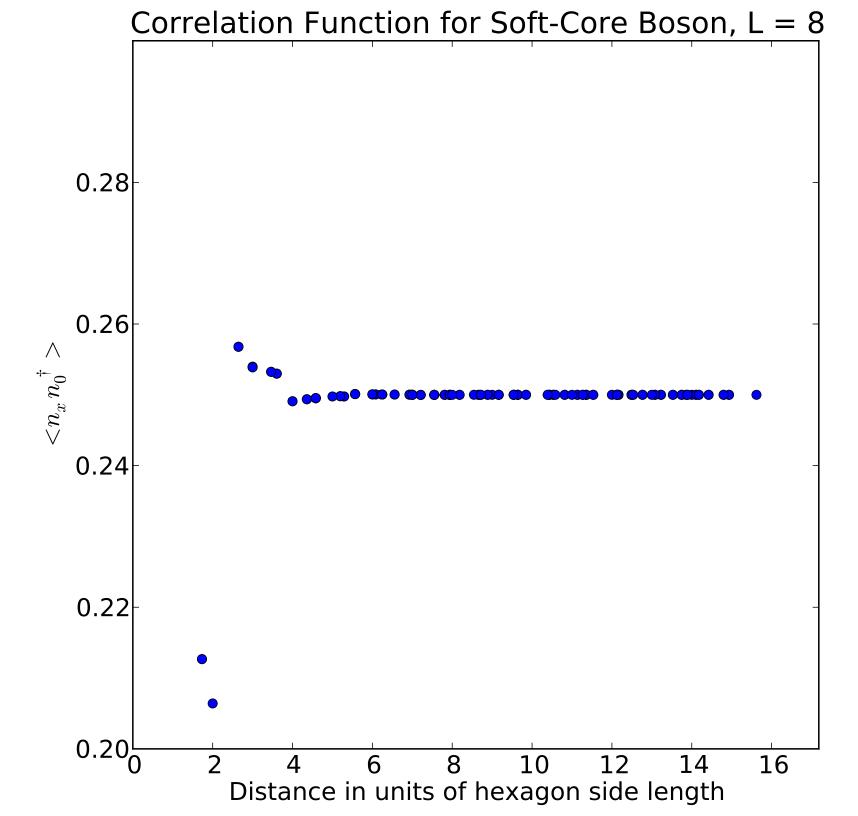


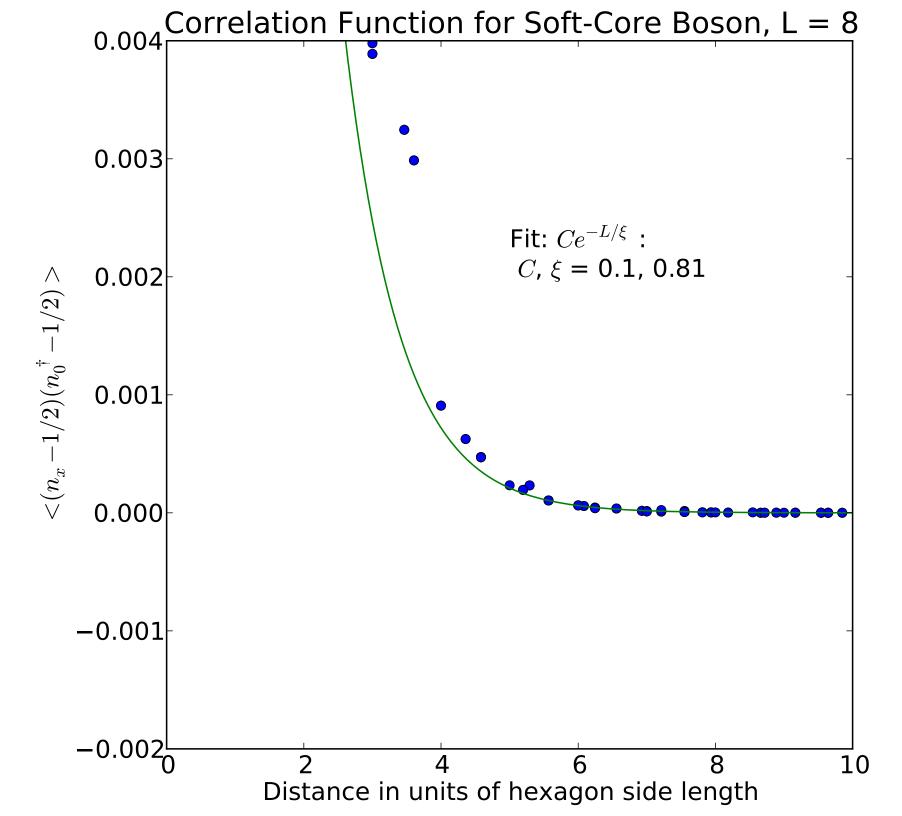




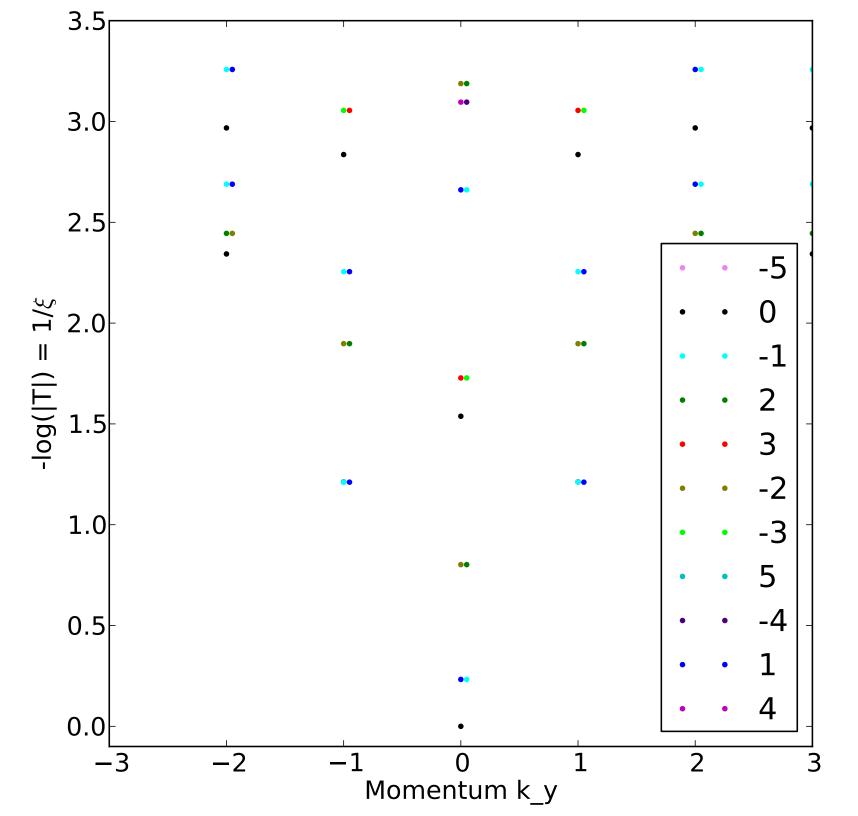
	,	©0.0436_ ©.0	00398		.2e-05	3.57e-06.9.8	/ 4e-07	1.4e-08_ 2.4	2e-08	√J.67 e -09
`\) 	0373	0.00299_ 0.0	000472	3.65e-05 ₆ 7.2	22e-06	7.52e-07 6 9.	39e-08	3.28e-08 1.7	'8e-09
	,	0.00678_	00325	0.0002324.4	2e-05	2.25e-06.8.5	8e-07	1.21e-08 2.4	e-08	7.27e-09
`\	» 0 .0	00389	.0.000625 ₆ 0.0	000194	1.47e-05 33.3	38e-06	3.93e-07 3.	37e-08	2.54e-08 3.1	.8e-09
	<i>,</i>	o.000908.0.	000472	5.79e-05 1.7	/e-05	8.34e-07 4.6	3e-07	2.67e-08 2.0	8e-08	6.92 e -09
\	· • 0.	000471	0.000105 4.1	3e-05	4.42e-06 5.3	32e-07	1.59e-07 1.1	9e-08	2.07e-08 3.8	86e-09
	<i>,</i>	0.000105 6.2	24e-05	1.05e-05 3.	94e-06	7.06e-07 1.3	3e-07	4.76e-08 1.2	6e-08	7.53e-09
