Gravity and holography in low dimensions I (136.073)

Daniel Grumiller

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http://quark.itp.tuwien.ac.at/~grumil/teaching.shtml

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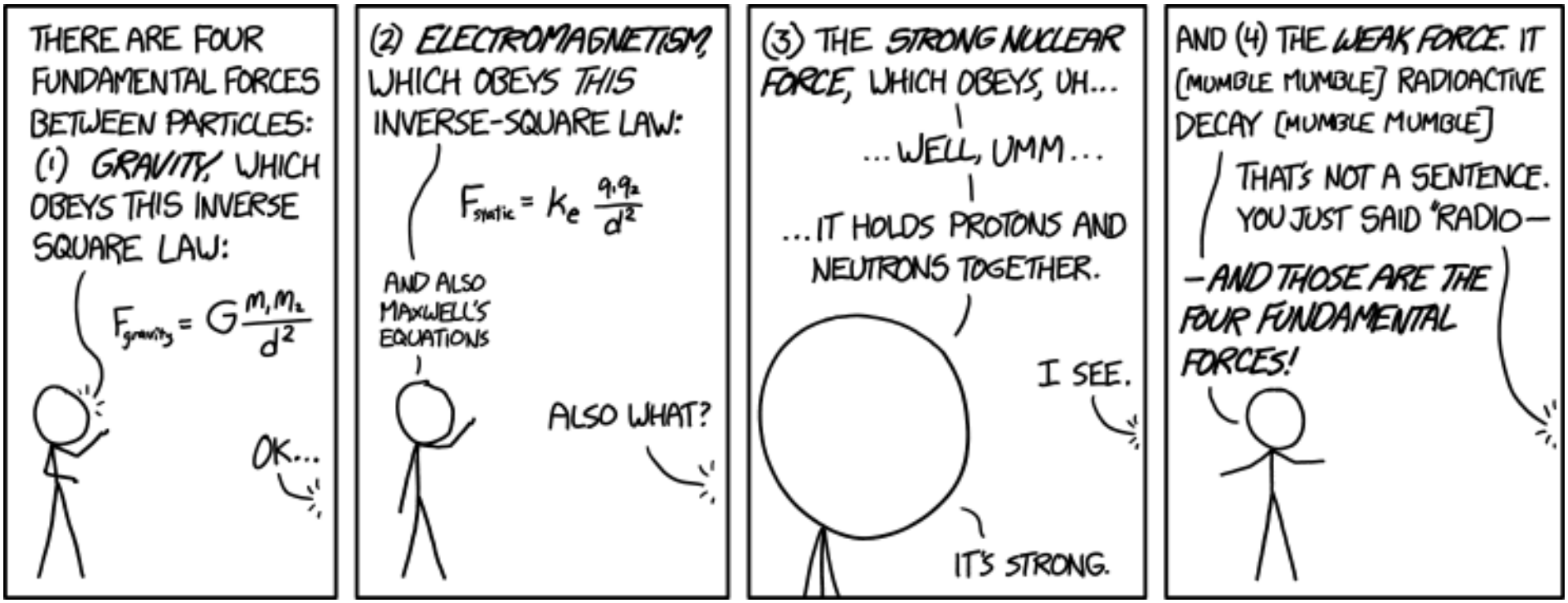
Fundamental forces (xkcd 1489)



