SMBH infancy:
the route to seed formation

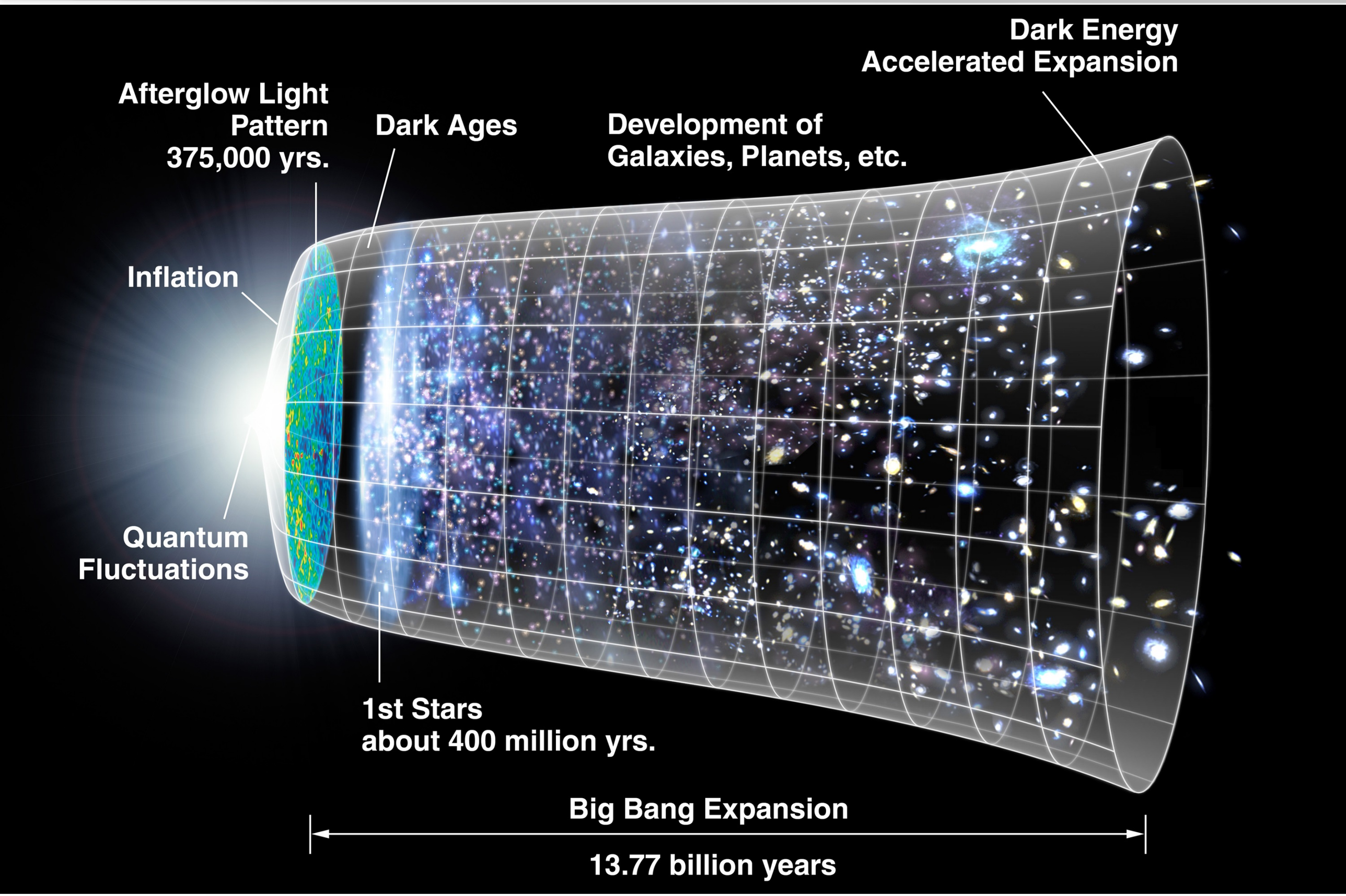
Lumen Boco

BiD4BEST Final conference

