Research Talk

BLACK HOLE THERMODYNAMICS VIA A-DISCRIMINANTS

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Research interests: Black holes, general relativity, mathematical physics.

SPEAKER INTRODUCTION

Dr. Yen-Kheng Lim is an Associate Professor at Xiamen University Malaysia. He received his PhD in December 2015 from the National University of Singapore. His research interests are black holes and general relativity, particularly in seeking exact solutions in gravity theories and their orbital dynamics. Recently he has also been exploring mathematical concepts like algebraic geometry and tropical geometry, and applying these ideas in solving problems in statistical mechanics, quantum mechanics, and gravity.

ABSTRACT

We show that the free energy $\mathcal{F}$ and temperature T of black holes, considered as a thermodynamic system, can be viewed as an A-discriminant of an appropriately-defined polynomial. As such, mathematical results about A-discriminants may lead to implications about black hole thermodynamics. In particular, for static spacetimes with spherical, planar, or hyperbolic symmetry, the number of distinct thermodynamic phases depend on the number of distinct terms in the metric component g_{tt}. We prove that if g_{tt} consists of N_f distinct terms, then the $\mathcal{F}$-T curve consists of $N_f - 2$ cusps, which in turn leads to $N_f - 1$ distinct thermodynamic phases. This result is applied to explicit examples of the Schwarzschild-AdS, Reissner–Nordström, power-law Maxwell, and Euler–Heisenberg black holes. This is a joint work with Mounir Nisse and Linus Chang.