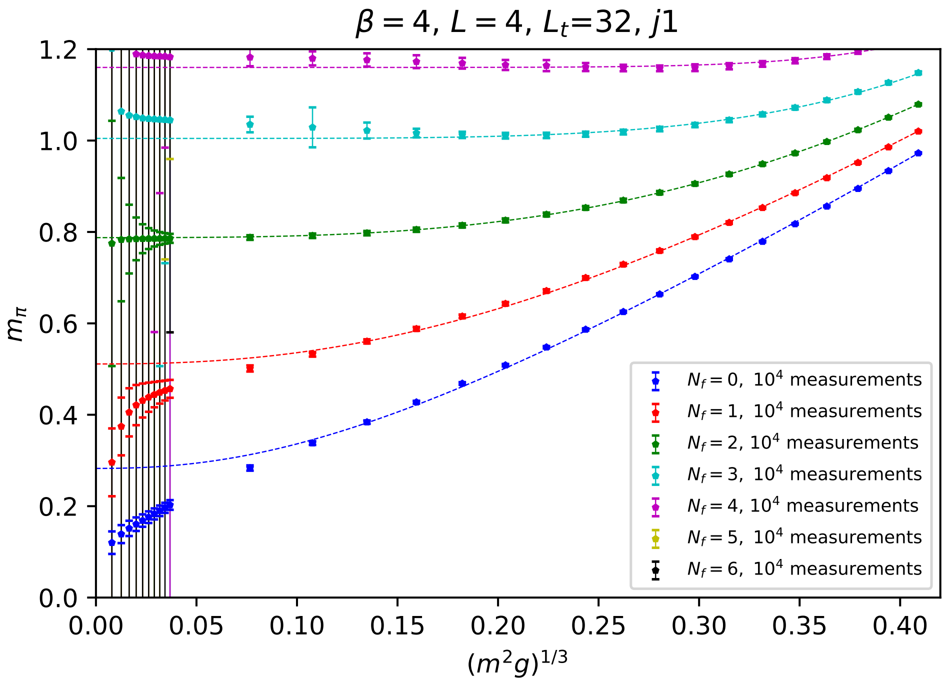
Mass Reweighting

May 12, 2022

We show the pion mass as a function of $(m^2 g)^{1/3}$. In order to extrapolate the pion mass we fitted a function of the form $m_\pi = \sqrt{a + b\,x^c}$, with $x = (m^2 g)^{1/3}$ and a, b, c fitting parameters. We only fit the region $x > 0.076$.



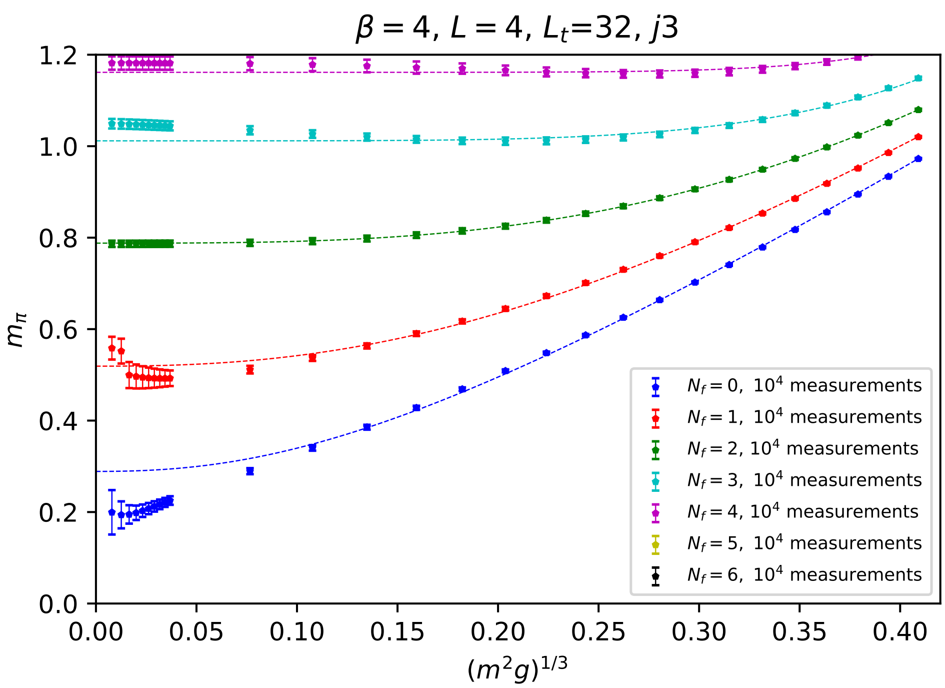


Figure 1: Pion mass as a function of the degenerate $(m^2g)^{1/3}$ for different flavors. $L = 4$, $L_t = 32$.

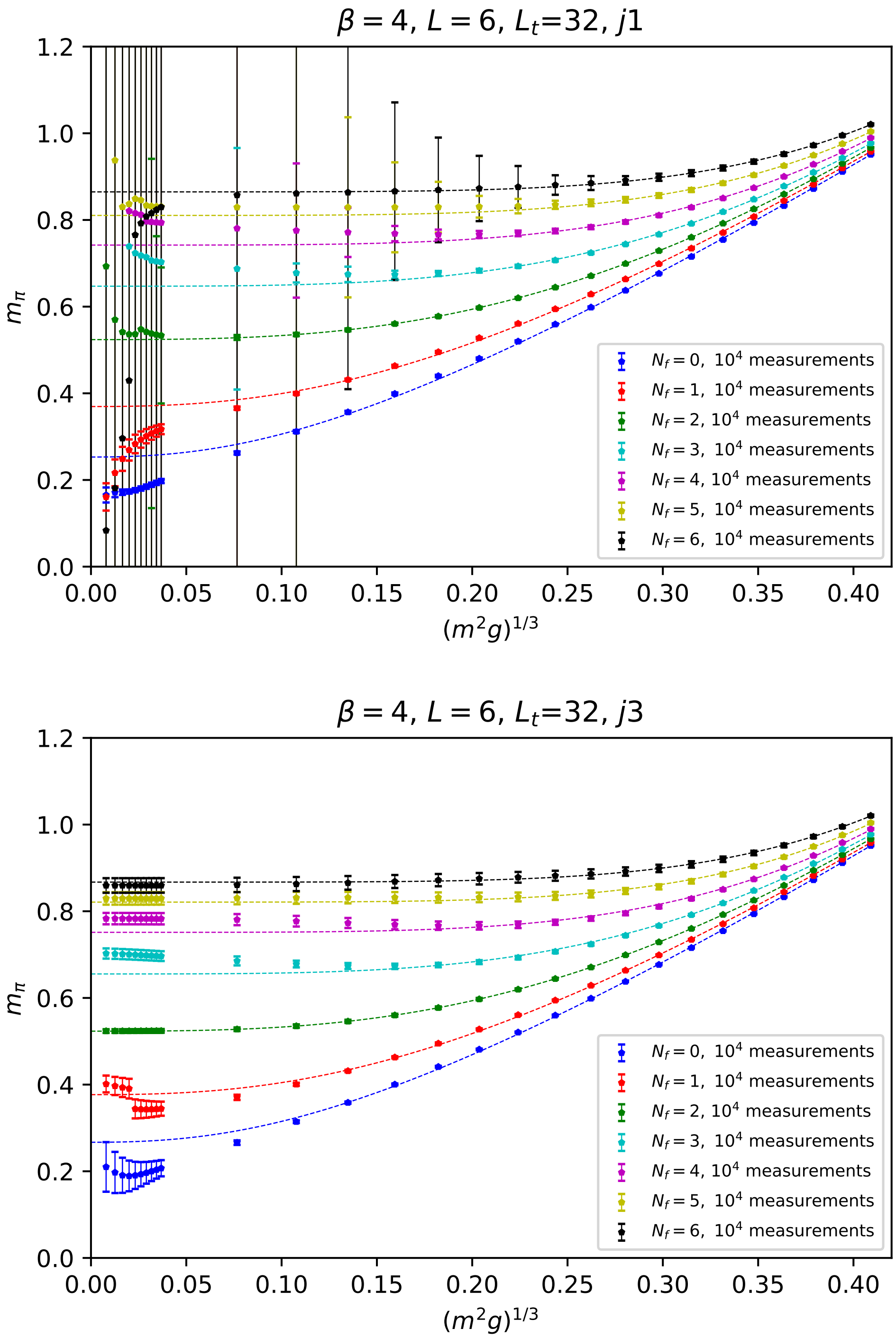


Figure 2: Pion mass as a function of the degenerate $(m^2 g)^{1/3}$ for different flavors. $L = 6$, $L_t = 32$.