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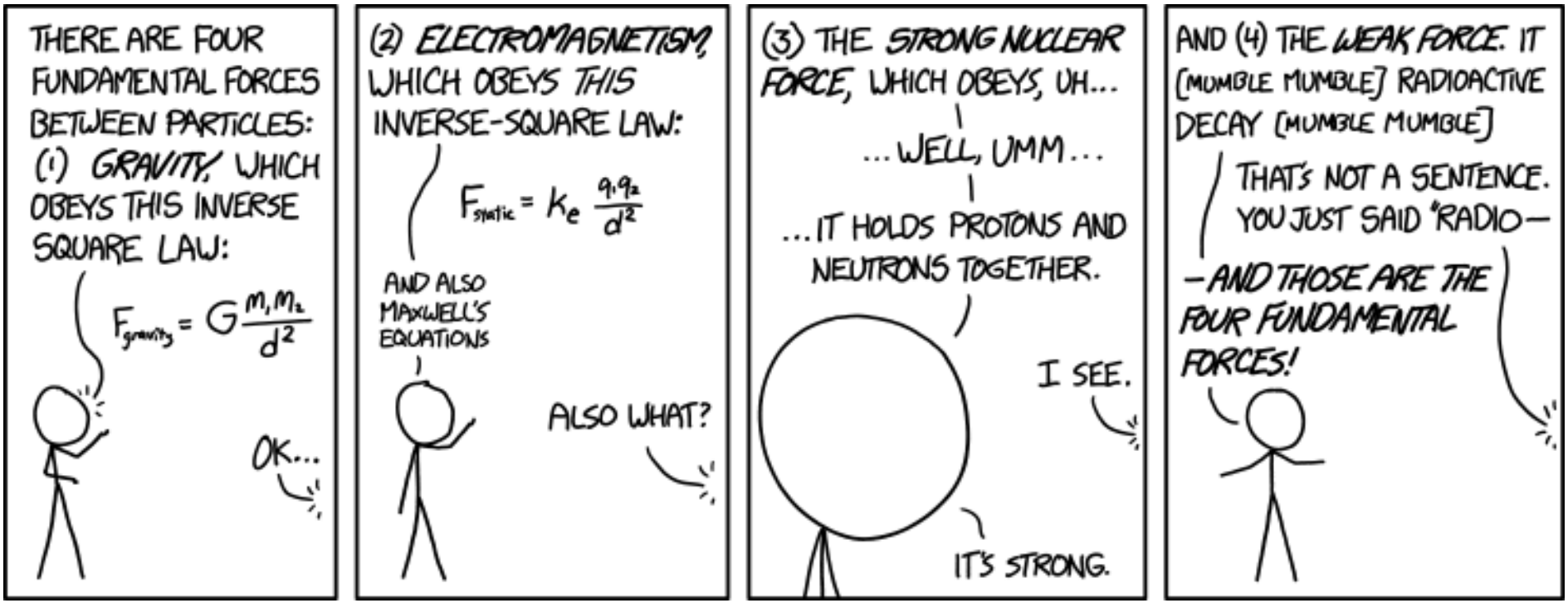

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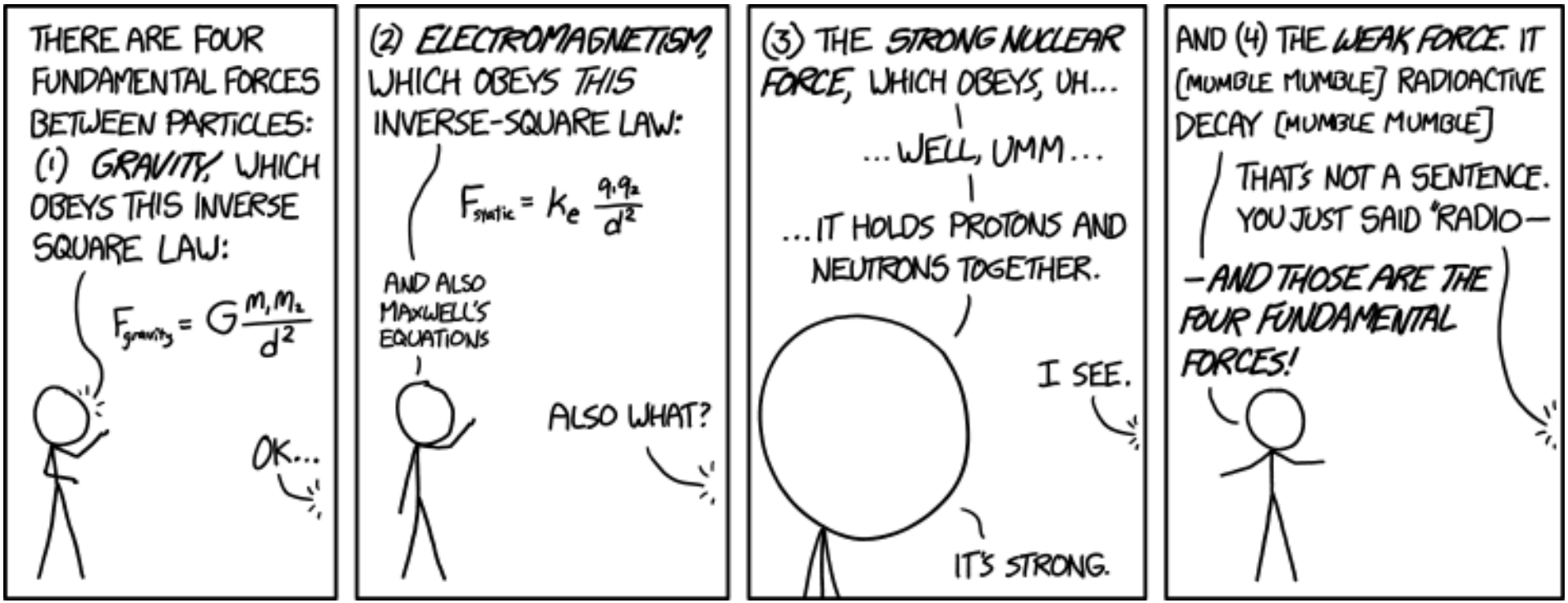

