

# Finite size scaling of conformal theories in the presence of a near-marginal operator

Anqi Cheng, Anna Hasenfratz, Yuzhi Liu, Gregory Petropoulos, and David Schaich  
*Department of Physics, University of Colorado, Boulder, CO 80309, USA*

The slowly evolving gauge coupling of strongly coupled gauge-fermion systems makes the numerical analysis of these models challenging. We show that finite size scaling techniques lead to inconsistent results if the near-marginal gauge coupling is neglected. When the corrections are included we find consistent results not only between different operators but between different gauge coupling values, even when combining data obtained using different lattice actions. Our results indicate that the SU(3) 12-fermion system is conformal with mass anomalous dimension  $\gamma_m = 0.22(x)$ . We also consider the finite size scaling fits of the 8-fermion system where again we find consistent scaling, though in this case we are not able to distinguish conformal and chirally broken but volume squeezed behavior.

Operator	$\beta$	$y_m$	$y_0$	$c_0$	$s_m$	$\chi^2/\text{dof}[\text{dof}]$	$\chi^2/\text{dof}[\text{dof}]$
PS	4.0	1.4216(33)	-	0	-	5.9[42]	3.3 [29]
PS	4.0	1.178 (15)	-0.36	-0.790 (42)	-	1.9[42]	1.5 [28]
<b>PS</b>	4.0	1.24 (15)	-0.36	-0.65	-		1.3 [28]
PS	4.0	1.172 (15)	-0.219(6)	-0.768 (31)	1	1.7 [42]	
PS	4.0	1.195 (16)	0.406(4)	-0.761 (45)	1	2.8 [76]	
PS	4.5			-0.575 (50)	0.71		
PS	4.0	1.220(15)	-0.429(27)	-0.688(39)	1	3.6[117]	<b>1.2 [95]</b>
	4.5			-0.486(49)	0.71		
	5.0			-0.379(56)	0.55		
PS	2.8	1.193 (11)	-0.386(12)	-1.267 (14)	3.0	5.1 [182]	
	4.0			-0.766 (27)	1		
	4.5			-0.592 (34)	0.71		
	5.0			-0.501 (38)	0.55		
	5.5			-0.412 (42)	0.44		
	6.0			-0.013 (59)	0.31		
PS	2.8	1.194 (11)	-0.339(11)	-1.266 (14)	3.0	4.7 [200]	
	4.0			-0.761 (27)	1		
	4.5			-0.586 (34)	0.71		
	5.0			-0.494 (37)	0.55		
	5.5			-0.404 (41)	0.44		
	6.0			<b>-0.xxx</b> (58)	0.31		
	LHC[? ]			-0.859 (24)	1.1		
PS	2.8	1.1952(96)	-0.339(11)	-1.189(11) <b>1.62 ??</b>	3.0	7.6 [225]	
	4.0			-0.765(22)	1		
	4.5			-0.614(28)	0.71		
	5.0			-0.545(30)	0.55		
	5.5			-0.466(33)	0.44		
	6.0			-0.147 (46)	0.31		
	LHC[? ]			-0.852 (19)	1.1		
	KMI 3.7[? ]			-0.525(31)	0.43		
	KMI 4.0[? ]			-0.525(31)	0.xx		
PS,V	4.0	1.xx	-0.xx	xx	1	xxx	
	4.5			xx	xx		
	5.0			xx	xx		
PS,V, $f_\pi$	4.0,4.5,5.0		as above	xx	1		
	LHC[? ]			xx	xx		
	KMI[? ]			xx	xx		

TABLE I: Results of the finite size scaling analysis in the 12 flavor system. The pseudoscalar and vector masses and  $f_{pi}$  are analyzed at various  $\beta_F$  couplings with the nHYP action, combined with the published data of the LHC and Lat-KMI collaborations [? ?].  $c_0$  denotes the amplitude of the gauge coupling in the fit and  $s_m$  is the scale factor of the bare mass relative to the  $\beta_F = 4.0$  nHYP data.