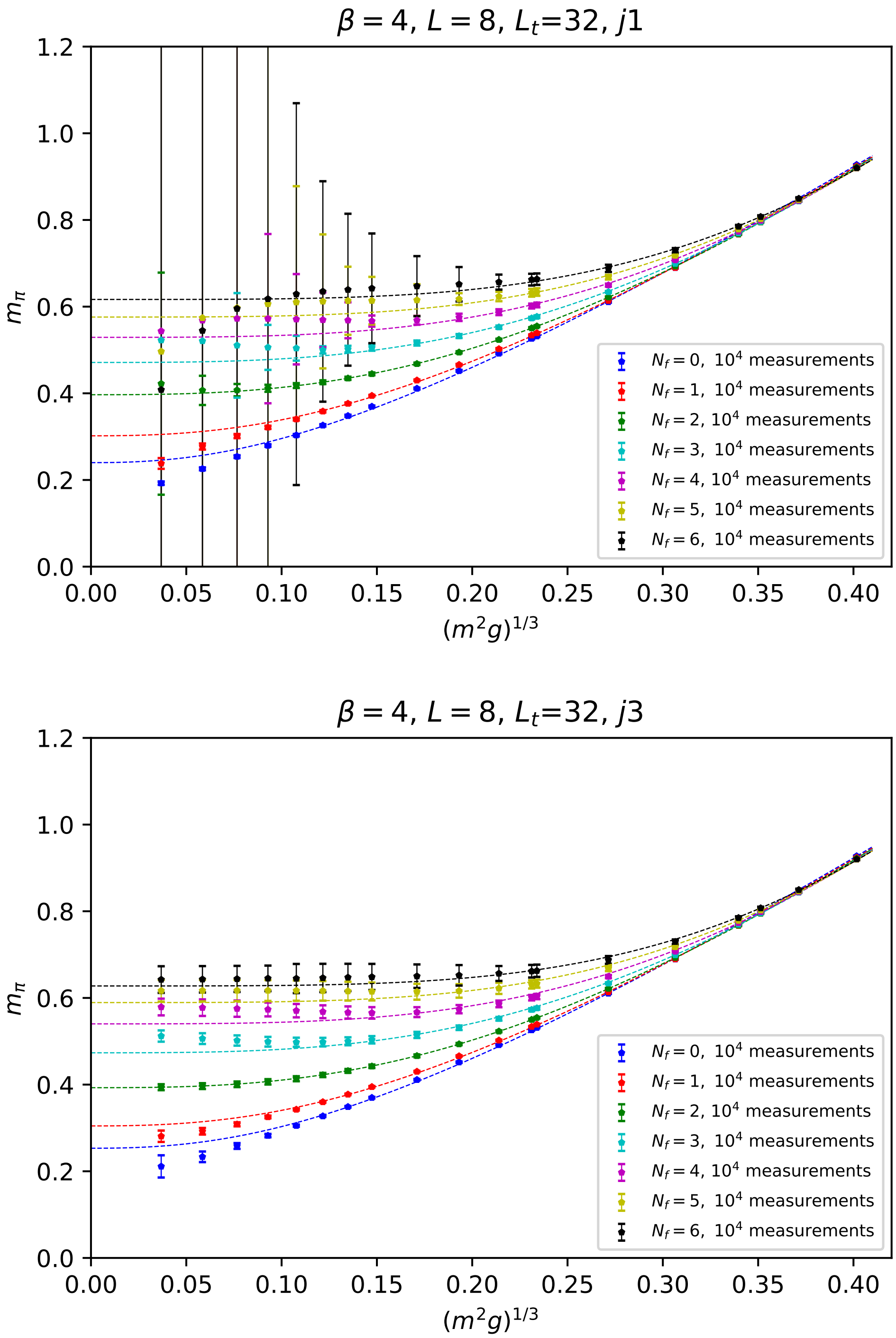


Figure 3: Pion mass as a function of the degenerate $(m^2g)^{1/3}$ for different flavors. $L = 8$, $L_t = 32$.

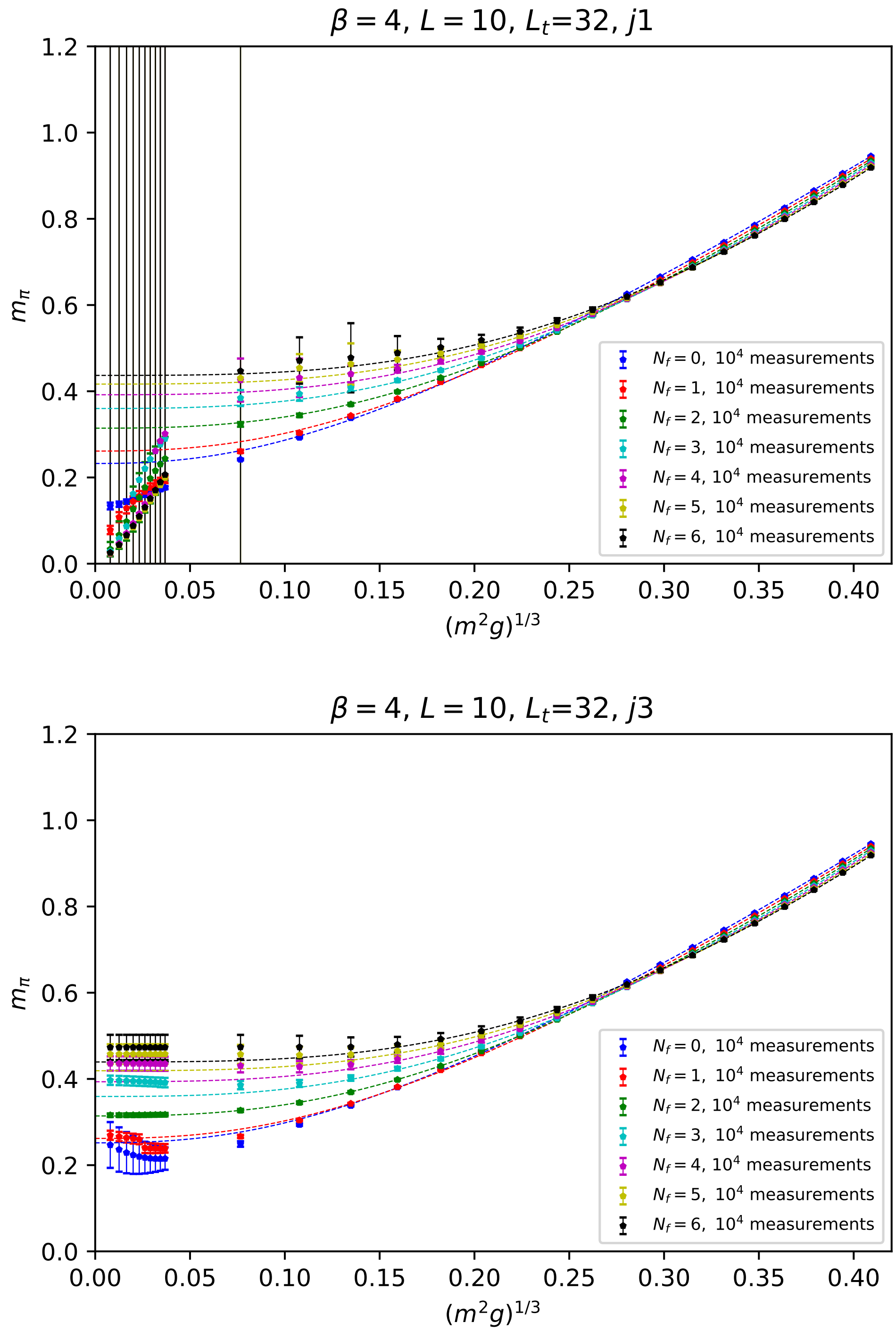


Figure 4: Pion mass as a function of the degenerate $(m^2g)^{1/3}$ for different flavors. $L = 10$, $L_t = 32$.