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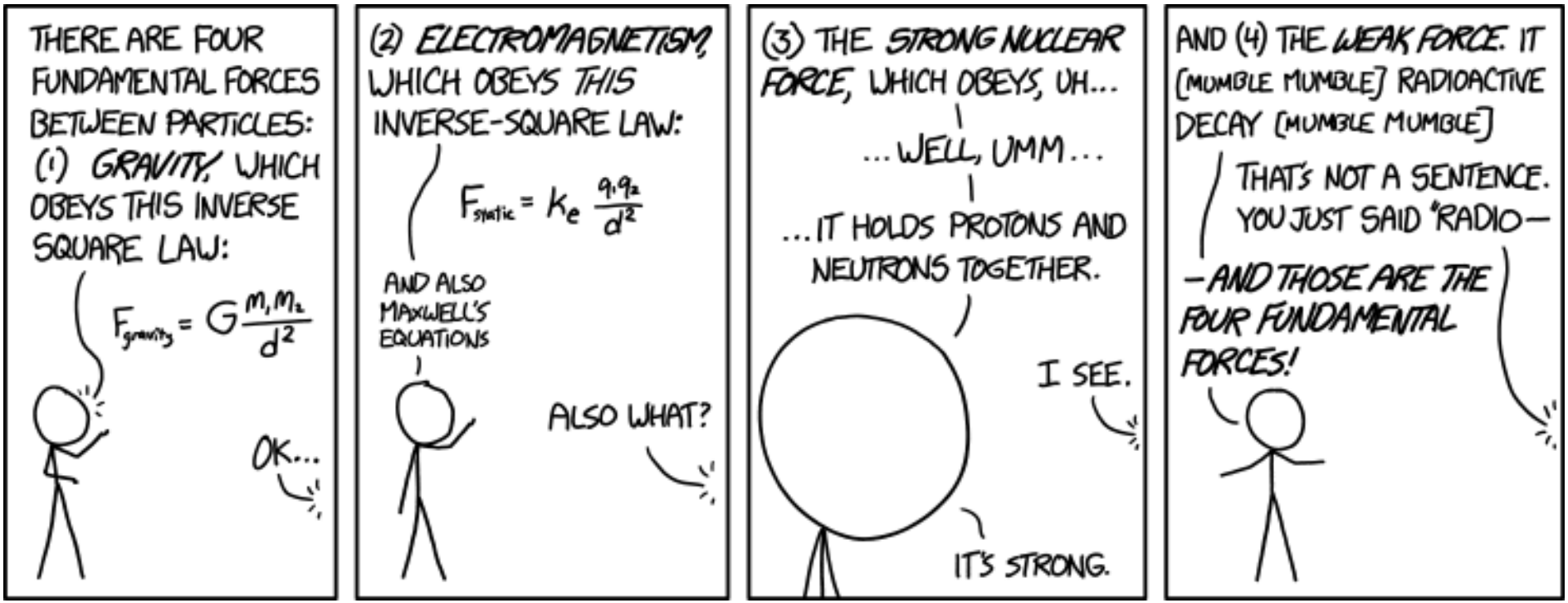