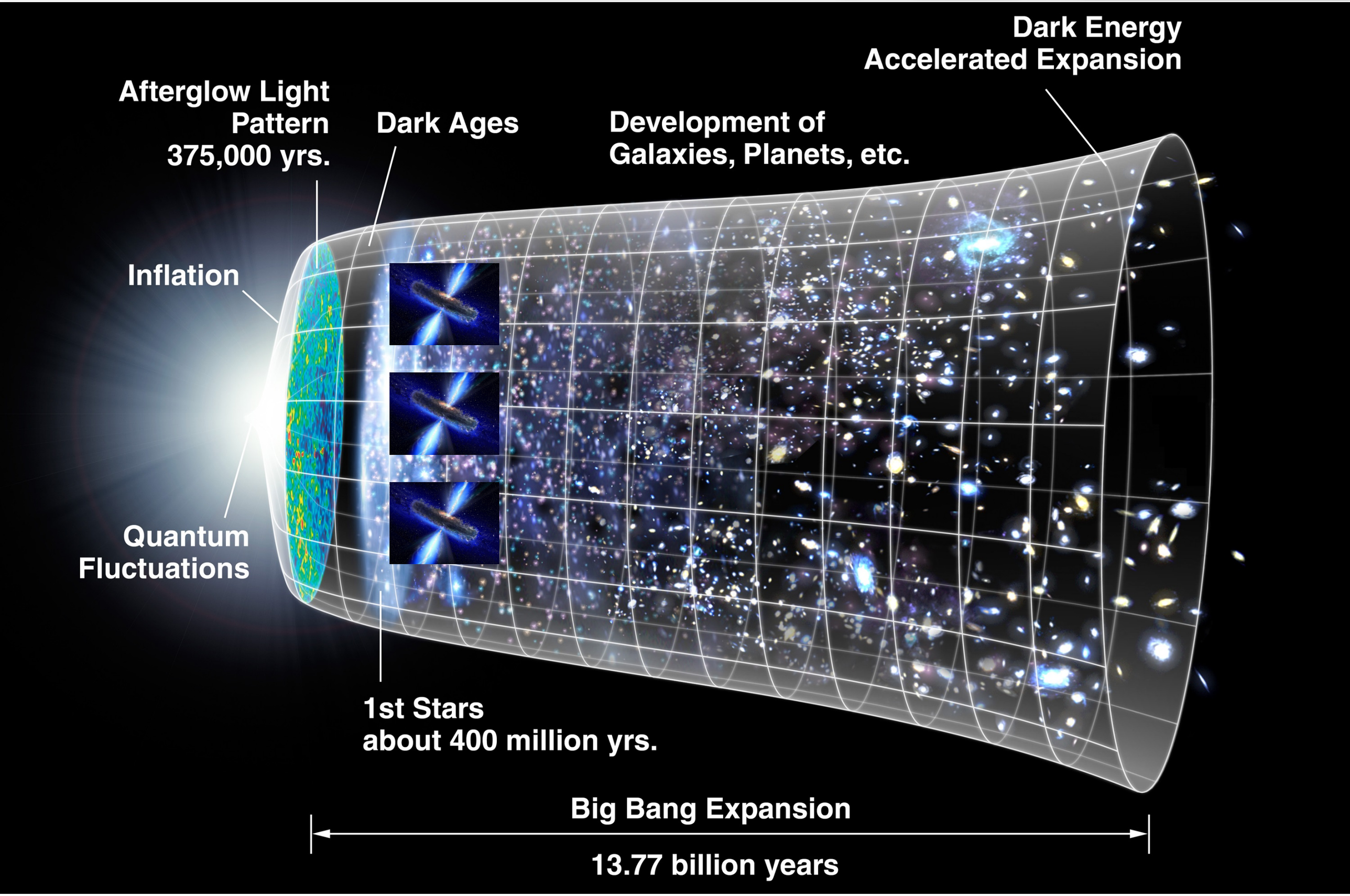
Collaborators

Prof. Andrea Lapi
Prof. Luigi Danese

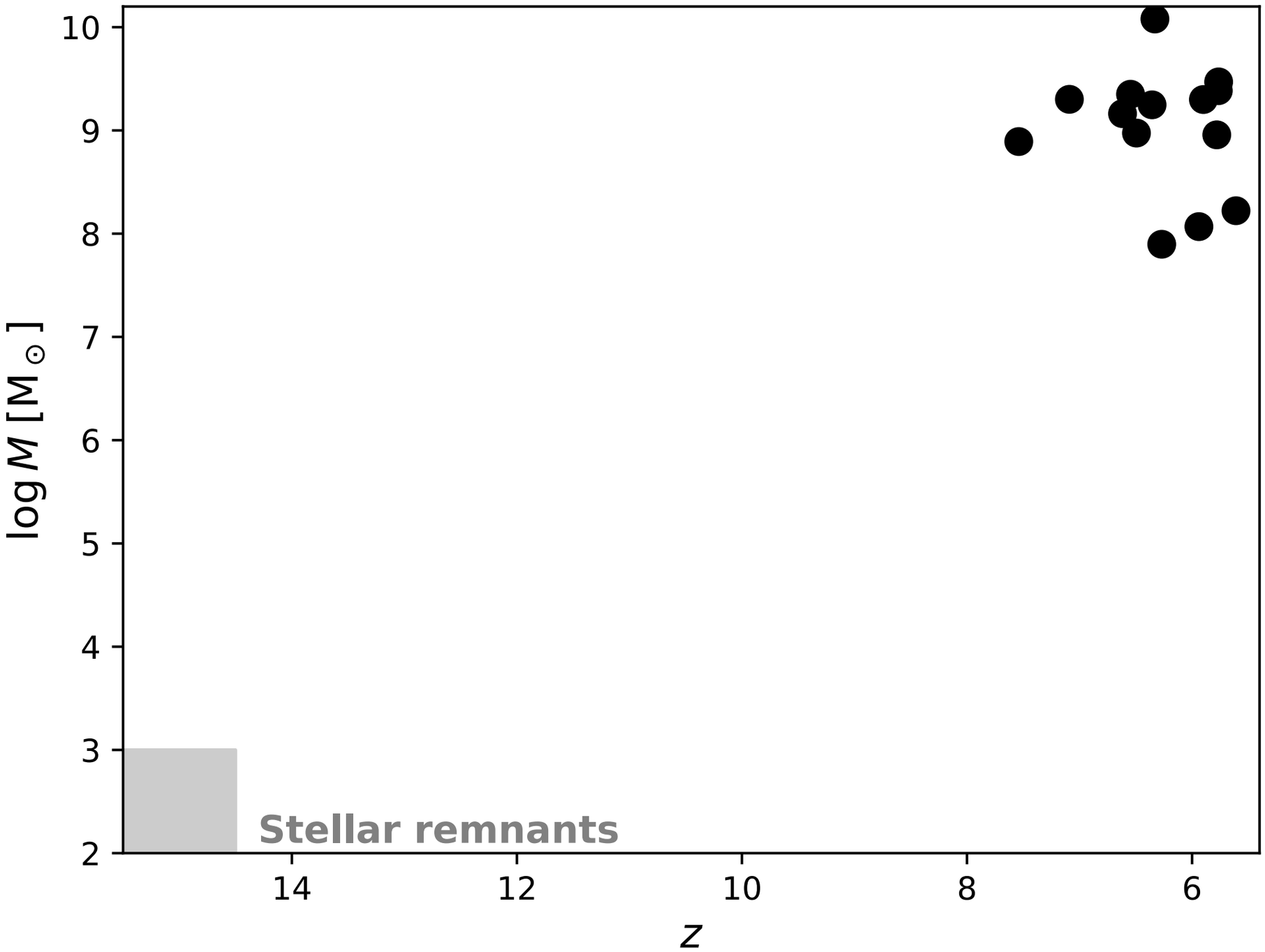
