Black Holes II (136.029)

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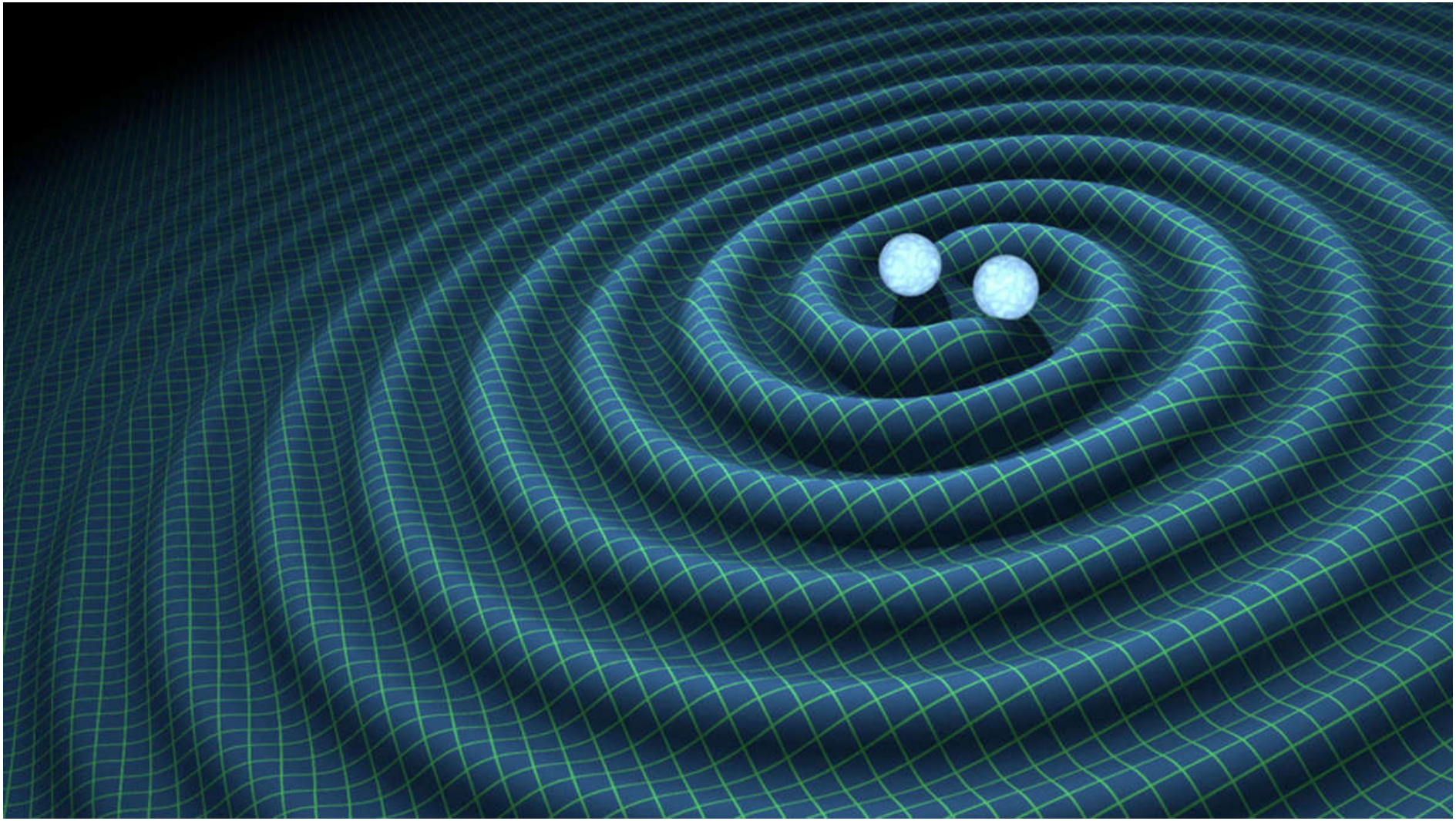
Announcement on February 11, 2016

LIGO detection of gravitational waves from black hole merger; 1602.03837



initial BHs: $\approx 36 M_\odot$, $29 M_\odot$; final BH: $\approx 62 M_\odot$; radiated energy: $\approx 3 M_\odot$

Outline

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Why Study Black Holes?

