The Contribution of Mergers and Secular Processes to the Evolution of AGNs

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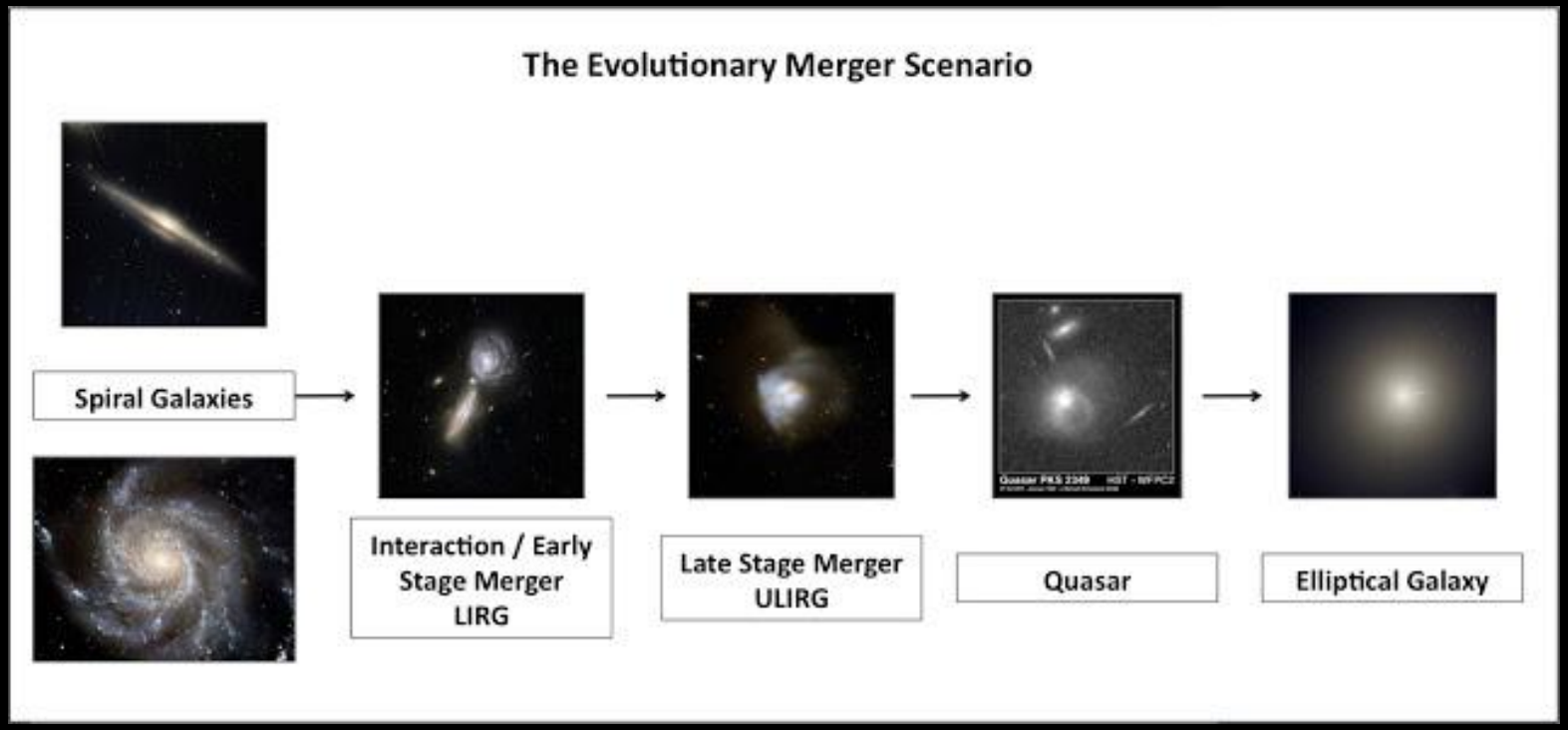
