

M_Ω Scale Setting with HISQ

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The Hadronic Vacuum Polarization from Lattice QCD at High Precision

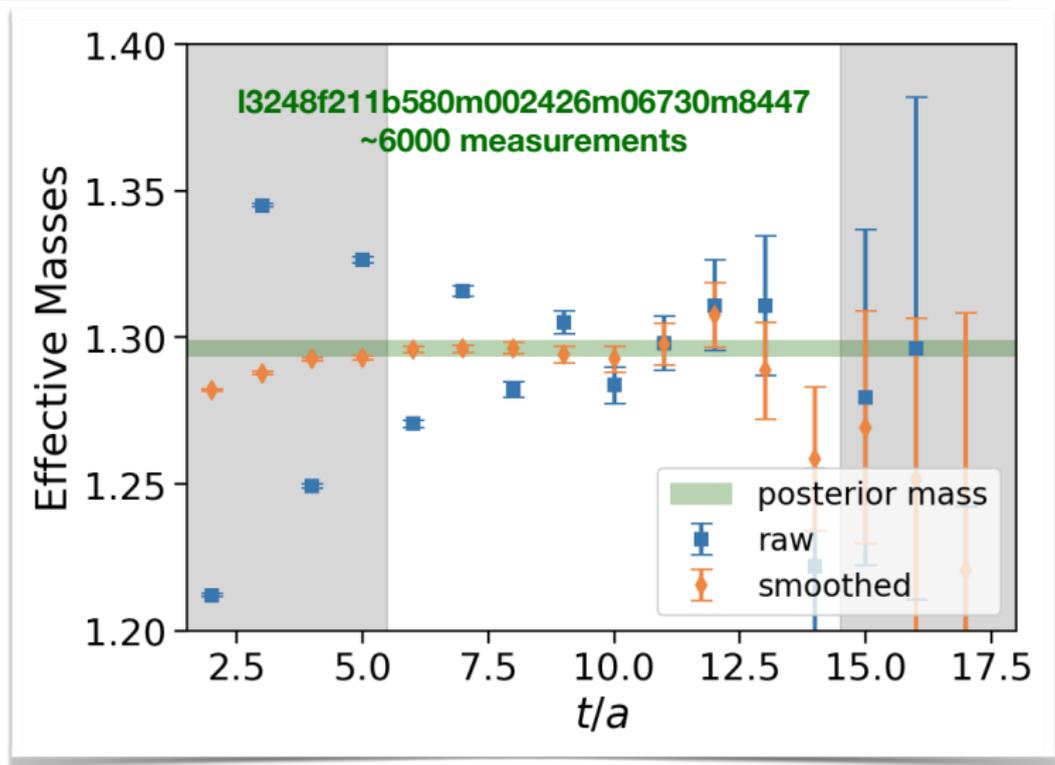
Ω in HISQ

GTS irrep	$I_s = 3/2$	$I_s = 1/2$
8	$3N_s + 2\Omega$	$5N_s + 1\Omega$
8'	$0N_s + 2\Omega$	$0N_s + 1\Omega$
16	$1N_s + 3\Omega$	$3N_s + 4\Omega$

- ▶ Taste multiplicities w/ $SU(3)$ flavor studied by Bailey [PhysRevD.75.114505]
- ▶ 2 flavors valence strange quark
 \implies “strange isospin” I_s & easy generalization from light quark sector
- ▶ N_s “strange nucleon” w/ no physical analogue, decouples when $a \rightarrow 0$

- ▶ Single-taste “physical” $\Omega \in (I_s = 3/2)$ irrep
- ▶ Properties of Ω in all irreps listed related by symmetry in $a \rightarrow 0$
 \implies any irrep listed may be used to infer properties of physical Ω
- ▶ $8', I_s = 1/2$ ideal taste multiplicity

