Taming Mass Gap with Anti-de Sitter Space

Based on 2312.09277 with ***Christian Copetti, Lorenzo Di Pietro, Shota Komatsu***

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The Focus:

Boundary Diagnostic of the Mass Gap

- Asymptotic free theories with dynamically generated mass gaps in the IR in flat space.
- In AdS, by choosing different boundary conditions, we realize gapped and gapless phases.
- As we vary the AdS radius L, the theory interpolates between weak coupling and strong coupling.
- Consistency with flat space limit demands gapless phases to disappear at large enough L.
- Can we see this gapless-gapped transition from the boundary? How?

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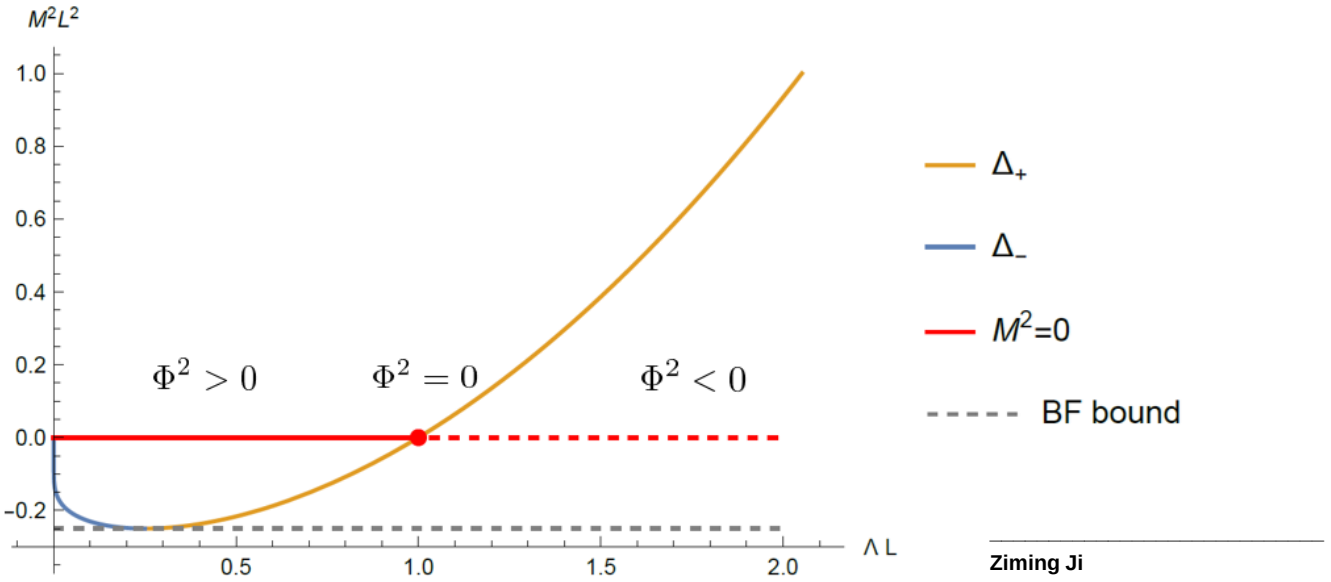
$O(N)$ NLSM at large N

- In flat space, $O(N)$ symmetric gap $M \sim \Lambda$. No SSB in 2d.
- In AdS, analog of SSB can happen due to IR regularity.
- At large N, bulk phases at all values of ΛL can be found by solving the gap equations.



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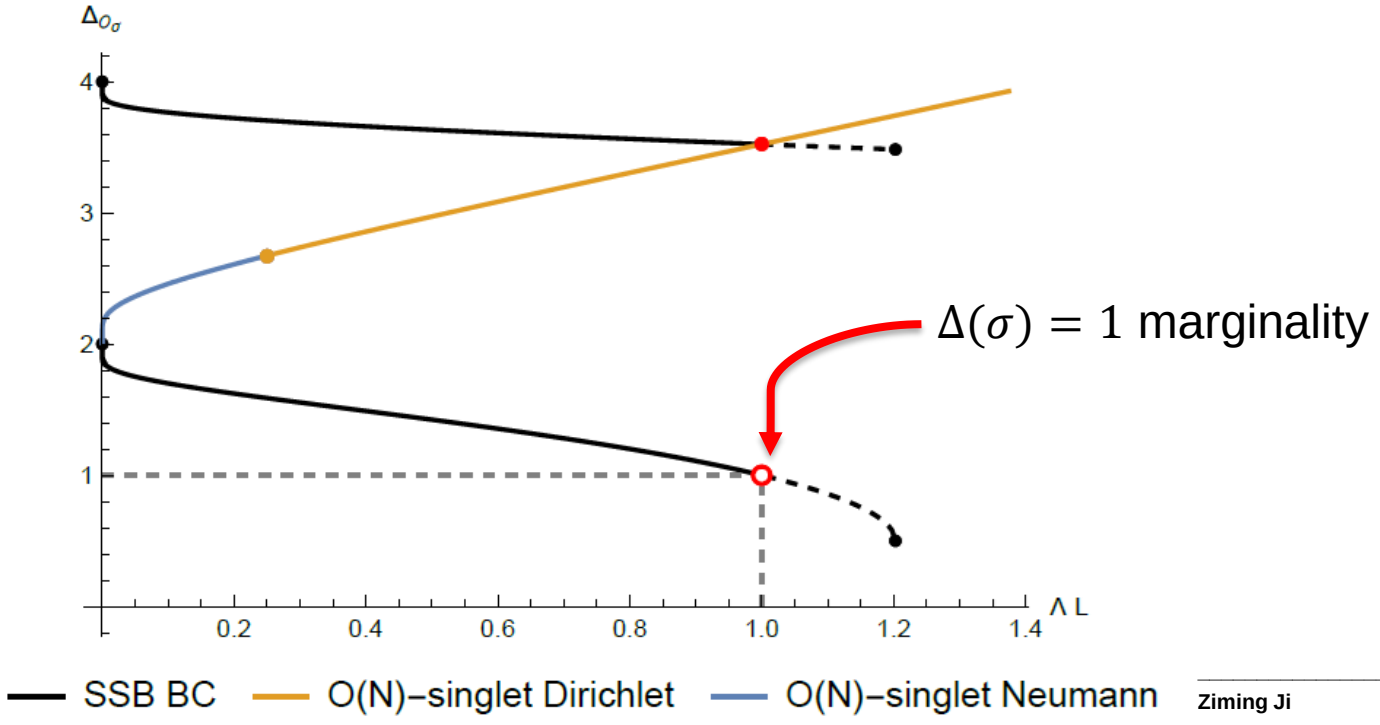
$O(N)$ NLSM at large N

