Numerical S-matrix Bootstrap

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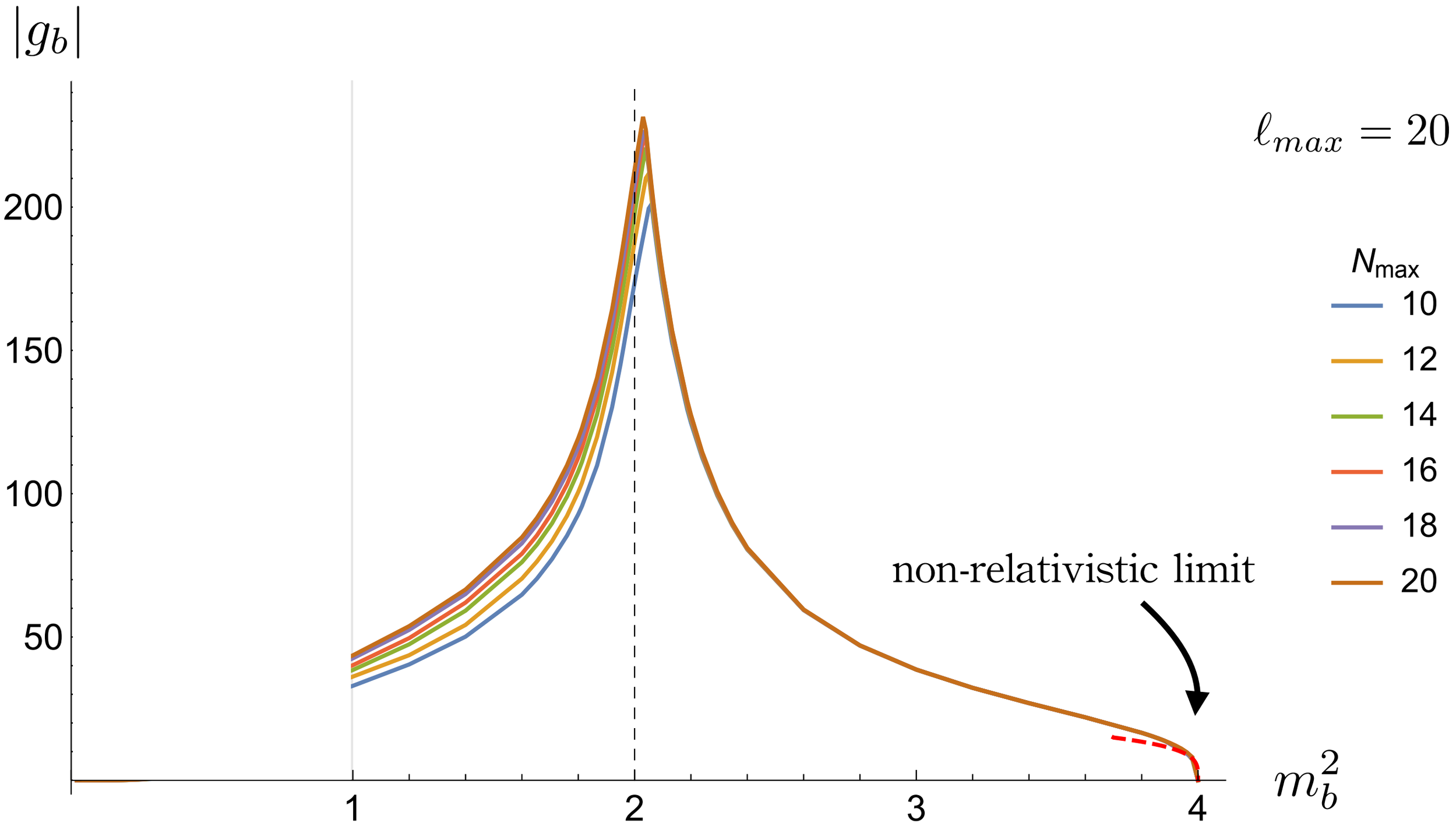
Based on [arXiv:1708.06765] and [arXiv:1810.12849] with

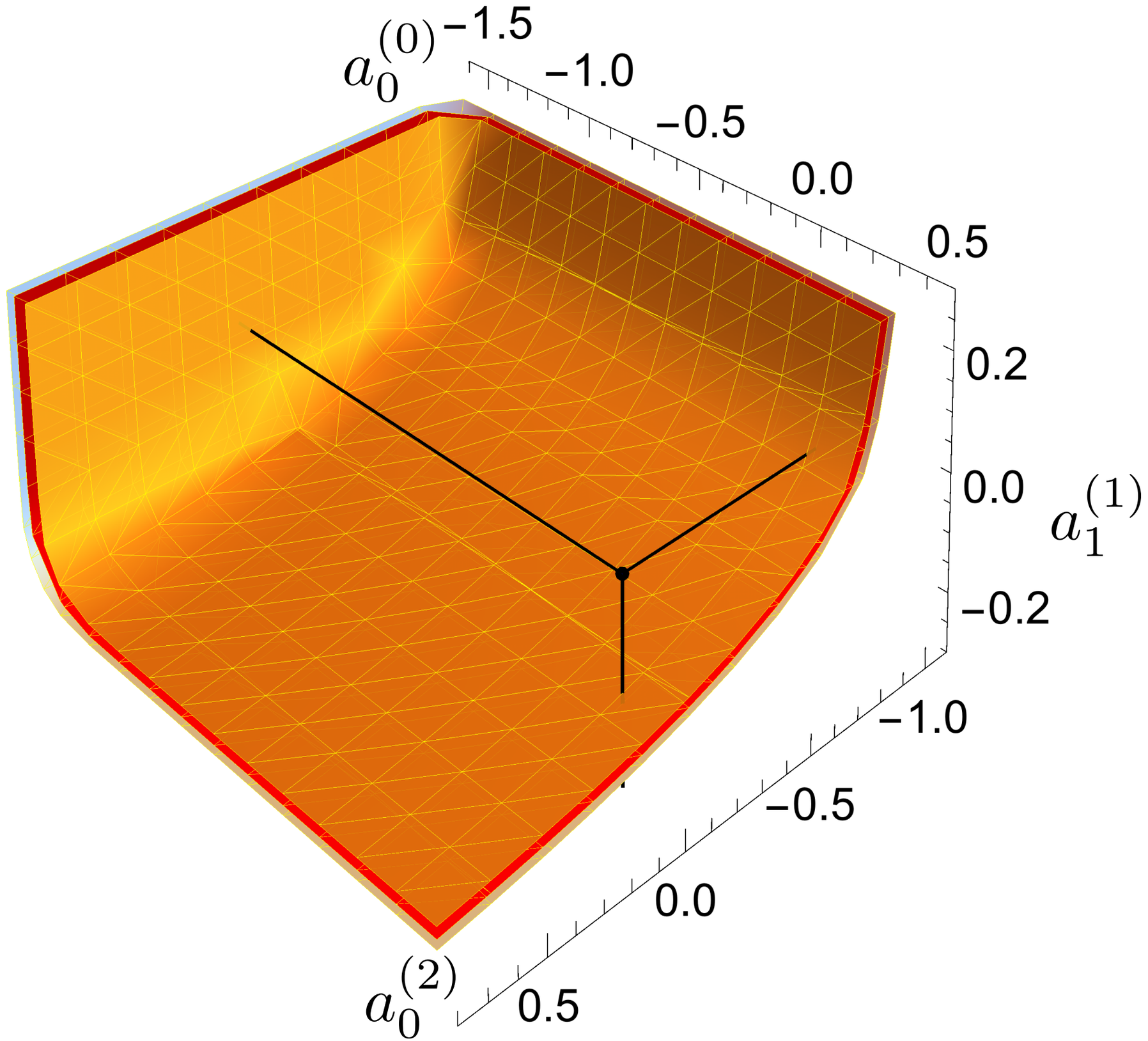
A. Guerrieri, M. Paulos, J. Toledo, B. Van Rees, P. Vieira

