

Active Galaxies: program. I

- ✓ Introduction to the course.
- 1. Brief historical perspective on AGN.
- 2. Pills on on radiative transfer and on thermal and non-thermal processes.
- 3. AGN classification and unification model.
- 4. Insights into AGN innermost regions via X-ray observations.
- 5. Jetted vs. not-jetted AGN. Emission processes, observational features, spectral energy distributions, and blazar sequence. Prospects for the Cerenkov Telescope Array.
- 6. On the nature of obscuration in AGN: torus vs. host galaxy. Photometric and spectroscopic selection techniques of obscured AGN.

Active Galaxies: program. II

7. The black hole paradigm. Radiatively efficient (Shakura-Sunyaev) accretion discs vs. ADAF solutions. Slim discs and their potential application to growing BHs.
8. A close look at the innermost regions of AGN: EHT and GRAVITY results.
9. The Galactic Center: SgrA* and its accretion history up the recent flares. The Galactic Plane: Fermi bubbles and X-ray chimneys.
10. AGN-galaxy co-evolution models at high redshift vs. AGN unification model. Formation and evolution of AGN. X-ray surveys and the cosmic X-ray background. The Soltan argument.
11. The realm of high-redshift AGN and theories on seed black holes.
12. BH masses from reverberation studies and scaling relations.
13. Feedback (radiative/mechanic) from AGN. The impact of winds and outflows on small and large scales in setting the M-sigma relation. Recent multi-wavelength studies.

Suggested textbooks (not needed to read all/everything)

- H. Bradt: "*Astrophysics Processes: The Physics Of Astronomical Phenomena*", Cambridge University Press
- G. B. Rybicky, A. P. Lightman: "*Radiative Processes in Astrophysics*", Wiley
- G. Ghisellini: "*Radiative processes in high energy astrophysics*", Springer, Lecture Notes in Physics 873
Emission processes
- B. M. Peterson: "*An introduction to Active Galactic Nuclei*", Cambridge University Press
- H. Netzer: "*The Physics and Evolution of Active Galactic Nuclei*", Cambridge University Press
- V. Beckmann, C. Shrader: "*Active Galactic Nuclei*", Wiley-VCH
AGN properties+class
- Frank J., King A. & Raine D.: "*Accretion Power in Astrophysics*", Cambridge University Press
Accretion-disc physics
- F. D. Seward, P. A. Charles: "*Exploring the X-ray Universe*", Cambridge University Press
- Haardt F., Gorini V., Moschella U., Treves A., Colpi M.: "*Astrophysical Black Holes*", Springer, Lecture Notes in Physics, 905
- Falanga M., Belloni T., Casella P., Gilfanov M., Jonker P., King A.: "*The Physics of Accretion onto Black Holes*", Springer, Space Sciences Series of ISSI
Several topics

+ literature articles (<https://arxiv.org>)

Suggested readings (not needed to read all/everything). I

- [1,12] B. Peterson: "*The central black hole and relationships with the host galaxy*", New Astronomy Reviews, 52, 240 (2008)
- [1,7] A. King: "*Disc accretion in active galactic nuclei*", New Astronomy Reviews, 52, 253 (2008)
- [1,3,6] S. Bianchi, R. Maiolino, G. Risaliti: "*AGN Obscuration and the Unified Model*", Advances in Astronomy, Vol. 2012, id. 782030 (arXiv:1201.2119)
- [1,10] A. Merloni: "*Observing Supermassive Black Holes Across Cosmic Time: From Phenomenology to Physics*", Astrophysical Black Holes, Lecture Notes in Physics, Springer, Vol. 905, p.101 (2015; arXiv:1505.04940)
- [1,4] M. Middleton: "*Black hole spin: theory and observation*", Astrophysics of Black Holes, Astrophysics and Space Science Library, Springer, Vol. 440, p.99 (2016, arXiv:1507.06153)
- [3] C. Tadhunter: "*An introduction to active galactic nuclei: Classification and unification*", New Astronomy Reviews, 52, 227 (2008)
- [3,5,6,10] P. Padovani et al.: "*Active galactic nuclei: what's in a name?*", Astron. Astrophys. Rev., 25, 2 (2017)
- [3,6] H. Netzer: "*Revisiting the Unified Model of Active Galactic Nuclei*", ARA&A, 53, 365 (2015)
- [5] R. Blandford, D. Meier, A. Readhead: "*Relativistic jets from Active Galactic Nuclei*", ARA&A, 57, 467 (2019)
- [5] A. Tchekhovskoy, J.C. McKinney, R. Narayan: "*General relativistic modeling of magnetized jets from accreting black holes*", Astronomy at High Angular Resolution 2011, Journal of Physics, Conf. Series 372 (2012)
- [5] M.J. Hardcastle, J.H. Croston: "*Radio galaxies and feedback from AGN jets*", New Astronomy Reviews, 88, 101539 (2020)
- [5] P.N. Best, T.H. Heckman: "*On the fundamental dichotomy in the local radio-AGN population: accretion, evolution and host galaxy properties*", MNRAS, 421, 1569 (2012)