High redshift quasar observations



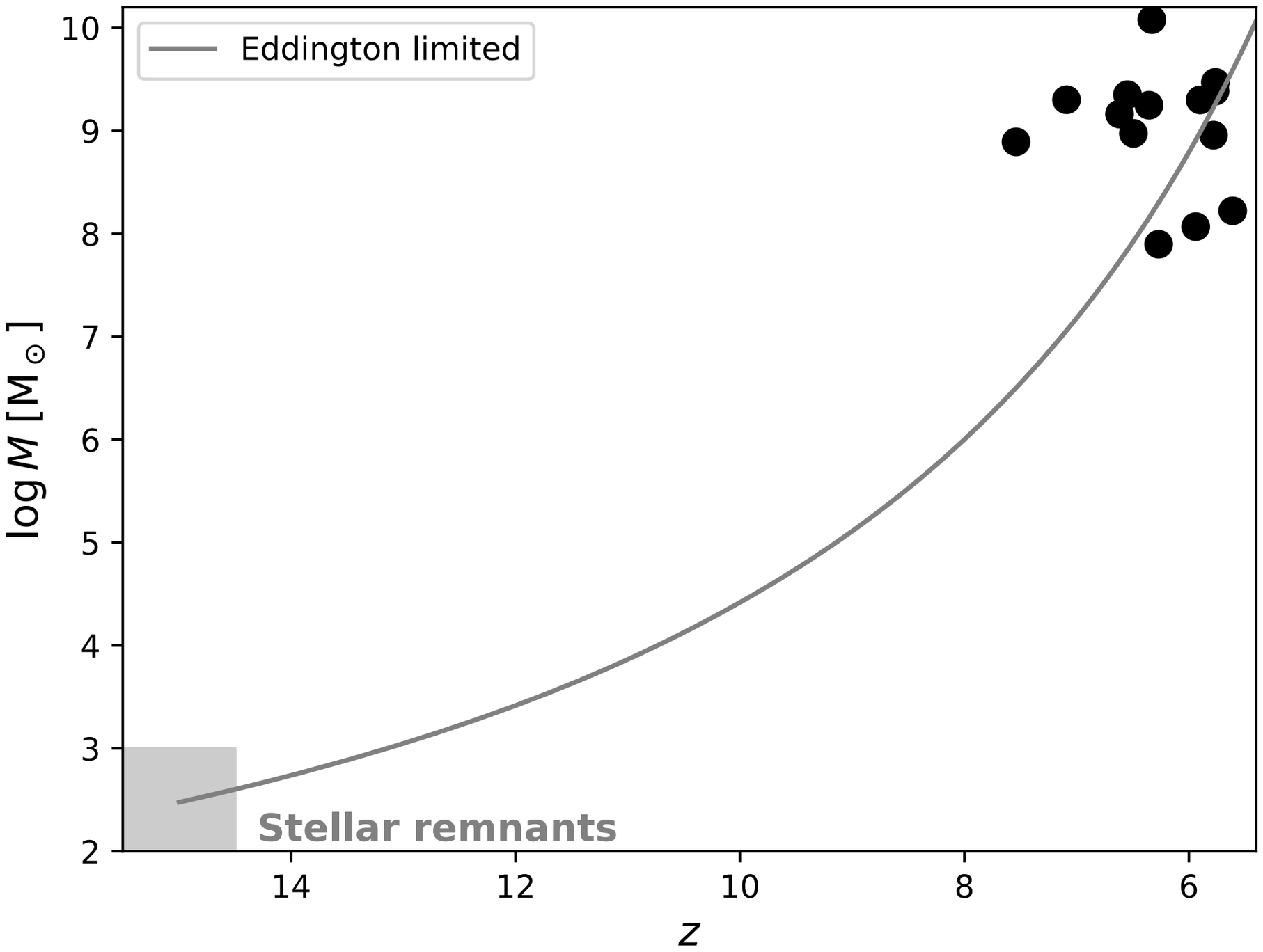
High redshift quasar observations