Nazareth, 19th of February, 2019

Maximal cubic coupling in 3+1 QFT

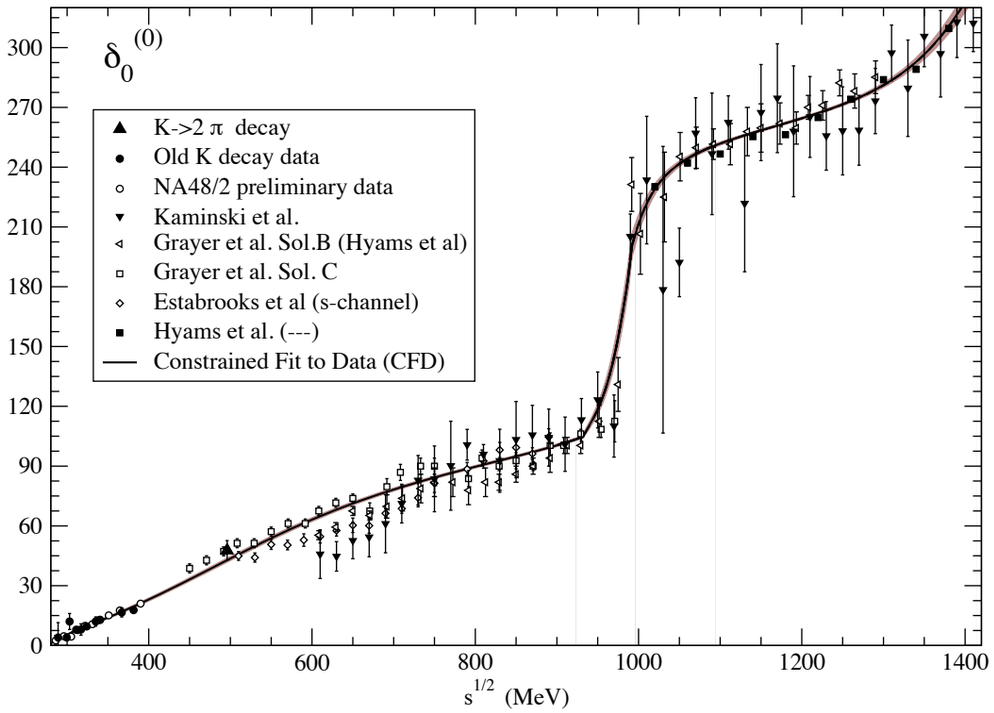


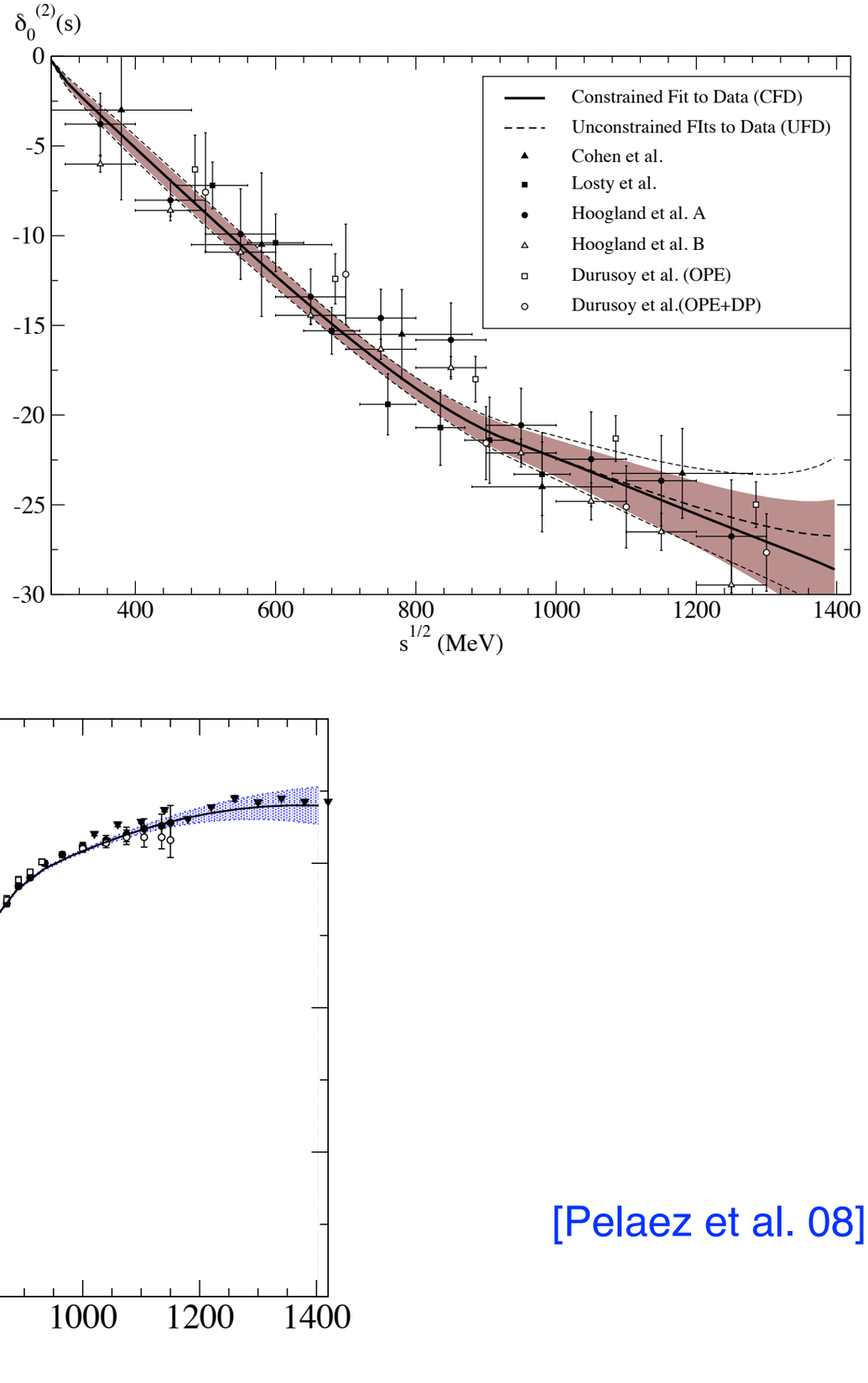