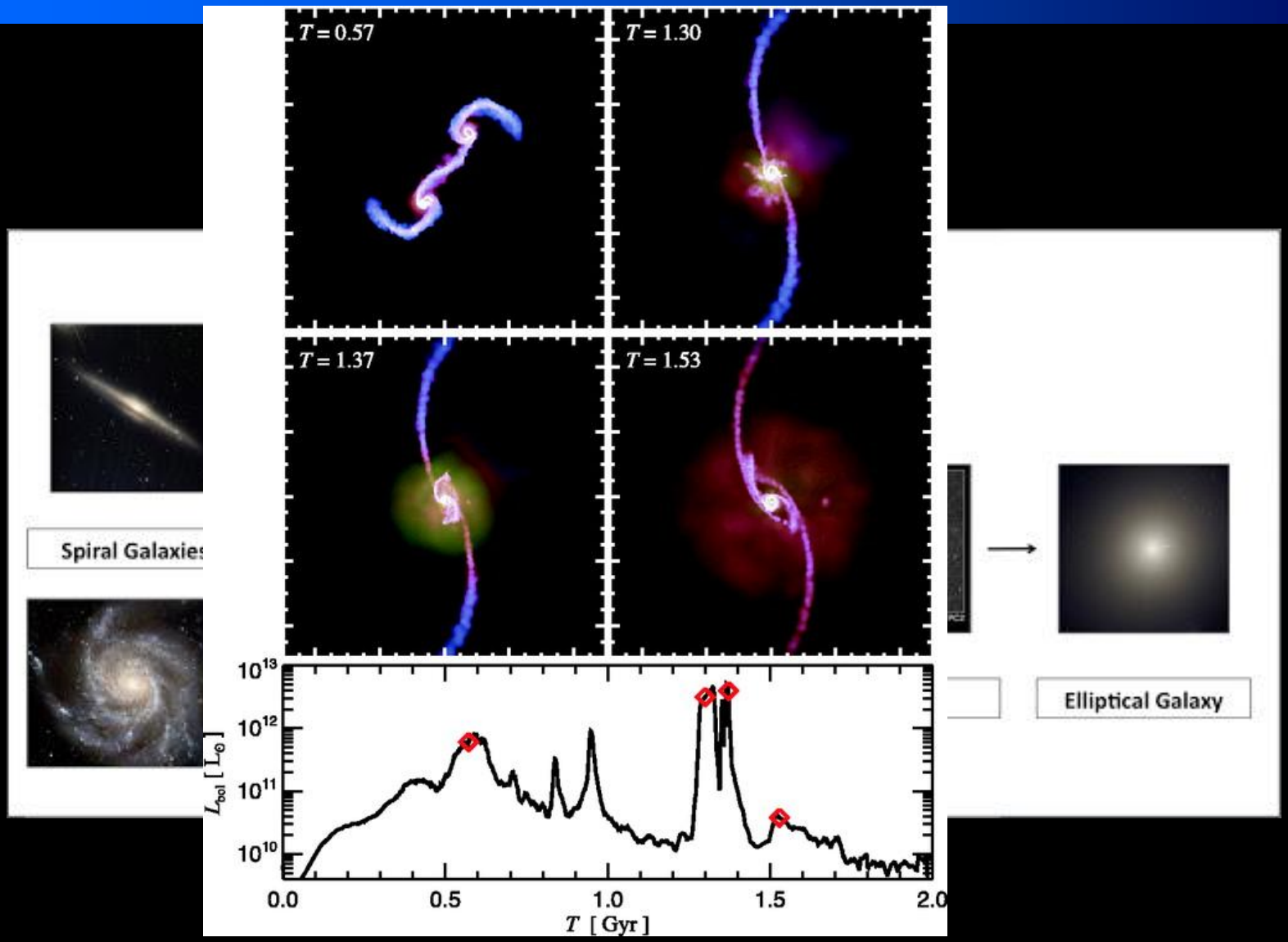
- Draper, A.R. & Ballantyne, D.R., 2012, ApJ, 751, 72
- Draper, A.R. & Ballantyne, D.R., 2012, ApJ, 753, L37 (application to ULIRGs)