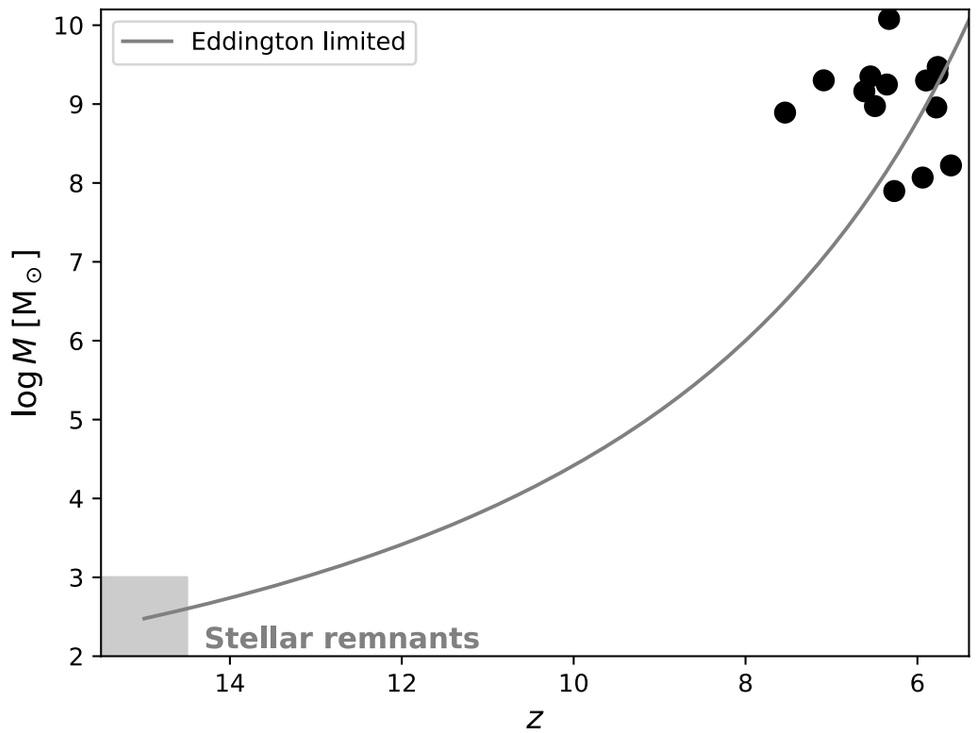
High redshift quasar problem



High redshift quasar problem



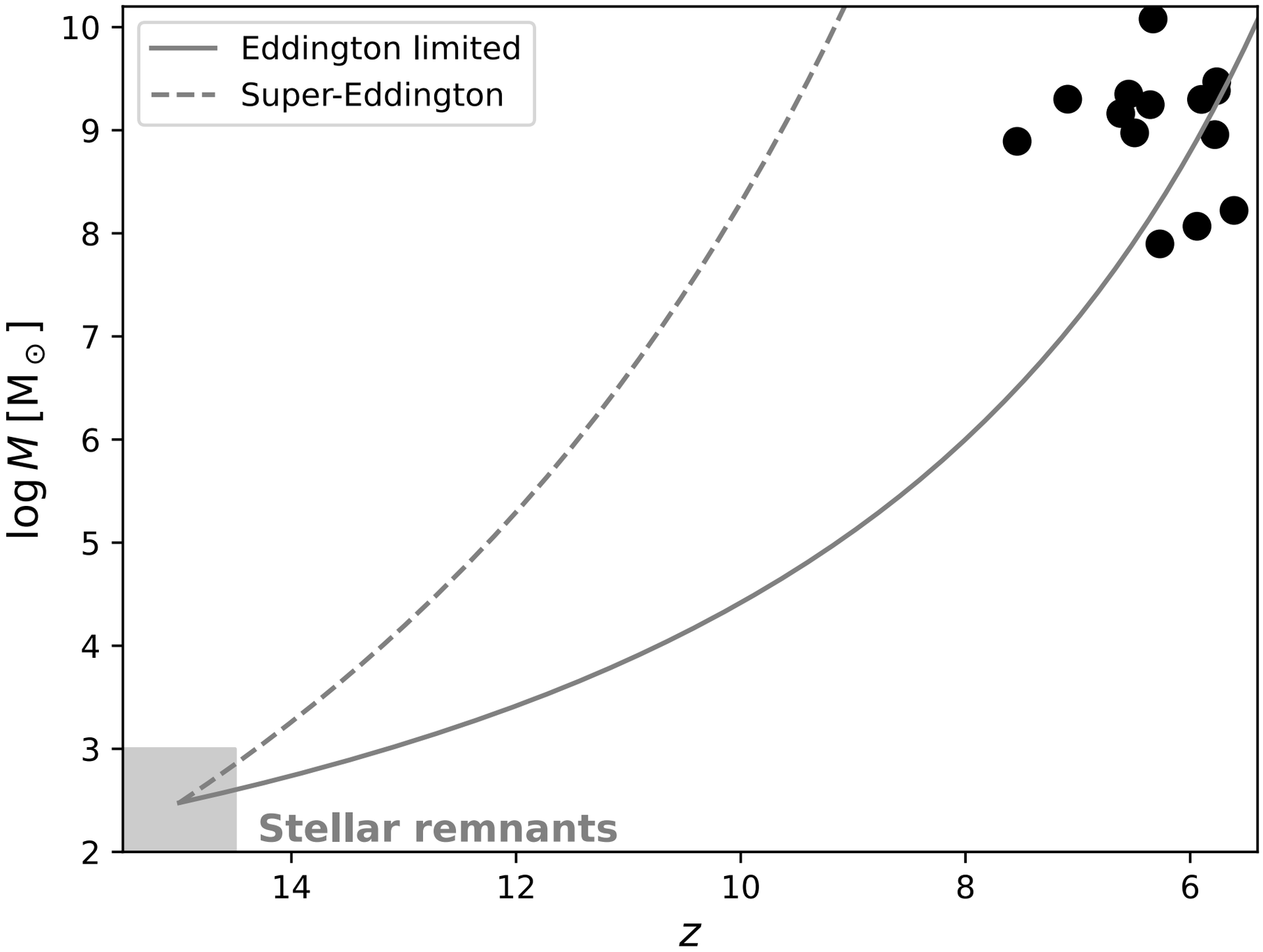
