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Electromagnetic quasinormal modes of rotating black strings and the AdS/CFT correspondence. (English) Zbl 1342.83194

J. High Energy Phys. 2013, No. 3, Paper No. 169, 23 p. (2013).

Summary: We investigate the quasinormal spectrum of electromagnetic perturbations of rotating black strings. Among the solutions of Einstein equations in the presence of a negative cosmological constant there are asymptotically anti-de Sitter (AdS) black holes whose horizons have the topology of a cylinder. The stationary version of these AdS black holes represents rotating black strings. The conformal field theory (CFT) dual of a black string lives in a Minkowski space with a compact dimension. On the basis of the AdS/CFT duality, we interpret a CFT plasma moving with respect to the preferred rest frame introduced by the topology as the holographic dual to a rotating black string. We explore the consequences of this correspondence by investigating the electromagnetic perturbations of a black string for different rotation parameter values. As usual the electromagnetic quasinormal modes (QNM) correspond to the poles of retarded Green's functions of R-symmetry currents in the boundary field theory. The hydrodynamic regime of the QNM dispersion relations are analytically studied. Finally, we investigate numerically the effect of rotation on all the family of black-string electromagnetic quasinormal modes. We interpret these results from the CFT perspective and notice the emergence of effects like Doppler shift of the frequencies and dilation of the thermalization times.

MSC:

83C57 Black holes

83E30 String and superstring theories in gravitational theory

Cited in 4 Documents

Keywords:

AdS-CFT correspondence; classical theories of gravity; black holes

Full Text: [DOI](#) [arXiv](#)

References:

- [1] J.M. Maldacena, *The large-N limit of superconformal field theories and supergravity*, *Adv. Theor. Math. Phys.* **2** (1998) 231 [*Int. J. Theor. Phys.* **38** (1999) 1113] [[hep-th/9711200](#)] [[INSPIRE](#)]. · [Zbl 0914.53047](#)
- [2] Witten, E., Anti-de Sitter space and holography, *Adv. Theor. Math. Phys.*, **2**, 253, (1998) · [Zbl 0914.53048](#)
- [3] Gubser, S.; Klebanov, IR; Polyakov, AM, Gauge theory correlators from noncritical string theory, *Phys. Lett., B* **428**, 105, (1998) · [Zbl 1355.81126](#)
- [4] Aharony, O.; Gubser, SS; Maldacena, JM; Ooguri, H.; Oz, Y., Large-N field theories, string theory and gravity, *Phys. Rept.*, **323**, 183, (2000) · [Zbl 1368.81009](#) · [doi:10.1016/S0370-1573\(99\)00083-6](#)
- [5] Boschi-Filho, H.; Braga, NR, Gauge/string duality and hadronic physics, *Braz. J. Phys.*, **37**, 567, (2007) · [doi:10.1590/S0103-97332007000400016](#)
- [6] Son, DT; Starinets, AO, Viscosity, black holes and quantum field theory, *Ann. Rev. Nucl. Part. Sci.*, **57**, 95, (2007) · [doi:10.1146/annurev.nucl.57.090506.123120](#)
- [7] S.S. Gubser, *Heavy ion collisions and black hole dynamics*, *Int. J. Mod. Phys. D* **17** (2008) 673 [*Gen. Rel. Grav.* **39** (2007) 1533] [[INSPIRE](#)]. · [Zbl 1181.83117](#)
- [8] Erdmenger, J.; Evans, N.; Kirsch, I.; Threlfall, E., Mesons in gauge/gravity duals — a review, *Eur. Phys. J., A* **35**, 81, (2008)
- [9] Iancu, E., Partons and jets in a strongly-coupled plasma from AdS/CFT, *Acta Phys. Polon., B* **39**, 3213, (2008)
- [10] Myers, R.; Vazquez, S., Quark soup al dente: applied superstring theory, *Class. Quant. Grav.*, **25**, 114008, (2008) · [Zbl 1144.83333](#) · [doi:10.1088/0264-9381/25/11/114008](#)
- [11] Hubeny, VE; Rangamani, M., A holographic view on physics out of equilibrium, *Adv. High Energy Phys.*, 2010, 297916, (2010) · [Zbl 1216.83028](#)
- [12] Herzog, CP, Lectures on holographic superfluidity and superconductivity, *J. Phys., A* **42**, 343001, (2009) · [Zbl 1180.82218](#)
- [13] Hartnoll, SA, Lectures on holographic methods for condensed matter physics, *Class. Quant. Grav.*, **26**, 224002, (2009) · [Zbl 1181.83003](#) · [doi:10.1088/0264-9381/26/22/224002](#)
- [14] McGreevy, J., Holographic duality with a view toward many-body physics, *Adv. High Energy Phys.*, 2010, 723105, (2010) · [Zbl 1216.81118](#)