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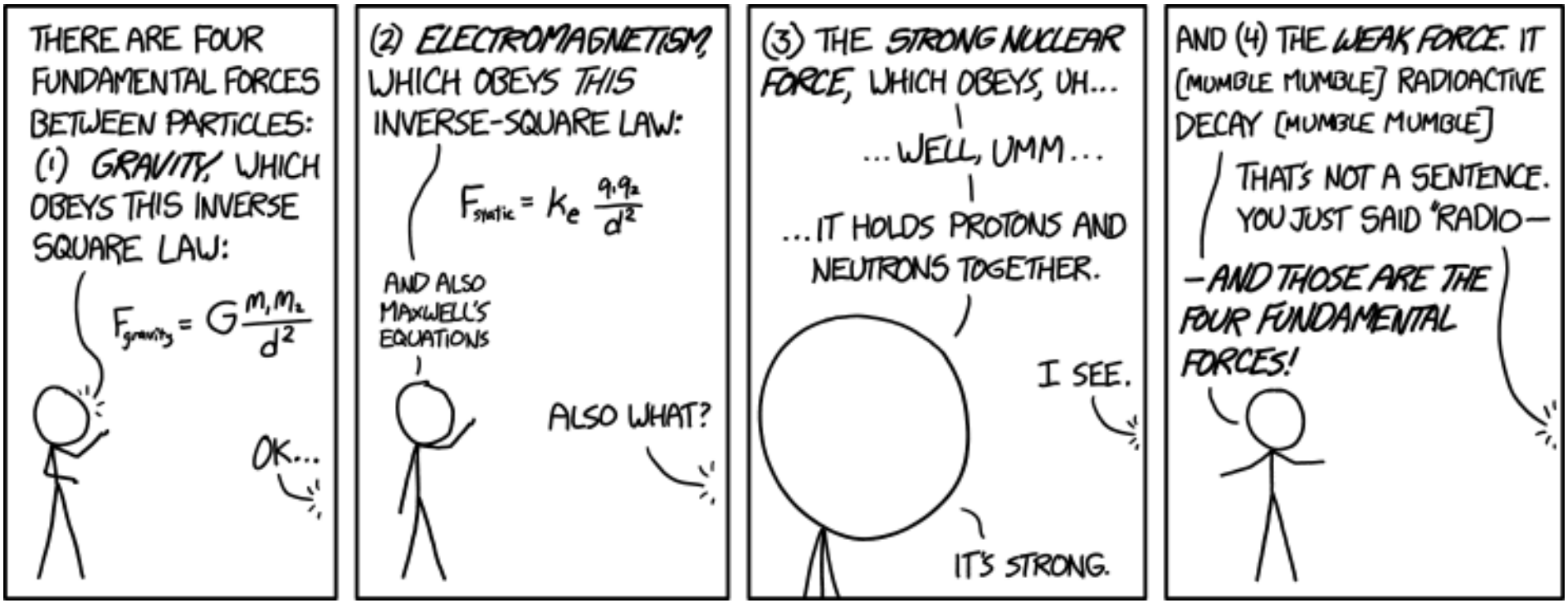

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Main goal: understand quantum gravity

Top-10 fundamental physics* papers of all times

Counted in INSPIRE 01 Oct 2018

1. J. M. Maldacena, "The Large N limit of superconformal field theories and supergravity," *Adv. Theor. Math. Phys.* **2** (1998) 231, `hep-th/9711200`.
   14023 citations