Merger-triggered AGNs



e.g., Sanders et al. (1988); Hernquist (1989); Kauffman & Haehnelt (2000); Di Matteo et al. (2005); Hopkins et al. (2006)



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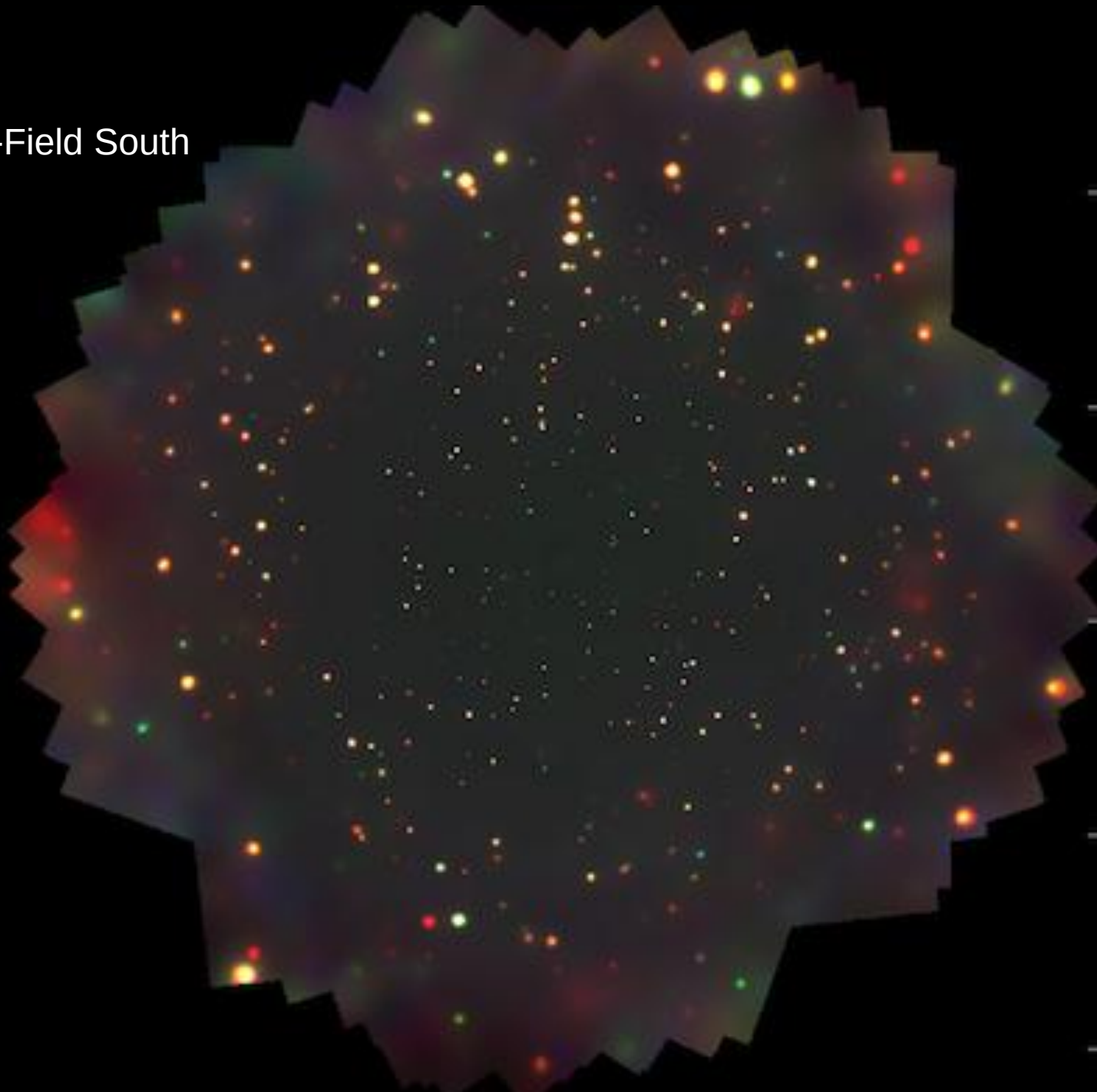
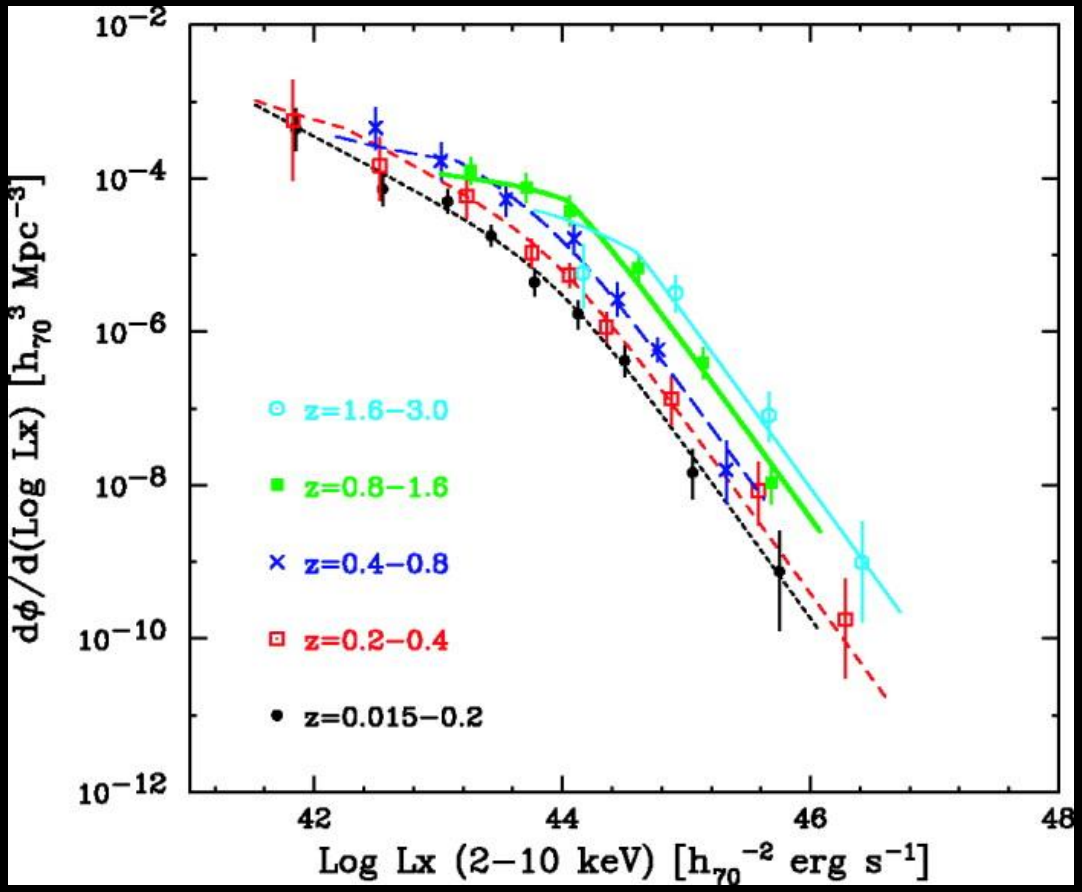
Secular triggering

- Interactions, stellar bars, nuclear starburst disks.
- Unlikely to change the morphology of the galaxy

NGC 1531 & 1532

4 Ms *Chandra* Deep-Field South





Ueda et al. (2003)

- The deep surveys over the last decade have measured the Hard X-ray Luminosity Function (HXLF)
- Strong evidence for cosmic downsizing of AGNs
- Are the obscured Seyferts at z <~ 1 fading quasars, or is there another fueling mechanism dominating?