- [15] Gubser, SS, Breaking an abelian gauge symmetry near a black hole horizon, *Phys. Rev., D* 78, 065034, (2008)
- [16] Hartnoll, SA; Herzog, CP; Horowitz, GT, Building a holographic superconductor, *Phys. Rev. Lett.*, 101, 031601, (2008) · doi:10.1103/PhysRevLett.101.031601
- [17] Hartnoll, SA; Herzog, CP; Horowitz, GT, Holographic superconductors, *JHEP*, 12, 015, (2008) · Zbl 1329.81390 · doi:10.1088/1126-6708/2008/12/015
- [18] K.S. Thorne, R.H. Price and D.A. Macdonald, *Black holes: the membrane paradigm*, Yale Univ. Press, New Haven U.S.A. (1986) [INSPIRE]. · Zbl 1374.83002
- [19] Parikh, M.; Wilczek, F., An action for black hole membranes, *Phys. Rev., D* 58, 064011, (1998)
- [20] Kovtun, P.; Son, DT; Starinets, AO, Holography and hydrodynamics: diffusion on stretched horizons, *JHEP*, 10, 064, (2003) · doi:10.1088/1126-6708/2003/10/064
- [21] Fujita, M., Non-equilibrium thermodynamics near the horizon and holography, *JHEP*, 10, 031, (2008) · Zbl 1245.83062 · doi:10.1088/1126-6708/2008/10/031
- [22] Iqbal, N.; Liu, H., Universality of the hydrodynamic limit in AdS/CFT and the membrane paradigm, *Phys. Rev., D* 79, 025023, (2009)
- [23] Bhattacharyya, S.; Hubeny, VE; Minwalla, S.; Rangamani, M., Nonlinear fluid dynamics from gravity, *JHEP*, 02, 045, (2008) · doi:10.1088/1126-6708/2008/02/045
- [24] Bhattacharyya, S.; et al., Forced fluid dynamics from gravity, *JHEP*, 02, 018, (2009) · Zbl 1245.83019 · doi:10.1088/1126-6708/2009/02/018
- [25] Bredberg, I.; Keeler, C.; Lysov, V.; Strominger, A., Wilsonian approach to fluid/gravity duality, *JHEP*, 03, 141, (2011) · Zbl 1301.81165 · doi:10.1007/JHEP03(2011)141
- [26] Bredberg, I.; Keeler, C.; Lysov, V.; Strominger, A., From Navier-Stokes to Einstein, *JHEP*, 07, 146, (2012) · doi:10.1007/JHEP07(2012)146
- [27] Kovtun, P.; Son, D.; Starinets, A., Viscosity in strongly interacting quantum field theories from black hole physics, *Phys. Rev. Lett.*, 94, 111601, (2005) · doi:10.1103/PhysRevLett.94.111601
- [28] Caldarelli, MM; Dias, OJ; Emparan, R.; Klemm, D., Black holes as lumps of fluid, *JHEP*, 04, 024, (2009) · doi:10.1088/1126-6708/2009/04/024
- [29] Lemos, JP, Two-dimensional black holes and planar general relativity, *Class. Quant. Grav.*, 12, 1081, (1995) · Zbl 0825.53012 · doi:10.1088/0264-9381/12/4/014
- [30] Huang, C-G; Liang, C-B, A torus like black hole, *Phys. Lett., A* 201, 27, (1995) · Zbl 1020.83608
- [31] Cai, R-G; Zhang, Y-Z, Black plane solutions in four-dimensional space-times, *Phys. Rev., D* 54, 4891, (1996)
- [32] Brill, DR; Louko, J.; Peldan, P., Thermodynamics of $(3+1)$ -dimensional black holes with toroidal or higher genus horizons, *Phys. Rev., D* 56, 3600, (1997)
- [33] Stachel, J., Globally stationary but locally static space-times: a gravitational analog of the Aharonov-Bohm effect, *Phys. Rev., D* 26, 1281, (1982)
- [34] Lemos, J., Cylindrical black hole in general relativity, *Phys. Lett., B* 353, 46, (1995)