- What is the boundary signal?
- Look at the lightest operator in the boundary spectrum of the Hubbard–Stratonovich field σ which is a singlet.



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Gross-Neveu at large N

- In flat space, vector symmetric gap $M \sim \Lambda$. The discrete axial symmetry is spontaneously broken.
- In AdS, we define massive vector boundary conditions and massless axial preserving boundary conditions.
- At large N, bulk phases at all values of ΛL can be found by solving the gap equations.
- No signal of gapless-gapped transition from the bulk gap equations.
- However, the gapless axial preserving boundary condition should disappear at large enough ΛL.

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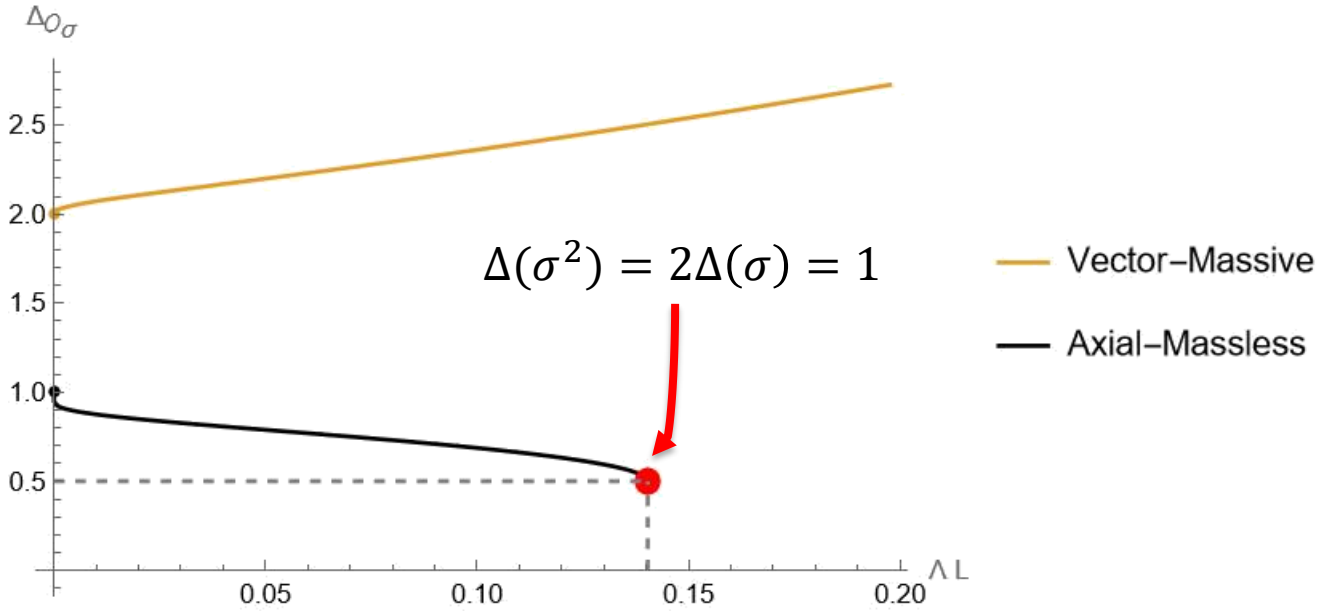
Gross-Neveu at large N

- Try to look at the boundary data!
- Look at the lightest operator in the boundary spectrum of the Hubbard–Stratonovich field σ. σ^2 is axial singlet.



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The conjecture:

Boundary Singlet Marginal Gaps!

- Yang-Mills in four-dimensional Anti-de Sitter Space.
- Dirichlet boundary condition with boundary global symmetry and boundary conserved currents dual to gluons should disappear before the flat space limit.
- We conjecture that some singlet operator on the boundary will become marginal at some ΛL and destabilize this Dirichlet boundary condition, mediating a quantum phase transition to confinement.

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Thank you!