Bounds on scattering lengths



Pion Scattering

Experimental phase shifts

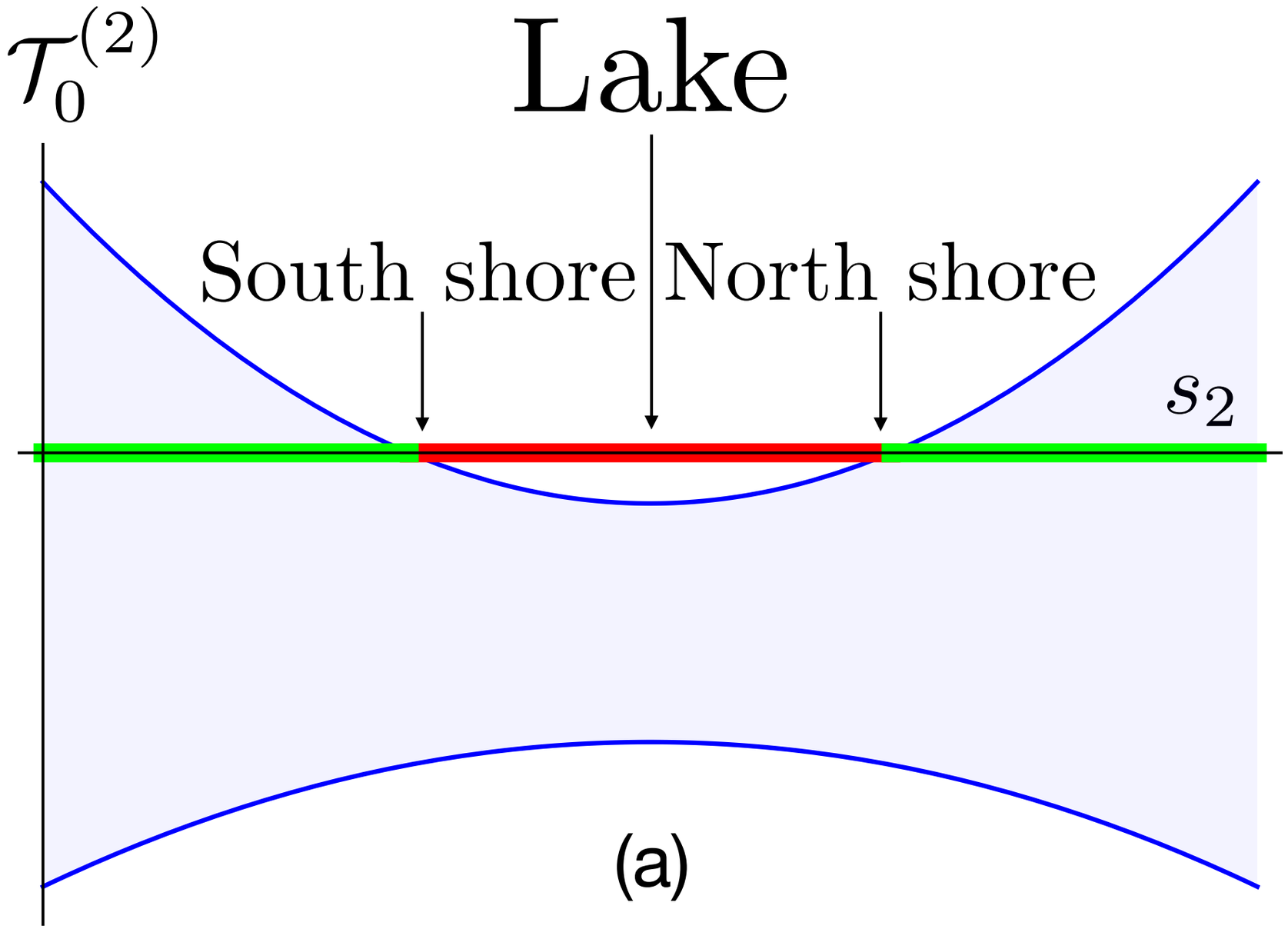




[Pelaez et al. 08]