Depending whom you ask you'll hear:

- General Relativist: because they are unavoidable
- Mathematician: because they are interesting
- Science Fiction Writer: because they are cool
- Astrophysicist: because they explain the data
- String Theoretician: because they hold the key to quantum gravity
- Particle Physicist: because they might be produced at LHC
- Cosmologist: because they exist
- Numerical Relativist: because they present challenge for coding skills
- Nuclear Physicist: because they are dual to a strongly coupled plasma
- Condensed Matter Physicist: because we can produce them in the lab
- Gravitational Wave Experimentalist: because we need to understand black holes to provide templates for gravitational wave detection

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Last semester

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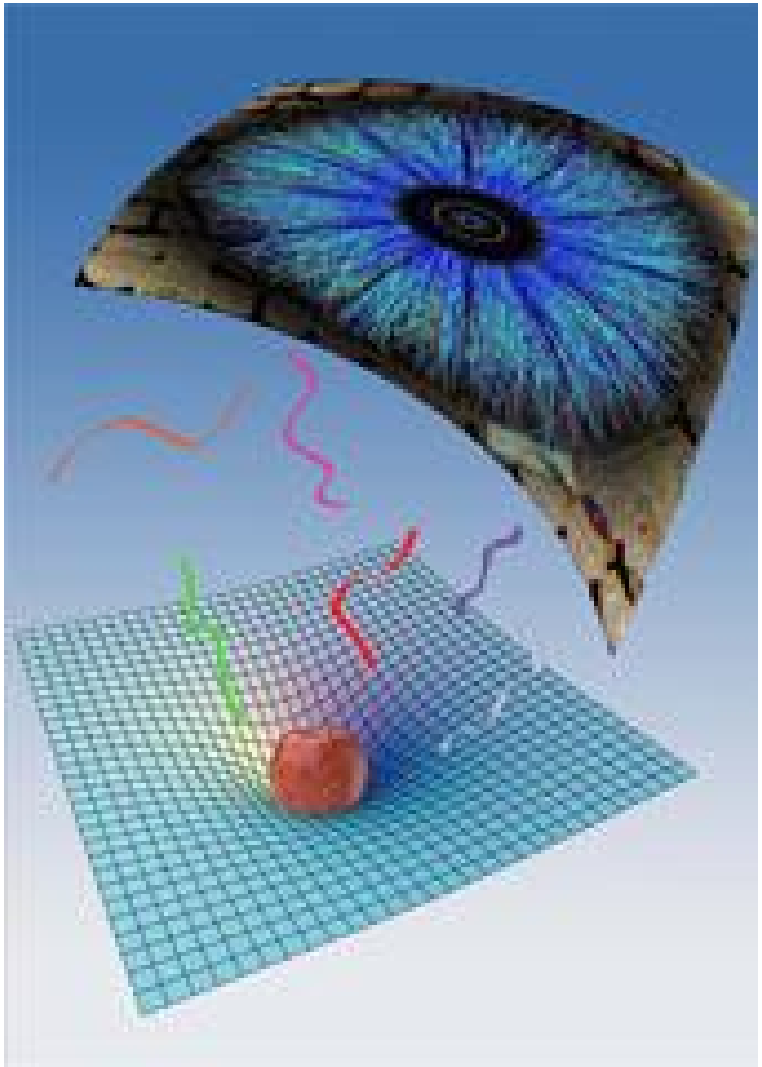