Two Populations of AGNs

- Consider the space density of major-mergers of gas rich galaxies.
- Assume each merger creates an AGN

$$dN_{\rm merg}(z) = \frac{d^2\Psi}{dN\,dt}\, N_{\rm gal}\left(M_* > M_*^{\rm min}(z)\right)\, f_g(z)\, dt\ {\rm Mpc}^{-3}$$

Merger rate/galaxy/Gyr
Hopkins et al. (2010)

Space density of massive galaxies
Perez-Gonzalez et al. (2008)

Fraction of gas rich galaxies
Treister et al. (2010)

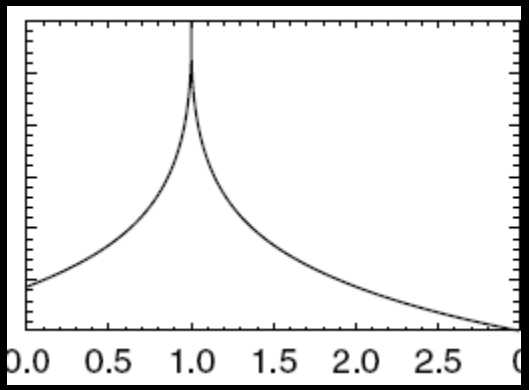
- AGNs can also be triggered by `secular' effects (i.e., minor mergers, cold-flow accretion, starburst winds, etc.)

$$dN_{\rm sec}(z) = f_{\rm sec}\, N_{\rm gal}\left(M_* > M_*^{\rm min}(z)\right) f_g(z)\, dt\, {\rm Mpc}^{-3}$$

Fractional rate of AGNs triggered per Gyr << 0.3
free parameter

- Light-curve for all AGNs:

$$\lambda(t) = \left[1 + (|t|/t_Q)^{1/2}\right]^{-2/\beta}$$



λ=Eddington ratio
$t_Q(\eta,t_0)$, β= free parameters
Hopkins & Hernquist (2009)

