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Editorial
Quantum Information and Holography

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The discovery of AdS/CFT and, more generally, the gauge/gravity correspondence has led to many new insights in quantum gravity and quantum field theory. Its relevance in theoretical physics is with no doubt exceptional, since it provides one of the few nonperturbative definitions of string theory, a quantum theory of gravity.

In recent years, the AdS/CFT community has borrowed various tools of quantum information theory. Quantities such as complexity and entanglement in its various guises have been extremely useful to understand the emergence of bulk spacetime from quantum field theory degrees of freedom. The chaotic and fast scrambling properties of black holes and their dual field theories have provided a fresh look into the thermodynamic nature of gravity, providing new hints on various long-standing problems, puzzles, and paradoxes.

This special issue focusses on the interplay between different aspects of quantum information theory and holography, with applications to both, quantum aspects of gravity and strongly coupled gauge theories.

In the paper by S. F. Lokhande entitled "Spread of Entanglement in Non-Relativistic Theories" the author studies a simple holographic toy model that describes a global quench in strongly coupled non-relativistic theories and uses entanglement entropy to characterize the post-quench evolution. The author shows that the quantum entanglement of small subsystems follows a simple linear response relation that can be thought of as a time-dependent generalization of the first law of entanglement entropy. Via holography, this result can be extrapolated to a wide class of non-relativistic critical theories and some condensed matter systems.

In the paper by J.-C. Ding et al. entitled "Apparent Horizon and Gravitational Thermodynamics of Universe in the Eddington-Born-Infeld Theory" the authors investigate the thermodynamics of the Universe in the Eddington-Born-Infeld using holographic gravitational equations. Various properties of the apparent horizon are discussed including cases where the surface is timelike, spacelike, or null, depending on the parameter of state in the EBI Universe. The unified first law and second law of gravitational thermodynamics for the open system inside the apparent horizon are obtained.

In the paper by M. Gogberashvili entitled "Cosmological Constant from the Entropy Balance Condition" the author argues that the entanglement between degrees of freedom inside and outside the apparent horizon should be taken into account in the thermodynamic description of cosmological backgrounds. This is due to the fact that the variations of quantum fields should be extended up to the event horizon, instead of the apparent horizon. The author identifies this missing term with the dark energy density and expresses it as the critical density multiplied by the ratio of the apparent and event horizons radii.

In the paper by J. A. Zapata entitled "Gauge from Holography and Holographic Gravitational Observables" the author investigates the holographic imprints of a spacetime

divided into two regions by a hypersurface. A nontrivial perturbation of a bulk field leaving a holographic imprint on the dividing hypersurface which does not affect perturbations on the other side should be considered physically irrelevant. For a large class of theories including vacuum general relativity, it is shown that all local observables are holographic in the sense that they can be written as integrals of over the dividing surface. However, non-holographic observables are needed to distinguish between gauge inequivalent solutions.

In the review paper by A. Kundu entitled "Steady States, Thermal Physics, and Holography" the author revisits the main features of a large class of holographic systems in a steady-state that admit an effective thermodynamic description. This idea has arisen in various setups, including in the dynamics of fundamental matter coupled to adjoint degrees of freedom. In this article, the author discusses some features of this physics, ranging from the basic description of such configurations in terms of strings and branes to observable effects of this effective thermal description.

In the review paper by V. Jahnke entitled "Recent Developments in the Holographic Description of Quantum Chaos" the author gives an overview of the connection between quantum chaos and black holes in holographic theories. Particular attention is given to the characterization of quantum chaos based on the time evolution of out-of-time-order correlators and its realization in the dual gravitational description. Other topics that are covered in the review include the connections between chaos and the spread of quantum entanglement and diffusion phenomena.

Conflicts of Interest

The guest editors declare that they do not have any conflicts of interest.

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