Parametric instability of classical Yang-Mills fields

Shoichiro Tsutsui, Teiji Kunihiro (Kyoto Univ.), Akira Ohnishi (YITP)

Abstract: Plasma instabilities play an important role in thermalization. Recently, classical gluon fields in a nonexpanding geometry are found to show parametric instability under a longitudinally polarized background. The growth rates of low momentum modes are large enough compared with other instabilities proposed so far. Surprisingly, parametric instability survives even in an expanding geometry. We introduce the conformal coordinates which enable us to map an expanding problem into a nonexpanding problem. We find that fluctuations with finite longitudinal momentum can grow exponentially.

1. Instabilities in Heavy Ion Collisions

In the earliest stage of HIC, the system is under strong fields (color electromagnetic flux tubes).

2. Parametric Instabilities in Physics

Parametric instabilities play important roles in many fields of physics.

pendulum with time-dependent length

preheating in cosmology

exponential growth of particle number

Greene, Kolman, Linde,斯塔宾斯基(1997)

classical Yang-Mills theory

let us consider a simplified situation

Bz

SU(2) Yang-Mills

temporal gauge

non-expanding or expanding geometry

homogenous magnetic field

Berges, Scheffler, Schlichting, Sexty (2013)

A2

Ay

EOMs of fluctuation

background color magnetic field is periodic function of time

B(t) = B_0 e^{2\sqrt{B_0 t} / 1}\sqrt{2}]

4. Instabilities in an Expanding System

EOM of background field

a_2 \dot{A} + 1/4 \dot{A} + \dot{A} = 0

almost periodic in conformal time

parametric instability survives in an expanding geometry

Berges, Scheffler, Schlichting, Sexty (2013)

S.T. Iida, Kunihiro, Ohnishi PRD 91 (2015)

amplification factor \mu

0.7 fm (@LHC)

~120

~30