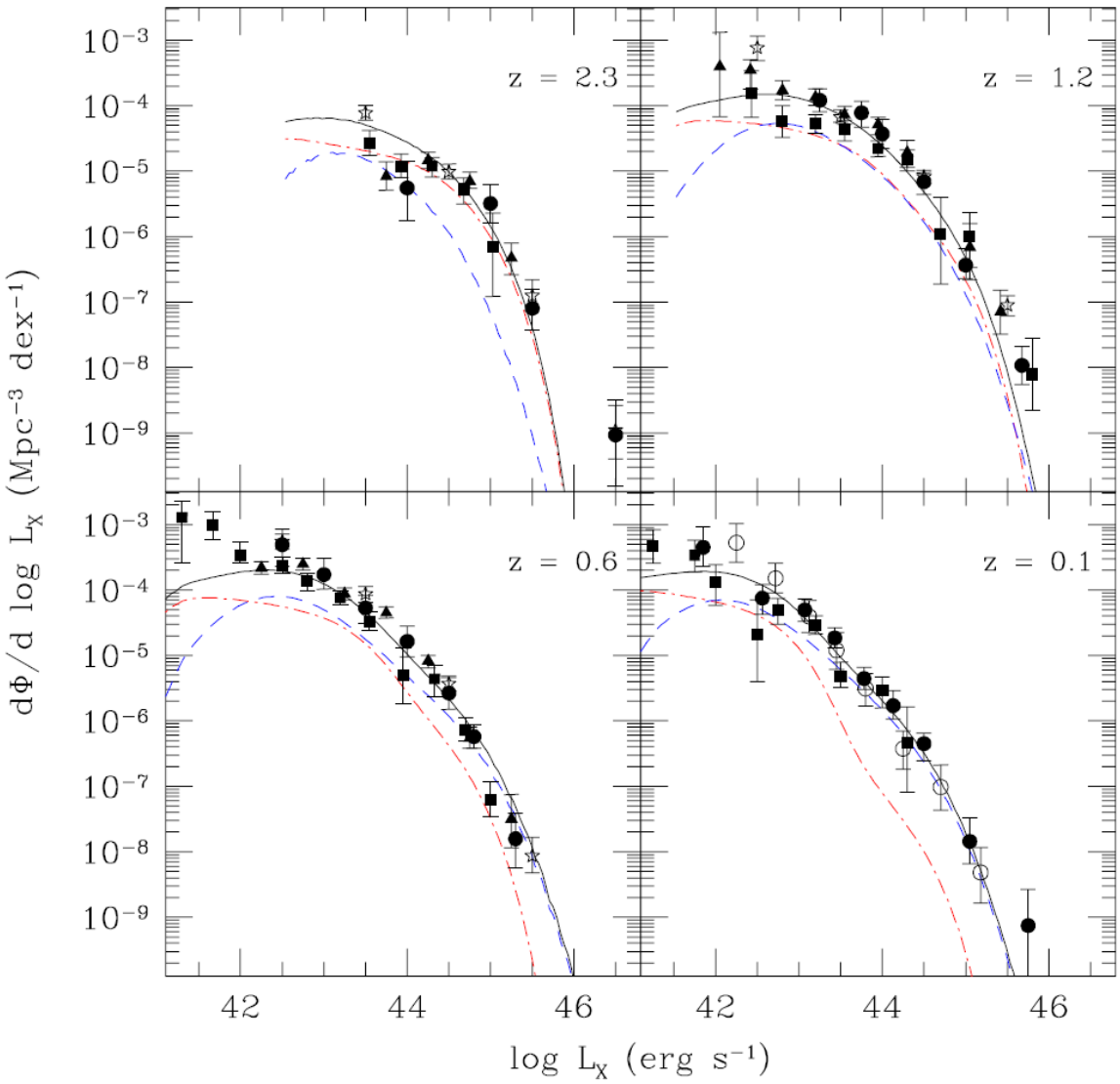
- Need to evolve an active BHMF
  - Considered 2 measurements of the active BHMF:
    - Netzer (2009) derived from z~0.15 type 1 & 2 AGNs (log-normal)
    - Merloni & Heinz (2008) (Schechter)
  - Considered 2 evolutions:
    - Continuity:

$$\frac{\partial n_M(M_\bullet, t)}{\partial t} + \frac{\partial [n_M(M_\bullet, t)\langle \dot{M}(M_\bullet, t)\rangle]}{\partial M} = 0,$$

    - Labita et al. (2009) observationally-derived measurement:

      Max BH mass $\propto (1+z)^{1.64}$

- Use Marconi et al. (2004) BC to get X-ray luminosity.
- Compared to HXLF, XRB, BH mass density and X-ray number counts to constrain models