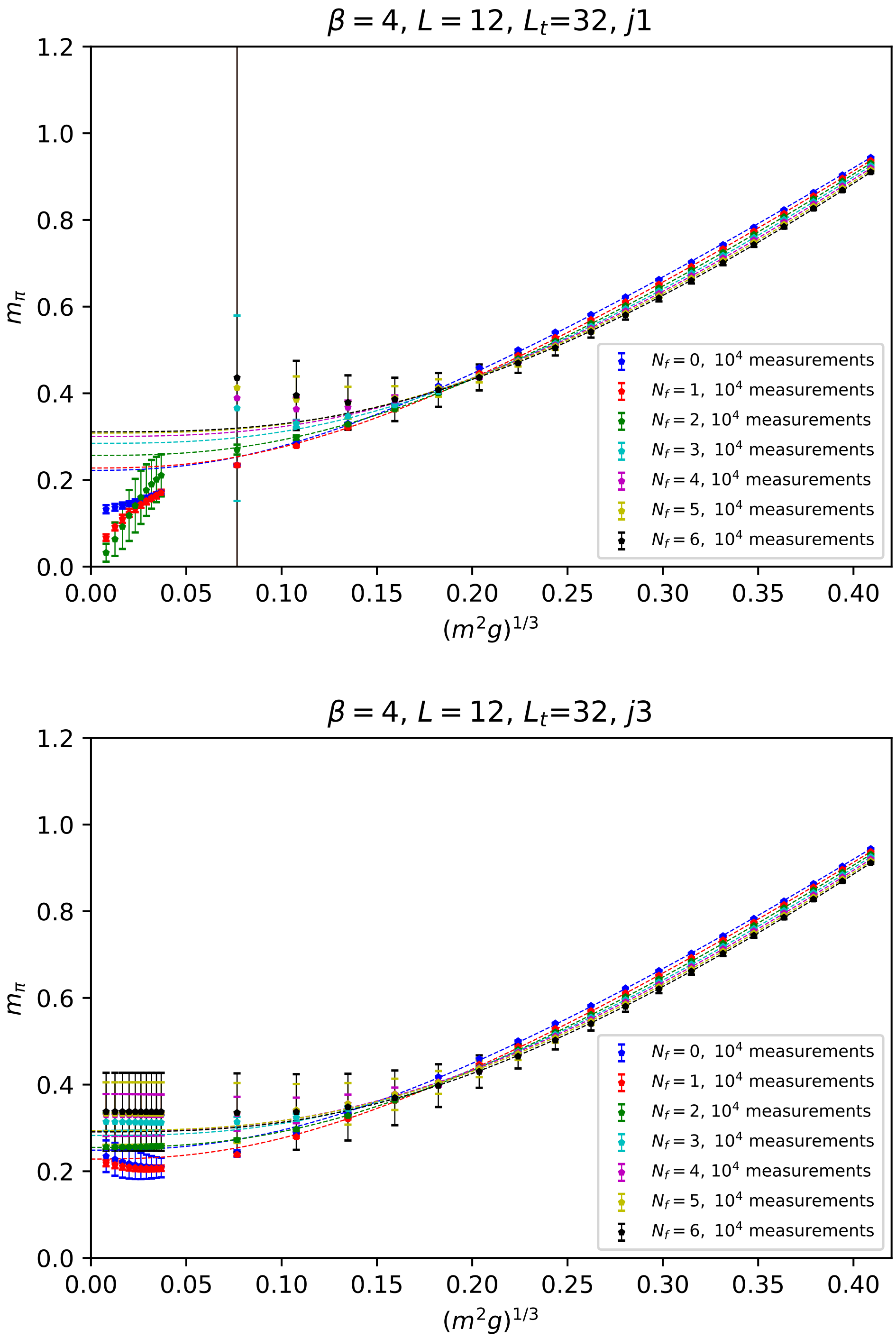
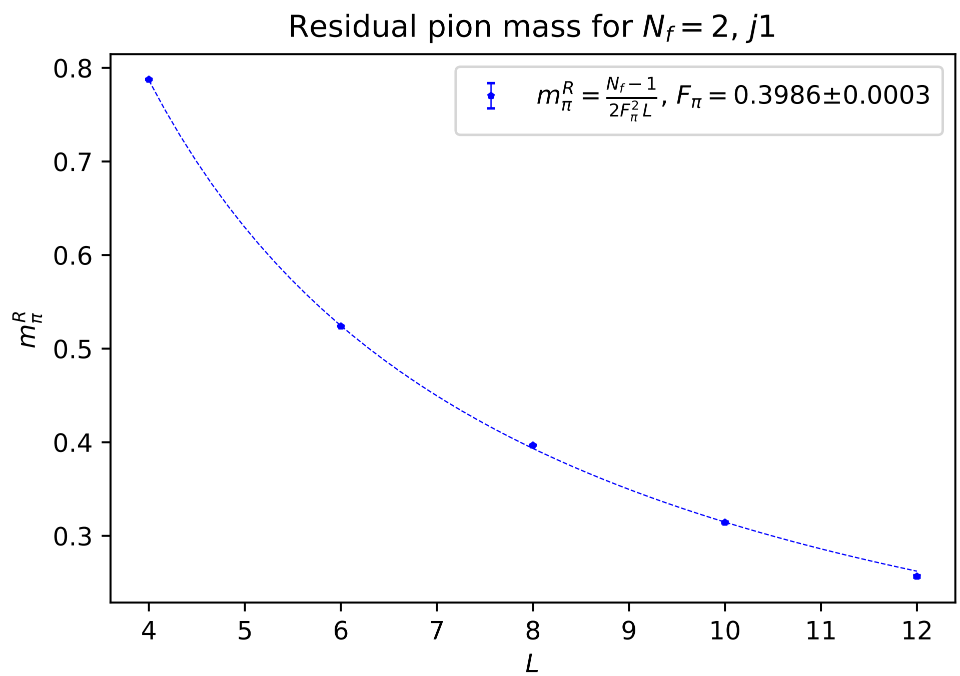


Figure 5: Pion mass as a function of the degenerate $(m^2 g)^{1/3}$ for different flavors. $L = 12$, $L_t = 32$.

1 Pion decay constant in the delta-regime

We show the residual pion mass m_π^R as a function of the spatial size L and fit a function proportional to $1/L$ to obtain F_π.



