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Dispersive Bootstrap in Cosmological Collider Physics

It is widely believed that during inflation heavy particles ($m \tilde{} H$ up to 10^13 GeV) beyond the Standard Model can be produced and they can leave imprints on large cosmic scales. This mechanism provides a unique window to explore physics at extremely high energy scales—a paradigm known as cosmological collider (CC) physics. The central observables in CC physics are inflation correlators with massive exchanges, which are difficult to compute due to many technical challenges. In recent work, we proposed a new program to bootstrap inflation correlators using dispersion relations on the complex momentum plane, conceptually analogous to the famous dispersion relations in flat spacetime. We developed two distinct types of dispersion relations, the vertex and line dispersion relations. The framework allows us to extract the full analytic expressions for massive correlators solely from their oscillatory signals, thereby drastically simplifying the computational process. Furthermore, we demonstrated that these dispersion relations are highly effective at the loop level and give rise to "irreducible results" which are free of UV divergence and independent of renormalization schemes. By applying the line dispersion relation to several one-loop correlators which are difficult to compute using other techniques, we obtained new analytical expressions that are much simpler than existing results.

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