new hot papers - 2010

March 2010

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Christopher P. Herzog, Mukund Rangamani, Simon F. Ross talk with *ScienceWatch.com* and answer a few questions about this month's New Hot Papers in the field of *Physics.

Article Title: Heating up Galilean holography
Authors: **Herzog, CP;Rangamani, M;Ross, SF**
Journal: J HIGH ENERGY PHYS, Volume: (11), Page: art. no.-080,
Year: NOV 2008
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**Note: two articles for the field of Physics were tied by total citations in this month's New Hot Papers.*

SW: Why do you think your paper is highly cited?

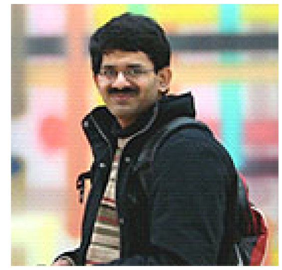
There has been considerable excitement recently about applying techniques from string theory to condensed matter systems. Our work was a contribution to this activity, helping to open up a new line of research involving a new class of symmetries which are important in condensed matter physics. The fact that we provide a technique for constructing solutions has also led to many papers applying this technique.

It is worth noting that similar work was performed simultaneously by other groups (Allan Adams, Koushik Balasubramanian, and John McGreevy, "Hot spacetimes for cold atoms," *JHEP*:11, article 059, 2008; and Juan Maldacena, Dario Martelli, and Yuji Tachikawa, "Comments on string theory backgrounds with non-relativistic conformal symmetry," *JHEP*:10, article 072, 2008).

SW: Does it describe a new discovery, methodology, or synthesis of knowledge?

Our paper represents both a new discovery (that these new symmetries are realized in string theory) and a methodology (a solution-generating technique for constructing geometries describing non-trivial states in a theory with this symmetry).

SW: Would you summarize the significance of your paper in layman's terms?



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Atomic physicists working the lab with dilute gases of atoms such as lithium-6 have made an interesting strongly interacting form of matter called fermions at unitarity. It is notoriously difficult to gain a good theoretical understanding of strongly interacting systems.

It is believed that the large-scale dynamics of such materials under certain conditions can have a simple description, in terms of a continuum theory where the results of measurements are independent of the length scale on which measurements are made (a conformal field theory).

In string theory, it is understood that some conformal field theories with strong interactions have an effective description in terms of a gravitational theory in one higher dimension (this relation is referred to as a holographic duality).

This had been understood for conformal field theories where the scale symmetry treats the time and spatial directions in the same way, and many tests of this duality in particular cases have been performed.

Our work was inspired by an earlier proposal of Dam T. Son, Koushik Balasubramanian, and John McGreevy to extend the holographic picture to theories where the scale symmetry treats the time and spatial directions differently (an anisotropic scaling symmetry).

We showed how such scalings could arise in string theory, and, in particular, were able to construct solutions describing theories with anisotropic scaling symmetry by a mapping on the space of solutions to string theory (a solution-generating transformation).

This solution-generating transformation enabled us to construct a gravitational solution corresponding to the field theory at non-zero temperature, and extract predictions for the behavior of the theory at finite temperature. We were thereby able to considerably extend the understanding of the duality for this interesting new class of theories.

SW: How did you become involved in this research, and were there any problems along the way?

We became involved when we realized that the geometries with the required symmetries were closely related to solutions in string theory some of us had studied earlier, which led us to expect that they could be constructed by solution-generating transformations.

This worked out pretty much as expected with no real difficulties, but understanding the physics of the finite-temperature solutions was more difficult, and we got stuck on parts of that calculation for some time.

SW: Where do you see your research leading in the future?

Further work on the gravitational description of these anisotropic scaling symmetries should shed light on condensed matter physics or, at least, on the general properties of strongly coupled field theories.

Studying these new examples can also help us to better understand the general features of the relations between field theories and the dual gravitational description.

SW: Do you foresee any social or political implications for your research?

No; this is purely theoretical research.

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KEYWORDS: ADS-CFT CORRESPONDENCE; BLACK HOLES IN STRING THEORY; FIELD-THEORY; SUPERGRAVITY; WAVES; GAS.

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