\	<u></u>	95e-05	\$1.23e-05 7.3	34e-06	1.52e-06 2.3	5e-07	1.22e-07 1.8	/ 5e-08	2.12e-08 3.4	/ I5e-09
- ø	/	\$2.35e-05 1.	59e-05	3.93e-06 1.1	8e-06	1.46e-07 ₆ 3.3	39e-08	6.31e-08 8.1	4e-09	8.02e-09
\	à 3 .9	95e-05	1.23e-05 7.3	34e-06	1.52e-06 2.3	5e-07	1.22e-07 1.8	/ 5e-08	2.12e-08 3.4	/ I5e-09
	/	0.000105 6.2	24e-05	1.05e-05 3.	94e-06	7.06e-07 1.3	3e-07	4.76e-08 1.2	6e-08	7.53e-09
\	· • 0.	000471	0.000105 4.1	3e-05	4.42e-06 5.3	32e-07	1.59e-07 1.1	9e-08	2.07e-08 3.8	86e-09
	/	o.000908.0.	000472	5.79e-05 1.7	e-05	8.34e-07.4.6	3e-07	2.67e-08 2.0	8e-08	6.92e-09
\	, , , , , , , , , , , , , , , , , , ,	00389		000194	1.47e-05 3.3	38e-06	3.93e-07 3.	7 37e-08	2.54e-08 3.1	.8e-09
	′ \	0.00678_ 0.0	00325	0.0002324.4	·2e-05	2.25e-06 ₈ .5	8e-07	1.21e-08 2.4	e-08	7.27e-09
``		./	\ _\o002990.(000472	3.65e-05 _e 7.2	22e-06	√ √7.52e-07 √9.	, 39e-08	3.28e-08 4.7	/ 8e-09



