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Transport coefficients and low energy excitations of a strongly interacting holographic fluid

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Curriculum Vitæ

Nick Poovuttikul was born in Bangkok, Thailand on May 1990. He stayed in Bangkok until he graduated from high school in 2008. During that time he participated in a few physics competitions and got a scholarship from the Thai government to study physics. At Imperial College London, he obtained a bachelor degree in Physics with Theoretical Physics and a master degree in Quantum Fields and Fundamental Forces. He worked on a condensed matter problem for his final year project with Dr. Derek K.K. Lee and wrote a literature review on fermions in gauge/gravity duality for his master degree dissertation under the guidance of Prof. Dr. Toby Wiseman. While in London, he was a bassist in a Thai pop rock band at Thai Square Putney; a member of the editorial board for an annual journal of “Samaggi Samagom”, the Thai association in the UK, from 2011-2012; and Vice president of Imperial College’s Thai society in 2011. He also did a few volunteering jobs for education in Thailand during the summer breaks.

He moved to Leiden, the Netherlands, to start his PhD under the supervision of Prof. Dr. Jan Zaanen in autumn 2013. He published his work in peer-reviewed journals, volunteered to organise a holography journal club while grading homeworks for master students attending the theory of general relativity course at Leiden. He tried to make friends and promote his work by giving talks and poster presentations and attending several schools, meetings, workshops and conferences in the Netherlands, Brazil, Belgium, Germany, Portugal, Denmark, Spain, Greece, England, Sweden and Thailand.

After his PhD, he will be a postdoctoral researcher in the high energy theoretical physics group at the University of Iceland. Eventually, bound by his so-called “scholarship” contract, he will go back to do research in one of the universities in Thailand.

List of Publications

1. A. Parnachev, N. Poovuttikul, “Topological entanglement entropy, ground state degeneracy and holography,” JHEP **1510** (2015) 092 [arXiv:1504.08244 [hep-th]].
2. P. Burikham, N. Poovuttikul, “Shear viscosity in holography and effective theory of transport without translational symmetry,” Phys.Rev. D **94** (2016) 106001 [arXiv:1601.04624 [hep-th]].
3. S. Grozdanov, N. Poovuttikul, “Universality of anomalous conductivities in theories with higher-derivative holographic duals,” JHEP **1609** (2016) 046 [arXiv:1603.08770 [hep-th]].
4. S. Grozdanov, N. Poovuttikul, “Magnetohydrodynamic waves in a strongly coupled holographic plasma,” [arXiv:1707.04182 [hep-th]].
5. T. Andrade, M. Baggioli, A. Krikun, N. Poovuttikul, “Pinning of longitudinal phonons in holographic helical crystals,” [arXiv:1708.08306 [hep-th]].

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My journey into the world of hydrodynamics would never have happened without Richard Davison, Andrea Amoretti, Nikos Kaplis and, especially, Sašo Grozdanov. I am deeply grateful for everything I have learned from all of you. I would like to give a special thanks to Sašo Grozdanov for all enjoyable collaborations and many inspirational ideas during my PhD. It is very much fun to work with you and I hope we will be able to continue working together on many other interesting things.

Furthermore, I would like to thank all my collaborators whom I haven't mentioned yet: Misha Goykhman, Ann-Kathrin Straub, Steffen Klug, Matteo Baggioli, Sasha Krikun, Tomas Andrade, Juan Pedraza, Bartek Benenowski and Piyabut Burikham for letting me collaborate on many interesting projects and for all they taught me. I am particularly grateful to Steffen, Nikos and Sasha for

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I would like to thank my flatmates, Miggy and Jaakko, as well as my officemates, Marco, Misha and Petter for the pleasant time and many intriguing discussions about physics, politics and whatnot. My years at Leiden would be very dull without friends and fellow member of the quantum matter group: Miggy, Petter, Jaakko, Louk, Robert-Jan, Misha, Andrea, Richard, Steffen, Nikos, Sašo, Balasz, Andrey, Ke, Bartek, Sasha, Vincenzo, Aurelio, Philippe, Simon and Koenraad. For all the enjoyable discussions and time we spent together, I thank you all.

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Stellingen

behorende bij het proefschrift

*Transport coefficients and low energy excitations
of a strongly interacting holographic fluid*

1. In the situation where additional degrees of freedom are added to a hydrodynamical system, the shear viscosity is defined through the constitutive relation, not the Kubo formula derived for a relativistic fluid.

Chapter 3

2. Before declaring results from holography to be “universal”, one has to make sure that these do not rely on the fine-tuning of the equation of state or the coupling constants.

Chapter 4

3. Magnetohydrodynamics is a theory of dissipative strings, not of charged particles and photons.

Chapter 5

4. Gauge/gravity duality can be useful for studying macroscopic properties but is useless for extracting microscopic information unless one is interested in supersymmetric quantum field theories.

Chapter 1

5. Despite its widespread usage, the ideal fluid is unstable: it is highly sensitive to initial conditions. For example, in the simplest model of the Earth’s atmosphere, the deviations grow by a factor of 10^5 in 2 months.

V.I. Arnold & B.A. Khesin,
Topological Methods in Hydrodynamics, Springer 1998

6. Hydrodynamical fluctuations, such as long-time tails, cannot be observed in a field theory with a classical gravity dual. Instead, they are intriguingly connected to quantum gravity corrections. This connection has largely been ignored in the literature.

e.g. P. Kovtun & L. Yaffe, Phys.Rev. D **68** 02 (2003) [arxiv:hep-th/0303010]
and S. Caron-Hout & O. Saremi, JHEP **11** 013 (2010) [arxiv:0909.4525]

7. From the condensed matter point of view, one of the most interesting aspects of entanglement entropy is topological entanglement entropy. In the holographic literature, a topological term is often mentioned in the introductions as a motivation to study the entanglement entropy but has almost never been the main focus.

A. Parnachev & A. Pakman JHEP **07** 097 (2008) [arxiv:0805.1891]
and A. Parnachev & N. Poovuttikul, JHEP **10** 092 (2015) [arxiv:1504.08244]

8. A popular toy model for weak momentum relaxation, where only the conservation of momentum is modified (taking the form $\partial_\mu T^{\mu i} = -\Gamma T^{ti}$), cannot reliably capture dissipative properties. This is because it ignores, by construction, the correction from momentum relaxation to the constitutive relation.

S.Hartnoll, P.Kovtun, M.Muller & S.Sachdev,
Phys.Rev. B **76** 144502 (2007) [arXiv:0901.0924]

9. Despite being trained to be logical, scientists are still highly susceptible to arguments from authority.

Nick Poovuttikul
Leiden, 16 November 2017