Omega Baryon: 8' irrep Isospin-1/2 Statistics



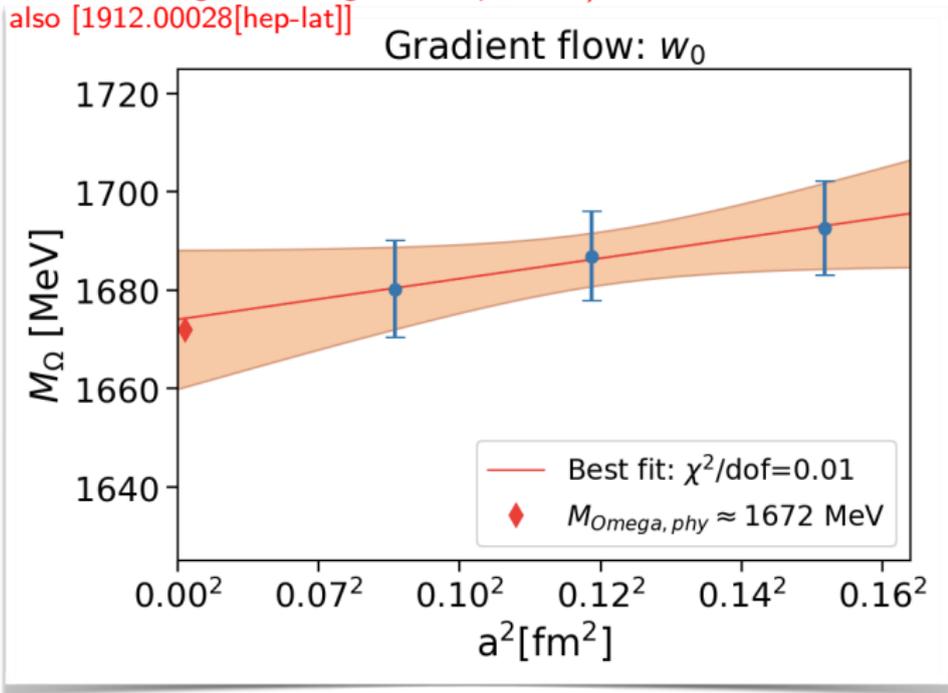
(~0.2% uncertainty)

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Slides by Yin Lin

Continuum Extrapolation with w_0

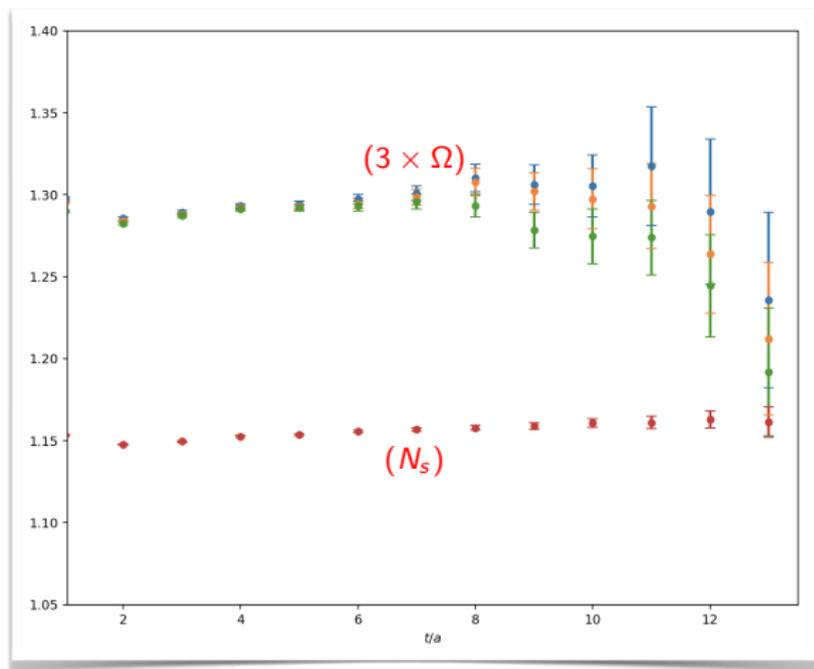
(Use w_0 scale setting to investigate extrapolation)
see also [1912.00028[hep-lat]]



$$M_\Omega = 1674(14) \text{ MeV}$$

Summary

- ▶ Goal of 0.1% statistical uncertainty is feasible (0.2% uncertainty from 6000 measurements)
- ▶ Checks for finite volume and quark mistuning corrections can be investigated on the existing HISQ ensembles
- ▶ The main obstacle is how to reduce QED corrections to the desired uncertainty
- ▶ Long term goal: reduce scale setting uncertainty to 0.1%