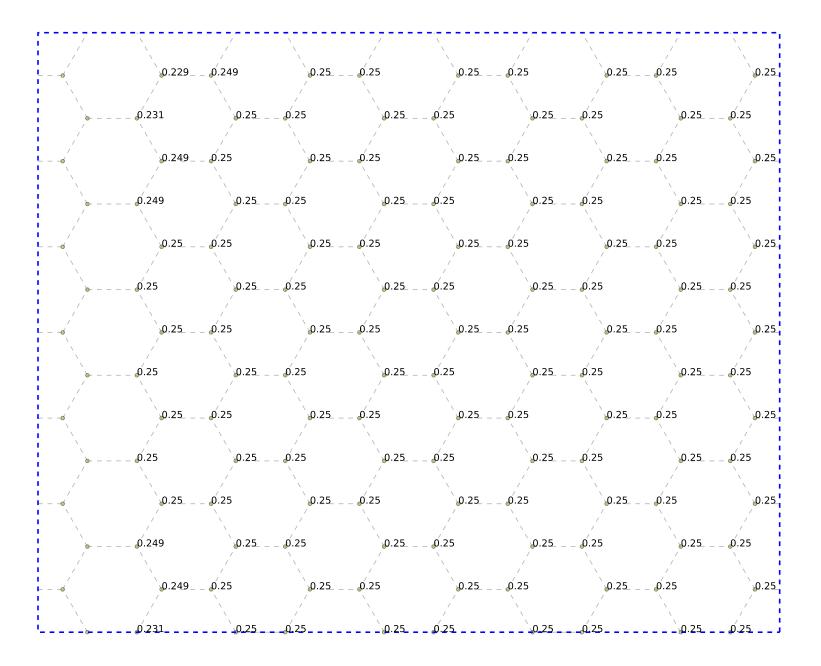




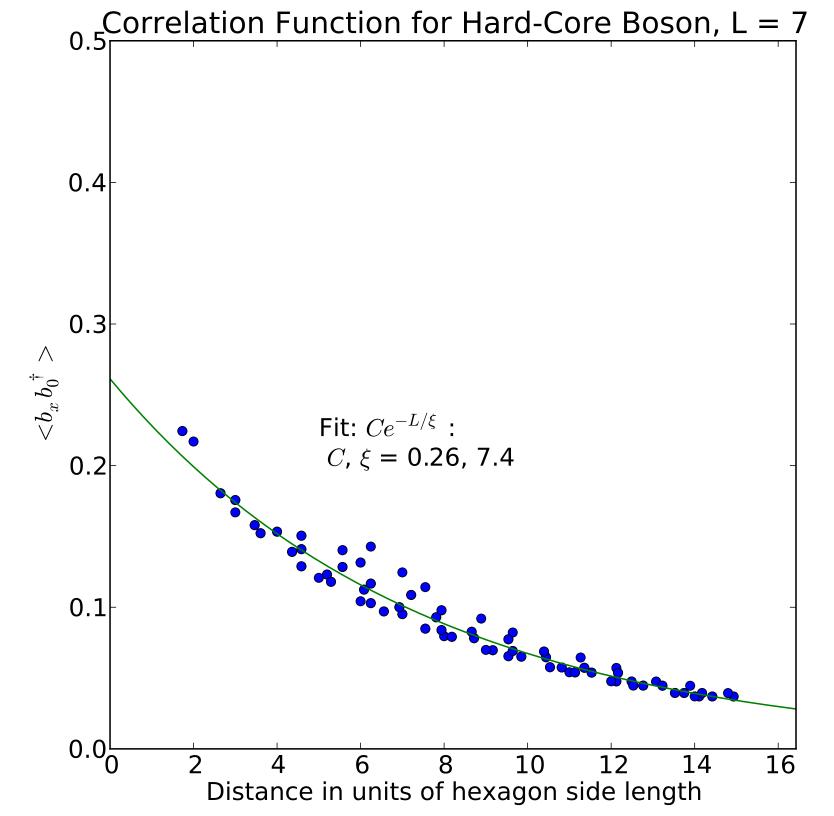
2.2 Hard Core Boson Plots

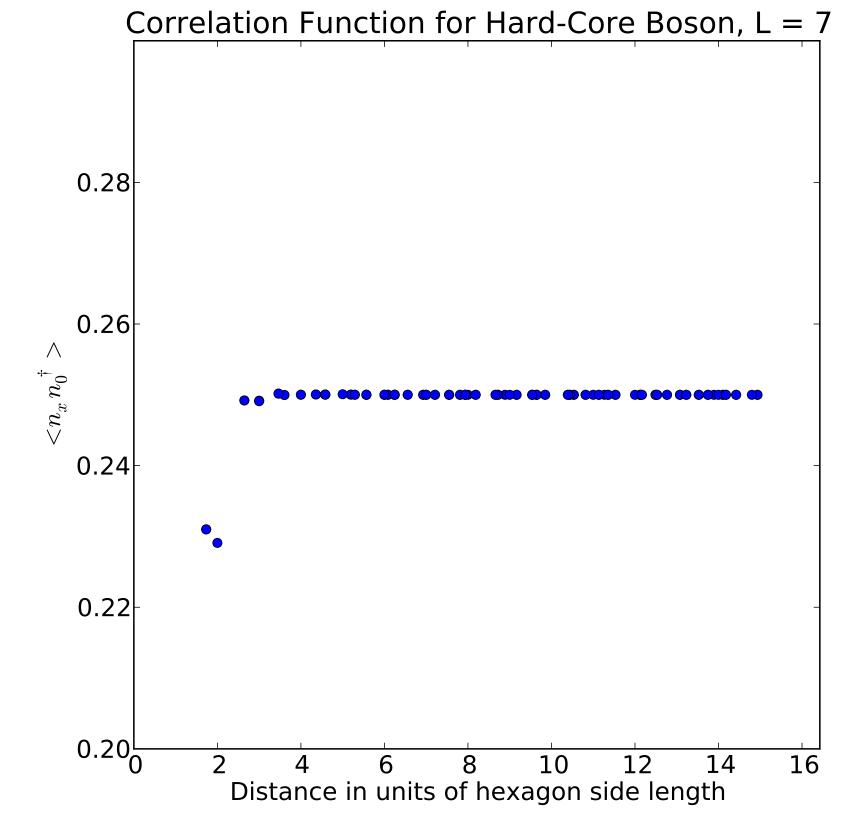


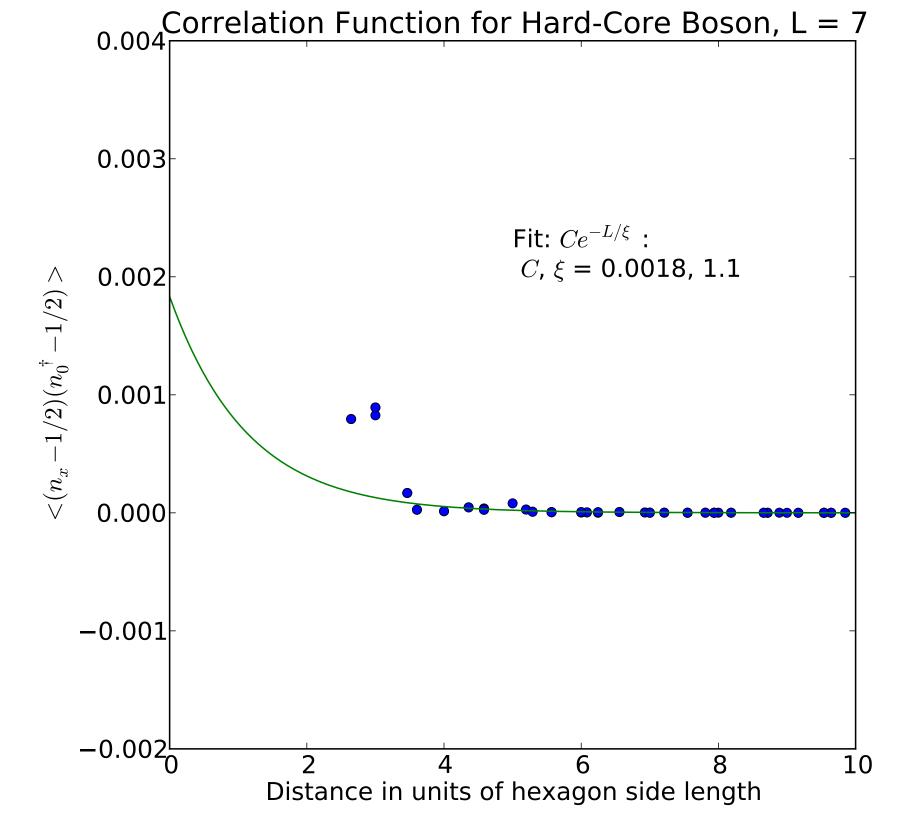
/	/		/		, ,		/		/	
	,	0.217 0.10	67	0.121 0.1	04).07.960.0 /	0699	0.0541 _ 0.0	477	0.0371
) 	24	0.152 0.1	29	0.0971 _ 0.0	849	0.0654 _ 0.0	577	0.0447 _ 0.0	395
	/	0.18 0.19	58	0.118 0.1	03	0.0791 _ 0.0	0697	0.054 0.0	477	0.037
) 	76	0.1390.1	23	0.0951 _ 0.00	839	0.0651 _ 0.0	575	0.0447 _ 0.0	395
		0.153 0.14	41	0.112 0.1	`\	0.0781 _ 0.0	0691	0.0538 _ 0.0	476	0.037
1) 0.1	5	0.128 0.1	17	0.0929 _ 0.0	827	0.0647 _ 0.0	573	0.0446 _ 0.0	394
L6		0.14 0.13	32	0.109 0.0	979	0.0774 _ 0.0	0687	0.053Z _ 0.0	475	0.037
) 0.1	43	0.1250.1	14	0.0920.0	822	0.0645 _ 0.0	572	0.0446 _ 0.0	394
		0.14 0.1:	32	0.1090.0	979	0.0774 _ 0.0	0687	0.0537 _ 0.0	475	0.037
) 	5	0.128 0.1	17	0.0929 _ 0.08	827	0.0647 _ 0.0	573	0.0446 _ 0.0	394
/ 	`	0.1530.16	41	0.1120.1	`	0.0781 _ 0.0	0691	0.0538 _ 0.0	476	0.037
) 	76	0.1390.1	23	0.0951 _ 0.0	839	0.0651 _ 0.0	575	0.0447 _ 0.0	395
 	`	0.18 0.19	58	0.118 0.1	03	0.0791 _ 0.0	0697	0.054 0.0	477	0.037
		24	0.152 0.1	29		849	0.06540.0	527		395