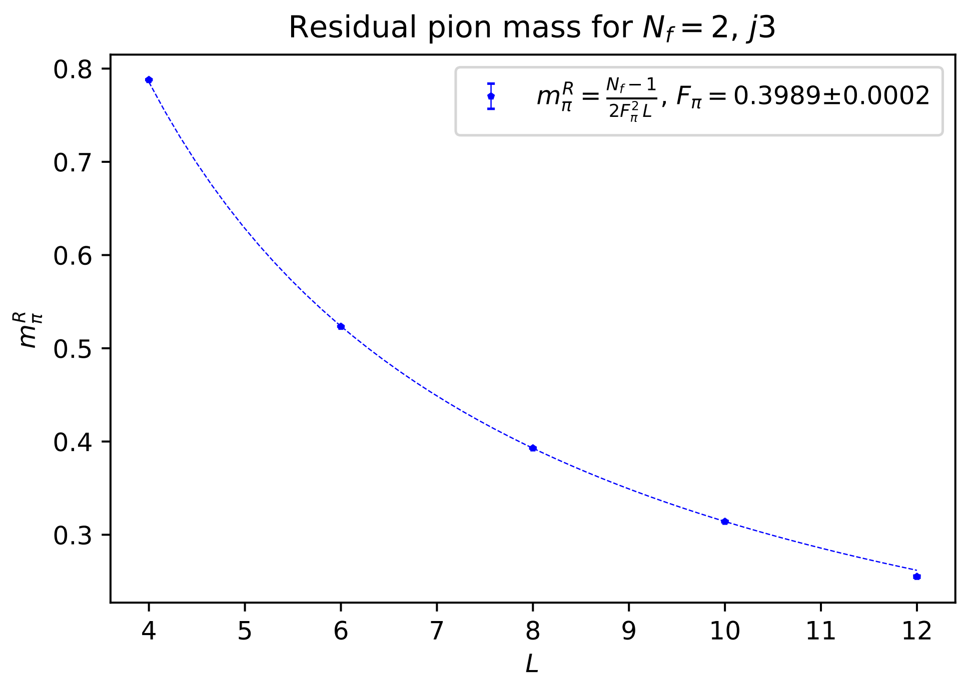
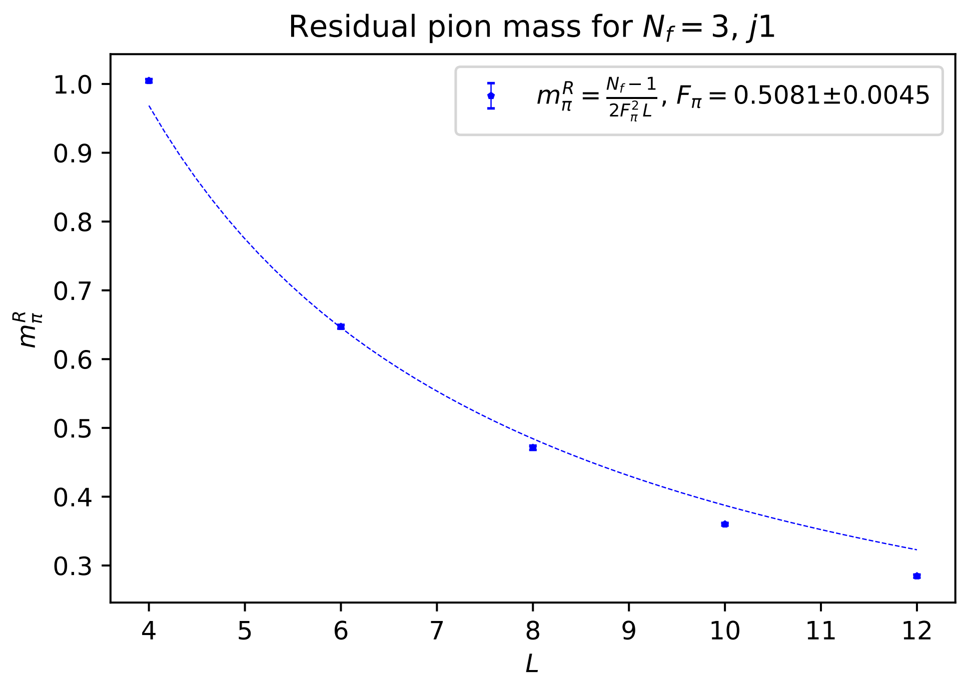
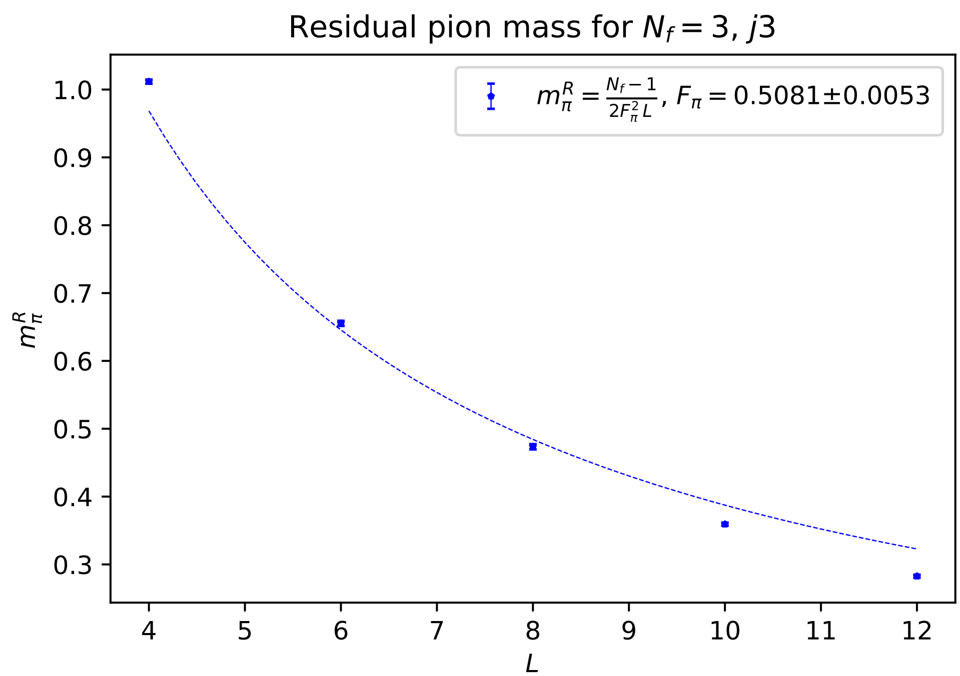


Figure 6: $N_f = 2$; $1/\sqrt{2\pi} = 0.39894\ldots$

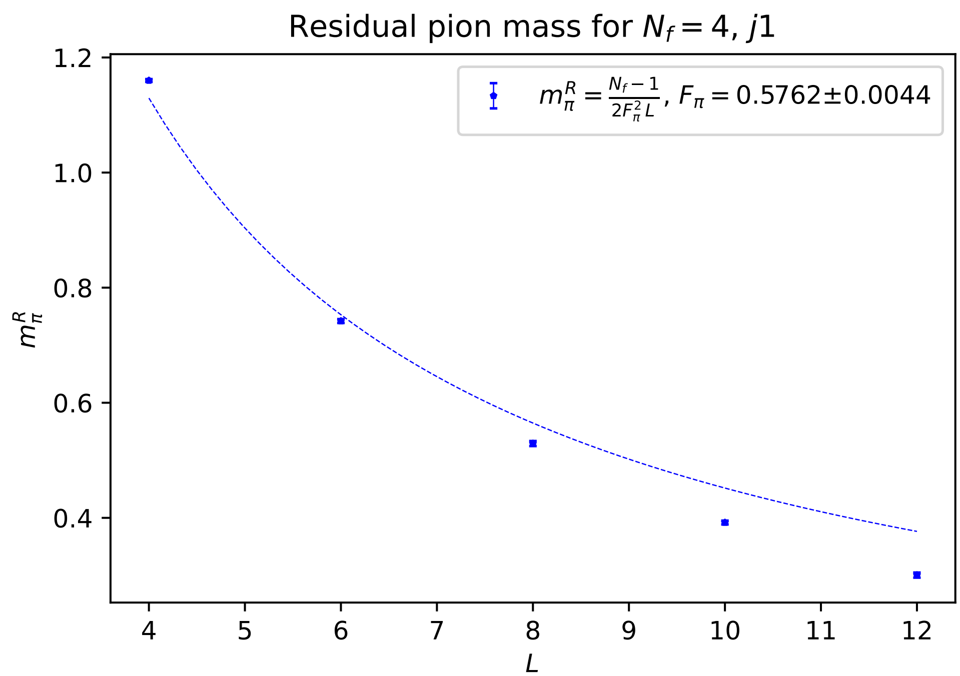


Residual pion mass for $N_f = 3$, $j1$
$m_\pi^R = \frac{N_f - 1}{2F_\pi^2 L}$, $F_\pi = 0.5081 \pm 0.0045$
m_π^R
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
4
5
6
7
8
9
10
11
12
L

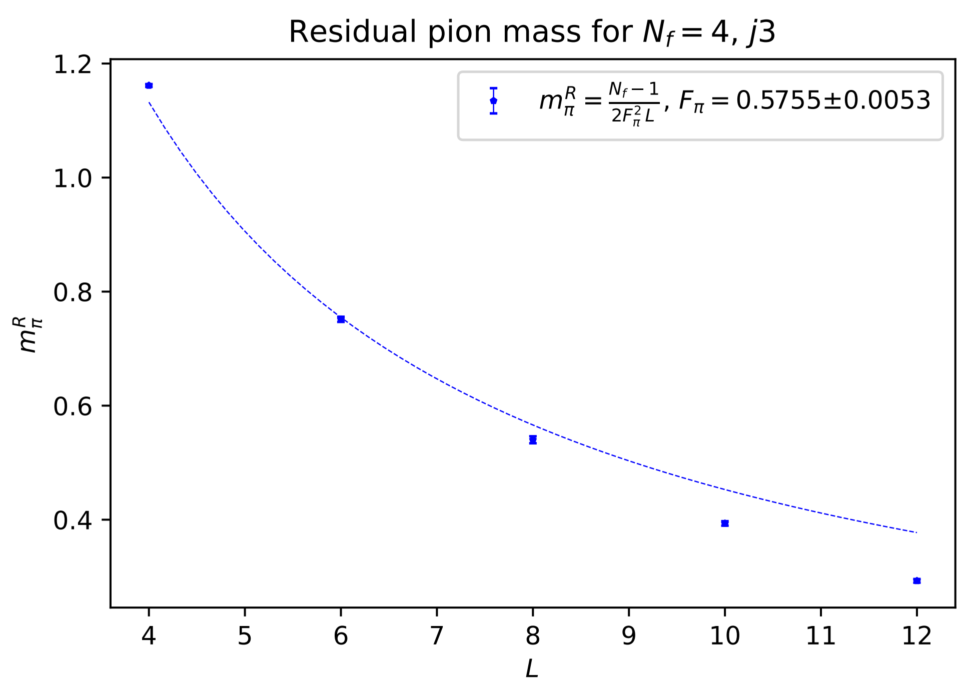


Residual pion mass for $N_f = 3$, $j3$
$m_\pi^R = \frac{N_f - 1}{2F_\pi^2 L}$, $F_\pi = 0.5081 \pm 0.0053$
m_π^R
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
4
5
6
7
8
9
10
11
12
L

