

Reading Group on Mathematical aspects of AdS Spacetimes

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Introduction

This is a reading list for the study of Anti-de Sitter (AdS) spacetimes. The emphasis is on the geometry of AdS, its causal and conformal structure, black hole solutions, and PDE/stability issues.

References by Topic

Background and Geometry of AdS

- B. O'Neill, *Semi-Riemannian Geometry with Applications to Relativity*, Academic Press (1983).
- Hawking, S., Ellis, G.: *The Large Scale Structure of Space-Time*. Cambridge University Press (1973)

Causality and Conformal Infinity: Initial-Boundary value problem

- Friedrich, H.: “Einstein equations and conformal structure: existence of Anti-de Sitter-type space-times”. *J. Geom. Phys.* 17, 125–184 (1995)
- Friedrich, H.: “On the AdS stability problem”. *Class. Quantum Gravity* 31(10), 105001 (2014)
- Ludovic Souetre, “Geometric reflective boundary conditions for asymptotically anti-de Sitter spaces”, arXiv preprint arXiv:2507.20661

AdS Black Holes

- G. Galloway, S. Surya, and E. Woolgar, “A uniqueness theorem for the AdS soliton,” *Phys. Rev. Lett.* 88 (2002), 101102.
- P. T. Chruściel and J. Lopes Costa, “On uniqueness of stationary black holes,” *Astérisque* 321 (2008), 195–265. [esp. sections on AdS]

Stability and PDE Aspects

- M. Anderson, “On the uniqueness and global dynamics of AdS spacetimes,” *Class. Quant. Grav.* 23 (2006), 6935–6954.
- G. Holzegel. “On the massive wave equation on slowly rotating Kerr-AdS spacetimes.” *Communications in Mathematical Physics*, 294(1):169–197, (2010).
- G. Holzegel, “Well-posedness for the massive wave equation on asymptotically AdS space-times,” *J. Hyperbolic Differ. Equ.* 9 (2012), 239–261.

- Holzegel, G., Smulevici, J.: “Self-gravitating Klein–Gordon fields in asymptotically Anti-de-Sitter spacetimes.” *Ann. Henri Poincaré* 13(4), 991–1038 (2012)
- Vasy, A.: “The wave equation on asymptotically anti de Sitter spaces.” *Anal. PDE* 5(1), 81–144 (2012)
- Warnick, C.: “The massive wave equation in asymptotically AdS spacetimes.” *Commun. Math. Phys.* 321(1), 85–111 (2013)
- G. Holzegel and J. Smulevici, “Decay properties of Klein-gordon fields on Kerr-AdS spacetimes.” *Communications on Pure and Applied Mathematics*, 66(11):1751–1802, (2013).
- G. Holzegel and J. Smulevici, “Stability of Schwarzschild–AdS for the Einstein–Klein–Gordon system,” *Comm. Math. Phys.* 317 (2013), 205–251.
- G. Holzegel and J. Smulevici, “Quasimodes and a lower bound on the uniform energy decay rate for Kerr–AdS spacetimes”. *Analysis & PDE*, 7(5):1057–1090, (2014).
- Gustav H Holzegel and Claude M Warnick. “Boundedness and growth for the massive wave equation on asymptotically anti-de Sitter black holes.” *Journal of Functional Analysis*, 266(4):2436–2485, (2014).
- Holzegel, G., Warnick, C.: “The Einstein–Klein–Gordon–AdS system for general boundary conditions.” *J. Hyperbolic Differ. Equ.* 12(2), 293–342 (2015)
- Dominic Dold. “Unstable mode solutions to the Klein–Gordon equation in Kerr-anti-de Sitter spacetimes.” *Communications in Mathematical Physics*, 350:639–697, (2017)
- Holzegel, G., Luk, J., Smulevici, J., Warnick, C.: “Asymptotic properties of linear field equations in anti-de Sitter space.” *Commun. Math. Phys.* 374(2), 1125–1178 (2020)
- G. Moschidis “A proof of the instability of AdS for the Einstein-massless Vlasov system”, *Inventiones Mathematicae*, DOI : 10.1007/s00222-022-01152-7. (2022)
- Olivier Graf and Gustav Holzegel. “Mode stability results for the Teukolsky equations on Kerr–anti-de Sitter spacetimes.” *Classical and Quantum Gravity*, 40(4):045003, (2023).
- Olivier Graf and Gustav Holzegel. “Linear stability of schwarzschild-anti-de sitter spacetimes i: The system of gravitational perturbations.” arXiv preprint arXiv:2408.02251, 2024.
- Olivier Graf and Gustav Holzegel. “Linear stability of schwarzschild-anti-de sitter spacetimes ii: Logarithmic decay of solutions to the teukolsky system.” arXiv preprint arXiv:2408.02252, 2024.
- Filip Ficek and Maciej Maliborski, “Instability mechanisms on asymptotically AdS black hole backgrounds” arXiv preprint arXiv:2508.20483