Suggested readings (not needed to read all/everything). II

- [5] D.E. Harris, H. Krawczynski: "*X-ray emission from extragalactic jets*", ARA&A, 44, 463 (2006)
- [6] M. Elitzur: "*The toroidal obscuration of active galactic nuclei*", New Astronomy Reviews, 52, 274 (2008)
- [6] C. R. Almeida, C. Ricci: "*Nuclear obscuration in active galactic nuclei*", Nature Astronomy 1, 679 (2017)
- [6] R.C. Hickox, D.M. Alexander: "*Obscured Active Galactic Nuclei*", ARA&A, 56, 625 (2018)
- [6] M. Suganuma et al.: "*Reverberation measurements in the inner radius of the dust torus in nearby Seyfert 1 galaxies*", ApJ, 639, 46 (2006)
- [7] N.I. Shakura, R.A. Sunyaev: "*Black Holes in Binary Systems. Observational appearance*", A&A, 24, 337 (1973)
- [7] F. Yuan, R. Narayan: "*Hot Accretion Flows Around Black Holes*", ARA&A, 52, 529 (2014)
- [8] The Event Horizon Telescope Collaboration: "*First M87 Event Horizon Telescope results. I. The shadow of the supermassive black hole*", ApJ, 875, L1 (2019)
- [8] GRAVITY Collaboration: "*Spatially resolved rotation of the broad-line region of a quasar at sub-parsec scale*", Nature, 563, 657 (2018)
- [9] R. Genzel, F. Eisenhauser, S. Gillessen: "*The Galactic Center massive black hole and nuclear star cluster*", Reviews of modern physics, 82 (2010)
- [9] M.R. Morris, L. Meyer, A.M. Ghez: "*Galactic Center research: manifestations of the central black hole*", Research Astronomy Astrophysics, 12, 995 (2012)
- [9] G. Ponti, M.R. Morris, R. Terrier, A. Goldwurn: "*Traces of past activity in the Galactic Center*", arXiv:1210.3034 (2012)
- [10] W.N. Brandt, D.M. Alexander: "*Cosmic X-ray surveys of distant active galaxies. The demographics, physics and ecology of growing supermassive black holes*", Astron. Astrophys. Rev., 23, 1 (2015)

Suggested readings (not needed to read all/everything). III

- [10] W.N. Brandt, D.M. Alexander: "*Supermassive black-hole growth over cosmic time: Active galaxy demography, physics, and ecology from Chandra surveys*", Publications of the National Academy of Science, 107, 16, p.7184 (2010)
- [11] K. Inayoshi, E. Visbal, Z. Haiman: "*The Assembly of the First Black Holes*", ARA&A, 58, 27 (2020)
- [12] B.M. Peterson: "*Toward precision measurement of central black hole masses*", proceedings IAU Symposium 267 (2010)
- [12] Y. Shen: "*The mass of quasars*", Bulletin of the Astronomical Society of India, 41, 61 (2013)
- [13] A. King & K. Pounds: "*Powerful Outflows and Feedback from Active Galactic Nuclei*", ARA&A, 53, 115 (2015)
- [13] A. King: "*The supermassive black-hole - galaxy connection*", Space Science Reviews, 183, 427
- [13] A. King: "*The AGN-starburst connection, galactic superwinds, and $M_{\text{bh}}-\sigma$* ", ApJ, 635, L121 (2005)
- [13] A. King, "*Accretion and outflow in active galaxies*", proceedings of IAU Symposium 267, 273 (2010)
- [13] A.C. Fabian: "*Observational evidence of active galactic nuclei feedback*", ARA&A, 50, 455 (2012)
- [13] C.M. Harrison: "*Impact of supermassive black hole growth on star formation*", Nature Astronomy, 1, 0165, arXiv:1703.06889 (2017)
- [13] C.M. Harrison et al.: "*AGN outflows and feedback twenty years on*", Nature Astronomy 2, 198, arXiv:1802.10306 (2018)
- [13] C. Ciccone et al.: "*Massive molecular outflows and evidence for AGN feedback from CO observations*", A&A, 562, A21 (2014)
- [13] R. Morganti: "*The many routes to AGN Feedback*", Frontiers in Astronomy and Space Sciences, 4, 42 (2017)



[96382 - ACTIVE GALACTIC NUCLEI AND SUPERMASSIVE BLACK HOLES - 6 cfu](#)



Cristian Vignali

Associate Professor

Department of Physics and Astronomy

Academic discipline: FIS/05 Astronomy and Astrophysics

Check latest news for info/change of dates/exams/etc

Latest news

Orario lezioni frontali X-ray lab 29-30
ottobre, Sala Seminari IV piano OAS
Published on: October 19 2018

[View all](#)



Restricted area
[Login](#) to manage all website contents.



Contacts

E-mail: cristian.vignali@unibo.it

Tel: +39 051 20 9 5785

Other contacts

Web: [Go to personal web site](#)

Dipartimento di Fisica e Astronomia
Via Piero Gobetti 93/2, Bologna - [Go to map](#)

Office hours

Tuesday and Thursday, 17-18

Room 4S1, IV floor Department building, U3 – Navile
Email: cristian.vignali@unibo.it

- Oral examination (one topic at your choice, then questions on all course)
- Textbooks for deeper insights + specialistic papers + slides (as a “guideline”) + <https://arxiv.org>

Slides available on Virtual Learning Environment

and at [http://www.bo.astro.it/~vignali/Active Galaxies/AA2021-22](http://www.bo.astro.it/~vignali/Active_Galaxies/AA2021-22)