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   A. G. Riess *et al.* [Supernova Search Team], "Observational evidence from supernovae for an accelerating universe and a cosmological constant," *Astron. J.* **116** (1998) 1009, `astro-ph/9805201`.
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9. G. Aad *et al.* [ATLAS Collaboration], "Observation of a new particle in the search for the Standard Model Higgs boson with the ATLAS detector at the LHC," *Phys. Lett.* **B716** (2012) 1, `arXiv:1207.7214`.
   8867 citations
   S. Chatrchyan *et al.* [CMS Collaboration], "Observation of a new boson at a mass of 125 GeV with the CMS experiment at the LHC," *Phys. Lett.* **B716** (2012) 30, `arXiv:1207.7235`.
   8657 citations

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14. S. S. Gubser, I. R. Klebanov and A. M. Polyakov, "Gauge theory correlators from noncritical string theory," *Phys. Lett.* **B428** (1998) 105, hep-th/9802109.
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Why gravity and holography?

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- Examples II: microsopic understanding of black holes, information paradox/firewalls, higher spin theories, flat space holography, quantum gravity in lower dimensions, ...

Why lower dimensions?

"As simple as possible, but not simpler"

- Gravity is simpler in lower dimensions

11D: 1144 Weyl, 66 Ricci

⋮

5D: 35 Weyl, 15 Ricci

4D: 10 Weyl, 10 Ricci

3D: 0 Weyl, 6 Ricci

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  York-decomposition of metric: only trace part and gauge part, but no transverse-traceless part

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- Holographic tools for 2D condensed matter systems

Prerequisites

Basic knowledge about black hole physics

Topics covered in Black Holes I and II of relevance for these lectures:

1. Metric and geodesic equation
2. Curvature and basics of differential geometry
3. Hilbert action and Einstein equations
4. Spherically symmetric black holes and Birkhoff theorem
5. Rotating black holes: the Kerr solution
6. Black hole thermodynamics
7. Hawking effect
8. Action principle and boundary issues
9. Holographic renormalization and Brown–York stress tensor
10. Asymptotic symmetries and black holes in AdS
11. Gravity aspects of AdS/CFT

Gravity and holography in lower dimensions I

Main goal: Understanding of basic aspects of holography, mostly on the gravity side

Topics covered in this course:

1. Gravity with boundaries

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7. Holographic renormalization and correlation functions
8. Holographic entanglement entropy
9. ... and possibly further selected recent research topics

Related lectures this semester (ordered alphabetically by lecturer)

- VO Geometrie und Gravitation II (136.008), Herbert Balasin
- PA Black Hole Physics (136.025), Daniel Grumiller
- SV Thermal field theory (135.006), Anton Rebhan
- SV Literaturseminar Mathematische Physik 1 (135.046), Anton Rebhan et al.
- PR Seminar on Fundamental Interactions 1 (132.071), Anton Rebhan et al.
- UV: VO+UE Relativity and Cosmology I (260038), Piotr Chrusciel
- UV: SE Relativistic field theories and supersymmetry (260053), Stefan Fredenhagen
- UV: VU Non-perturbative effects in quantum field theory (260044), Johanna Knapp

Outline

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- Each Tuesday, 9:00am-11:00am, seminar room on 3rd floor

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- PA's for preparation of lecture notes – in case of interest meet me after the lectures until end of March

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Textbooks and Lecture Notes

- Lecture sheets (in preparation)
- Dilaton gravity in two dimensions (D. Grumiller, W. Kummer and D. Vassilevich), 2002, hep-th/0204253
- How general is holography? (Max Riegler) PhD thesis, 2016, arXiv:1609.02733
- Menagerie of AdS_2 boundary conditions (D. Grumiller, R. McNees, J. Salzer, C. Valcárcel, D. Vassilevich), 2017, arXiv:1708.08471
- Canonical charges in flatland (M. Riegler, C. Zwikel), 2017 arXiv:1709.09871

Increasingly relevant resource: arXiv.org

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