Figure 7: $N_f = 3$

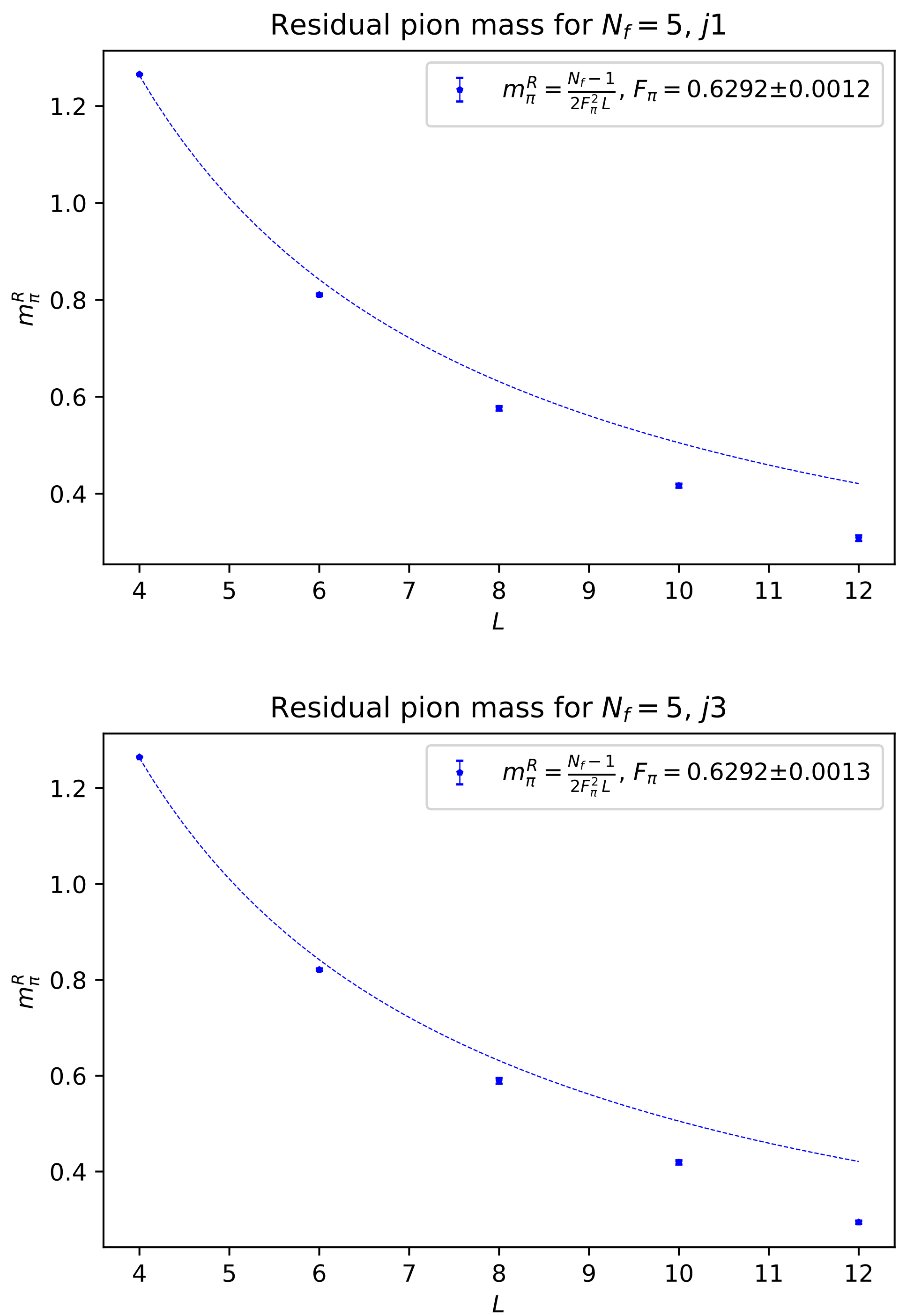


Residual pion mass for $N_f = 4$, $j1$
$m_\pi^R = \frac{N_f - 1}{2F_\pi^2 L}$, $F_\pi = 0.5762 \pm 0.0044$
m_π^R
L
1.2
1.0
0.8
0.6
0.4
4
5
6
7
8
9
10
11
12



Residual pion mass for $N_f = 4$, $j3$
$m_\pi^R = \frac{N_f - 1}{2F_\pi^2 L}$, $F_\pi = 0.5755 \pm 0.0053$
m_π^R
L
1.2
1.0
0.8
0.6
0.4
4
5
6
7
8
9
10
11
12

Figure 8: $N_f = 4$



Residual pion mass for $N_f = 5$, $j1$
$m_\pi^R = \frac{N_f - 1}{2F_\pi^2 L}$, $F_\pi = 0.6292 \pm 0.0012$
m_π^R
1.2
1.0
0.8
0.6
0.4
4
5
6
7
8
9
10
11
12
L
Residual pion mass for $N_f = 5$, $j3$
$m_\pi^R = \frac{N_f - 1}{2F_\pi^2 L}$, $F_\pi = 0.6292 \pm 0.0013$
m_π^R
1.2
1.0
0.8
0.6
0.4
4
5
6
7
8
9
10
11
12
L

Figure 9: $N_f = 5$

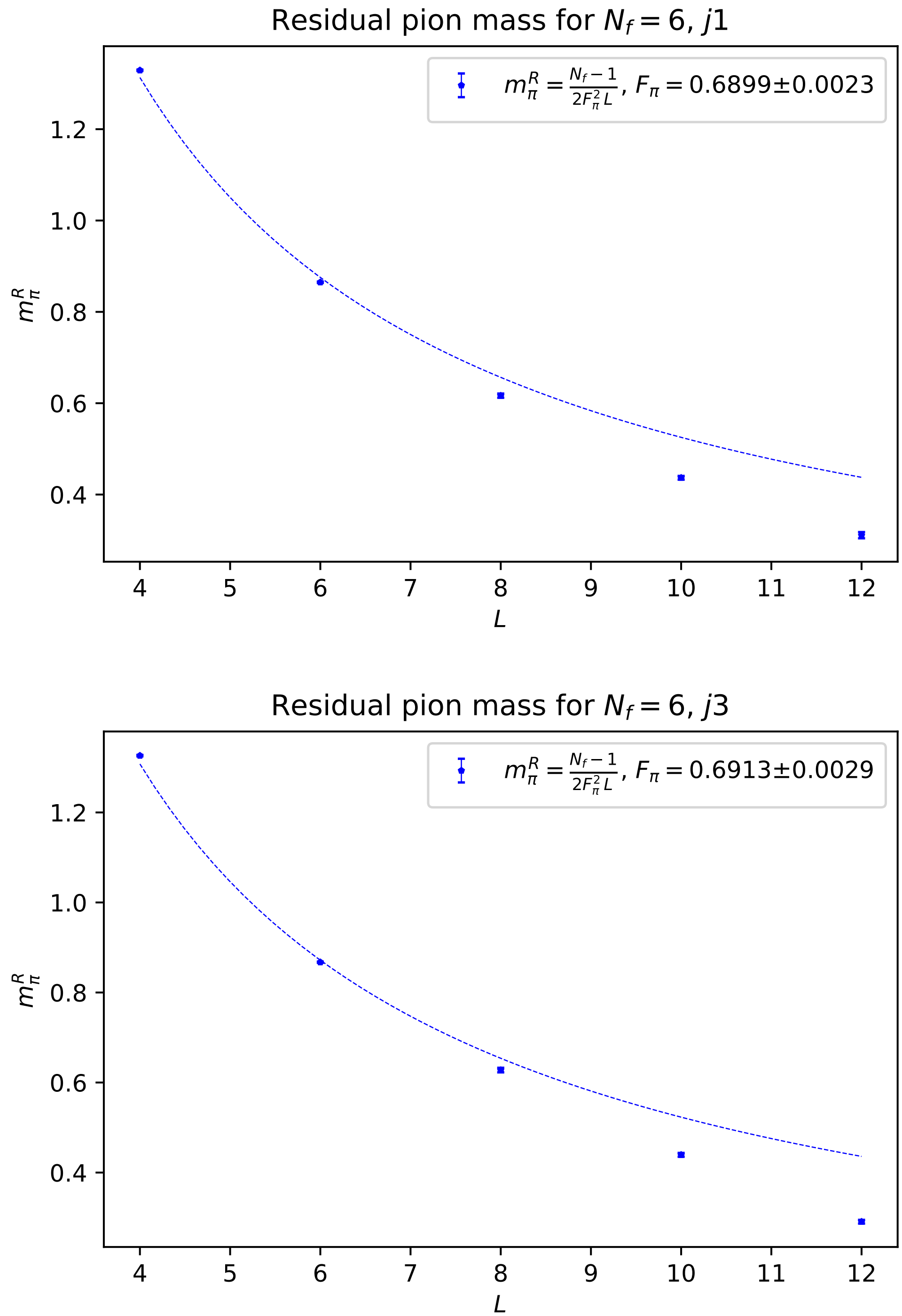
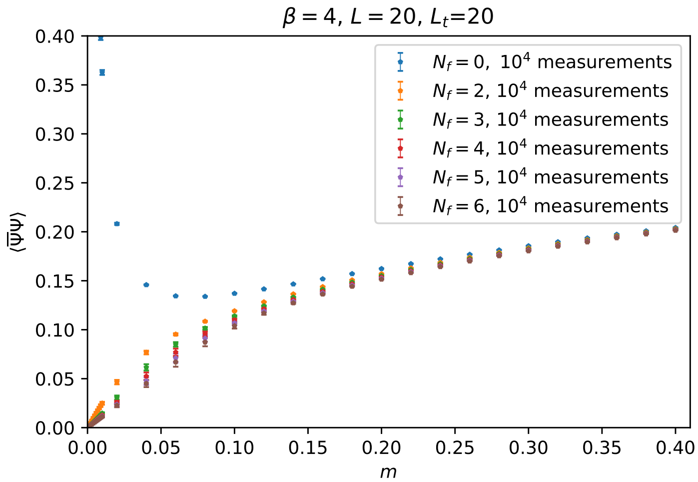


