Title: Recent developments in the holography of black holes and conformal field theories

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It is recently conjectured that generic non-extremal Kerr black hole could be holographically dual to a hidden conformal field theory (CFT) in two dimensions. Moreover, it is known that there are two CFT duals (pictures) to describe the charged rotating black holes which correspond to angular momentum J and electric charge Q of the black hole. Furthermore these two pictures can be incorporated by the CFT duals (general picture) that are generated by $SL(2,Z)$ modular group. The general conformal structure can be revealed by looking at charged scalar wave equation in some appropriate values of frequency and charge. In this regard, we consider the wave equation of a charged massless scalar field in the background of Kerr–Sen black hole and show that in the 'near region', the wave equation can be reproduced by the Casimir operator of a local $SL(2,\mathrm{R})_{\mathrm{L}} \times SL(2,\mathrm{R})_{\mathrm{R}}$ hidden conformal symmetry. We find the exact agreement between macroscopic and microscopic physical quantities like entropy and absorption cross section of scalars for Kerr–Sen black hole. We then find an extension of vector fields that in turn yields an extended local family of $SL(2,\mathrm{R})_{\mathrm{L}} \times SL(2,\mathrm{R})_{\mathrm{R}}$ hidden conformal symmetry, parameterized by one parameter. For some special values of the parameter, we find a copy of $SL(2,\mathrm{R})$ hidden conformal algebra for the charged Gibbons– Maeda–Garfinkle–Horowitz–Strominger black hole in the strong deflection limit. Moreover, we consider generic non-extremal Kerr–Newman black holes that are holographically dual to hidden conformal field theories in two different pictures. The two pictures can be merged together to the dual conformal field theories (CFTs) in general picture that are generated by $S\,L\,(2,\mathrm{Z})$ modular group. We find some extensions of the conformal symmetry generators that yield an extended local family of $SL(2,\mathrm{R})_L \times SL(2,\mathrm{R})_R$ hidden conformal symmetries for the Kerr–Newman black holes, parameterized by one deformation parameter. The family of deformed hidden conformal symmetry for Kerr–Newman black holes also provides a set of deformed hidden conformal symmetry for the charged Reissner–Nordstrom black holes. The set of deformed hidden conformal generators reduce to the hidden $SL(2,\mathrm{R})$ conformal generators for the Reissner–Nordstrom black hole for specific value of deformation parameter. We also find agreements between the macroscopic and microscopic entropy and absorption cross-section of scalars for the Kerr–Newman black hole by considering the appropriate temperatures and central charges for the deformed CFTs.