decay $N_s \pi$ p-wave
 $M_\pi(p^2=1) = 0.22$

Fit by eye (~ 1.15): omega is stable*

TABLE I. Ensembles used in this calculation. The notation and symbols are discussed in the text. In the first column the approximate lattice spacings are mnemonic only; the precise values are tabulated in Table IX. The second column is used as a key to identify the ensembles at a given approximate lattice spacing. A dagger (\dagger) on am'_s flags ensembles for which the simulation strange-quark mass is deliberately chosen far from the physical value. The M_π and L values are different from those listed in Table I of Ref. [23], because those values assumed a mass-dependent scale setting scheme.

$\approx a$ (fm)	Key	β	am'_l	am'_s	am'_c	$(L/a)^3 \times (T/a)$	L (fm)	M_π (MeV)	$M_\pi L$	N_{conf}
0.15	$m_s/5$	5.80	0.013	0.065	0.838	$16^3 \times 48$	2.45	305	3.8	1020
0.15	$m_s/10$	5.80	0.0064	0.064	0.828	$24^3 \times 48$	3.67	214	4.0	1000
0.15	physical	5.80	0.00235	0.0647	0.831	$32^3 \times 48$	4.89	131	3.3	1000
0.12	$m_s/5$	6.00	0.0102	0.0509	0.635	$24^3 \times 64$	2.93	305	4.5	1040
0.12	unphysA	6.00	0.0102	0.03054 \dagger	0.635	$24^3 \times 64$	2.93	304	4.5	1020
0.12	small	6.00	0.00507	0.0507	0.628	$24^3 \times 64$	2.93	218	3.2	1020
0.12	$m_s/10$	6.00	0.00507	0.0507	0.628	$32^3 \times 64$	3.91	217	4.3	1000
0.12	large	6.00	0.00507	0.0507	0.628	$40^3 \times 64$	4.89	216	5.4	1028
0.12	unphysB	6.00	0.01275	0.01275 \dagger	0.640	$24^3 \times 64$	2.93	337	5.0	1020
0.12	unphysC	6.00	0.00507	0.0304 \dagger	0.628	$32^3 \times 64$	3.91	215	4.3	1020
0.12	unphysD	6.00	0.00507	0.022815 \dagger	0.628	$32^3 \times 64$	3.91	214	4.2	1020
0.12	unphysE	6.00	0.00507	0.012675 \dagger	0.628	$32^3 \times 64$	3.91	214	4.2	1020
0.12	unphysF	6.00	0.00507	0.00507 \dagger	0.628	$32^3 \times 64$	3.91	213	4.2	1020
0.12	unphysG	6.00	0.0088725	0.022815 \dagger	0.628	$32^3 \times 64$	3.91	282	5.6	1020
0.12	physical	6.00	0.00184	0.0507	0.628	$48^3 \times 64$	5.87	132	3.9	999
0.09	$m_s/5$	6.30	0.0074	0.037	0.440	$32^3 \times 96$	2.81	316	4.5	1005
0.09	$m_s/10$	6.30	0.00363	0.0363	0.430	$48^3 \times 96$	4.22	221	4.7	999
0.09	physical	6.30	0.0012	0.0363	0.432	$64^3 \times 96$	5.62	129	3.7	484
0.06	$m_s/5$	6.72	0.0048	0.024	0.286	$48^3 \times 144$	2.72	329	4.5	1016
0.06	$m_s/10$	6.72	0.0024	0.024	0.286	$64^3 \times 144$	3.62	234	4.3	572
0.06	physical	6.72	0.0008	0.022	0.260	$96^3 \times 192$	5.44	135	3.7	842
0.042	$m_s/5$	7.00	0.00316	0.0158	0.188	$64^3 \times 192$	2.73	315	4.3	1167
0.042	physical	7.00	0.000569	0.01555	0.1827	$144^3 \times 288$	6.13	134	4.2	420
0.03	$m_s/5$	7.28	0.00223	0.01115	0.1316	$96^3 \times 288$	3.09	309	4.8	724