Solutions



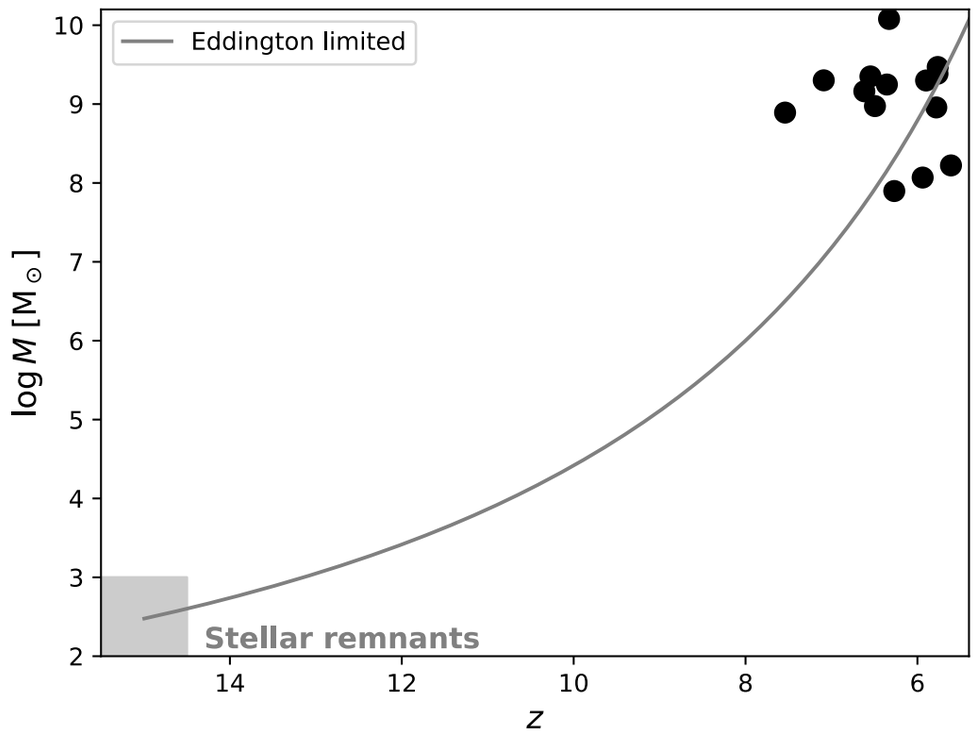
Speed up the BH growth

Super-Eddington accretion