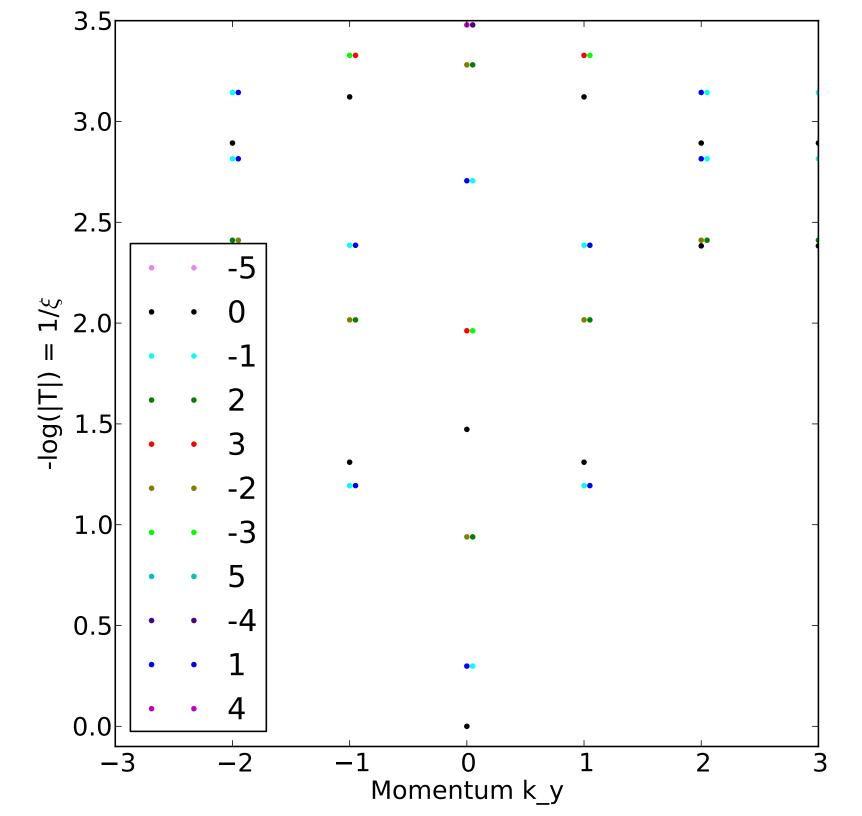
	≥ 0.0209_	0.000826	8.06e-05	6.71e-06	1.27e-06	2.41e-07	1.03e-07 2.9	99e-08	1.16e-0
•		2.63e-05	3.65e-05	6.95e-06	9.3e-07	3.16e-07	8.67e-08	3.34e-08	1.08e-08
	0.000795	0.000168	9.29e-06	4.45e-06	9.41e-07	2.85e-07	9.2e-08_ 3.	17e-08	1.12e-0
>		4.63e-05	2.78e-05	1.19e-06	9.69e-07	2.35e-07	9.68e-08	3.06e-08	1.12e-08
	1.38e-05	2.61e-05	3.96e-06	3.06e-06	4.79e-07	2.78e-07	8.2e-08_ 3.2	23e-08	1.09 ę -08
>	2.78e-05	5.89e-06	1.31e-06	1.11e-06	6.06e-07	2.17e-07	8.59e-08	3.07e-08	1.09e-08
	5.64e-06	2.71e-06	1.34e-06	2.56e-07	5.63e-07	1.86e-07	8.8e-08_ 2.	9e-08	1.12e-08
>	5.39e-06	9.12e-07	8.1e-07	1.06e-06	2.55e-07	2.42e-07	J .3e-08	3.21e-08	1.04e-08
	5.64e-06	2.71e-06	1.34e-06	2.56e-07	5.63e-07	1.86e-07	8.8e-08_ 2.	9e-08	1.12e-0
>	2.78e-05	5.89e-06	1.31e-06	1.11e-06	6.06e-07	2.17e-07	8.59e-08	3.07e-08	1.09e-08
	1.38e-05	2.61e-05	3.96e-06	3.06e-06	4.79e-07	2.78e-07	8.2e-08_ 3.2	23e-08	1.09 ¢ -08
>	0.000893	4.63e-05	2.78e-05	1.19e-06	9.69e-07	2.35e-07	9.68e-08	3.06e-08	1.12e-08
	°0.000795	0.000168	9.29e-06	4.45e-06	9.41e-07	2.85e-07	9.2e-08_ 3.	./ 17e-08	1.12e-08
\		2.6205	2 65 - 05	, C 0E = 0C	0 2- 07	2 16- 07	0,67-00	2 24- 00	/ !



