

Final Technical Report for DE-FG02-08ER41540

Title: Establishing the transport properties of QCD with heavy ion reactions

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Reporting Term: 3/1/08 – 11/30/14

Reporting Period End Date: 11/30/14

1 Research

This report covers the time period from 3/1/08 – 11/30/14. The title of the grant proposal is “Establishing the transport properties of QCD with heavy ion reactions” and this is its primary objective. The proposal also seeks to train individuals in nuclear theory and to disseminate results to a broad audience.

The research of the PI continues, and is supported by the larger Nuclear Theory group grant at Stony Brook, DE-FG-88ER40388. During the reporting period, grant supported research produced a total of 24 manuscripts (21 currently published) and two Ph.Ds, one of whom (Dr. Juhee Hong) has become a permanent member of the WCI Center for Fusion Theory in Daejeon Korea, and the other (Dr. Li Yan) is a currently a postdoctoral researcher in Saclay. The research of third student Mr. Aleksas Mazeliauskas continues under a different contract, DE-FG-88ER40388.

The research of the grant focused on three topics:

1. Understanding how the geometry determines the collective flow in heavy ion collisions, and quantifying the uncertainties in extracting η/s . The papers associated with this work are [24, 20, 18, 16, 15, 12, 11, 10, 7, 5, 4, 3]. Of this list of papers, one of the most important was Ref. [15], which introduced the first harmonic v_1 to the heavy ion physics community. The ideas developed in Ref. [3] are currently being pursued actively by the PI [2], and by the experimental heavy ion programs.
2. A substantial direction for the PI has been computing the transport properties of high temperature QGP at weak coupling beyond leading order. This effort resulted in the publications [17, 13, 8, 1]. In particular Ref. [8], determined the rate of thermal photon production beyond leading order. This is the first thermal process involving collinear bremsstrahlung that was computed at NLO. The computation (which is the result of a collaboration with the McGill group) suggests new research directions in the study of energy loss in heavy ion collisions. These ideas are currently being pursued [1], and implemented in realistic models of energy loss.
3. The PI studied equilibrium and non-equilibrium dynamics at strong coupling using the AdS/CFT correspondence. This resulted in several publications [23, 22, 21, 19, 14, 9, 6]. Out of this list, perhaps most notable are Ref. [22] and Ref. [14]. The first of these papers showed how Hawking radiation from black holes leads to Brownian motion of a heavy quark string. The second of these papers studied Hawking radiation in a non-equilibrium context setting the groundwork for further studies of non-equilibrium strongly coupled plasmas [9].

Student Name	Enter Grad. School	Joined Group	Mentor	Graduation
Dr. Juhee Hong (<i>a</i>)	Sept. 2005	Nov. 2007	D. Teaney	Aug. 2012
Dr. Li Yan (<i>b</i>)	Sept. 2007	Jan. 2009	D. Teaney	Aug. 2013
Mr. Aleksas Mazeliauskas (<i>c</i>)	Sep. 2012	July. 2014	D. Teaney	May. 2017

Table 1: Student Tracking Information. (a) Dr. Juhee Hong is currently a permanent staff member at the WCI Center for Fusion Theory in Daejeon Korea. (b) Dr. Li Yan is currently a postdoctoral researcher in Saclay. (c) Mr. Aleksas Mazeliauskas became fully supported by the grant in June 2014. His research is currently supported under DE-FG-88ER40388.

2 Participants

The grant has led to two complete Ph.Ds. Table 1 summarizes the Ph.D. students supported by the grant:

- Dr. Juhee Yan completed her Ph.D. in 2012 and is now a permanent staff member at the WCI Center for Fusion Theory in Daejeon Korea.
- Dr. Li Yan completed his Ph.D. in 2013 and has moved to a postdoctoral position in Saclay.
- Mr. Aleksas Mazeliauskas started his Ph.D. with the PI in June 2014. His work is currently supported by the contract, DE-FG-88ER40388.

A summary of the current and past participants supported by the grant is given in Table 1.

3 Additional Information

Here we would like to list an additional item which influences the ongoing research program of the PI:

- The PI was promoted to the rank of Associate Professor with tenure effective September 1, 2013.

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