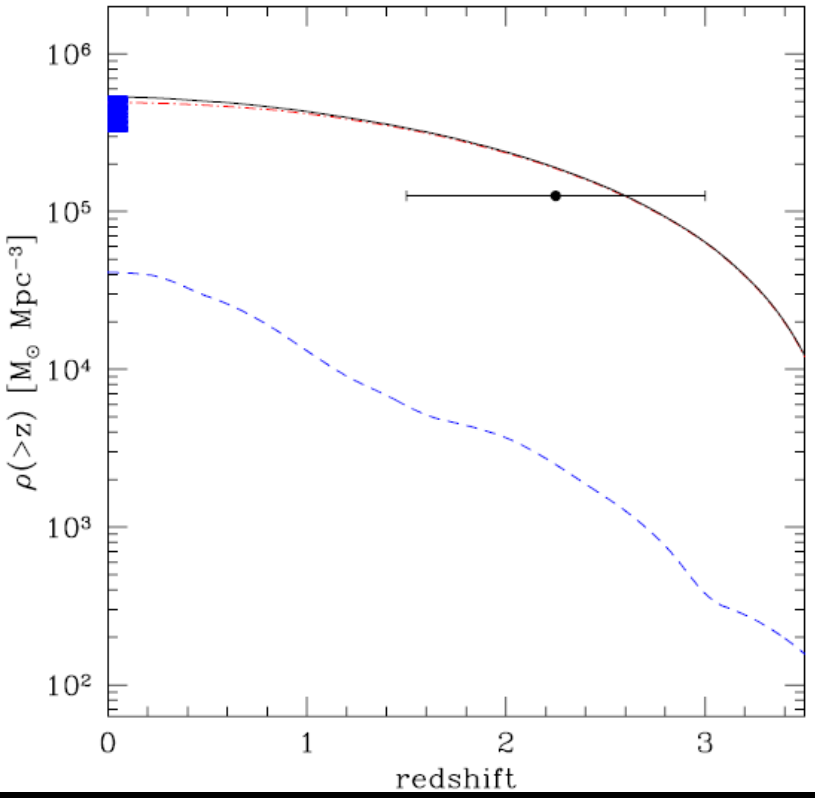


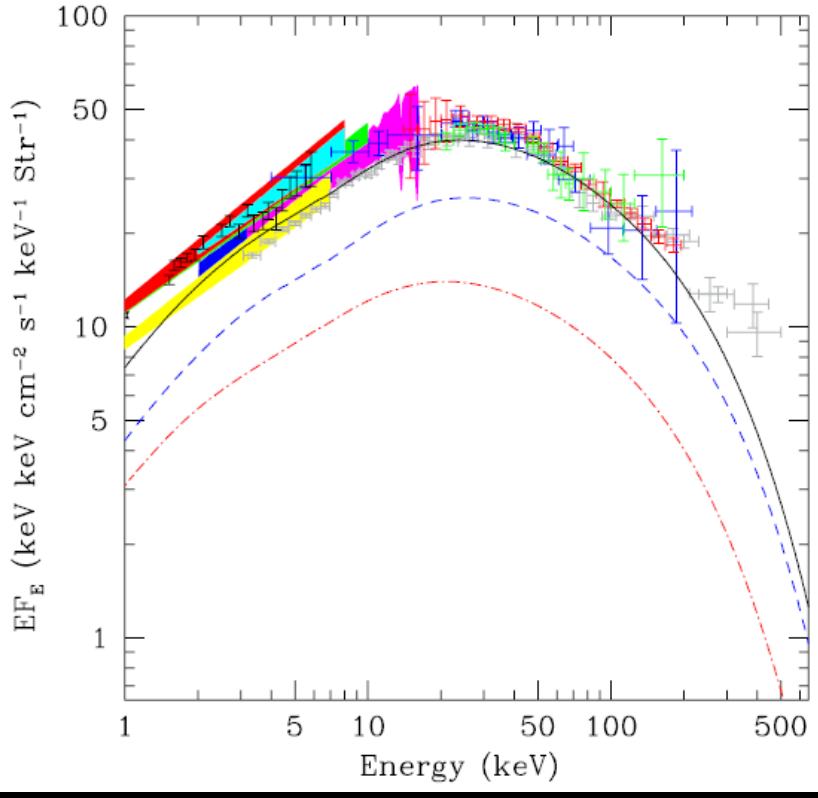
Draper & Ballantyne (2012)

Black = total HXLF

Red = merger-triggered AGNs (MH08 BHMF; Labita09 BH evolution)