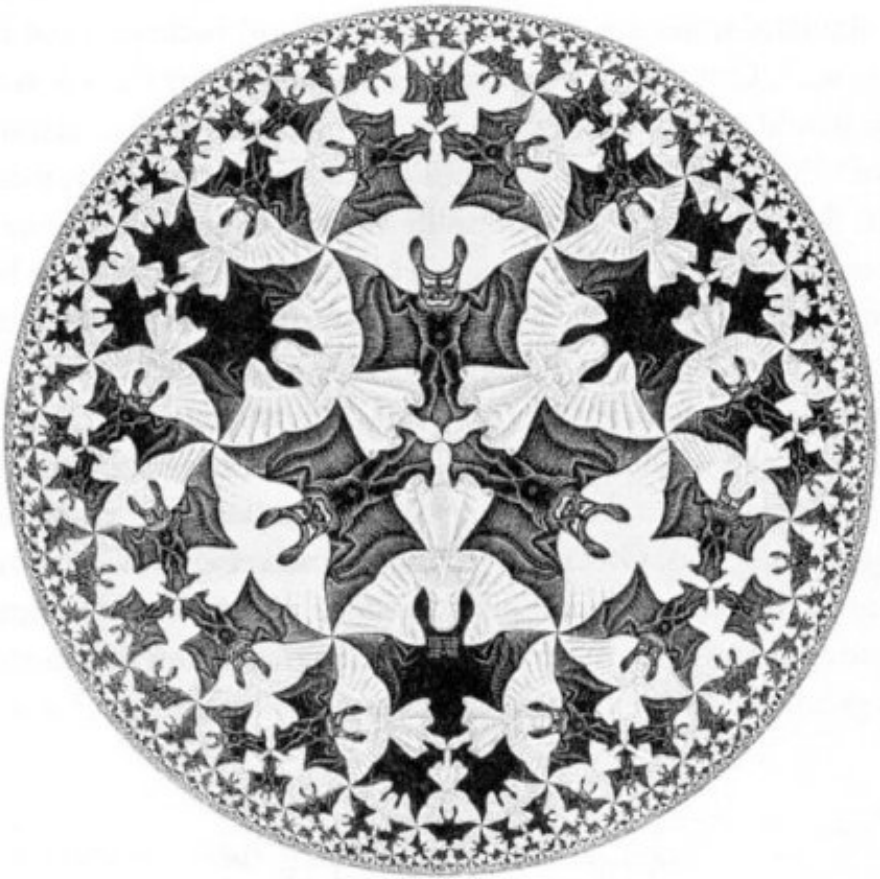

Open Universe Looking from inside, boundary at infinity
Limit Circle IV, by M. C. Escher

Prerequisites

Basic knowledge about black hole physics

Topics covered in Black Holes I of relevance for this semester:

1. History of black holes
2. Phenomenology of and experiments with black holes
3. Gravitational collapse and Chandrasekhar limit
4. Metric and geodesic equation
5. Geodesics for Schwarzschild black holes
6. Curvature and basics of differential geometry
7. Hilbert action and Einstein equations
8. Spherically symmetric black holes and Birkhoff theorem
9. Rotating black holes: the Kerr solution
10. Geodesics for Kerr black holes
11. Accretion disks and black hole observations
12. Black hole analogs in condensed matter physics

Black Holes II

Main goal: Understanding of advanced/current research black hole topics

Topics covered in this course:

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9. Black holes in AdS
10. ... and possibly further selected recent research topics

Related lectures this semester (ordered alphabetically by lecturer)

- VO Geometrie und Gravitation I (136.002), Herbert Balasin
- PA Black Hole Physics (136.025), Daniel Grumiller
- VO Introduction to QED (135.045), Andreas Ipp
- VO Introduction to QFT II (136.041), Anton Rebhan
- SV Literaturseminar Mathematische Physik 2 (135.048), Anton Rebhan et al.
- PR Arbeitsgemeinschaft für fundamentale Wechselwirkungen 2 (132.074), Anton Rebhan et al.
- VO Geometrische Methoden der Theoretischen Physik (135.029), Harald Skarke
- VO Thermal field theory (136.006), Kirill Boguslavski
- UV: VO Relativity III (260049), David Fajman
- UV: VO Superstring theory and interactions (442642), Pascal Anastasopoulos
- UV: VO Quantum gravity (260024), Lisa Glaser/Stefan Fredenhagen

Outline

Where, when, how?

- EITHER Each Tuesday, 9:00*am-12:00*am, seminar room on 3rd floor
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FIX THIS NOW!

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- Outlook: Projektarbeit Black Hole Physics, Master, PhD

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Textbooks and Lecture Notes

- Notes on Relativity and Cosmology, (D. Marolf, http://www.physics.ucsb.edu/∼marolf/MasterNotes.pdf)
- General Relativity, (R. Wald, 1984, U. Chicago Press, Chicago)
- Gravitation, (C. Misner, K.S. Thorne and J.A. Wheeler, 1973, W.H. Freeman and Co., New York)
- Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity (S. Weinberg, 1972, John Wiley)
- The large scale structure of space-time, (S.W. Hawking and G.F.R. Ellis, 1973, Cambridge University Press, Cambridge)
- Black Holes (P. Townsend), 1997, gr-qc/9707012
- Dilaton gravity in two dimensions (D. Grumiller, W. Kummer and D. Vassilevich), 2002, hep-th/0204253
- Black holes and thermodynamics — The first half century (D. Grumiller, R. McNees and J. Salzer), 2014, arXiv:1402.5127

Increasingly relevant resource: arXiv.org

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Get copies at the end of lecture (essentially now) or download PDF from
http://quark.itp.tuwien.ac.at/~grumil/teaching.shtml

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Later this week (Thu) OR next week (Tue) construct Penrose diagram: