pilot benchmarks

May 19, 2020

1 Timings

2   Comparison of algorithms

Algorithm	τ_G	Spin observables		
		E	χ_m	c
Heat bath	5	-0.765 ± 0.003	9.2 ± 0.2	0.97 ± 0.04
Metropolis	20	-0.762 ± 0.003	8.9 ± 0.2	1.01 ± 0.05

The configuration file was

```
lattice_length:  10
euclidean_dimension:  3
beta:  1.0
algorithm:  heatbath | metropolis
max_step:  N/A | 0.3
sample_size:  1000
sample_interval:  2 × τ_G
thermalisation:  100
bootstrap_sample_size:  100
```

The maximum step size for the Metropolis algorithm was chosen such that 2/3 of proposals were accepted.

3   Correlation length

The definition of the (squared) second-moment correlation length ξ_{2m}^2 on a lattice is given in the `pilot` documentation, along with two alternative definitions $\xi_{(1)}^2, \xi_{(2)}^2$ that rely solely on the correlation function at low momentum. These alternative definitions should converge to $\xi_{(2m)}^2$ as the lattice size $L \to \infty$, and their imaginary parts should disappear.

L	$\xi_{(2m)}^2$	$\xi_{(1)}^2$	$\Im(\xi_{(1)}^2)$	$\xi_{(2)}^2$	$\Im(\xi_{(2)}^2)$
10	2.09 ± 0.13	3.17 ± 0.05	0.003	1.388 ± 0.009	0.0006
20	3.36 ± 0.05	3.53 ± 0.07	0.002	2.60 ± 0.04	0.0016
30	3.70 ± 0.12	3.49 ± 0.12	0.012	3.02 ± 0.09	0.009

The configuration file was

```
lattice_length:  L
euclidean_dimension:  3
beta:  1.0
algorithm:  heatbath
sample_size:  1000
sample_interval:  L
thermalisation:  100
bootstrap_sample_size:  100
```

4 Berg and Luscher 1981: $O(3)$

Reference: B. Berg and M Luscher, *Definition and statistical distributions of a topological number in the lattice O(3) σ-model*, Nucl. Phys. B190 (1981), 412-424.

In this paper, a geometrical definition of topological charge was given for the $O(3)$ and CP^{N-1} non-linear σ models.

They provide results for $O(3)$ on a 100×100 lattice, using the heat bath algorithm. These have been reproduced using `pilot`.

β	E		χ_m		$10^4 \chi_t$	
	BL81	pilot	BL81	pilot	BL81	pilot
1.1	2.295	2.2956 ± 0.0007	14.4 ± 0.4	13.7 ± 0.4	125 ± 5	123 ± 6
1.2	2.109	-	23.5 ± 0.8	-	98 ± 4	-
1.3	1.924	-	39 ± 3	-	64.7 ± 1.8	-
1.4	1.751	-	82 ± 8	-	41.3 ± 1.3	-
1.5	1.592	-	191 ± 21	-	23.7 ± 0.9	-
1.6	1.457	-	370 ± 48	-	12.8 ± 0.7	-
1.7	1.342	-	871 ± 61	-	5.6 ± 0.3	-
1.8	1.247	-	1634 ± 82	-	2.7 ± 0.2	-
1.9	1.167	-	2285 ± 58	-	1.05 ± 0.06	-
2.0	1.098	-	2720 ± 85	-	0.52 ± 0.03	-

The configuration file was

```
lattice_length:  100
euclidean_dimension:  3
algorithm:  heatbath
sample_size:  1000
sample_interval:  10
thermalisation:  100
bootstrap_sample_size:  100
```