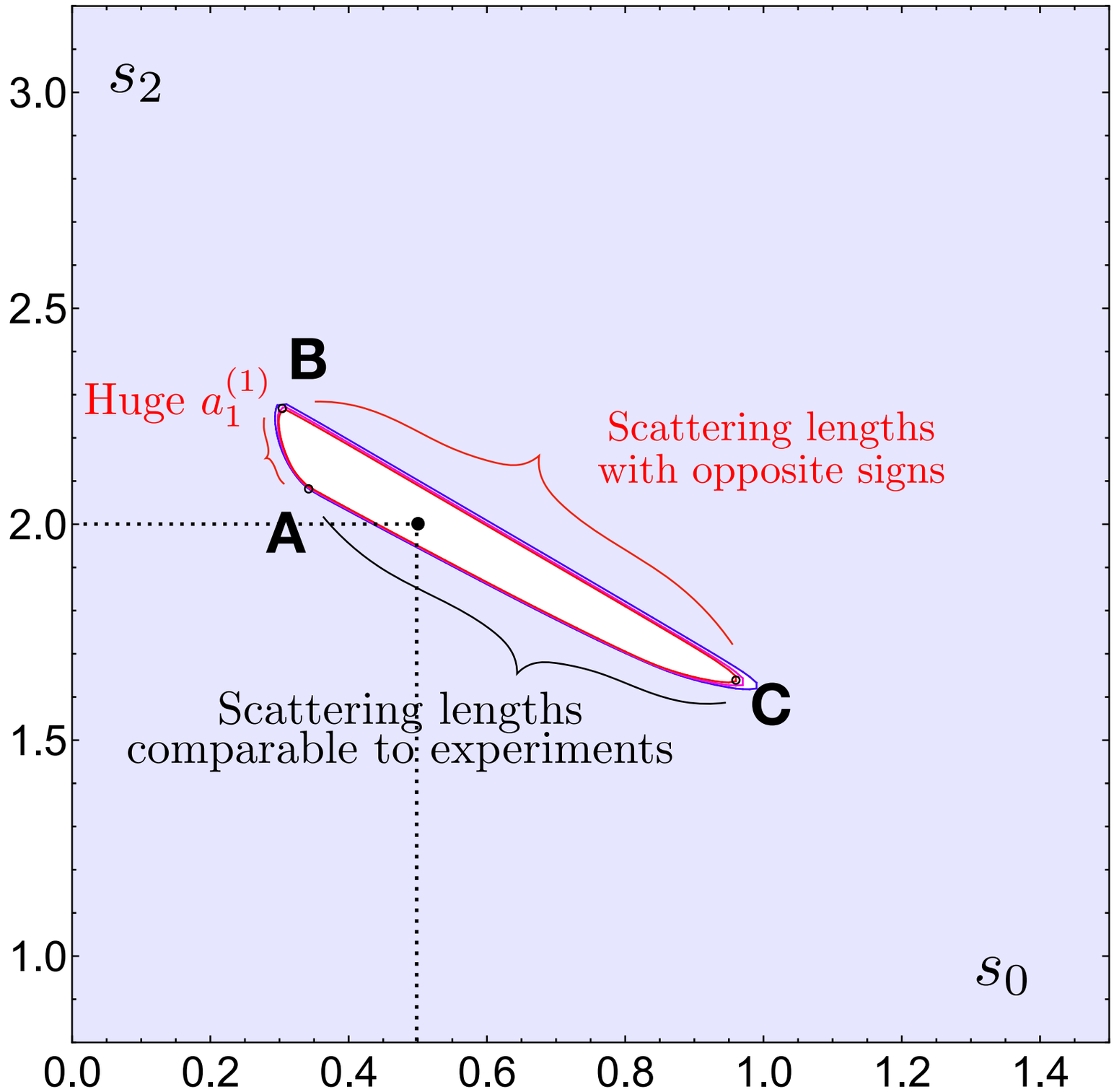
The Lake

Max-Min $\mathcal{T}_0^{(2)}$

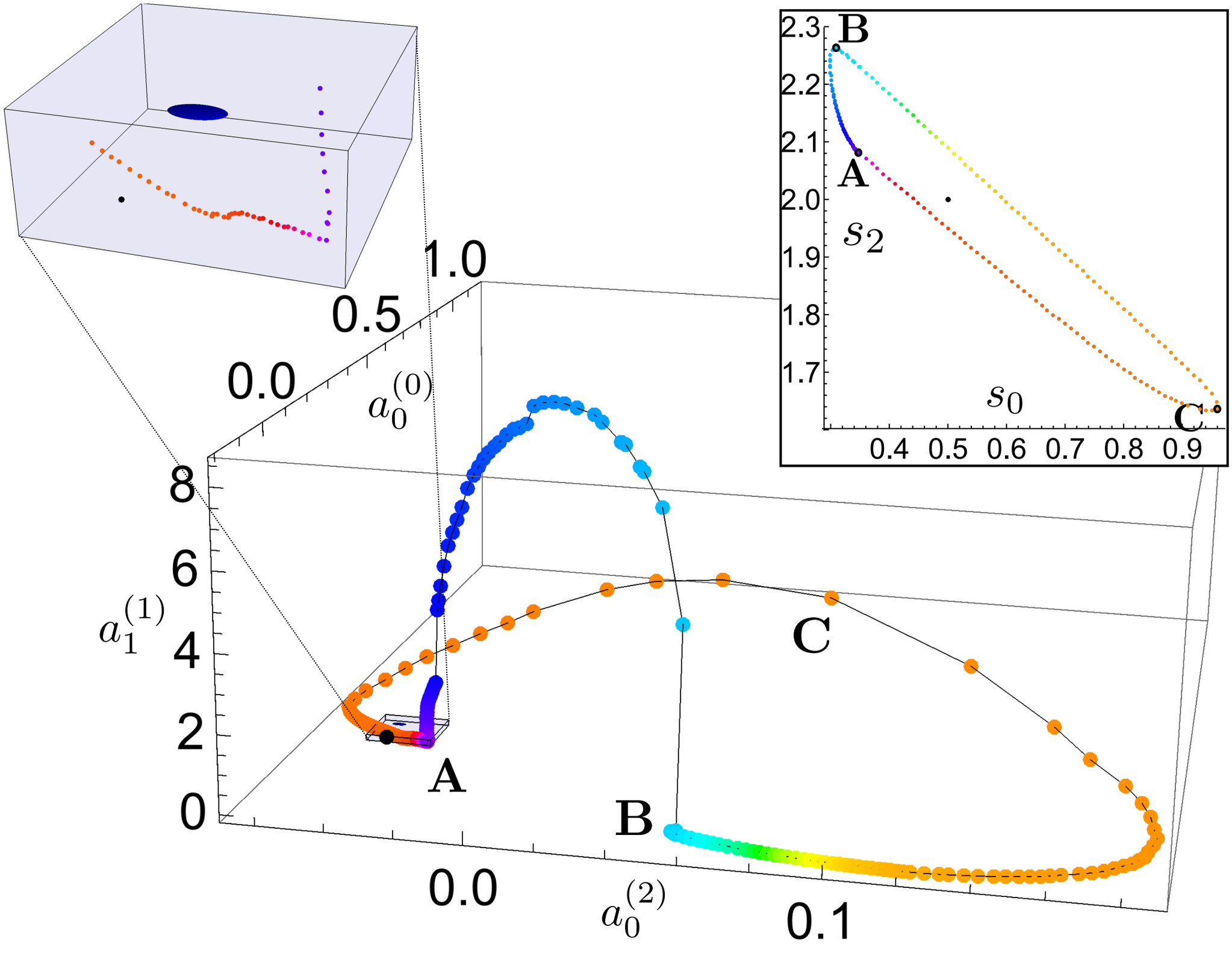


Impose: $S_1^{(1)}(m_\rho^2) = 0$ $\qquad$ $m_\rho \simeq (5.5 + 0.5\,i)$

The Lake