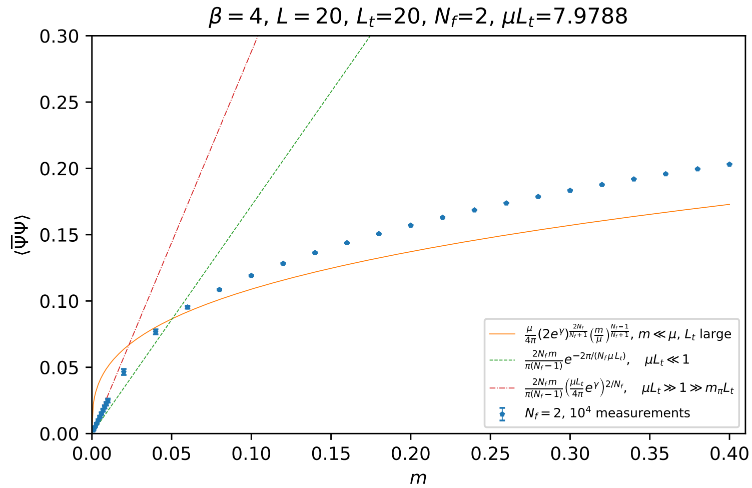
Figure 10: $N_f = 6$

2 Chiral condensate at finite temperature

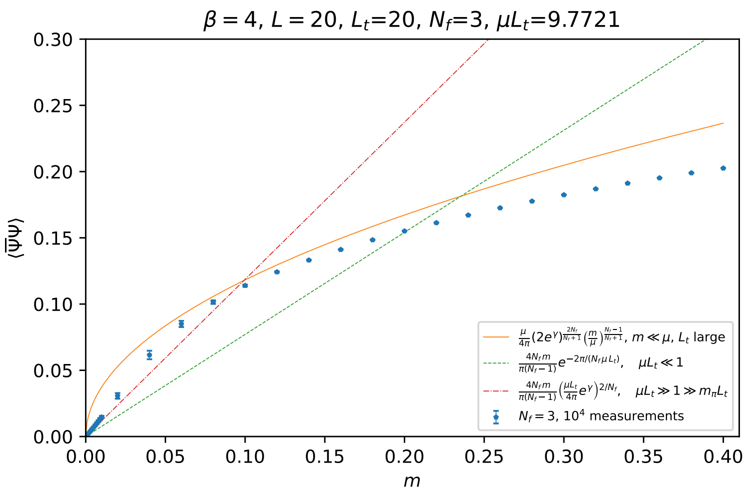
We show the chiral condensate for several lattices together with some predictions, valid in different regimes, for N_f flavors that are written in eqs. (13), (15) and (16) of ref. [1].



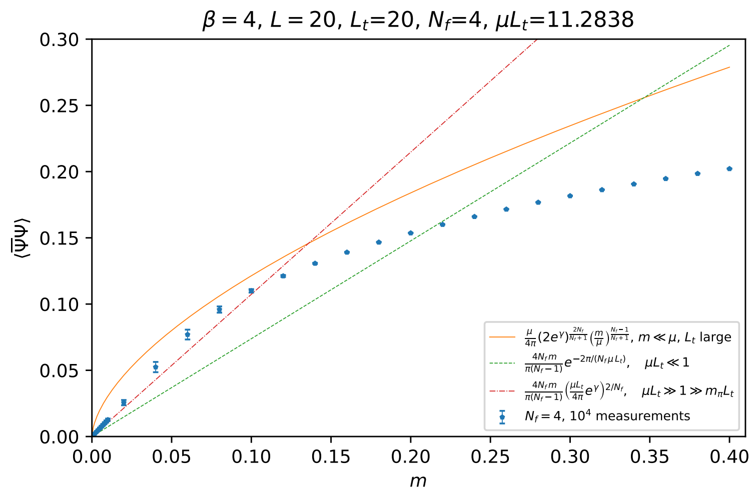
(a)



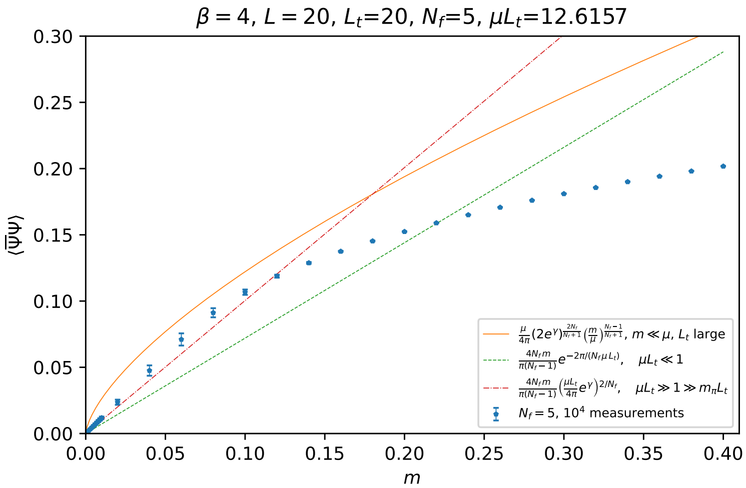
(b)



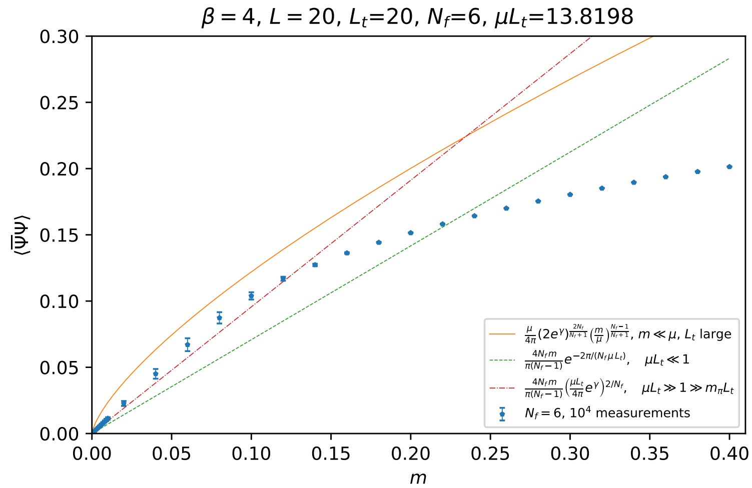
(c)



(d)

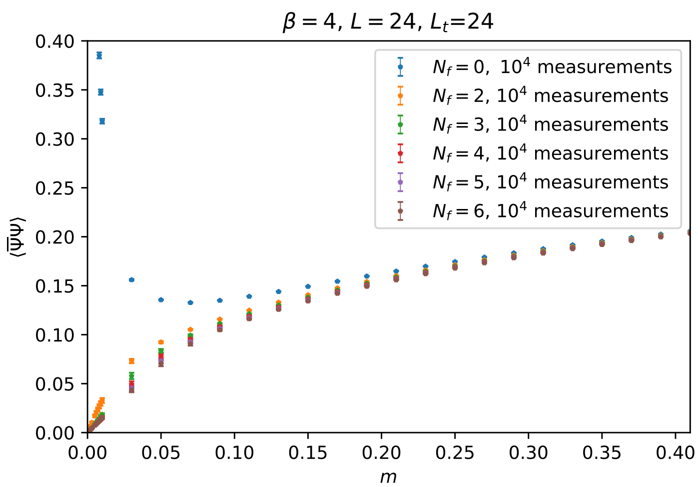


(e)