- [35] Berti, E.; Cardoso, V.; Starinets, AO, Quasinormal modes of black holes and black branes, *Class. Quant. Grav.*, 26, 163001, (2009) · Zbl 1173.83001 · doi:10.1088/0264-9381/26/16/163001
- [36] Konoplya, R.; Zhidenko, A., Quasinormal modes of black holes: from astrophysics to string theory, *Rev. Mod. Phys.*, 83, 793, (2011) · doi:10.1103/RevModPhys.83.793
- [37] Horowitz, GT; Hubeny, VE, Quasinormal modes of AdS black holes and the approach to thermal equilibrium, *Phys. Rev., D* 62, 024027, (2000)
- [38] J.P. Lemos, *Rotating toroidal black holes in anti-de Sitter space-times and their properties*, gr-qc/0011092 [INSPIRE].
- [39] Lemos, JP; Zanchin, VT, Rotating charged black string and three-dimensional black holes, *Phys. Rev., D* 54, 3840, (1996)
- [40] Bhattacharyya, S.; Loganayagam, R.; Mandal, I.; Minwalla, S.; Sharma, A., Conformal nonlinear fluid dynamics from gravity in arbitrary dimensions, *JHEP*, 12, 116, (2008) · Zbl 1329.83103 · doi:10.1088/1126-6708/2008/12/116
- [41] Miranda, AS; Morgan, J.; Zanchin, VT, Quasinormal modes of plane-symmetric black holes according to the AdS/CFT correspondence, *JHEP*, 11, 030, (2008) · doi:10.1088/1126-6708/2008/11/030
- [42] Kovtun, PK; Starinets, AO, Quasinormal modes and holography, *Phys. Rev., D* 72, 086009, (2005)
- [43] Miranda, AS; Zanchin, VT, Quasinormal modes of plane-symmetric anti-de Sitter black holes: a complete analysis of the gravitational perturbations, *Phys. Rev., D* 73, 064034, (2006)
- [44] Herzog, CP, The hydrodynamics of M-theory, *JHEP*, 12, 026, (2002) · doi:10.1088/1126-6708/2002/12/026
- [45] Policastro, G.; Son, DT; Starinets, AO, From AdS/CFT correspondence to hydrodynamics, *JHEP*, 09, 043, (2002) · doi:10.1088/1126-6708/2002/09/043
- [46] Policastro, G.; Son, DT; Starinets, AO, From AdS/CFT correspondence to hydrodynamics. 2. sound waves, *JHEP*, 12, 054, (2002) · doi:10.1088/1126-6708/2002/12/054
- [47] Herzog, CP, The sound of M-theory, *Phys. Rev., D* 68, 024013, (2003)
- [48] Baier, R.; Romatschke, P.; Son, DT; Starinets, AO; Stephanov, MA, Relativistic viscous hydrodynamics, conformal invariance and holography, *JHEP*, 04, 100, (2008) · Zbl 1246.81352 · doi:10.1088/1126-6708/2008/04/100

- [49] M. Natsuume and T. Okamura, *Causal hydrodynamics of gauge theory plasmas from AdS/CFT duality*, *Phys. Rev. D* **77** (2008) 066014 [*Erratum ibid.* *D* **78** (2008) 089902] [arXiv:0712.2916] [INSPIRE].
- [50] Morgan, J.; Cardoso, V.; Miranda, AS; Molina, C.; Zanchin, VT, Gravitational quasinormal modes of AdS black branes in d spacetime dimensions, *JHEP*, 09, 117, (2009) · doi:10.1088/1126-6708/2009/09/117
- [51] Myers, RC; Wapler, MC, Transport properties of holographic defects, *JHEP*, 12, 115, (2008) · Zbl 1329.81321 · doi:10.1088/1126-6708/2008/12/115
- [52] Jokela, N.; Lifschytz, G.; Lippert, M., Magnetic effects in a holographic Fermi-like liquid, *JHEP*, 05, 105, (2012) · doi:10.1007/JHEP05(2012)105

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