Inhomogeneous chiral condensates and nonanalyticity under external magnetic field

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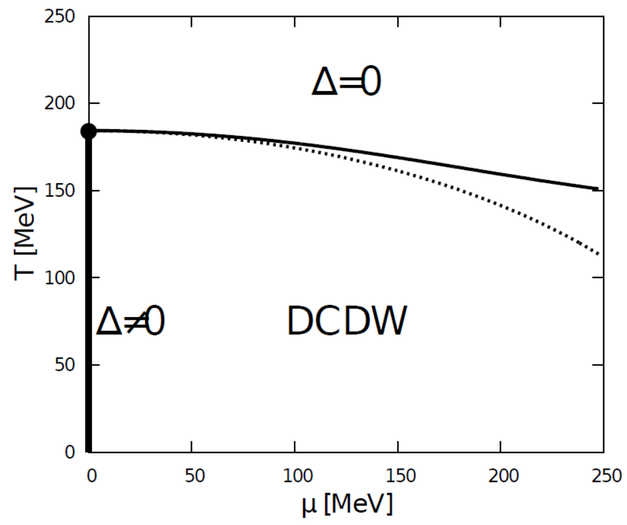
Question: Can we observe inhomogeneous chiral condensates on lattice at finite $\mu \neq 0$?

In dense lattice QCD, usually the Taylor expansion, the reweighting method, the canonical approach, the analytic continuation methods and so on are used.

Our statement: Inhomogeneous chiral condensed phases lead the non-analyticity and it breaks the validity of above methods.

Under the external magnetic field, the dual chiral density wave appears **very close to μ=0**.

$\langle \bar{q}q \rangle + \langle \bar{q} i\gamma_0 q \rangle = \Delta e^{iqz}$: spatially modulated chiral condensate



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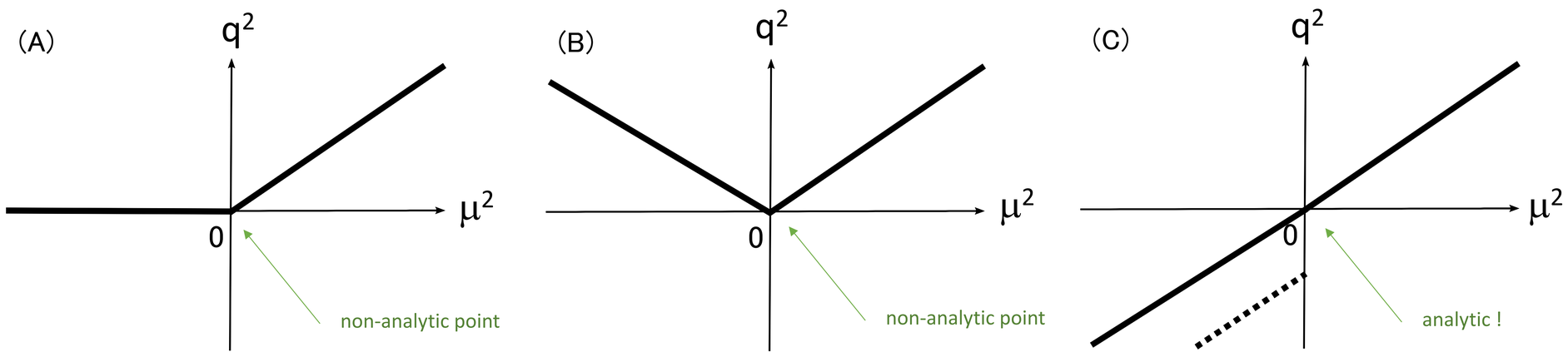
To apply several methods to lattice calculations, we must consider the imaginary chemical potential to evaluate the non-analyticity!

This non-analyticity breaks the validity of several methods

Then, we can consider following scenarios:

Three scenarios



	(A)	(B)	(C)
Analytic continuation:	Impossible	Impossible	Possible !

But, it seems difficult to realize …

If the analytic continuation fails, several lattice methods to circumvent of the sign problem can not describe the correct system.

Answer: **Maybe no** in the three color system except the scenario C …

We should check it in the **two color system** **or some other sign problem free theory**!