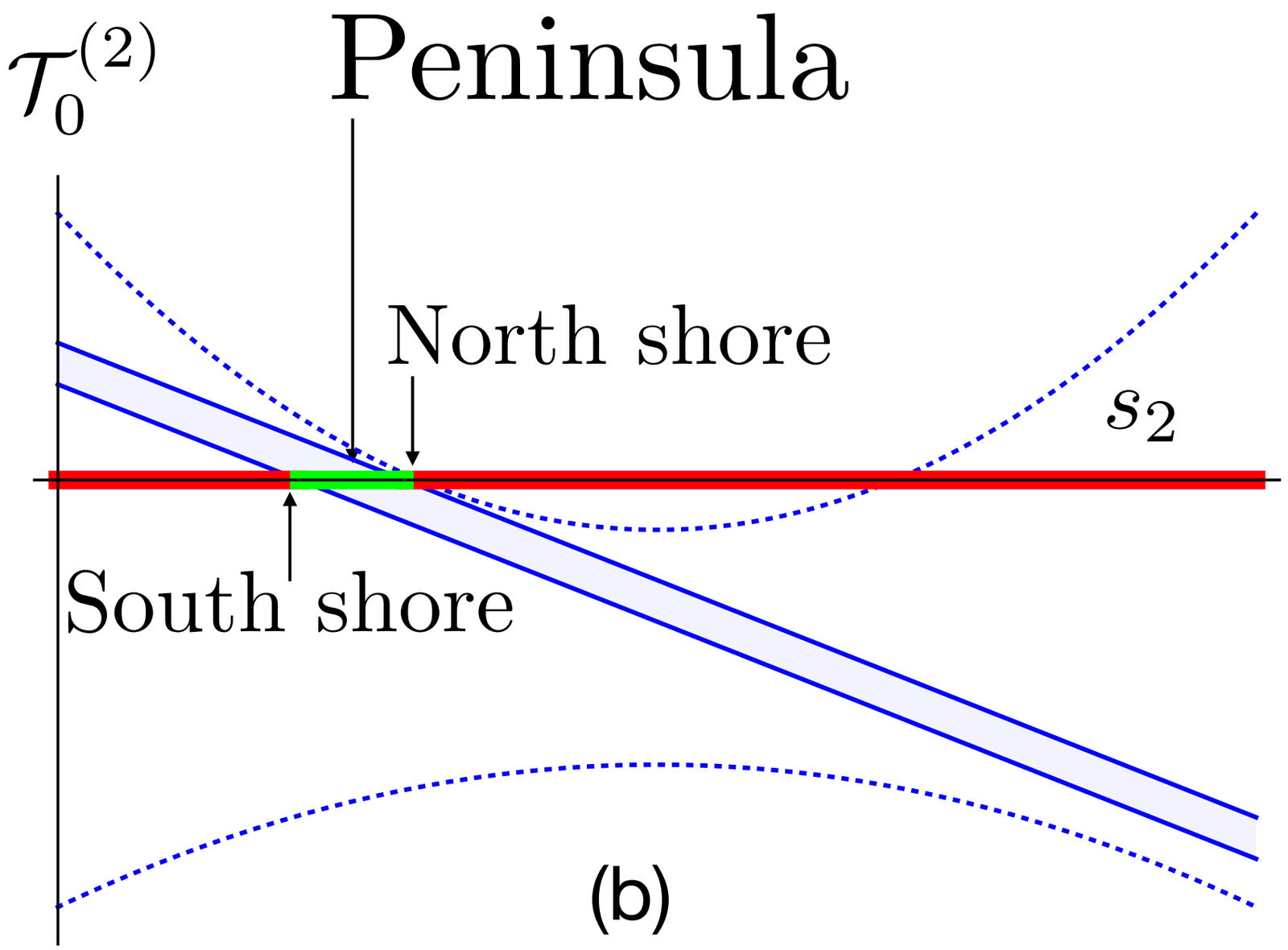

s_2
3.0
2.5
2.0
1.5
1.0
B
Huge $a_1^{(1)}$
Scattering lengths
with opposite signs
A
C
Scattering lengths
comparable to experiments
s_0
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4

