



# BLACKOUT

Black Holes: the stone guest at the galaxy formation supper

[blackholewinds.inaf.it](http://blackholewinds.inaf.it)

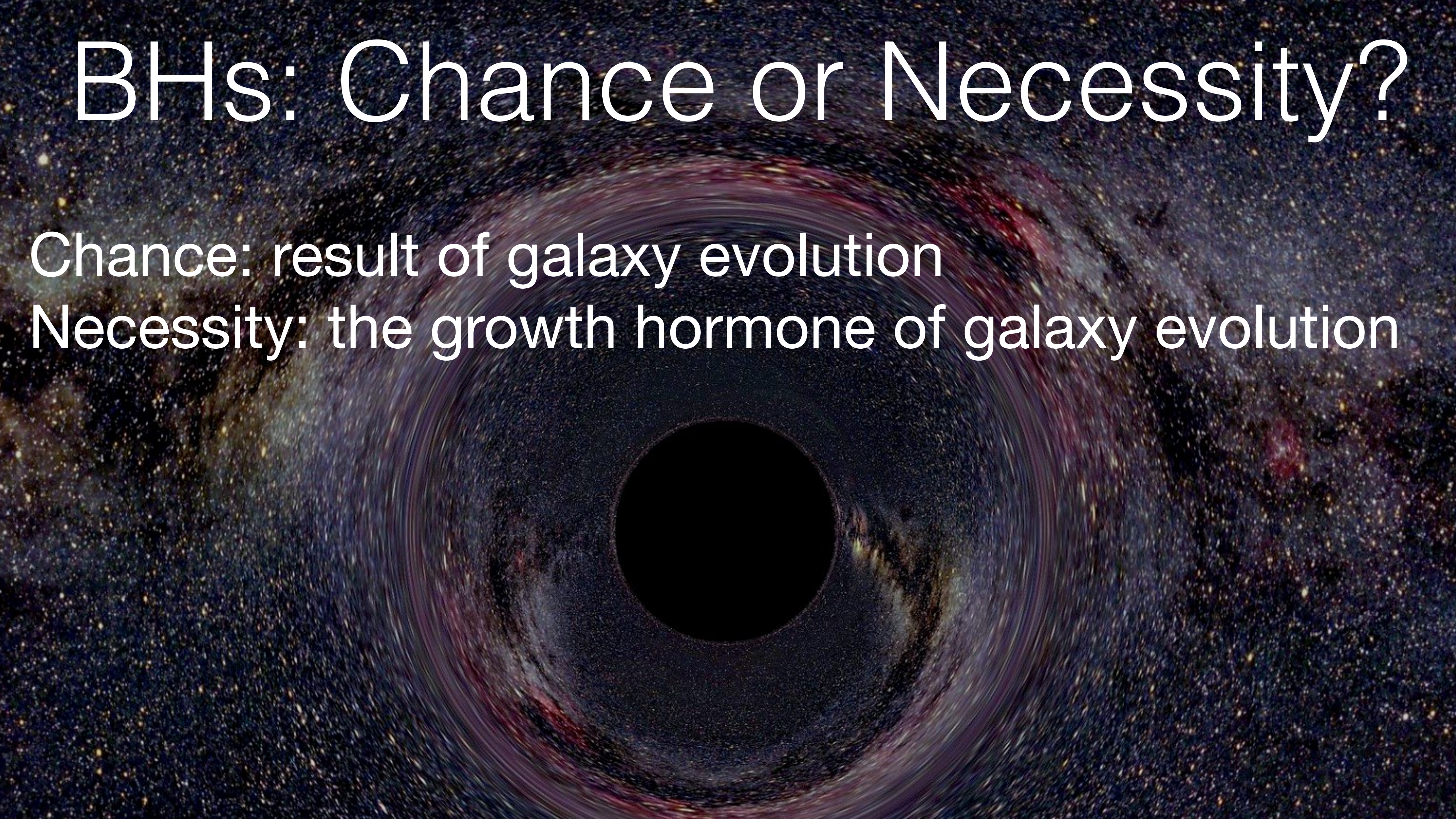
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# BHs: Chance or Necessity?

Chance: result of galaxy evolution

Necessity: the growth hormone of galaxy evolution







# Outline

- ▶ Origin (team, organization)
- ▶ Science & results
- ▶ Planning
- ▶ Funds & criticalities
- ▶ Outlook



# Origin/Team

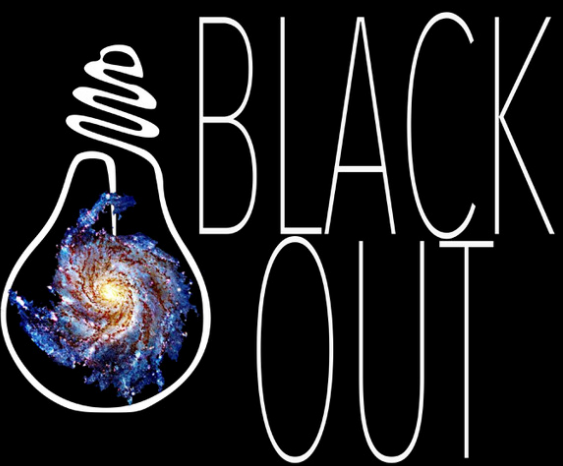
- BeppoSAX AGN projects and surveys, HELLAS —> the first type2 QSOs
- Chandra/XMM, HELLAS2XMM, ELAIS, COSMOS, GOODS —> large/deep surveys
- X-ray - optical identification - NIR/IR/submm/Radio characterization, first CO wind
- INAF-OAR/OAA/OABo/IASF-MI/IASF-Bo/UniRomaTRE/UniBO + SNS/IRA/OATs/OAPd/OAS/OABr + ...
- **Main results: our yr 2000' students are today lead researchers in the field**  
(Vignali, Brusa, Dadina, Malizia, Piconcelli, Zappacosta, Puccetti, Feruglio, Lanzuisi, Bongiorno, Bianchi, Lamastra, Marinucci, Cresci, Lusso, Nardini, Civano, Cappelluti... and many others)



# The Stone Guest







# Science: SMBH feedback

- Single topic attracting the largest number of AGN researcher and producing the largest number of AGN papers = *FASHIONABLE*
- Good and bad
- Fashion: generate a powerful *feedback*, concentrating most efforts on the mainstream and leaving few people working on new, alternative, even controversial ideas. But only new ideas can fertilize a field. Without new ideas a field sooner or later dry up.
- **Feymann: *science is organized skepticism in the reliability of expert opinion.***

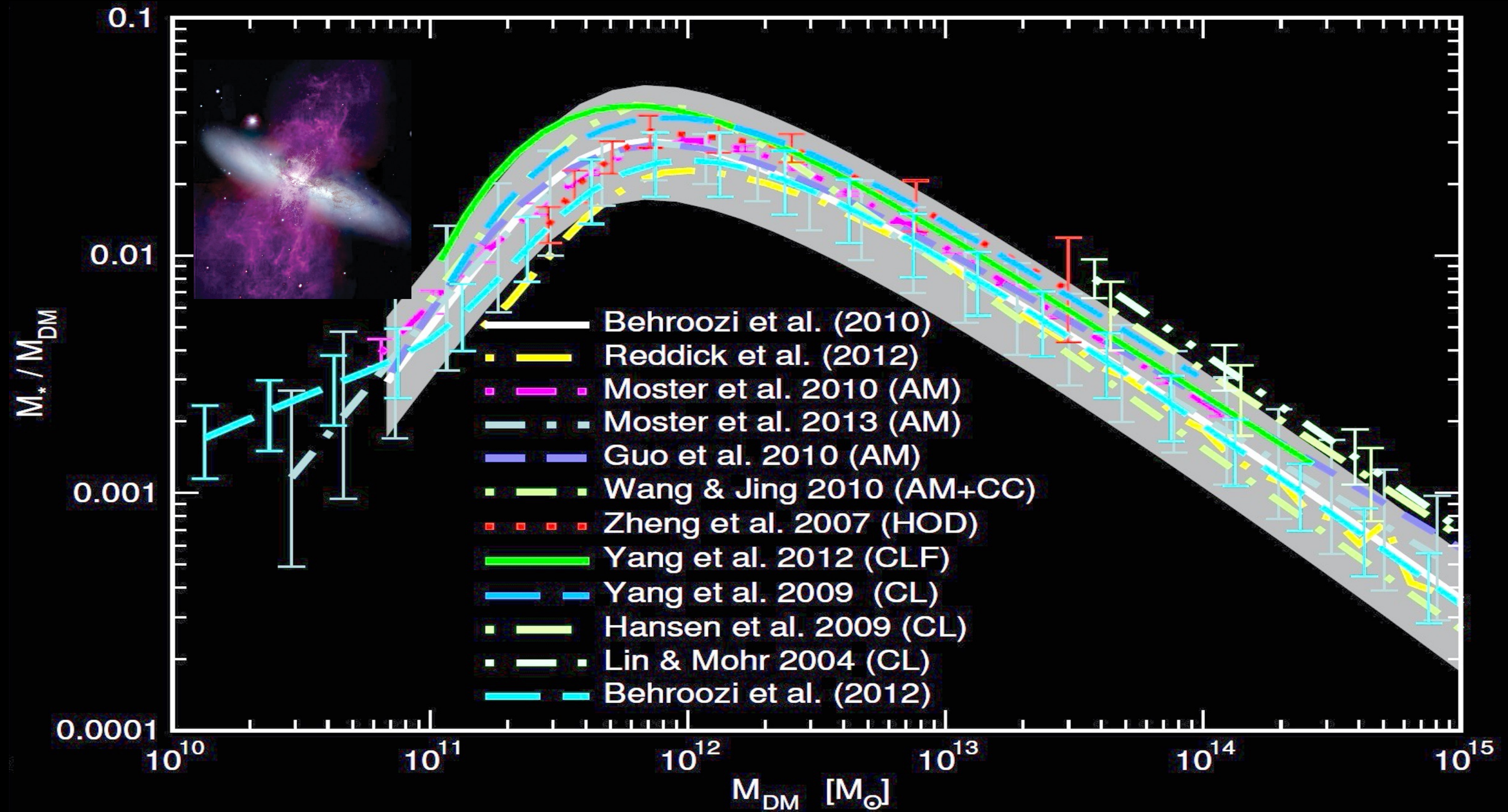


A detailed illustration of a black hole. At the center is a perfectly black circle representing the event horizon. Surrounding it is a thick, glowing accretion disk. The disk is composed of many concentric rings, with colors ranging from dark purple and blue in the outer regions to bright yellow and white near the center. The background is a deep space filled with numerous small, distant stars of varying brightness and colors, creating a sense of vastness and depth.

