Available online at www.sciencedirect.com

ScienceDirect

Nuclear Physics B 932 (2018) 119–128

NUCLEAR PHYSICS B

www.elsevier.com/locate/nuclphysb

# Unparticle may be a remedy to the information loss in the scattering of fermion off dilaton black-hole

Anisur Rahaman

*Hooghly Moghin College, Chinsurah, Hooghly-712101, West Bengal, India*

Received 2 March 2018; received in revised form 8 May 2018; accepted 9 May 2018

Editor: Stephan Stieberger

**Abstract**

We study s-wave scattering of fermion off dilaton black-hole. With one loop correction it was found to suffer from nonpreservation of information and that of course, went against Hawking's revised suggestion on this issue. A nonstandard approach, e.g. the probable existence of unparticle in $(1 + 1)$ dimension has been adopted here that shows a remedy to get rid of the danger of information loss to bring it in agrees with the Hawking's revised suggestion.



## 1. Introduction

There has been much interest in the physics of black-hole over the last few decades and the scattering of fermion off dilaton black hole carries special interest because the literatures related to this problem [1–11] have provided much insight into its connection to the Hawking radiation. The issue that attracted attention to a great extent was the possible information loss during the formation and the subsequent evaporation of the black-hole. A controversy in this context was generated from Hawking's initial suggestion about four decades ago [12], but his revised suggestion on this issue [13] has brought back moderately pleasant scenario. In spite of that, it is fair to admit that the matter related to the preservation of information did not yet

*E-mail addresses:* anisur.rahman@saha.ac.in, manisurn@gmail.com.

https://doi.org/10.1016/j.nuclphysb.2018.05.006

conclusively settle down from all corner. Therefore, investigation related to this problem still be of interest.

A general description of this process was pursued in [14], where it was found to be formulated through the s-matrix description of the event which involved lots of inherent constructional complexity and computational difficulty. Therefore, most of the authors preferred to handle this problem with less complicated but interacting and well formulated model [1]; see [7] for review. The model took birth in the description of two dimensional noncritical string theory and the black hole solution of this was carried out in [15]. An extremal magnetic charged black-hole solution was considered in these studies. Eventually, it was generated from a $(3 + 1)$ dimensional model involving a dilaton field. Since in the study of s-wave scattering of fermion in this black-hole, angular coordinates becomes irrelevant and an interesting $(1 + 1)$ dimensional effective action takes birth. It is known from the important publication [1], that when the energy involved in this process is not too high, the metric and the dilaton field can be treated as external classical quantities and an amusing version of quantum electrodynamics with position dependent coupling constant emerges out.

With this framework the scattering of massless Dirac fermion was studied in [1]. Although the mathematical formulation did involve a general description (as permitted within this framework), the authors did not encounter the problem of information loss since one loop correction was not included there. However, with the similar framework, when this scattering phenomena was extended with the chiral fermion in [9] the author had to face the danger of real information loss. The one loop correction [16,17] entered in this description automatically during bosonization. The present author in [18], showed that there exists a remedy of this danger if the possibility of allowance of anomaly is exploited judiciously. Note that, this framework is so powerful and beautifully designed that it itself has a room for taking the anomaly into consideration. In the study of scattering of Dirac fermion [1], though the author did not face the danger of information loss, the present author reported that information loss could not be avoided when one loop correction that entered during the process of bosonization was taken into account [10]. The result though led to an uncomfortable situation there was no known standard physical principal to avoid it as it was found in the case of chiral fermion [18]. It certainly diminishes the glory of this important and well formulated framework of studying the scattering problem [1] since the result went against Hawking's revised suggestion [13]. In this work, therefore, an attempt has been made to bring it in agreement with Hawking's revised suggestion [13] making it free from the danger of information loss even in the presence of one loop correction.

A failure to find the standard physical principal towards having a plausible solution of a standing unresolved problem does not mean that some non standard approach would not be of worth for that. A very good instance in this direction is the introduction of unparticle to get a plausible solution of momentum distribution [19] at high energy regime. After the introduction of the concept of unparticle in the seminal work [19], it has been used in different important studies. The studies related to dark matter using this concept is of worth mentioning [20,21]. Study of Casimir effect in presence of unparticle is another important phenomenological development [22]. An attempt to establish unparticle as holographic dual of gapped AdS gravity is also an interesting theoretical improvement [23]. Unparticle with one loop correction was studied in [24] where a remarkable retrieval of gauge invariance in the usual phase space was found. In this work we are, therefore, intended to exploit the advantage of having the probable existence of unparticle in $(1 + 1)$ dimension [25] to get a remedy of the problem of information loss that occurred in the s-wave scattering process when one loop correction got involved in [10]. Let us now turn towards that end.