Bread & Butter Astrophysics with GW Detections

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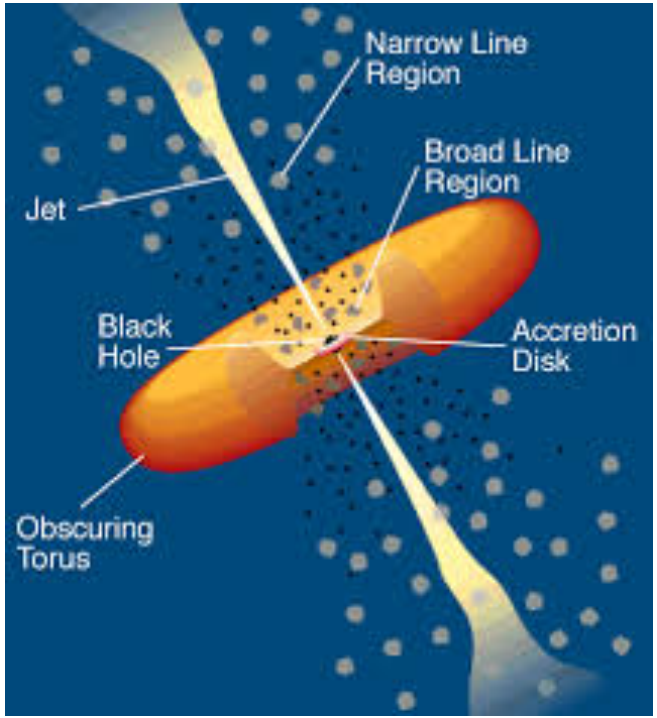
Collabs: B McKernan, J Bellovary, M-M MacLow, N Leigh, M O'Dowd, W Lyra, A Secunda, I Bartos, Z Haiman, B Kocsis, B Metzger, G Fabj, S Nasim, J Adorno, B Hernandez, A Mejia

A cartoon AGN



A different cartoon AGN

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Image credit: O'Dowd, Nasim

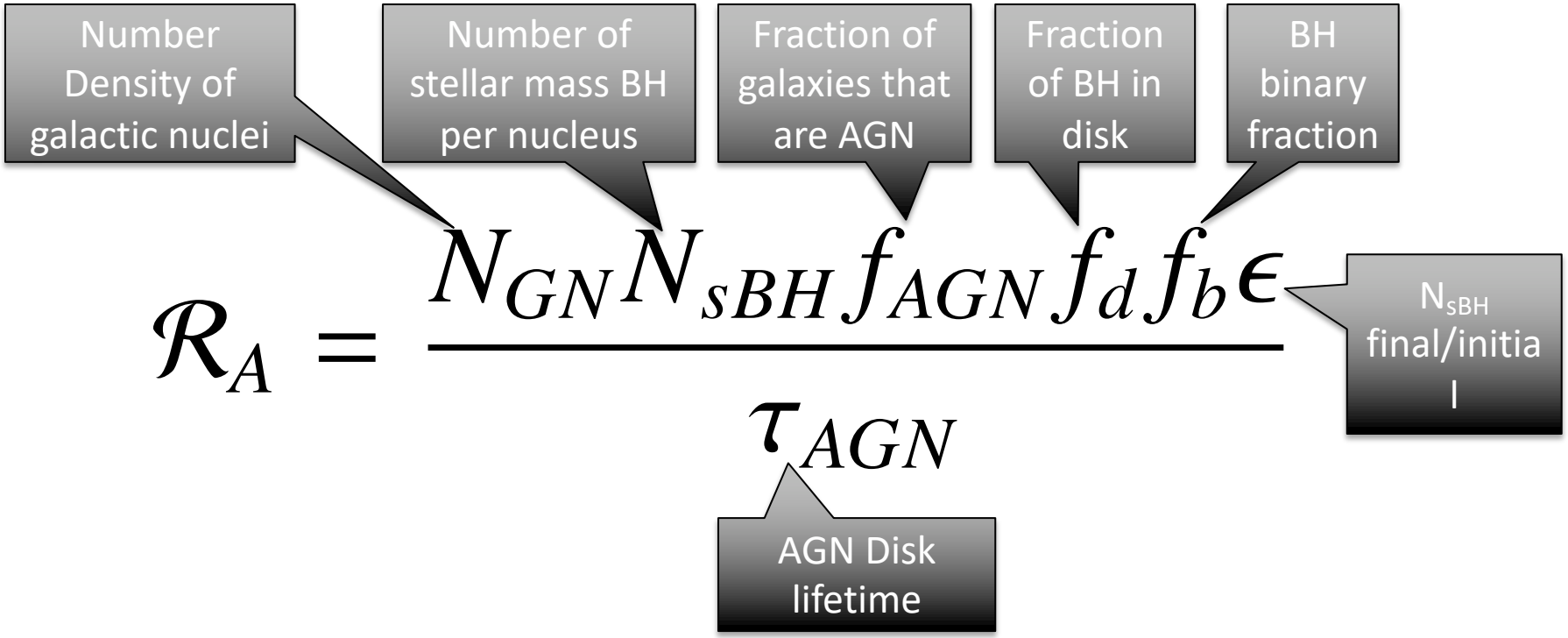
Assume GR

- Isolated, circularized binary

$$\tau_{GW} = \left(\frac{5}{64}\right)\left(\frac{c^5}{G^3}\right)\frac{a_{\rm bin}^4}{M_{\rm bin}^2 \mu_{\rm bin}}.$$