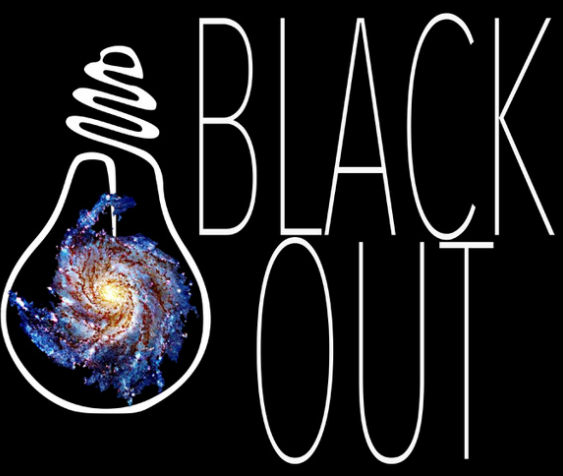
Three contexts



# Baryon cooling highly inefficient

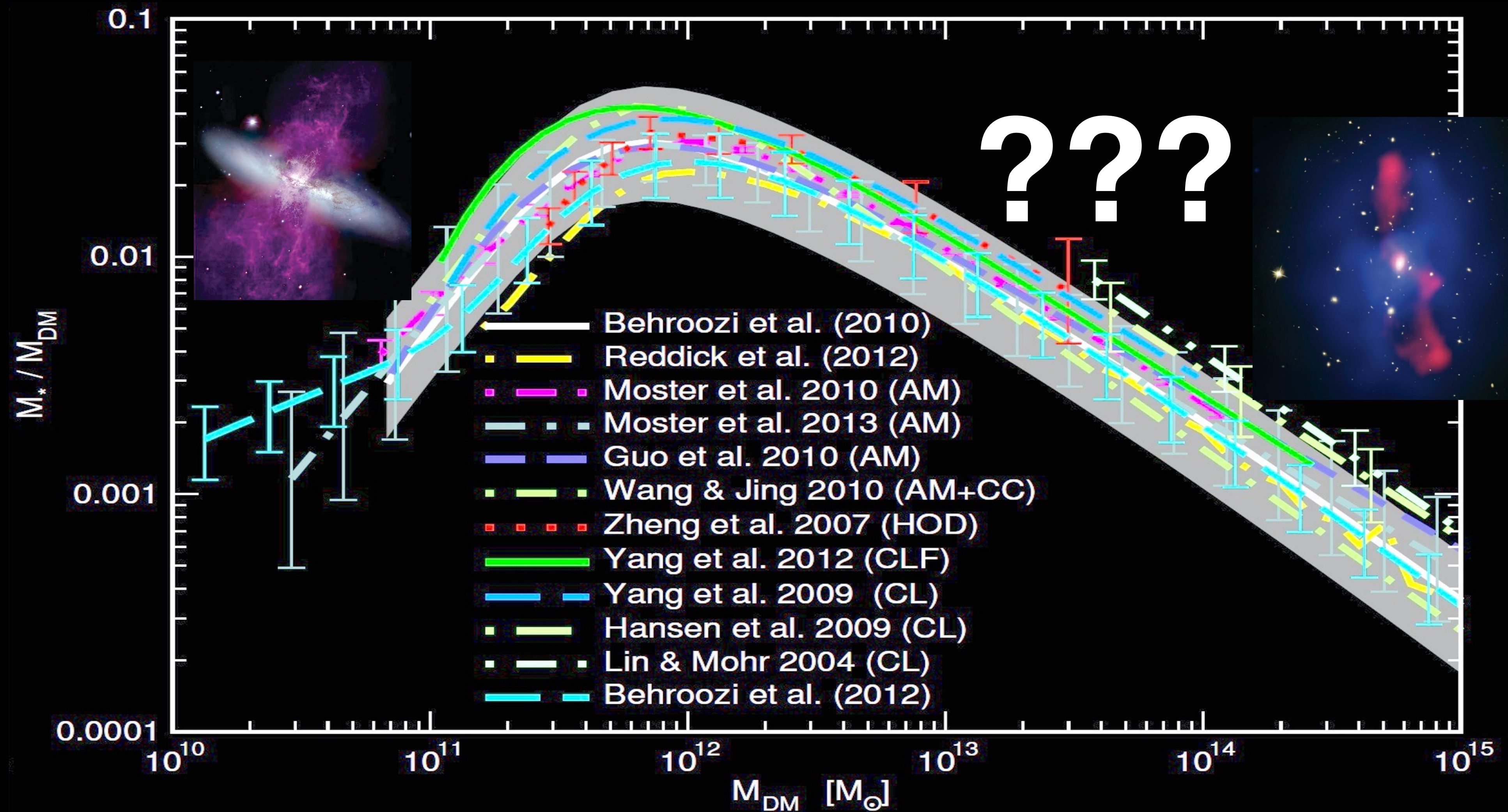


Kormendy & Ho 2013



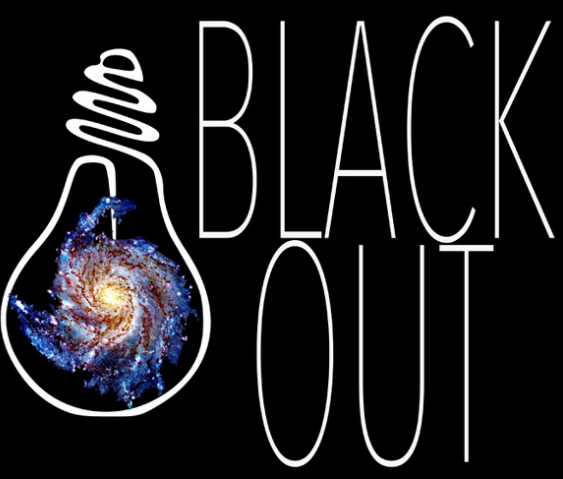


# Baryon cooling highly inefficient



Kormendy & Ho 2013

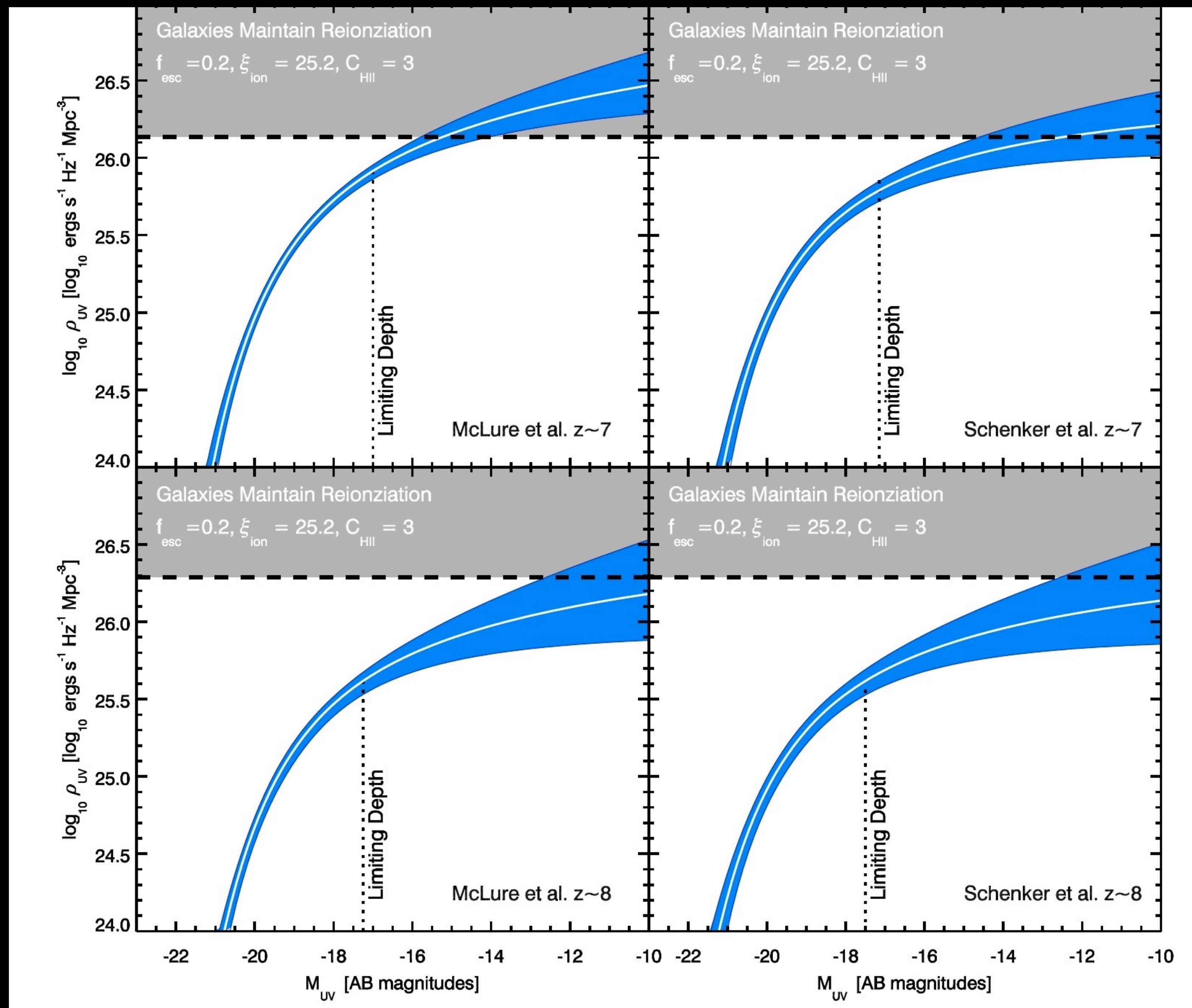
??? = AGN winds?







# Reionization

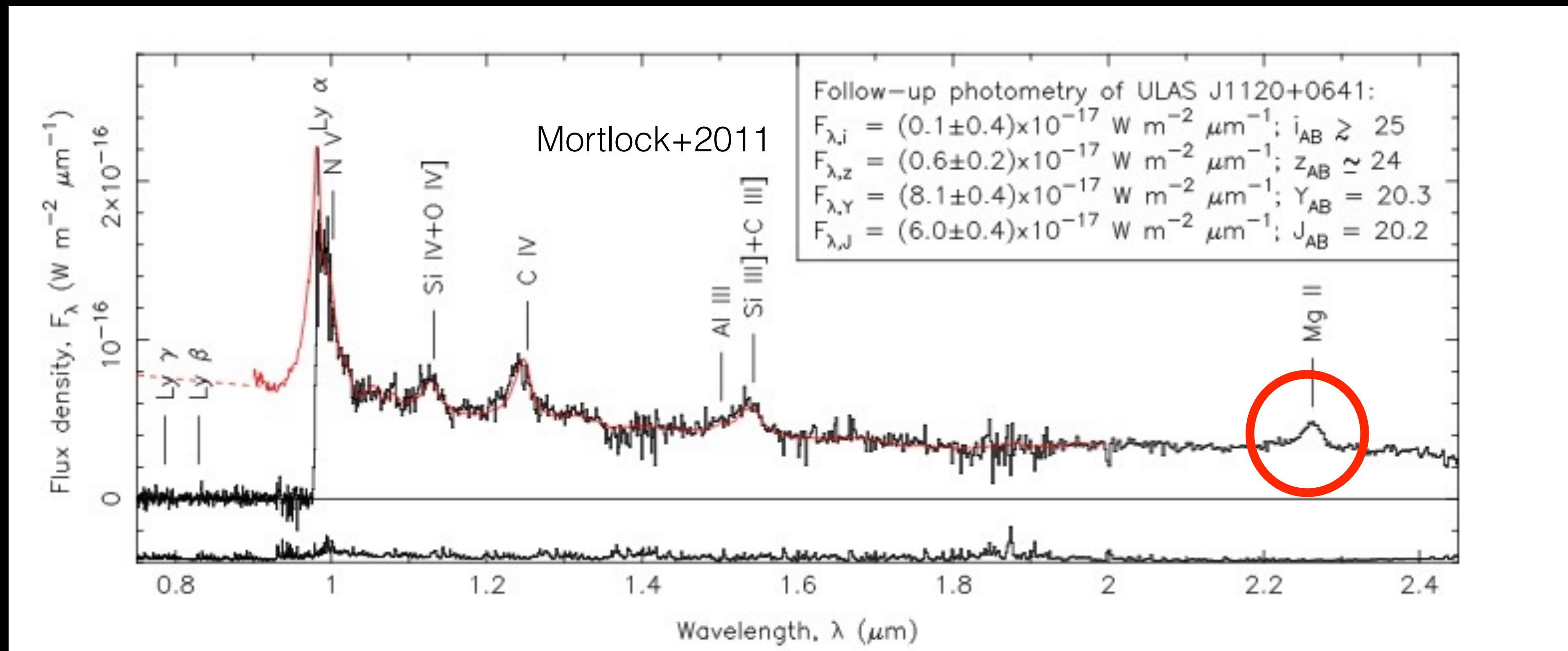


Robertson+2013





# SMBH growth



$z=7.085$   $M_{\text{BH}} \sim 2 \times 10^9 M_{\text{Sun}}$ !  $\sim 600 \text{ Myr}$  from putative formation



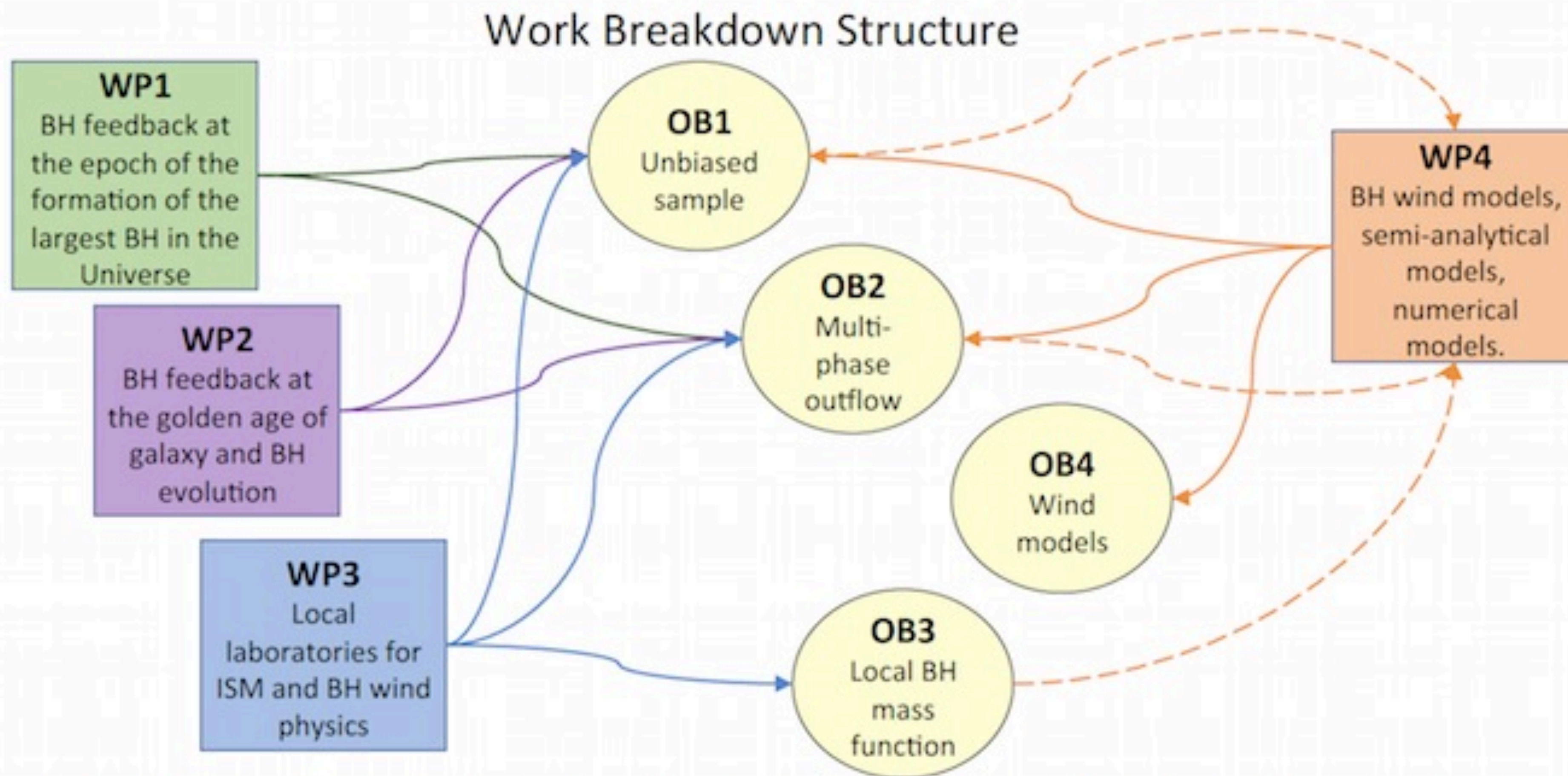


# Organization

- Frequent brainstorming meetings (until Covid emergency..)
  - Prompt interaction between observers and theoreticians
  - Planning of new papers
  - Planning of new proposals
- Avoid as much as possible the first circulation through the collaboration of nearly finished papers, involve the full collaboration in the preparation
- Push for a multifrequency approach as much as possible
- Empower postdocs and PhD students by letting them guide paper and proposal preparation



# Planning



All WPs will work independently and in parallel to achieve the objectives. All observational WPs will contribute to reach 2 or 3 objectives (OB1, OB2, and/or OB3); the theoretical WP will provide the physical models (OB4) but will also enable a comparison between the observational results and the models.





# Main projects

- IBISCO IRAM 30m/ALMA program + SINFONI, MUSE archive, local AGN
- MAGNUM ALMA, MUSE program, local AGN
- EIFFEL ALMA, local radio-loud ETG
- SUPER VLT/SINFONI large program  $z \sim 2$  AGN, unbiased sample
- WISSH LBT, SINFONI, MUSE, ALMA, NOEMA, hyper-luminous QSOs  $z > 2$
- Models
  - Disk models (RomaTRE), nuclear wind models (WINE), galaxy scale wind models (Menci)
  - SAM (Menci, Fontanot, De Lucia)
  - numerical (SNS, Gallerani, Trieste, Borgani, Saro)

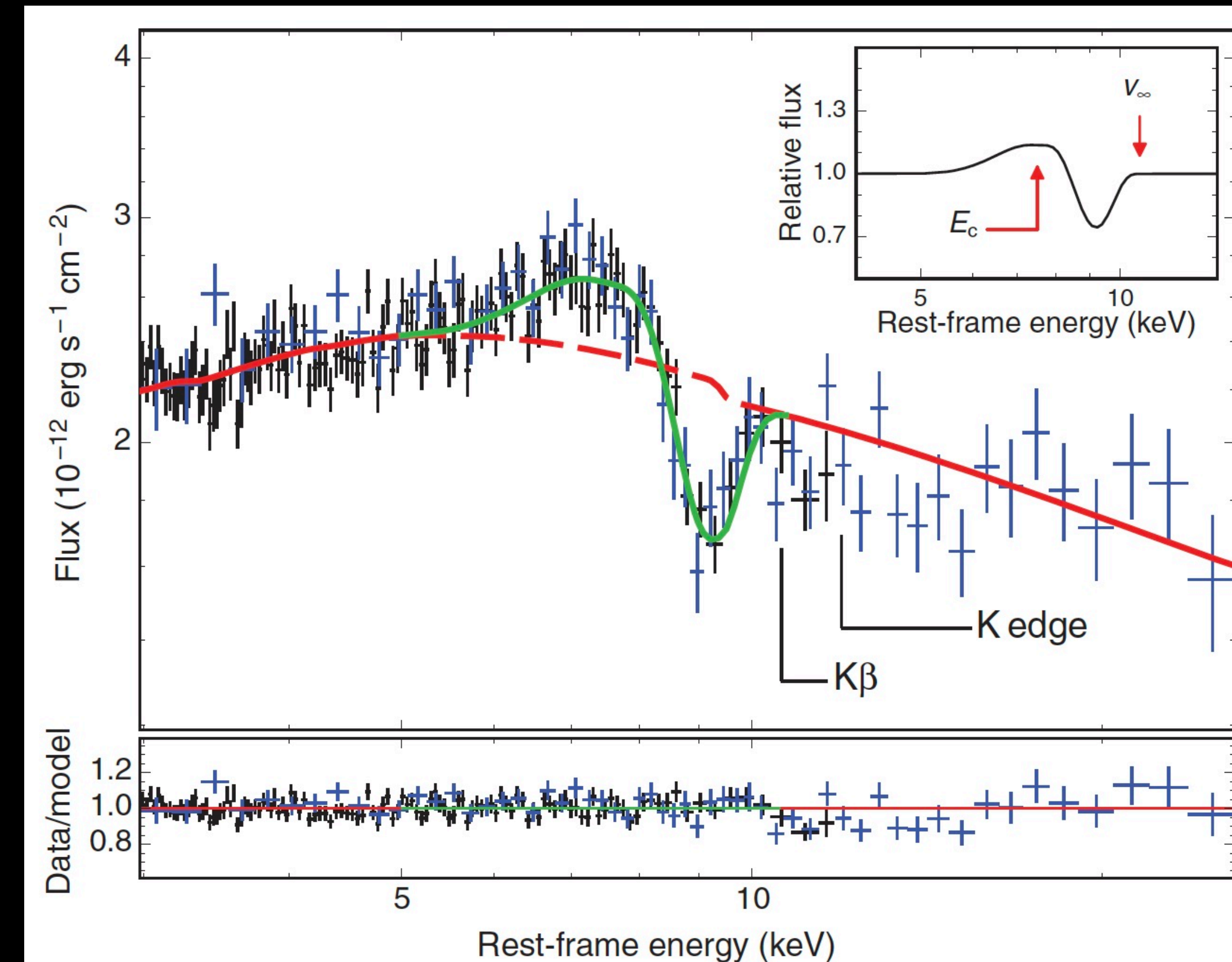


# Additional projects: Subways

XMM Large Program, 1.6Msec of observation, P.I. M. Brusa

NuStar Large Program, 630 ksec of observation, P.I. S. Bianchi

- Derive tight constraints on frequency and properties of the nuclear winds UFOs)
- Study the relation of UFO with large scale outflows (in the ionized, atomic and molecular phases) and UV absorbers.
- 17 QSO  $0.1 < z < 0.5$
- NOEMA, HST/COS, VLA on going follow-ups





# Additional linked projects: XQR30

ESO/X-shooter large Program of 248 h of observation, P.I. V. D'Odorico

## SAMPLE

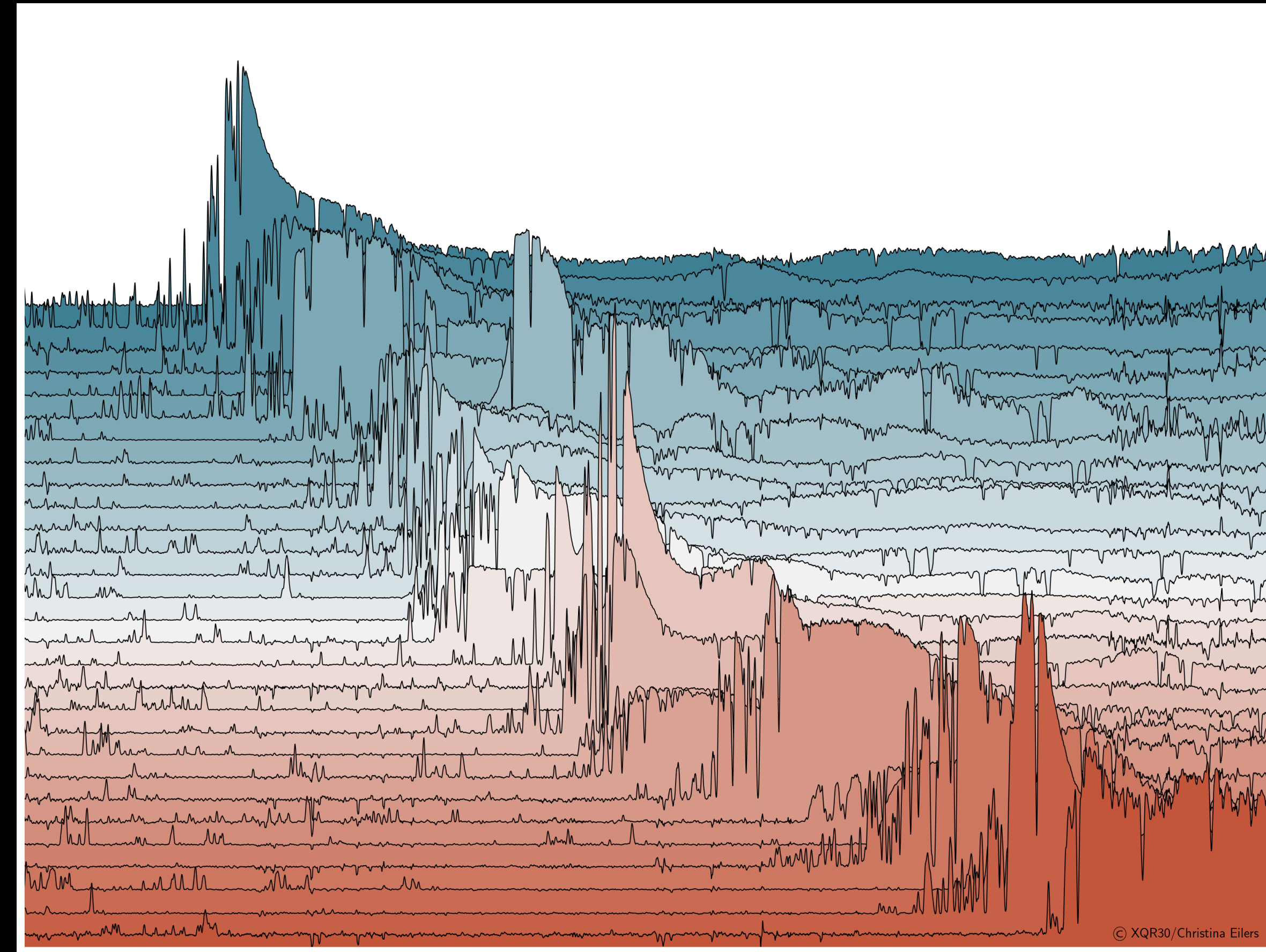
30 QSOs at  $5.8 < z < 6.6$  observed at intermediate resolution ( $R \sim 8000-9000$ ) and high signal-to-noise ratio ( $\sim 25$  per pixel).

Quadruple the existing sample of high quality,  $z > 5.8$

ALMA ([C II]) and MUSE parallel programmes.

## MAIN SCIENCE CASES

- Characterizing the second half of the reionization process;
- Metal enrichment and ionization sources in the early Universe;
- The nature of the first stars;
- Quasars in the early Universe and their environment.

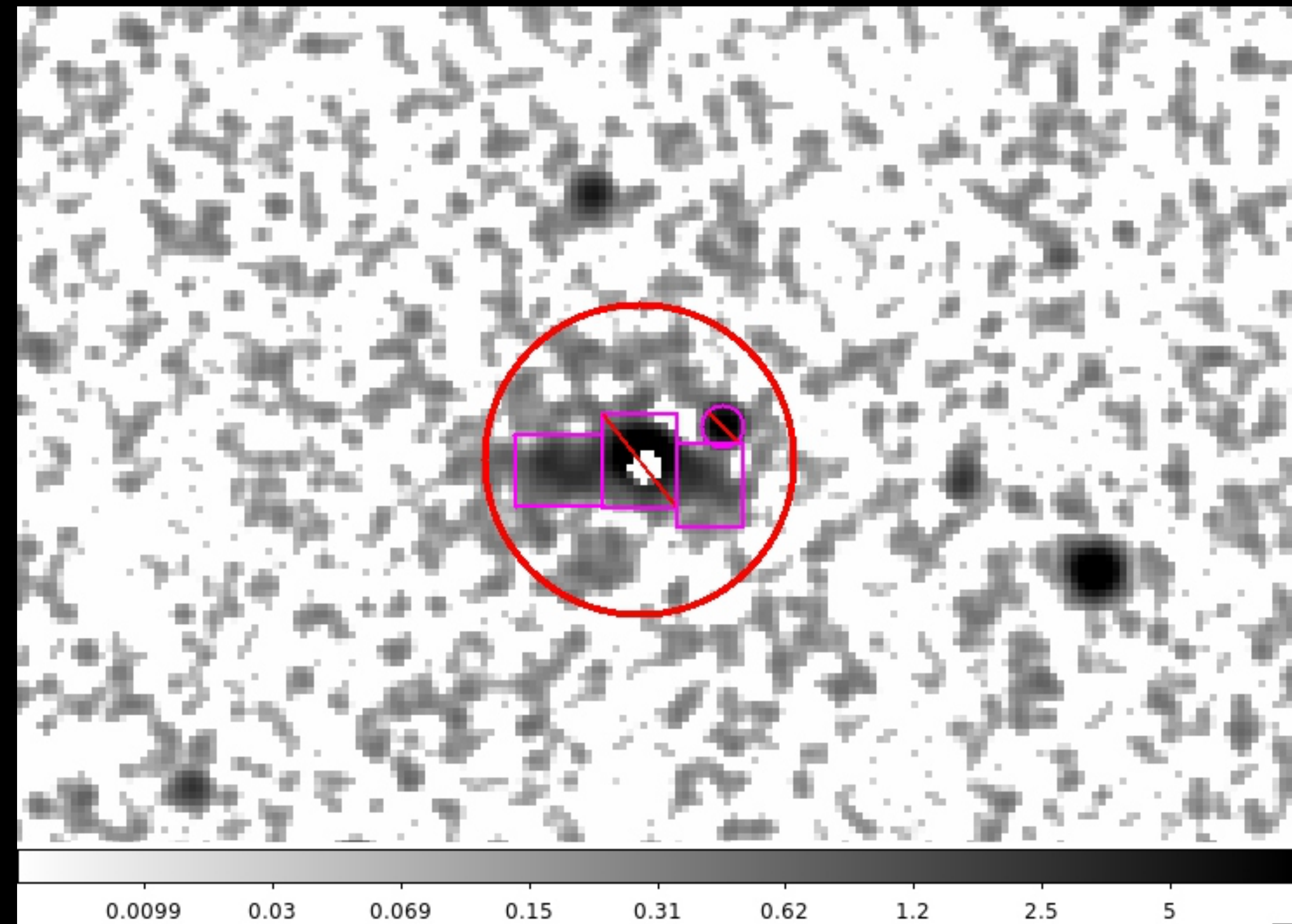




# Additional linked projects: Spiderweb

Chandra large Program 700ks of observation, P.I. P. Tozzi

- Science goals:
  1. Nuclear activity enhancement in protocluster members
  2. Nuclear activity and associated feedback in the central galaxy
- Spectral analysis of IC X-ray emission from the relativistic jets
- Detection and analysis of the thermal isotropic emission from hot gas, possibly heated by the feedback processes (red circles excluding boxes).
- Properties and variability of the nuclear emission in the Spiderweb (central box)
- Synergy with proprietary Submm/radio data (ALMA, JVLA, MeerKAT, GMRT) and archival OIR imaging and Spectroscopy.