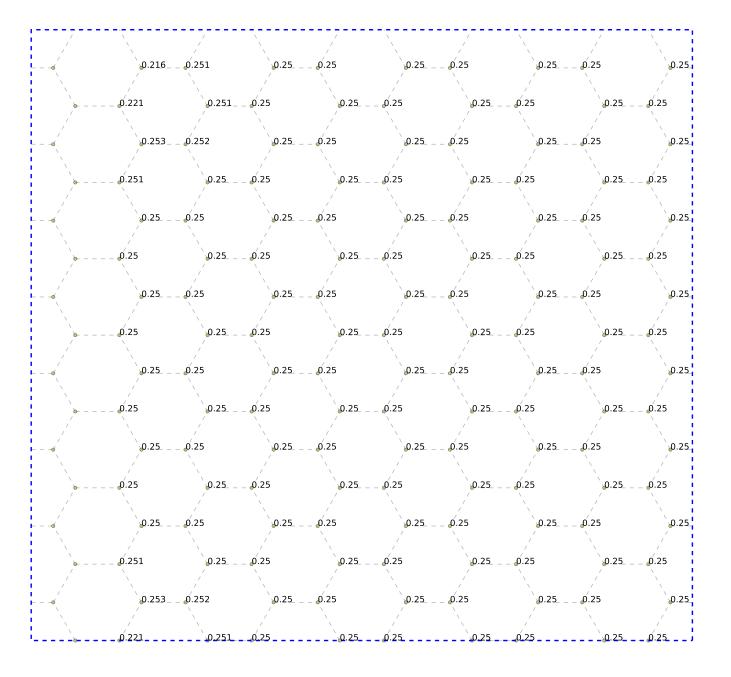




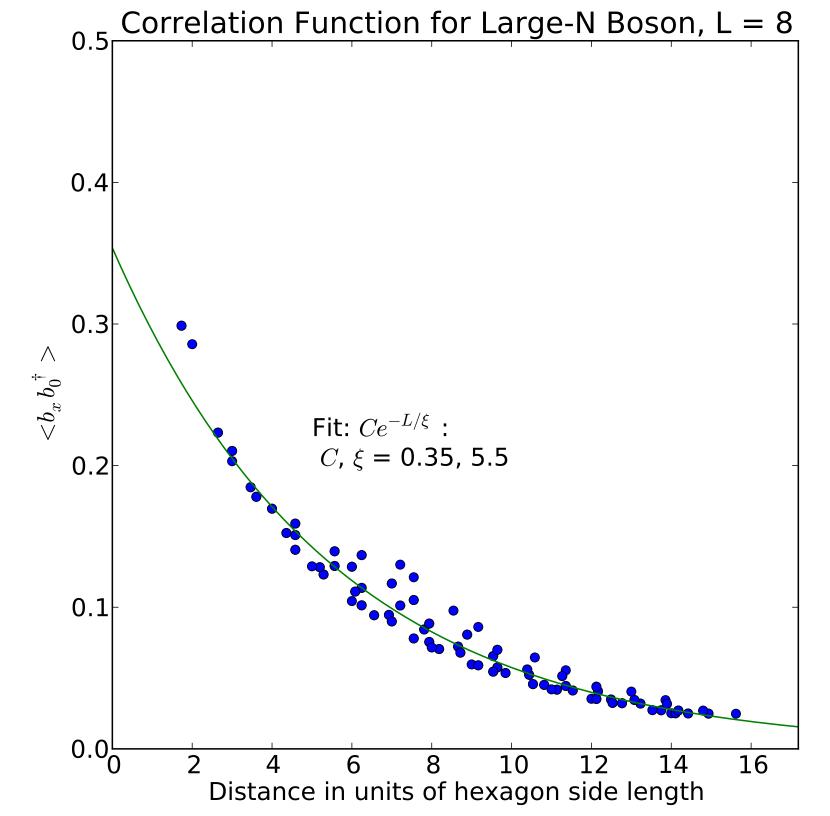
2.3 Large N Boson Plots

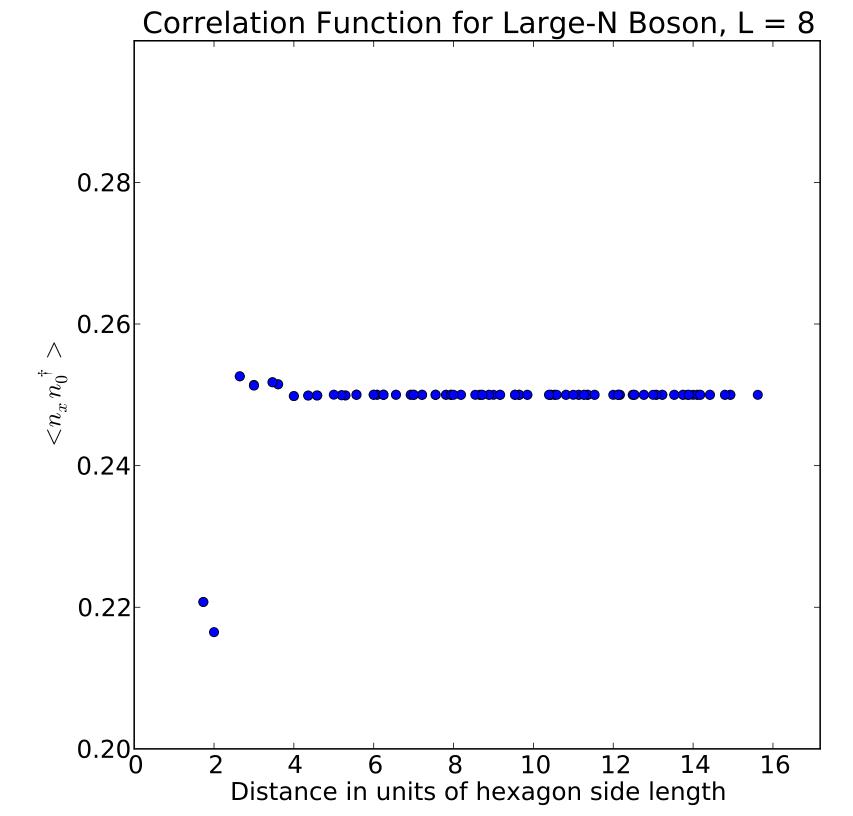


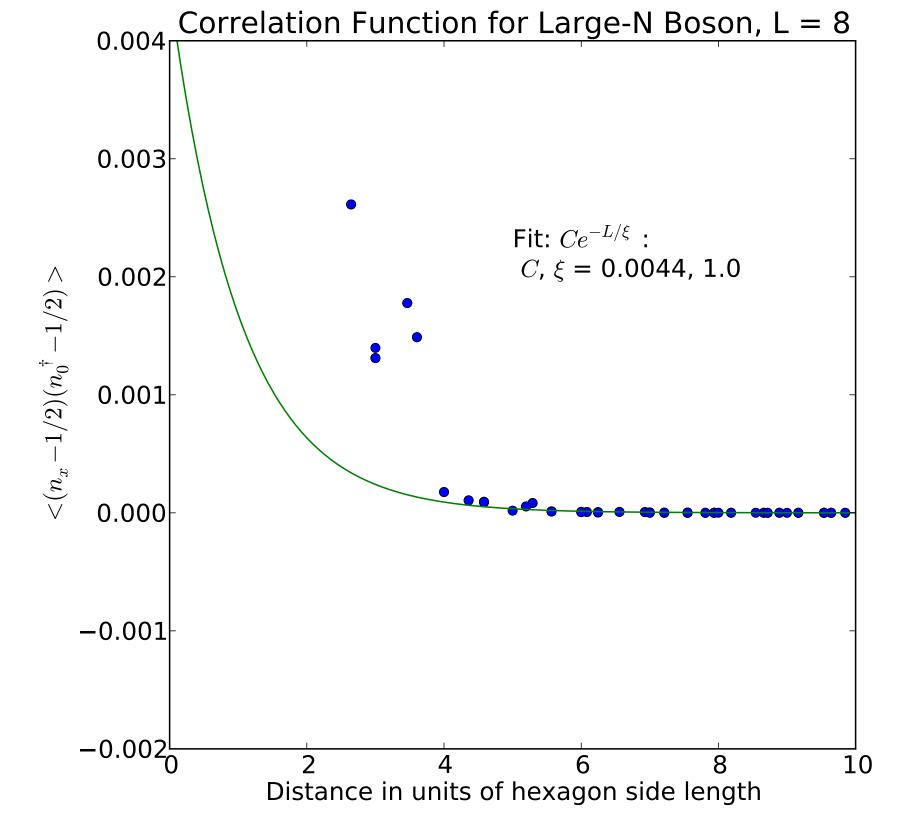
,	, ,		/		,		/		/	
		0.286 0.2	03	0.129 0.1	04	0.0716 _ 0.09	596	0.042 0.0	354	0.0252
)0.2	299	0.178 0.1	41	0.0944 _ 0.07	78	0.0545 _ 0.0)457	0.0325 _ 0.02	274
L	,	0.2230.1	85	0.123 0.1	01	0.0705 _ 0.09	59	0.0418 _ 0.0	352	0.0251
\ 	»	21	0.152 0.1	28) 0.050.07	755	0.0536 _ 0.0)452	0.0322 _ 0.02	272
 	,'	0.17 0.1	51	0.111 0.0	946	0.0679 _ 0.09	575	0.0412 _ 0.0	349	0.025
1) 	L59	0.129 0.1	14	0.0843 _ 0.07	722	0.0523 _ 0.0)444	\vartheta.032 \vartheta.02	271
I I I / L6	,'	0.14 0.1	29	`.0.1010.0	885	0.0655 _ 0.05	561	0.0407 _ 0 .0	346	0.0249
	, , ,	137	0.117 ø.1	05) 0.0807 _ ø.06	599	`ø.0514 _ ø.0)439	\ \p.0317 _ \phi.02	27
 	,/	`	/	,	861	0.0645 _ 0.09	555	0.0404 _ 0 .0	344	0.0248
I \	, , , , , , , , , , , , , , , , , , ,		0.117 0 .1	/	\ \ 0 .0807 _ 0 .06	/	\vartheta 0.0514 _ \vartheta 0.0	/	\visingle 0.0317 _ \visingle 0.02	,
I	,	\	/	,	′ \	, ,		0.040Z _ 0 .0		
	. /		. /	/	,′	/		/	, ,	/
,)0.1	L59	0.129 0.1	,	0.0843 _ 0.07	, /	0.0523 _ 0.0	, ,	0.0320.02	
		0.17 0.1	51	0.111 0.0	946	0.0679 _ 0.09	575	0.0412 _ 0.0	349	0.025
) 	21	0.152 0.1	28	0.09 0.07	755	0.0536 _ 0.0)452	0.0322 _ 0.02	272
	,	0.223 0.1	85	0.123 0.1	01	0.0705 _ 0.09	59	0.0418 _ 0.0	352	0.0251
!`		299	0.178 0.1	4L		7.8	0.0545 0.0)457		274 _ 1