High redshift quasar problem



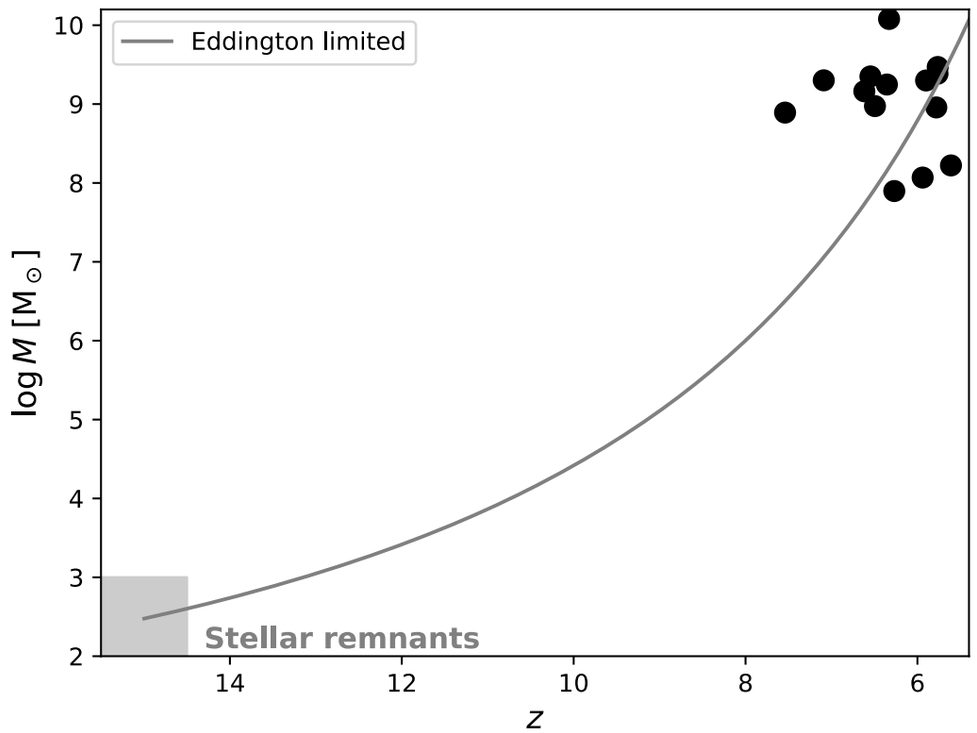
Solutions



Speed up the BH growth

Super-Eddington accretion