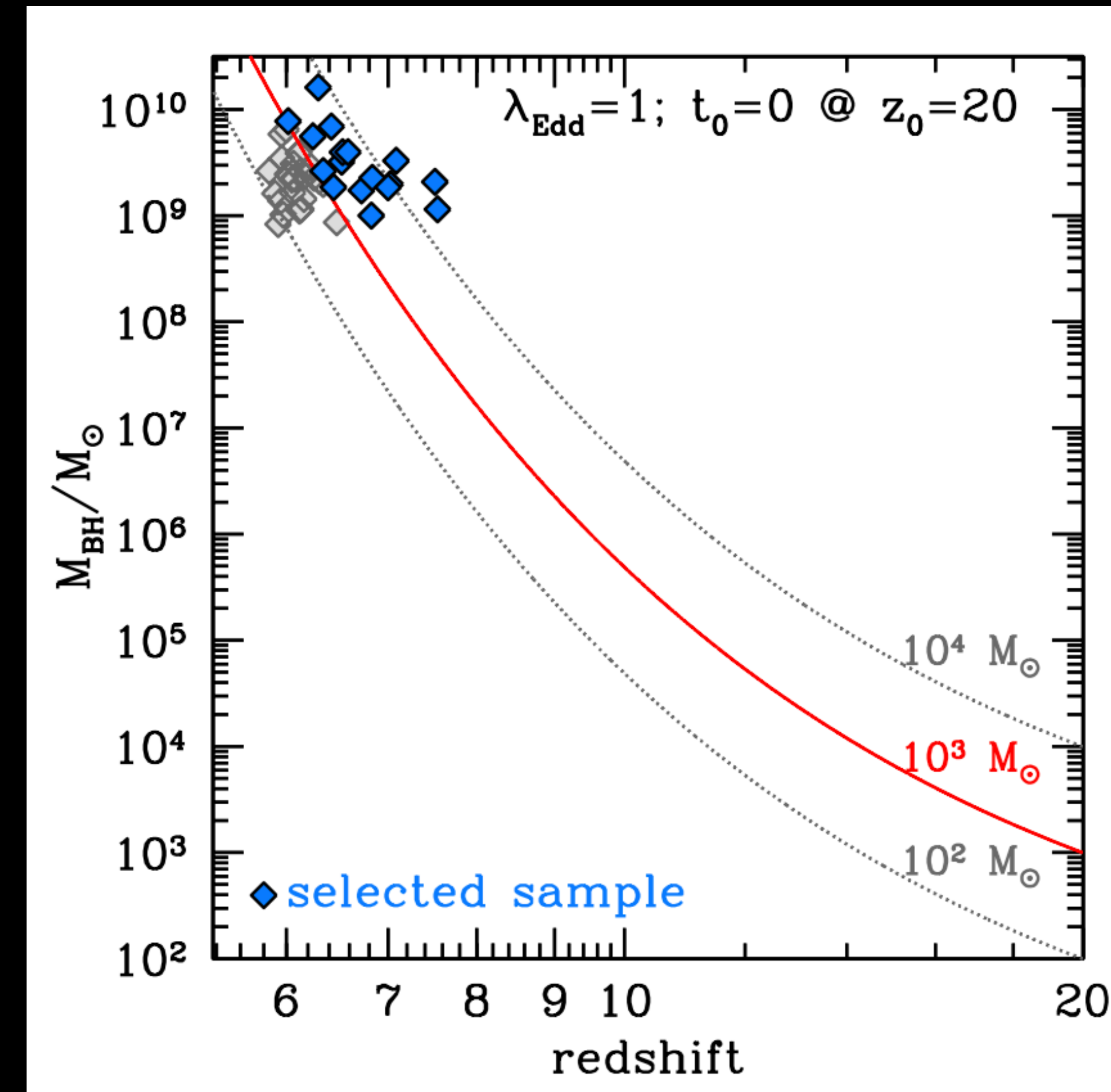




# Additional linked projects: Hyperion

XMM Multi-year Heritage program 2400ks of observation, P.I. L. Zappacosta

- The titans among  $z=6-7.5$  quasar, i.e. those which experienced the fastest SMBH growth (17 quasars  $M_{\text{BH}} > 10^9 M_{\text{sun}}$ ,  $L_{\text{bol}} > 10^{47} \text{ erg/s}$ ,  $\lambda_{\text{Edd}} > 0.2$ )
- Origin and properties of SMBH/quasars at the Epoch of Reionization (EoR)
- unprecedented constraints on nuclear properties, accretion, ejection, disc/corona complex at the EoR
- VLT/X-shooter, ALMA, NOEMA, LBT planned follow-ups







# Funds

- 2014 PRIN INAF (Fiore)
- 2016 PRIN SKA FORECAST (Prandoni)
- 2017 PRIN INAF Mainstream (Fiore)
- 2018 PRIN MUR (Fiore)
- 2018-2019 ASI AAE funds (Brusa, Tozzi)
- Total >1MEuro
- New applications: PRIN MUR 2020 (Mannucci)





# Outlook & criticalities

- Transform the *stone quest* in a pleasant diner. BHs are a *necessity* and are the main drivers of galaxy transformation
- ..or.. drag him to hell. BH are a *chance* and we need to find a different driver:
  - Heating through cosmological accretion (Birnboim & Dekel 2006)
  - Starvation (Peng & Maiolino 2015). But... AGN may be the responsible for starvation by heating GCM gas..
  - Mass/gravitational quenching. Bulge formation stabilizes disks against clumps formation and fragmentation. Galaxy quenched but gas fraction unaffected
- ...

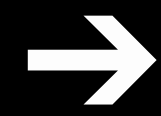


Can we really do it?