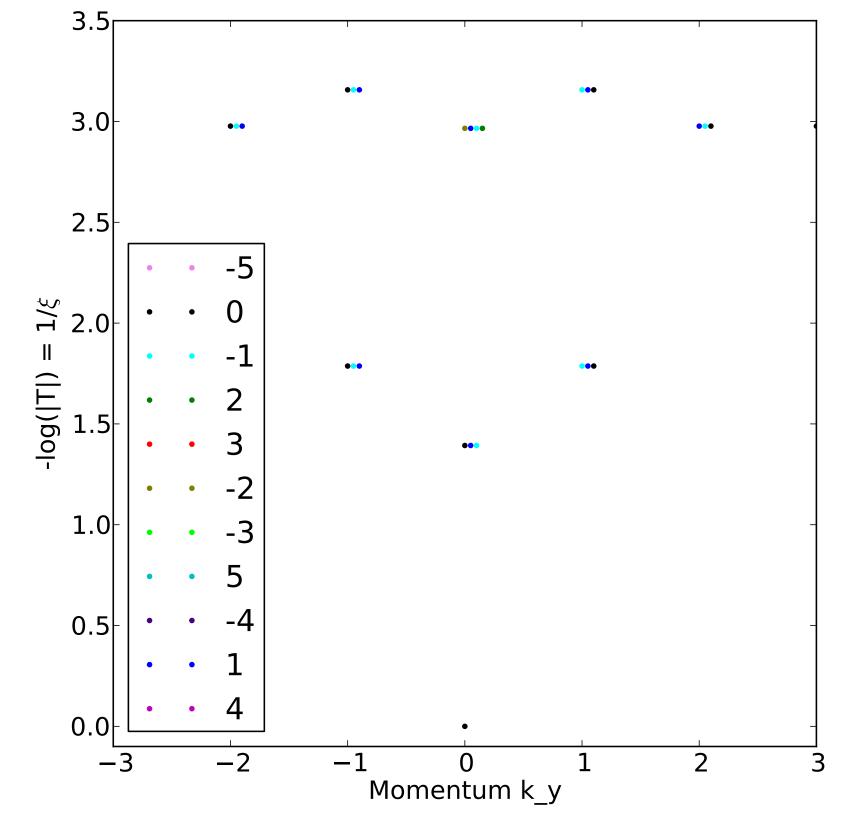
	·			/		,		/	
	©0.0335_ ©.C	0014	1.86e-05 8.6	52e-06	8.07e-07 1.2	3e-07	1.11e-07 2.0	9e-08	1.44e-08
	, , , , , , , , , , , , , , , , , , ,	0.00149_ 8	.92e-05	8e-061.:	21e-07	3.38e-07 5.1	2e-08	3.8e-08_ 8.8	87e-09
	ø.00261_ ø.c	00178	8.29e-05 5.6	51e-06	7.25e-07 2.0	7e-07	9.17e-08 2.4	4e-08	1.36e-08
`\	0.00131	60.0001065	.45e-05	3.62e-06 4.7	/5e-07	2.02e-07 J .2	e-08	3.23e-08 9.9	7 97e-09
	©0.000176g9.	28e-05	7.08e-06 6.4	16e-06	5.51e-08 2.3	e-07	7.12e-08 2.7	/ /3e-08	1.25e-08
``	9.29e-05	1.22e-05 2.	95e-06	2.75e-07 3.3	37e-07	1.6e-07_ 6.7	6e-08	3.04e-08 9.8	31e-09
L 6	1.1e-056.1	18e-06	2.32e-08 1.	41e-07	3.8e-07_ 1.3	7e-07	7.52e-08 2.2		1.29e-08
	4.93e-06	8.02e-07	.53e-06	Je-07 Je-	-08	1.91e-07 4.2	7e-08	3.32e-08 8.4	l9e-09
	\$2.35e-06 2.	29e-06	5.98e-07 2.	29e-07	4.14e-07 5.6	8e-08	8.4e-08_ 1.8	88e-08	1.34e-08
``	4.93e-06	8.02e-07	.53e-06	Je-07 Je-	-08	1.91e-07 4.2	7e-08	3.32e-08 8.4	19e-09
	1.1e-05_ 6.1	18e-06	2.32e-08 1.	41e-07	3.8e-07_ 1.3	7e-07	7.52e-08 2.2	?7e-08	1.29e-08
`	9.29e-05	1.22e-05 2.	95e-06	2.75e-07 3.3	37e-07	1.6e-07_6.7	6e-08	3.04e-08 9.8	31e-09
	©0.000176 ₈ 9.	28e-05	7.08e-06 6.4	16e-06	5.51e-08 2.3	e-07	7.12e-08 2.7	'3e-08	1.25e-08
	0.00131	60.000106 5	.45e-05	3.62e-06 4.7	75e-07	2.02e-07 J .2	e-08	3.23e-08 9.9	7e-09
	0.00261_0.0	00178	8.29e-05 5.6	51e-06	7.25e-07 2.0	7e-07	9.17e-08 2.4	4e-08	1.36e-08
	/ 	0.00149 8	.92e-05	8e-061	21e-07	3.38e-07_5.1	2e-08	3.8e_08_ 8.8	7.e-09.