Scattering lengths around the Lake



The Peninsula

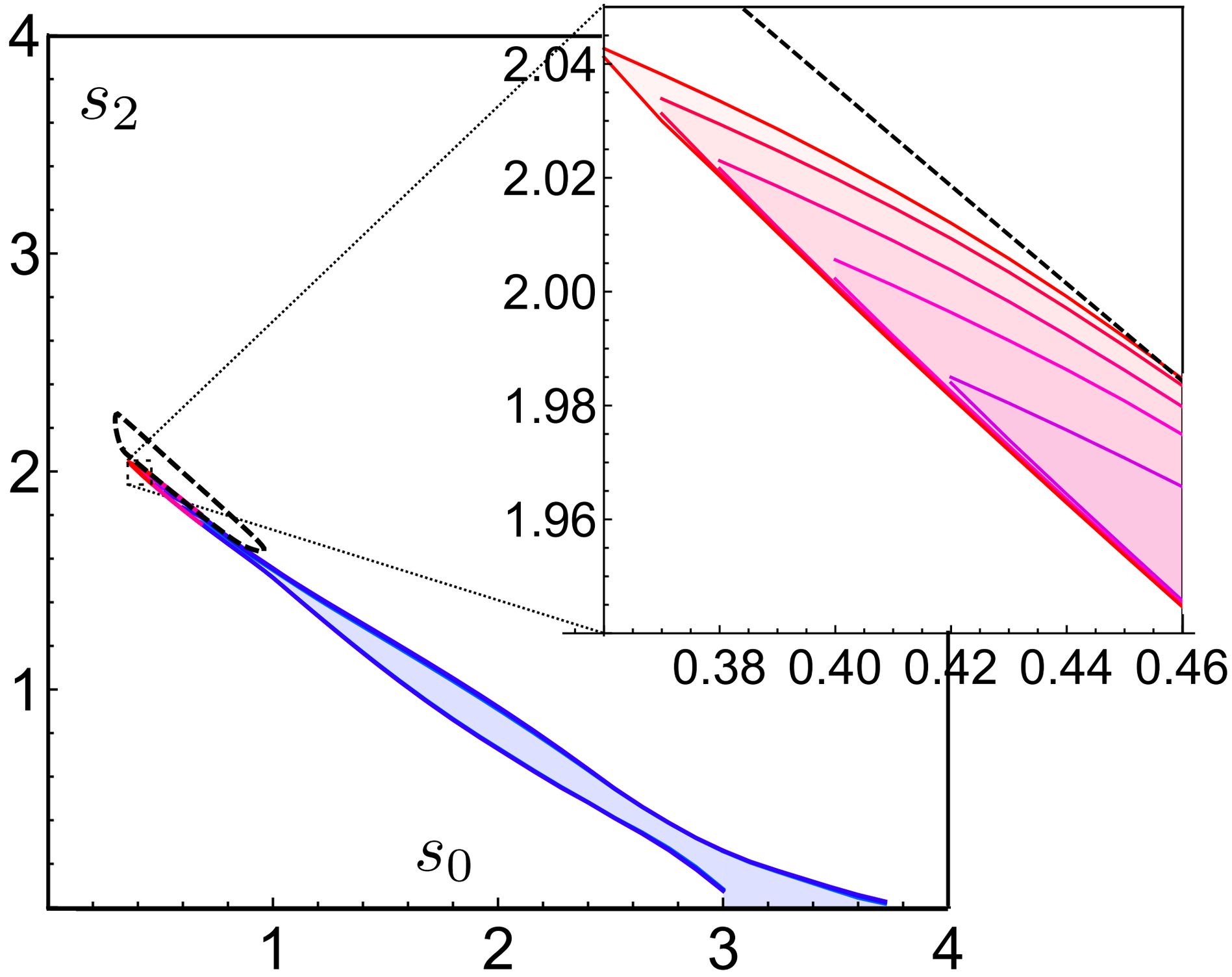
Max-Min $\mathcal{T}_0^{(2)}$



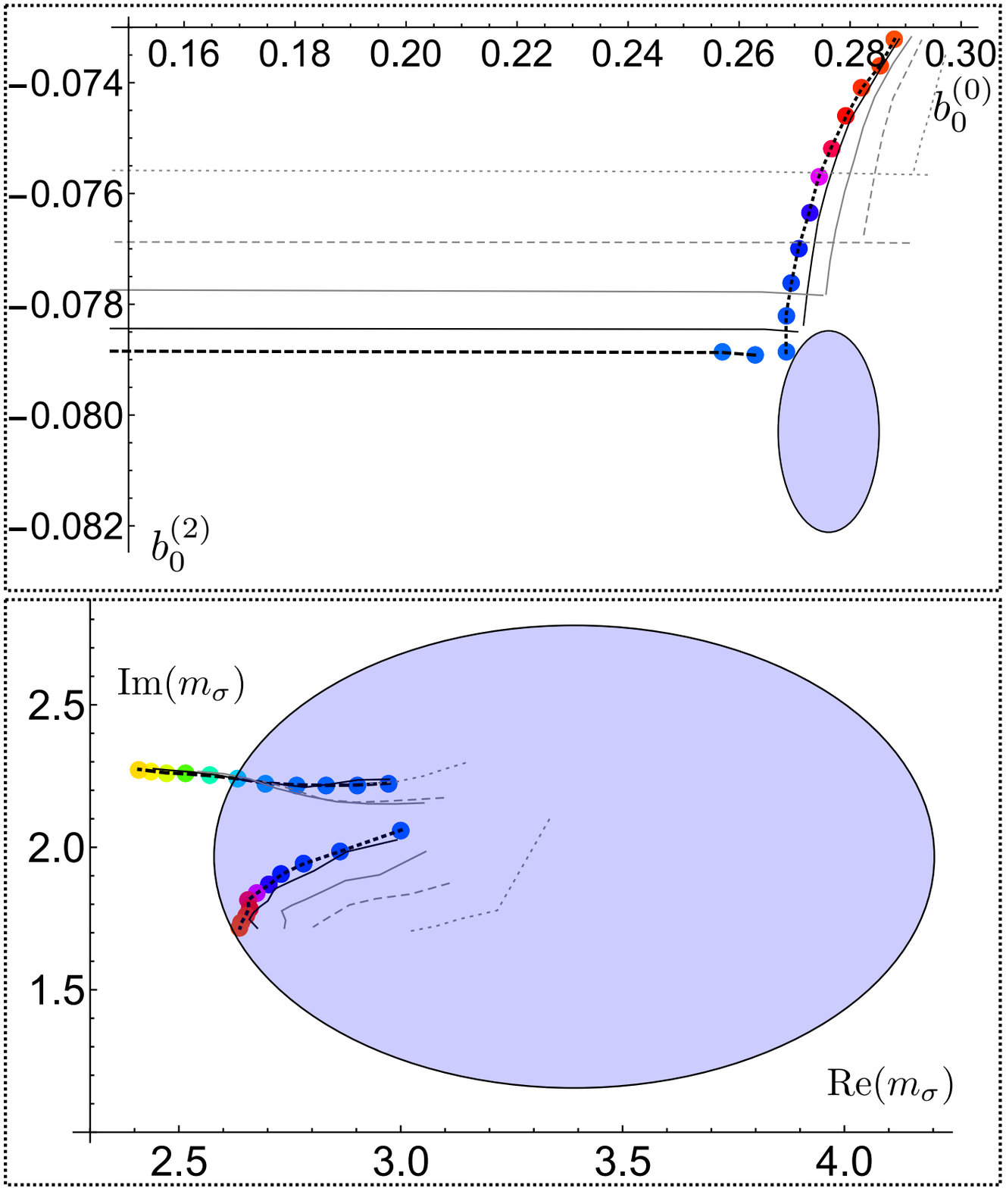
Impose: $S_1^{(1)}(m_\rho^2) = 0 \qquad m_\rho \simeq (5.5 + 0.5\,i)$