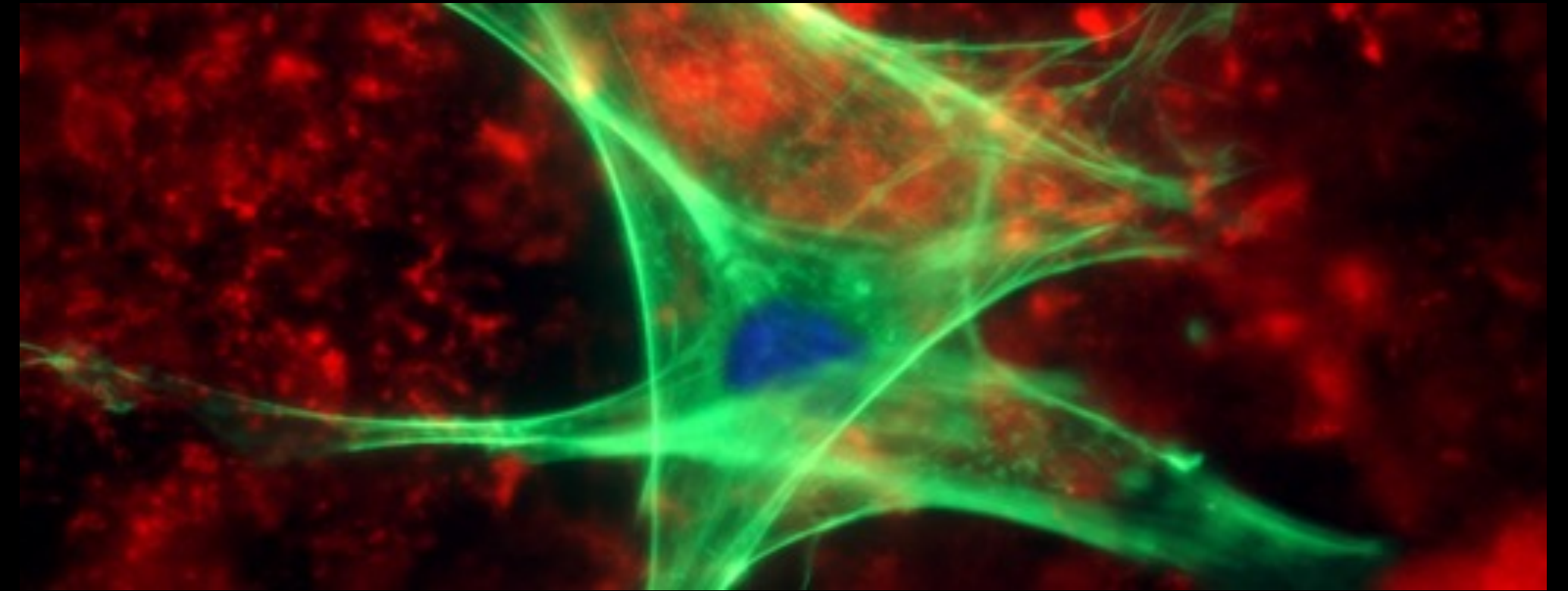


# A change in perspective

Universe island



Bio cells



Organisms exchanging *matter, energy and entropy* with the environment throughout a network of interactions:

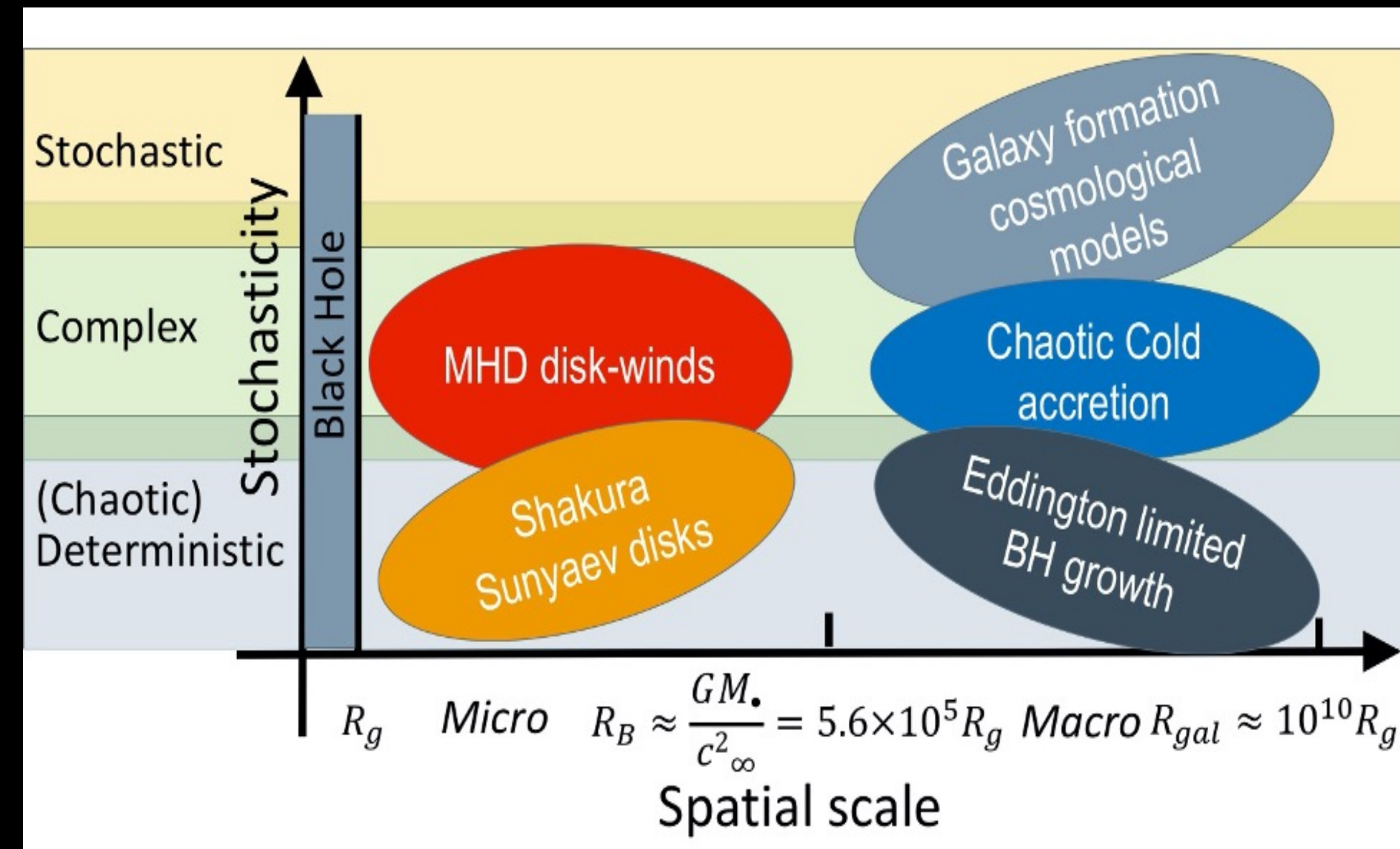
***The life cycle of galaxies***



# Complex dynamical systems

successful approach in evolutionary biology, neurology, condensed matter

- Non-linearity and sensitivity to initial conditions, stochastic variables
- Emergent properties produce a hierarchy of levels, developing power law scaling laws
- Self-organization attained through feedback. *co-evolution* in evolutionary biology: organisms create their environment, which in turn influences the same organisms.
- Criticality, the status just in between the phases where activity is only local and where is so strong that spans always the full size of the system





Stay tuned....!