- M_1=15M_{sun}, M_2=10M_{sun}, a_b=4AU
- t_{GW}=10^5 t_{Hubble}
- In AGN disk t_{merge}=1Myr

A Parameterized Rate Equation



McKernan, Ford + 2018

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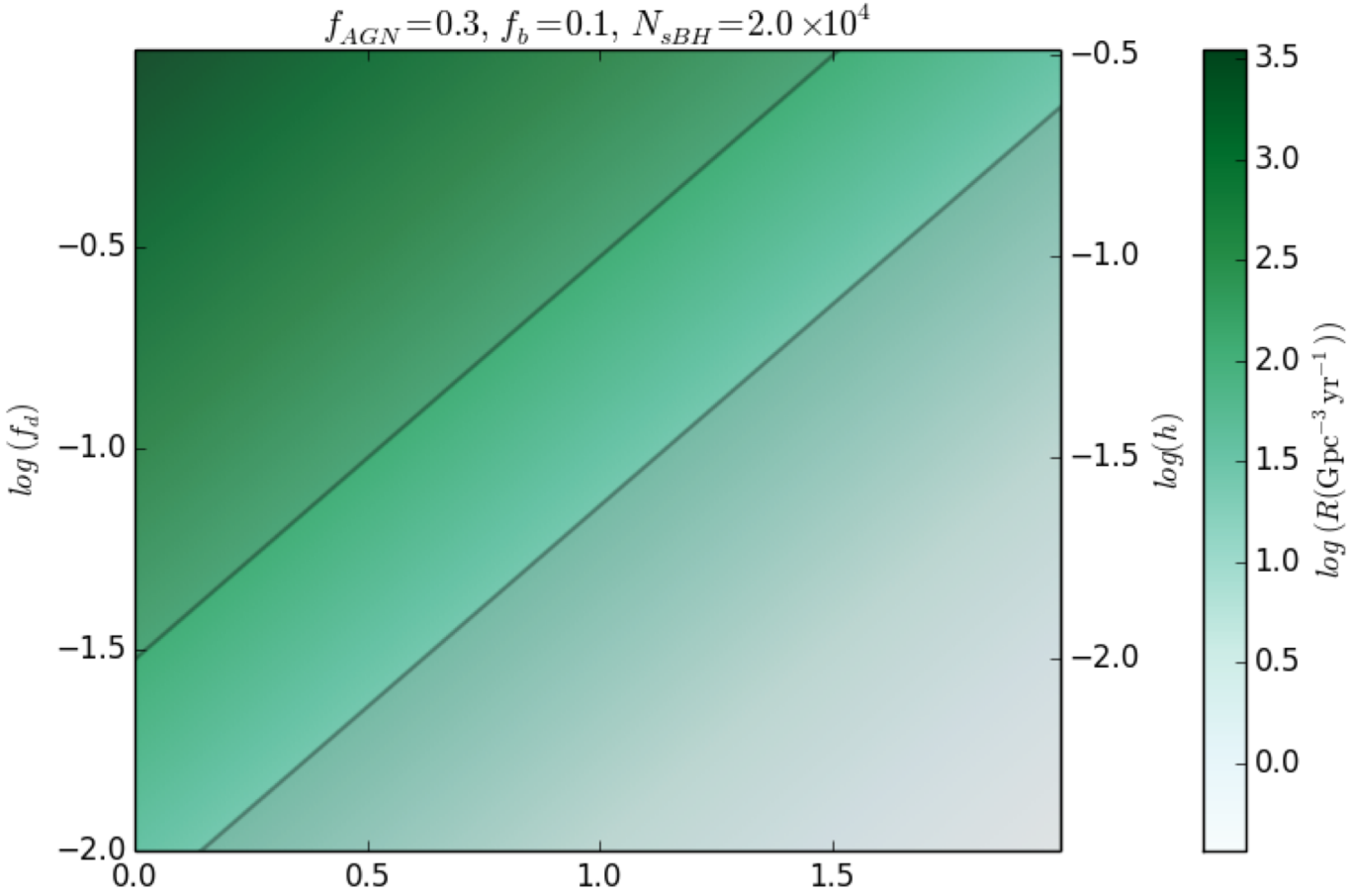
arXiv:1702.07818

Radiatively Inefficient Accretion Flows

- Low luminosity AGN are either:
  - Missing massive gas disks
  - Have geometrically fat disks (RIAFs: h>0.5)



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Ford, McKernan+ in prep

Can we do better?

- What fraction of LIGO events AGN-driven?
  - Imagine LIGO error boxes with $<N_{AGN}>=0.1$
  - But every event had an AGN in it!
  - Now imagine $<N_{AGN}>=10$
  - But every event had 11 AGN in it!
  - Bartos+ 18
- Statistical strategy requires ~200 LIGO detections for 100% AGN production (see Ford+ 2019 WP)

What if they're all AGN?

- We learn less about AGN lifetime, scale height
- We make lots of IMBH
  - see McKernan, Ford+ 12, 14 Bellovary+ 16, Secunda+ 19
- FeKa 'radial velocity' measurements
- SEDs(?)—but hard
- LISA—will see no sBHB, lots of IMBH-SMBH

Because it's Thursday

- AGN can accelerate sBHB mergers
  - Help explain high LIGO rate
- Can do AGN astrophysics with rate already
  - Constrain lifetime (very hard to measure)
  - Aspect ratio, density at midplane (challenging)
- 200 LIGO events is discriminating
- Major consequences for LISA sources