

Black-Hole Microstructure V



ID de Contribution: 16

Type: Non spécifié

New SYM phases at finite chemical potential

jeudi 8 juin 2023 10:00 (1 heure)

Abstract: We do a systematic search of supergravity solutions that, via the AdS₅/CFT₄ correspondence, are dual to thermal states in N=4 SYM at finite chemical potential. These solutions are required to ultimately reproduce the microscopic entropy of AdS black holes. Using a mix of analytical and numerical methods, we construct and study static and rotating charged hairy solitonic and black hole solutions with global AdS₅ asymptotics. They are constructed in a consistent truncation of five dimensional SO(6) gauged supergravity and can thus be uplifted to asymptotically AdS₅ x S⁵ solutions of type IIB supergravity (it is also a truncation of N=8 gauged supergravity). Hairy black holes exist above a critical electric charge and merge with the known Cvetic-Lu-Pope (CLP) black holes along a curve determined by the onset of superradiance in the latter family. The hairy black holes then extend all the way up to the BPS limit (in a phase diagram) and they dominant the microcanonical ensemble when they coexist with the CLP black holes. In the BPS limit, our finite temperature black holes approach new supersymmetric hairy black holes that reduce to the supersymmetric Lucietti-Kunduri-Reall black hole family when the hair condensate vanishes. Our findings permit a good understanding of the full phase space of SYM thermal states with three arbitrary chemical potentials and finite charged scalar fields.

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