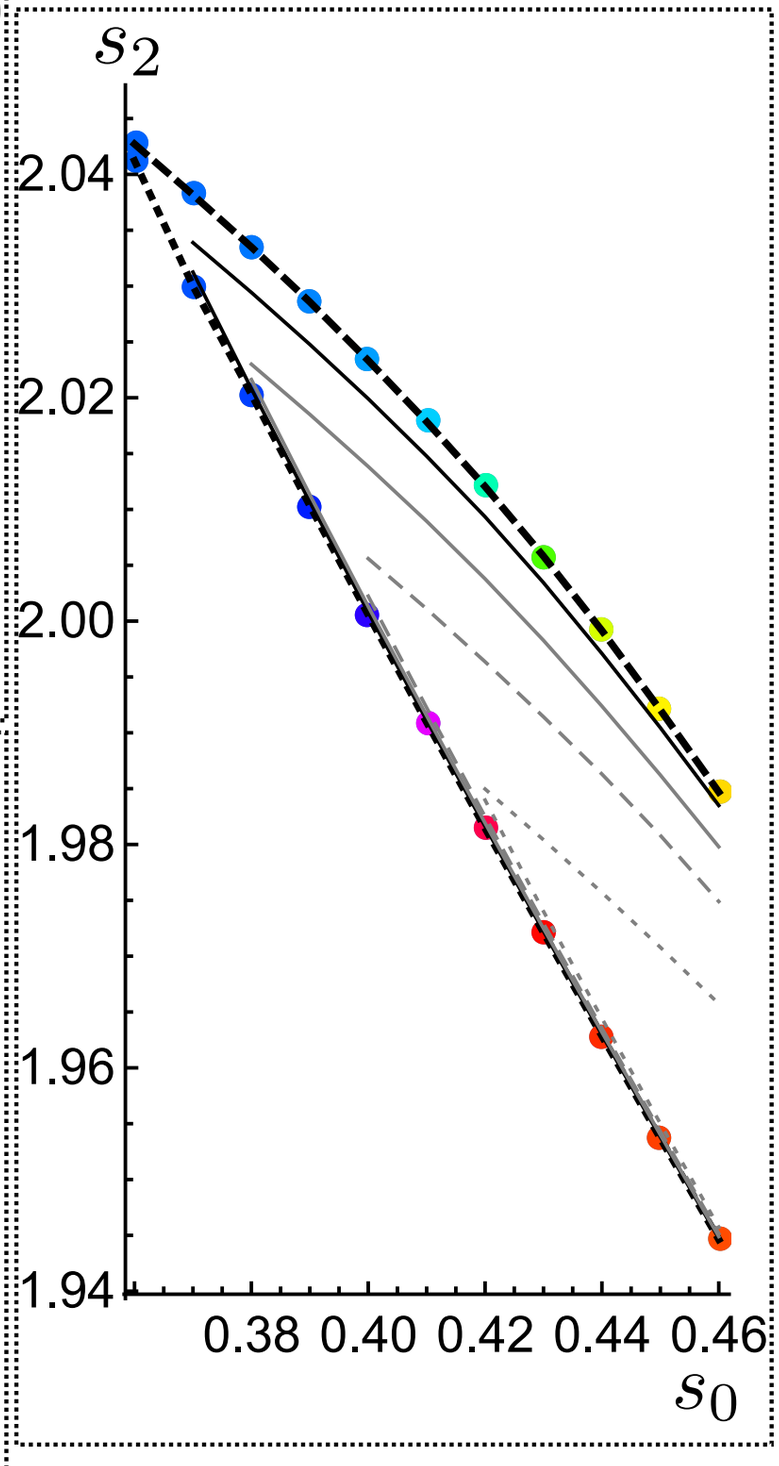
$$\left|a_0^{(0)} - 0.2196\right| < 0.0034\,, \qquad \left|a_1^{(1)} - 0.038\right| < 0.002\,, \qquad \left|a_0^{(2)} + 0.0444\right| < 0.0012$$

