Stanford



Sean Hartnoll

CONTACT INFORMATION

- **Alternate Contact**

  Julie Shih - Administrative Associate

  Email julie.shih@stanford.edu

  Tel 650-723-4232

Bio

BIO

I am a theorist working on problems in gravitational, high energy and condensed matter physics. In recent years the holographic correspondence, the physics of quantum entanglement and quantum field theory more generally have led to strong connections between central concerns in these different fields.

For example, I am interested in understanding the emergence of spacetime from large N matrix quantum mechanics models. These can be thought of as the simplest models of holographic duality, and will likely hold the key to understanding the emergence of local physics as well as black holes. The most basic object in these theories is the ground state wavefunction. Understanding this wavefunction is a many-body problem and I am interested in using modern ideas from condensed matter theory -- such as topological order -- to characterize it.

Another example has to do with dissipation. How quickly can a quantum mechanical system thermalize itself? From this perspective, there are remarkable similarities between strongly quantum mechanical systems such as the quark-gluon plasma and high temperature superconductors and the dynamics of black holes in classical gravity. This may suggest that a fundamental limitation imposed by quantum statistical mechanics is at work in these systems. I have pursued this possibility from many angles, including variational principles for entropy production, the Lieb-Robinson bound on velocities in quantum systems and bounds on the magnitude of quantum fluctuations near thermal equilibrium.

In parallel to a "bird's eye" approach to quantum statistical mechanics, I am also increasingly interested in specific scattering mechanisms in unconventional materials that may give a relatively simple explanation of transport behavior that has otherwise been considered anomalous --- using this approach my collaborators and I have 'demystified' aspects of transport in quantum critical ruthenate materials. I am currently interested, for example, in the role of phonons in strongly correlated electronic systems.

I have recently worked on black hole interiors in classical gravity. Black hole interiors are extremely rich mathematically, but their physical interpretation -- for example in a holographic context -- remains obscure. To start to address this question I have shown how important dynamics of the interior, such as the instability of the singularity and of Cauchy horizons, can be triggered in a relatively simple holographic setting.

Lists of my publications and of recorded talks and lectures can be found following the links on the right.

ACADEMIC APPOINTMENTS

- Principal Investigator, Stanford Institute for Materials and Energy Sciences

ADMINISTRATIVE APPOINTMENTS

- Assistant Professor, Stanford University, (2010-2015)
- Postdoctoral Fellow, Harvard University, (2008-2011)
- Postdoctoral Fellow, Kavli Institute for Theoretical Physics, Santa Barbara, (2006-2008)
- Junior Research Fellow, Clare College, Cambridge, (2004-2006)

HONORS AND AWARDS

- Simons Investigator, Simons Foundation (2019)
- New Horizons in Physics Prize, Fundamental Physics Prize Foundation (2014)
- Presidential Early Career Award (PECASE), Department of Energy (2014)
- Early Career Award, Department of Energy (2012)
- Alfred P. Sloan Fellowship, Sloan Foundation (2011)
- Terman Fellowship, Stanford (2011)

PROFESSIONAL EDUCATION

- PhD, Cambridge University , Theoretical Physics (2005)
- Part III, Cambridge University , Theoretical Physics (2001)
- BA, Cambridge University , Mathematics (2000)

LINKS

- Publications on Google Scholar: http://scholar.google.com/citations?hl=en&user=U2qlJmsAAAAJ
- Publications on INSPIRE: http://inspirehep.net/search?ln=en&p=find+a+hartnoll
- Publications on the arXiv: http://arxiv.org/find/all/1/all:+hartnoll/0/1/0/all/0/1
- Public lecture: From black holes to superconductors: https://www.youtube.com/watch?v=L5WY9xGPjS4
- Short interview: string theory and black holes: https://www.youtube.com/watch?v=FnHxswB-igs
- Lectures and talks on YouTube: https://www.youtube.com/results?search_query=sean+hartnoll