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Title: “What the ants are telling us about black hole and QGP”

I will talk about my recent work with a few different sets of collaborators, including the one in progress which is still speculative.

If the gauge/gravity duality is correct, Schwarzschild black hole in ten dimensions, which has the negative specific heat (E~T^{-7}) as Hawking has discovered, has to be described by QFT. But how can the negative specific heat be described by a healthy quantum theory? In the first part of the talk, I explain the partial deconfinement --- SU(M) degrees of freedom in SU(N) (M<N) deconfine while the rest of the degrees of freedom confine --- naturally explains the negative specific heat, including the power -7.

At first sight, the partial deconfinement appears to be ad hoc. However it is actually a generic feature of various gauge theories. In order to demonstrate it, I will introduce a startling similarity between the ant trail and black hole. Namely, by identifying the ants, pheromone and ant trail with D-branes, open strings and black hole, the dynamics of the ants is essentially the same as the thermodynamics of D-branes and strings in superstring theory. The collective behavior of the ants can be understood intuitively, and lead us to the understanding of the generic mechanism behind the black hole formation in string theory and deconfinement transition in gauge theory.

The lessons we learn from the ants suggest that the partial deconfinement is generic, even without gravity dual. Once we know it, we can actually confirm the partial deconfinement in various theories. An interesting point here is that the partial deconfinement is a well-defined notion even for the theories without center symmetry, such as QCD. The partial deconfinement phase spontaneously breaks the gauge symmetry (precise meaning is explained in the talk) and hence the two transitions --- breaking of gauge symmetry, which corresponds to the transition from the confined phase to the partially deconfined phase, and the restoration of gauge symmetry, which corresponds to the transition from the partially deconfined phase to the completely deconfined phase --- characterize the deconfinement. Similar "partial breaking" can also take place when the chiral symmetry breaks, and interesting physics, which may be actually happening in colliders, shows up.