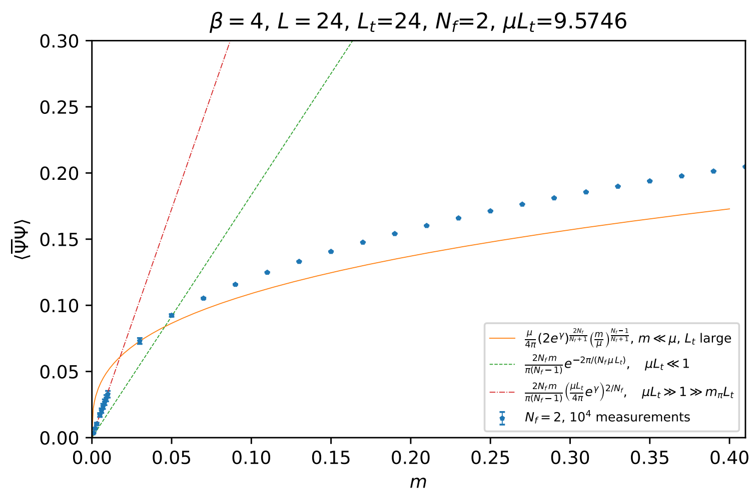


(f)

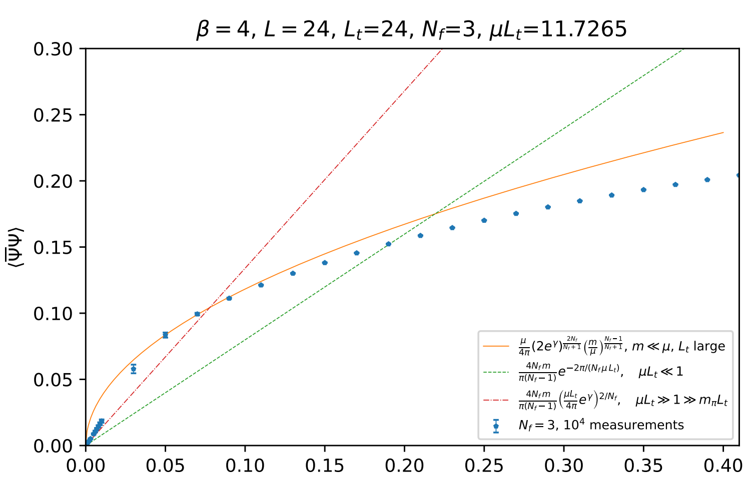
Figure 11: Chiral condensate as a function of the degenerate fermion mass for different flavors. $L = 20$, $L_t = 20$



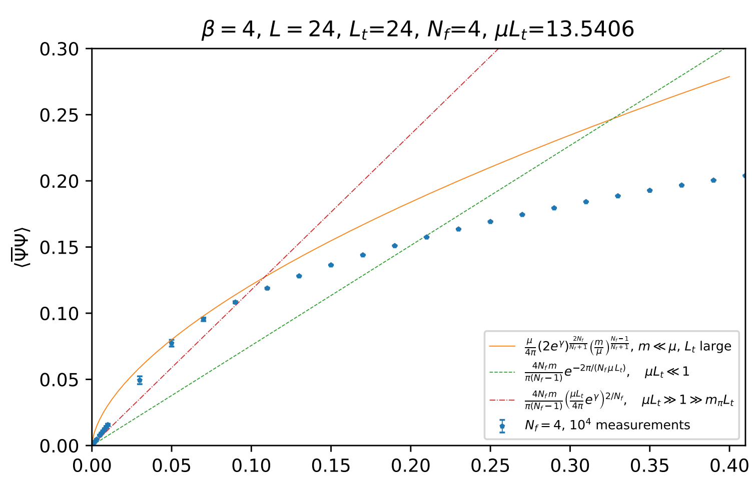
(a)



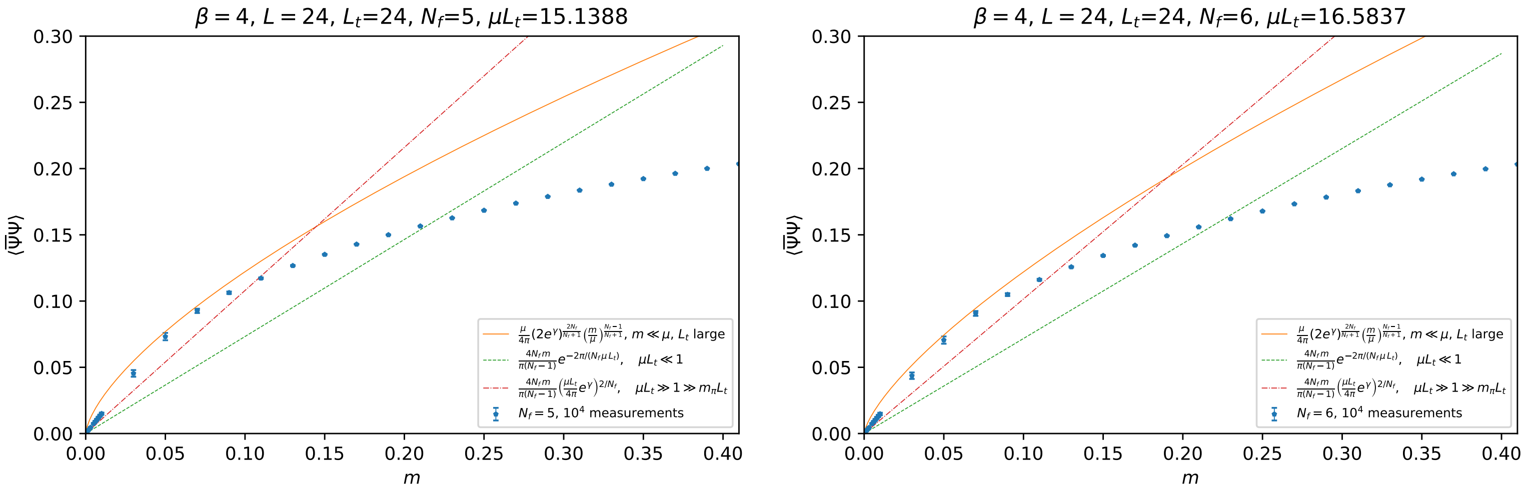
(b)



(c)



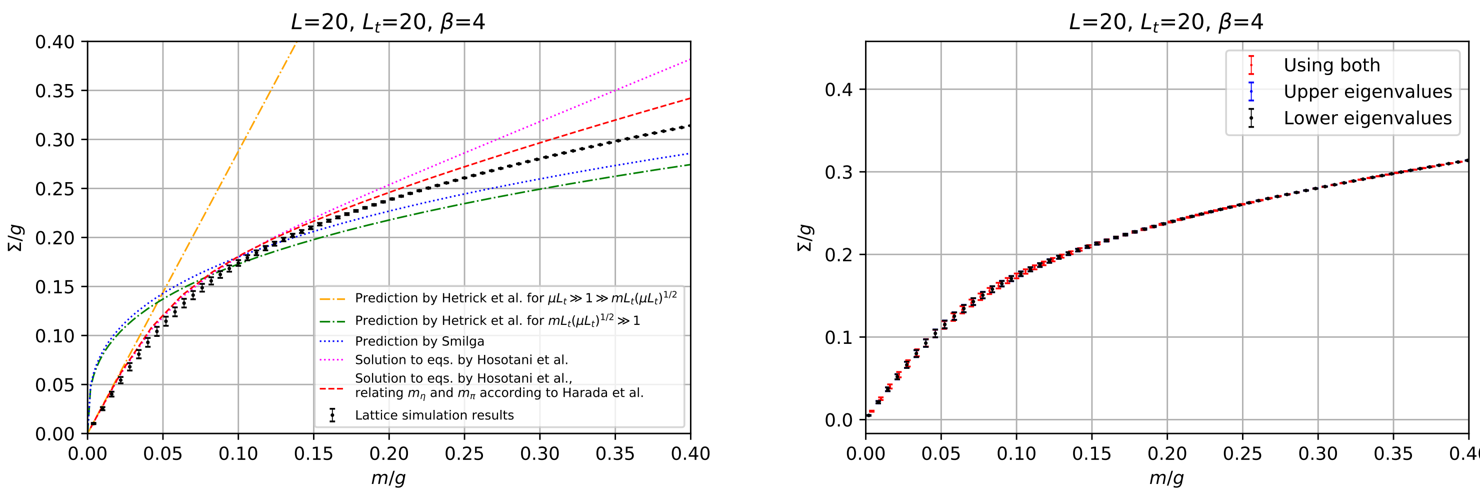
(d)