Solutions



Speed up the BH growth

↓

Super-Eddington accretion

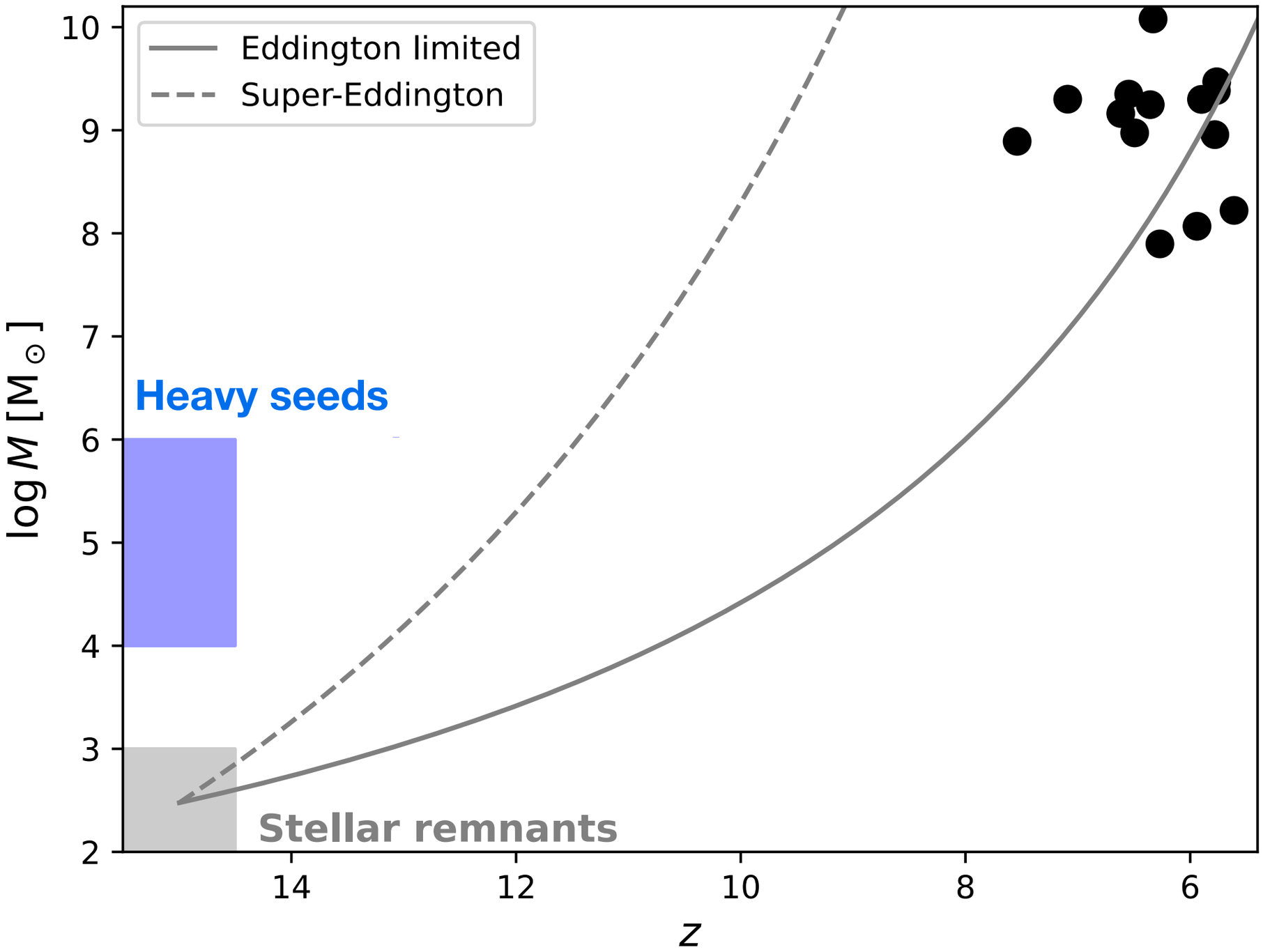