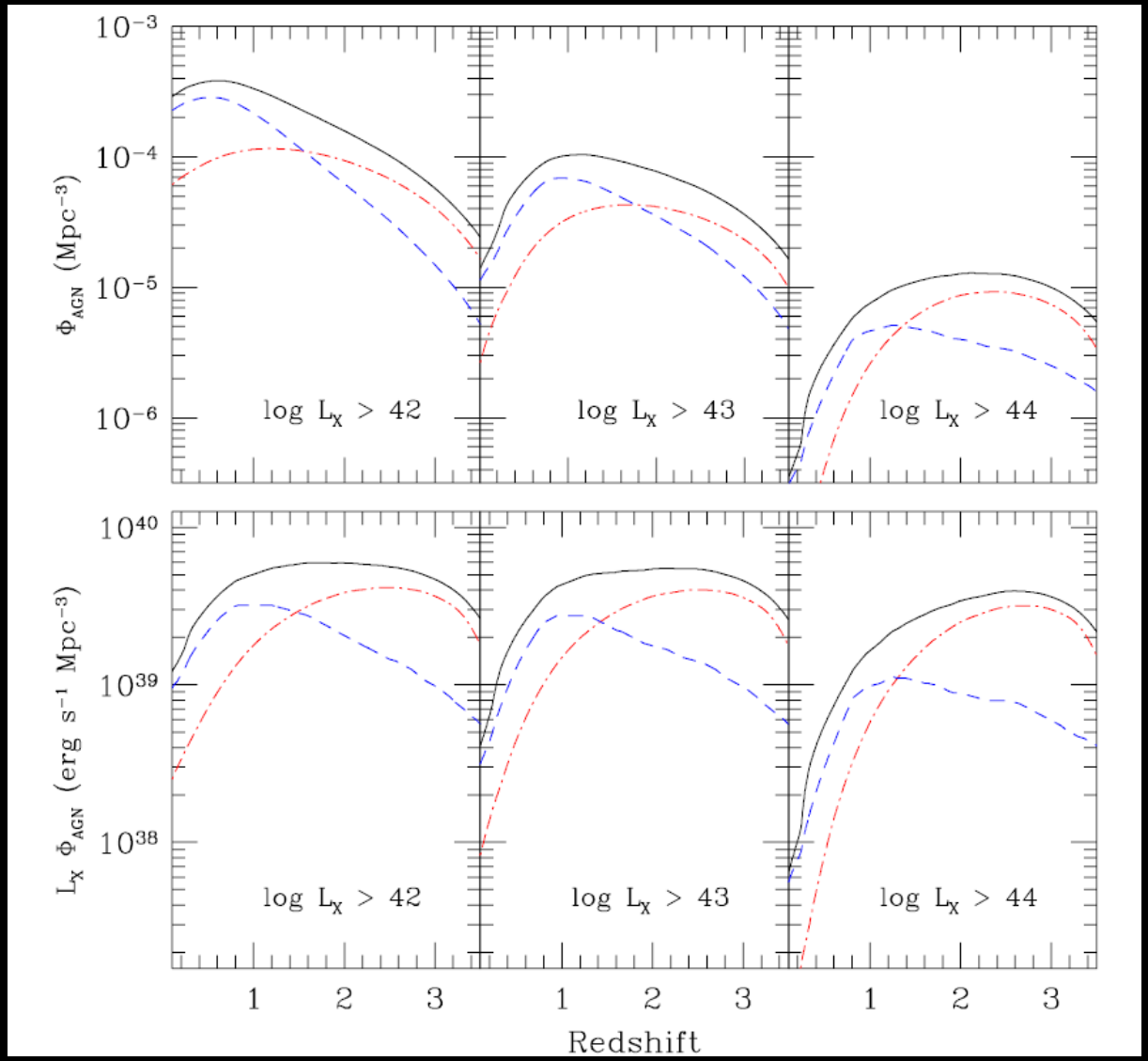
Blue = secular triggered AGN (Netzer09 BHMF; continuity)





Draper & Ballantyne (2012)

- BH mass grown through luminous accretion provided by major mergers (cf. Soltan)
- Integrated accretion light dominated by secularly-triggered AGNs



Draper & Ballantyne (2012)

- Galaxy evolution changes character at z ~ 1.
  - From merger to secular-dominated
  - Why?