Gauge Ensembles of the HotQCD Collaboration

Christian Schmidt for HotQCD

UNIVERSITÄT BIELEFELD
Faculty of Physics

CRC-TR 211

PUNCH 4NFDI

HotQCD Collaboration:
S. Ali, L. Altenkort, D. Bala, A. Bazavov, D. Bollweg, D. Clarke, H.-T. Ding, J. Goswami, P. Hegde, O. Kaczmarek, F. Karsch, A. Lahiri, R. Larsen, S.-T. Li, S. Mukherjee, M. Neumann, H. Ohno, P. Petreczky, M. Sarkar, CS, S. Sharma, H.-T. Shu

Action

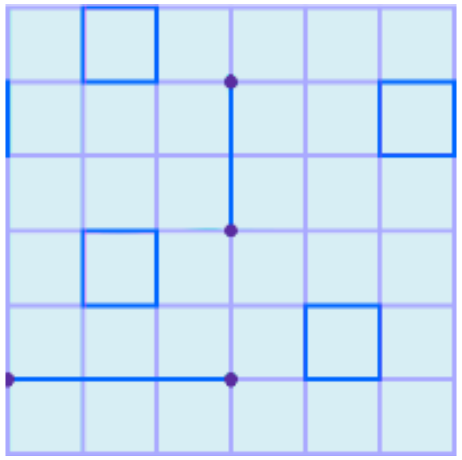
- We are using (2+1), 3, and 5-flavor of Highly Improved Staggered Quarks (HISQ/tree), at $\mu_I = 0$ and $\mu_I > 0$

Algorithm

- Rational Hybrid Monte Carlo (RHMC) with a 3-level leap-frog or Omelyan Integrator.
- Step sizes of light, strange and gauge force integrators are tuned to a meet an acceptance of ~70%.
- Trajectory length is 0.5-1.0 time units

Code

- SIMULATeQCD, a SImple MUlti-GPU LATtice code for QCD calculations
- Available on GitHub: https://github.com/LatticeQCD/SIMULATeQCD



[L. Mazur, et. al. Comput.Phys.Commun. 300 (2024) 109164]

Ensembles:

- (2+1)-flavor with physical quark masses: $m_l/m_s = 1/27$, aspect ratio $N_\sigma/N_\tau = 4$

$32^3 \times 8$ | $48^3 \times 12$ | $64^3 \times 16$

$N_\tau = 8$				$N_\tau = 12$				$N_\tau = 16$			
β	m_l	T[MeV]	#conf.	β	m_l	T[MeV]	#conf.	β	m_l	T[MeV]	#conf.
6.175	0.003307	125.28	1,471,861								
6.245	0.00307	134.84	1,275,380	6.640	0.00196	135.24	330,447	6.935	0.00145	135.80	17671
6.285	0.00293	140.62	1,598,555	6.680	0.00187	140.80	441,115	6.973	0.00139	140.86	23855
6.315	0.00281	145.11	1,559,003	6.712	0.00181	145.40	416,703	7.010	0.00132	145.95	26122
6.354	0.00270	151.14	1,286,603	6.754	0.00173	151.62	323,738	7.054	0.00129	152.19	26965
6.390	0.00257	156.92	1,602,684	6.794	0.00167	157.75	299,029	7.095	0.00124	158.21	21656
6.423	0.00248	162.39	1,437,436	6.825	0.00161	162.65	214,671	7.130	0.00119	163.50	18173
6.445	0.00241	166.14	1,186,523	6.850	0.00157	166.69	156,111	7.156	0.00116	167.53	19926
6.474	0.00234	171.19	373,644	6.880	0.00153	171.65	144,633	7.188	0.00113	172.60	17163
6.500	0.00228	175.84	294,311	6.910	0.00148	176.73	131,248	7.220	0.00110	177.80	3282

~ 912 TB (uncompressed, fp32) | ~ 938 TB (uncompressed, fp32) | ~ 210 TB (uncompressed, fp32)

[Phys.Rev.D 104 (2021) 7, 074512, Table I]

- (2+1)-flavor, below physical mass runs ($N_\tau = 8$)

$40^3 \times 8,\ H = 1/40$

β	m_l	T[MeV]	#conf
6.260	0.002025	136.98	71824
6.285	0.001975	140.62	71547
6.300	0.001930	142.85	71514
6.315	0.001900	145.11	71571
6.330	0.001865	147.40	70212
6.354	0.001820	151.14	51135
6.365	0.001790	152.88	49879
6.390	0.001735	156.92	51707
6.423	0.001675	162.39	52051
6.445	0.001630	166.14	50689
6.474	0.001580	171.19	28080
6.500	0.001535	175.84	29505

$56^3 \times 8,\ H = 1/80$

β	m_l	T[MeV]	#conf
6.285	0.0009875	140.62	23423
6.300	0.0009650	142.85	23184
6.315	0.0009500	145.11	23135
6.330	0.0009325	147.40	23132
6.354	0.0009100	151.14	22942
6.372	0.0008891	154.00	17242
6.390	0.0008675	156.92	17814
6.423	0.0008375	162.39	10937
6.445	0.0008150	166.14	10883

$56^3 \times 8,\ H = 1/160$

β	m_l	T[MeV]	#conf
6.285	0.00049375	140.62	9954
6.300	0.00048250	142.85	9999
6.315	0.00047500	145.11	6333
6.330	0.00046625	147.40	6314
6.354	0.00045500	151.14	6360
6.372	0.00044456	154.00	4551
6.390	0.00043375	156.92	6929
6.423	0.00041875	162.39	4544
6.445	0.00040750	166.14	4879

~ 98 TB (uncompressed, fp32)

~ 70 TB (uncompressed, fp32)

~ 24 TB (uncompressed, fp32)

→ plan for generation of corresponding $N_\tau = 12$ ensembles ($72^3 \times 12$)

Ensembles

- Large lattices with 2+1 flavour HISQ and $m_l = m_s/5$

T [MeV]	β	am_s	am_l	N_σ	N_τ	# conf.
195	7.570	0.01973	0.003946	64	20	5899
	7.777	0.01601	0.003202	64	24	3435
	8.249	0.01011	0.002022	96	36	2256
220	7.704	0.01723	0.003446	64	20	7923
	7.913	0.01400	0.002800	64	24	2715
	8.249	0.01011	0.002022	96	32	912
251	7.857	0.01479	0.002958	64	20	6786
	8.068	0.01204	0.002408	64	24	5325
	8.249	0.01011	0.002022	96	28	1680
293	8.036	0.01241	0.002482	64	20	6534
	8.147	0.01115	0.002230	64	22	9101
	8.249	0.01011	0.002022	96	24	688

[Altenkor et al. *Phys.Rev.Lett.* 130 (2023) 23, 231902]

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