The Peninsula



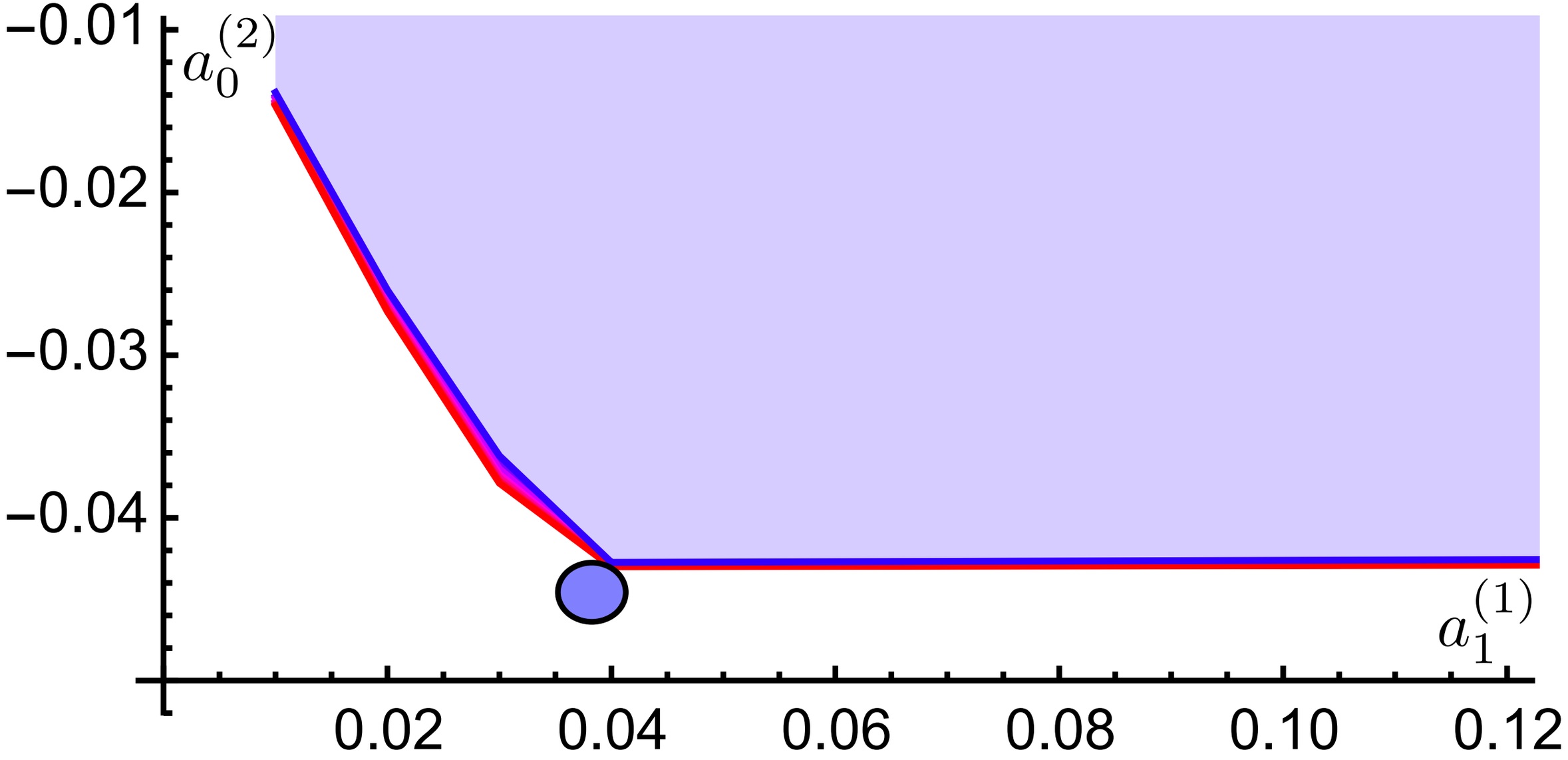
Physics at the cape





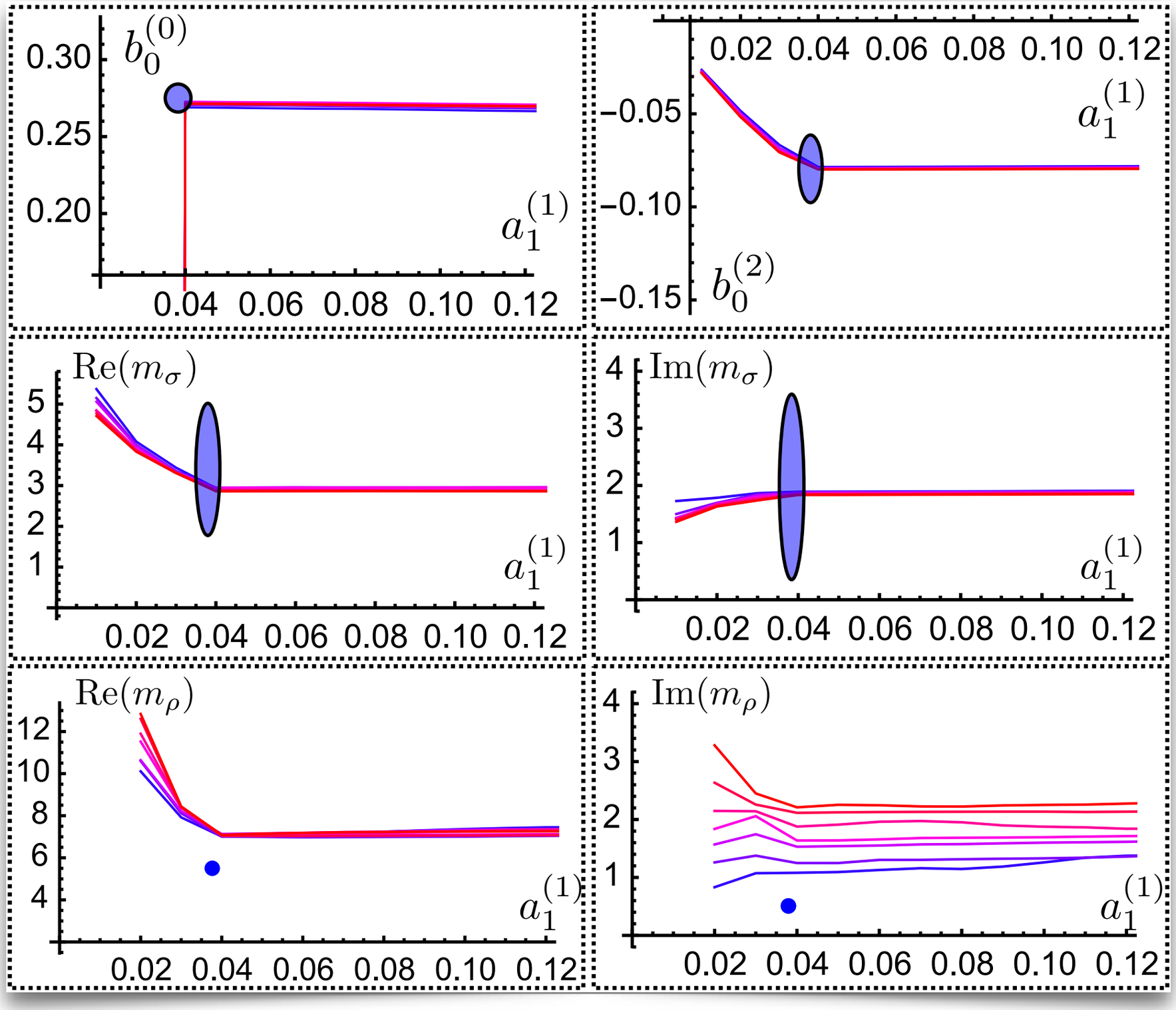
The Kink

The Kink



Impose: $s_0 = 0.36\,, \qquad s_2 = 2.04\,, \qquad a_0^{(0)} = 0.2196$

Physics at the Kink



Outlook I

- Detailed study of **phase shifts** of extremal solution and resonance content

- Comparison with **lattice** data for heavier pions

- Bootstrap study of **massless** pions

- Use our analytic and crossing symmetric ansatz to **fit** the experimental data subject to the unitarity constraints

Outlook II

- Bootstrapping multiple amplitudes

  [1+1D in progress with Homrich, Toledo, van Rees, Vieira]

- Anomalous thresholds (Landau diagrams)

- Particles with spin (internal and external)

- Massless particles (QCD flux tube)

- Connect with conformal bootstrap for D>2

- Other interesting questions? Maximize particle production?

- Can we input UV data about the QFT? Hard scattering? Form factors?

Thank you!