(e) (f)

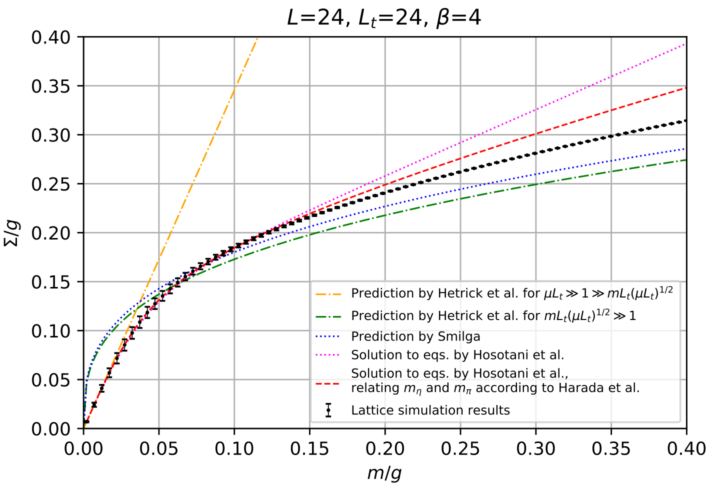
Figure 12: Chiral condensate as a function of the degenerate fermion mass for different flavors. $L = 24$, $L_t = 24$

2.1 Numerical stability check

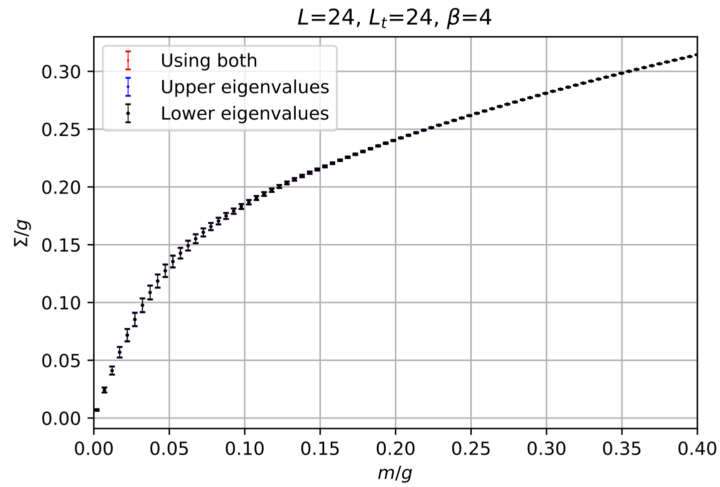


(a) (b)

Figure 13: $L = 20$, $L_t = 20$



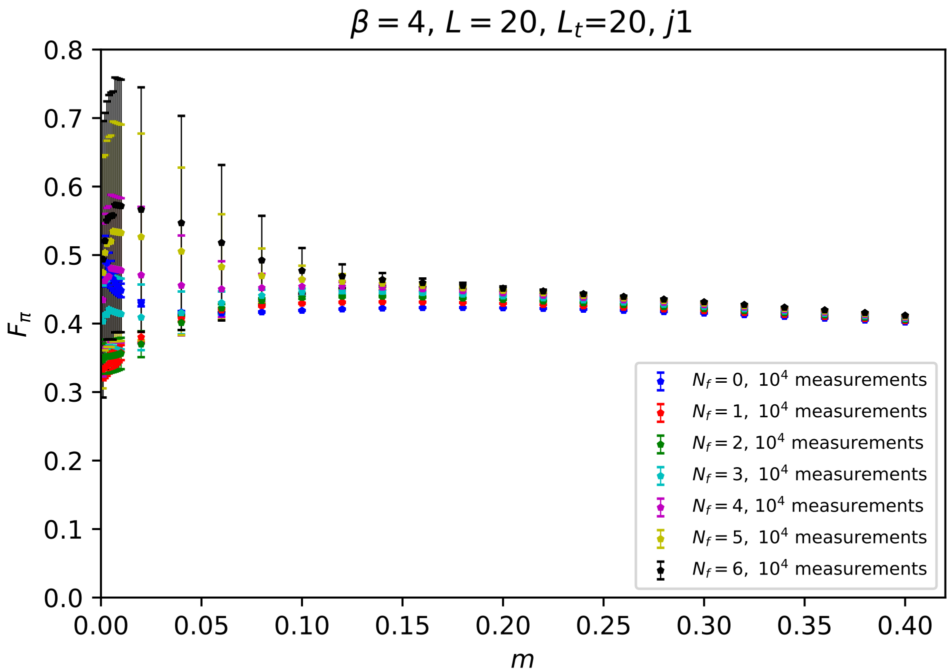
(a)



(b)

Figure 14: $L = 24,\ L_t = 24$

3 Pion decay constant at finite temperature



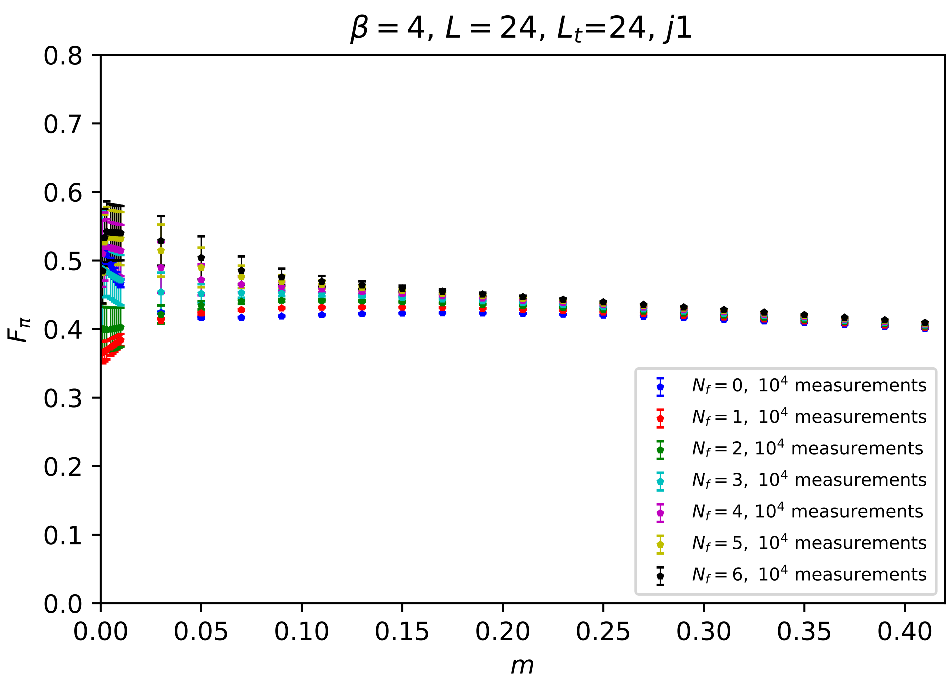


Figure 15: F_π for different flavors assuming the GMOR relation.

N_f	F_π Leut. form. j_1	F_π Leut. form. j_3	F_π magic form. j_1	F_π magic form. j_3	F_π finite T
2	0.3986(3)	0.3989(2)	0.3986(3)	0.3989(2)	0.4004(361)
3	0.5081(45)	0.5081(53)	0.4148	0.4148	0.4877(856)
4	0.5762(44)	0.5755(53)	0.4074	0.4069	0.5099(483)
5	0.6292(12)	0.6292(13)	0.3979	0.3979	0.4819(447)
6	0.6899(23)	0.6913(29)	0.3983	0.3991	0.4845(471)

Table 1: F_π measured with different methods and for different flavors. Leutwyler's formula stands for $m_\pi^R = (N_f - 1)/2F_\pi^2 L$, while magic formula refers to $m_\pi^R = (N_f - 1)/N_f F_\pi^2 L$. The finite temperature results correspond to the value of F_π at $m = 0.001$ in figure 15, for the 24x24 lattice.

References

[1] J. E. Hetrick, Y. Hosotani, and S. Iso. Interplay between mass, volume, vacuum angle and chiral condensate in N avor QED in two-dimensions. *Phys. Rev. D*, **53**, 1996. arXiv:hep-th/9510090.