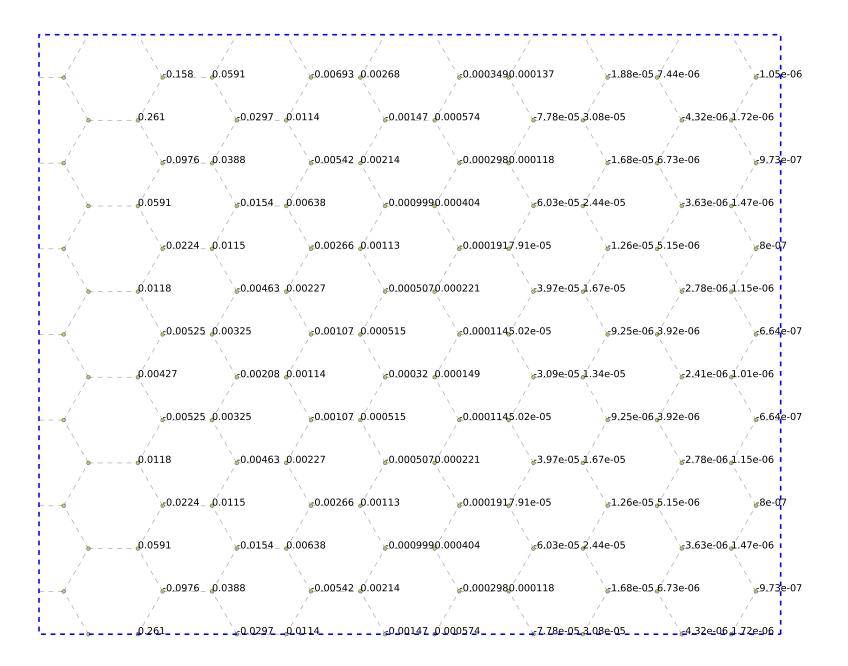




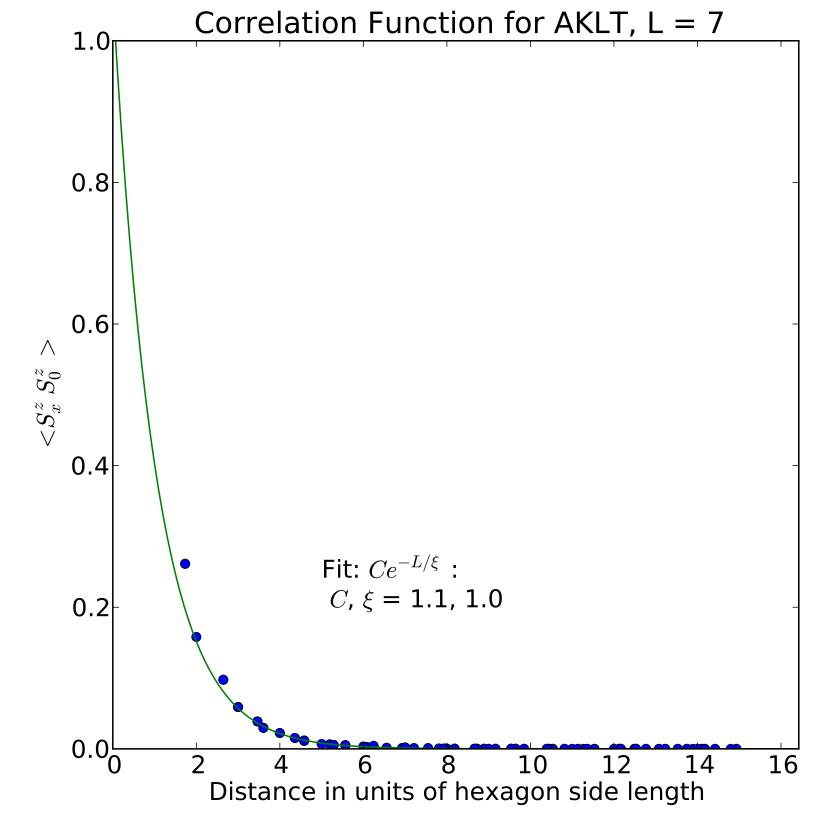


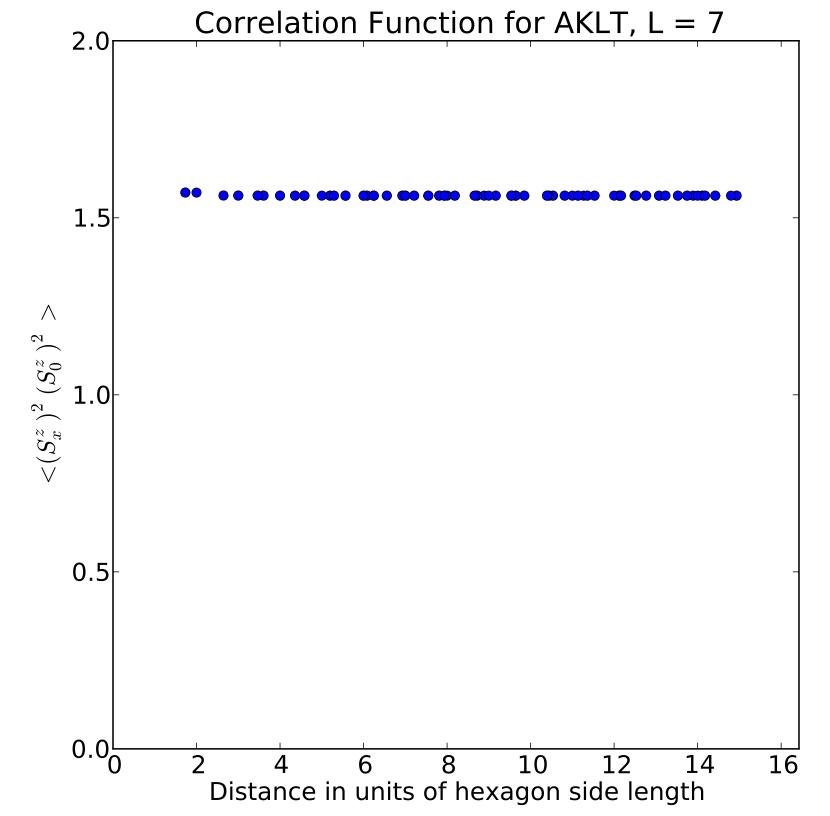
2.4 AKLT





	/		5	1.56 1.56	6	1.56 1.5	6	1.56 1.56) ₂ 1	L.56
		7	1.56 1.56	5	1.56 1.56	5	1.56 1.5	6	1.56 1.56	
L 6		1.56 1.56	5	1.56 1.50	6	1.56 1.5	6	1.56 1.56	1	L.56
	1.56	5	1.56 1.56	5	1.56 1.56	5	1.56 1.5	6	1.56 1.56	
e		1.56 1.56	,/	1.56 1.50	, /	1.56 1.5	,	1.56 1.56	,′	L.56_
, , , ,	1.56	5 \1.561.56	1.56 1.56	5 	1.56 1.56 /	5 	1.56 1.5 6	6 	1.56 1.56	L.56
	<u></u>	/	,′	/ \	\	/	1.56 1.5	/	1.56 1.56	
 	,	1.56 1.56	5	1.56 1.50	6	1.56 1.5	6	1.56 1.56	1	L.56
	1.56	5	1.56 1.56	5	1.56 1.56	5	1.56 1.5	6	1.56 1.56	1
	,	1.56 1.56	5	1.56 1.56	, ,	1.56 1.5	,	1.56 1.56)1	L.56_
 	1.56	/	1.56 1.56	/	1.56 1.56	, /	1.56 1.5	, /	1.56 1.56	
e].56].56 	, ,	/	6 	/	,	1.56 1.56	1.56 1.56.	1.56





Caution: AKLT data preliminary, not checked in detail.