Start from an intermediate mass BH

↓

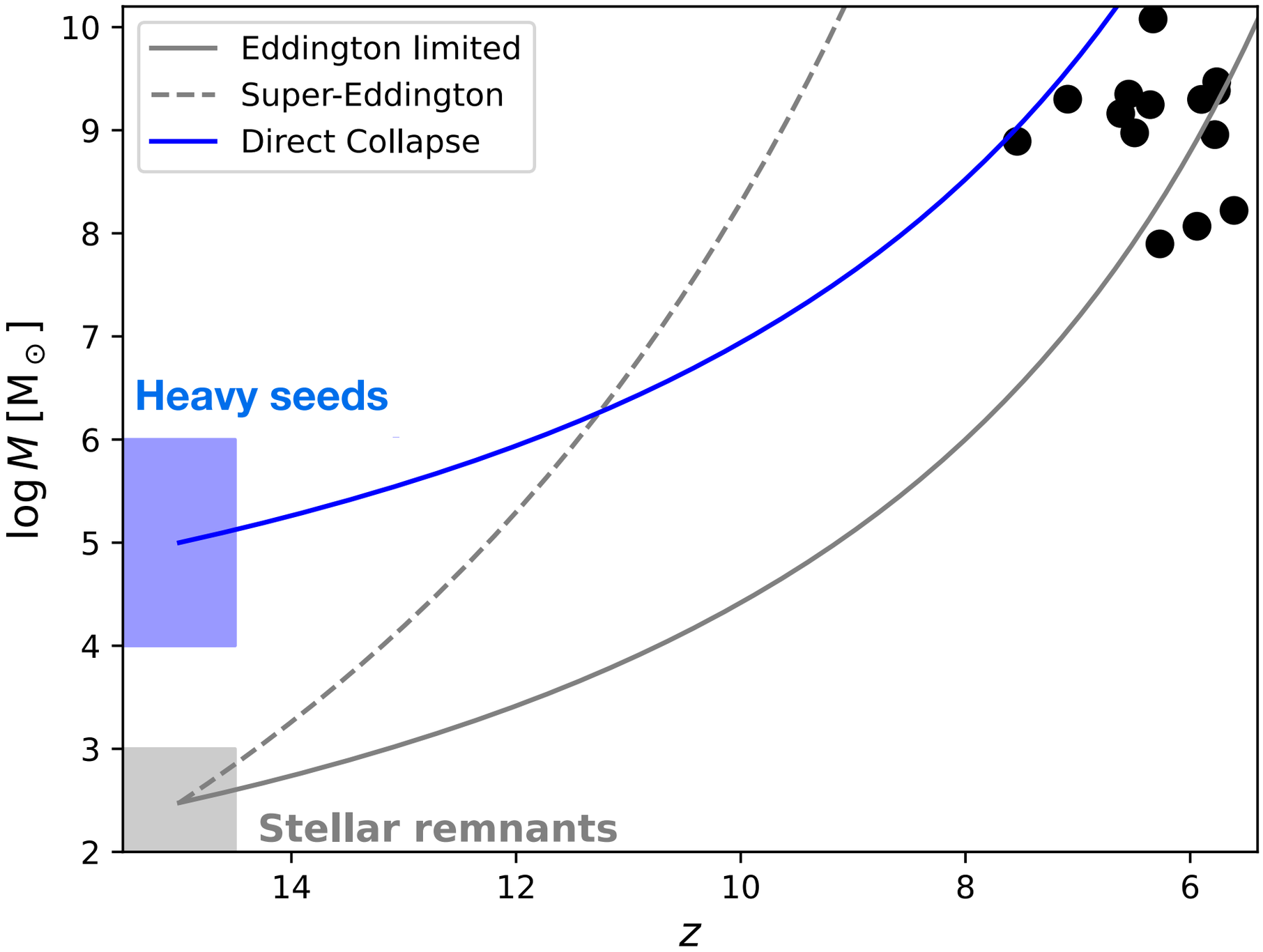
Heavy BH seed

$M_\bullet \sim 10^4 - 10^6 M_\odot$

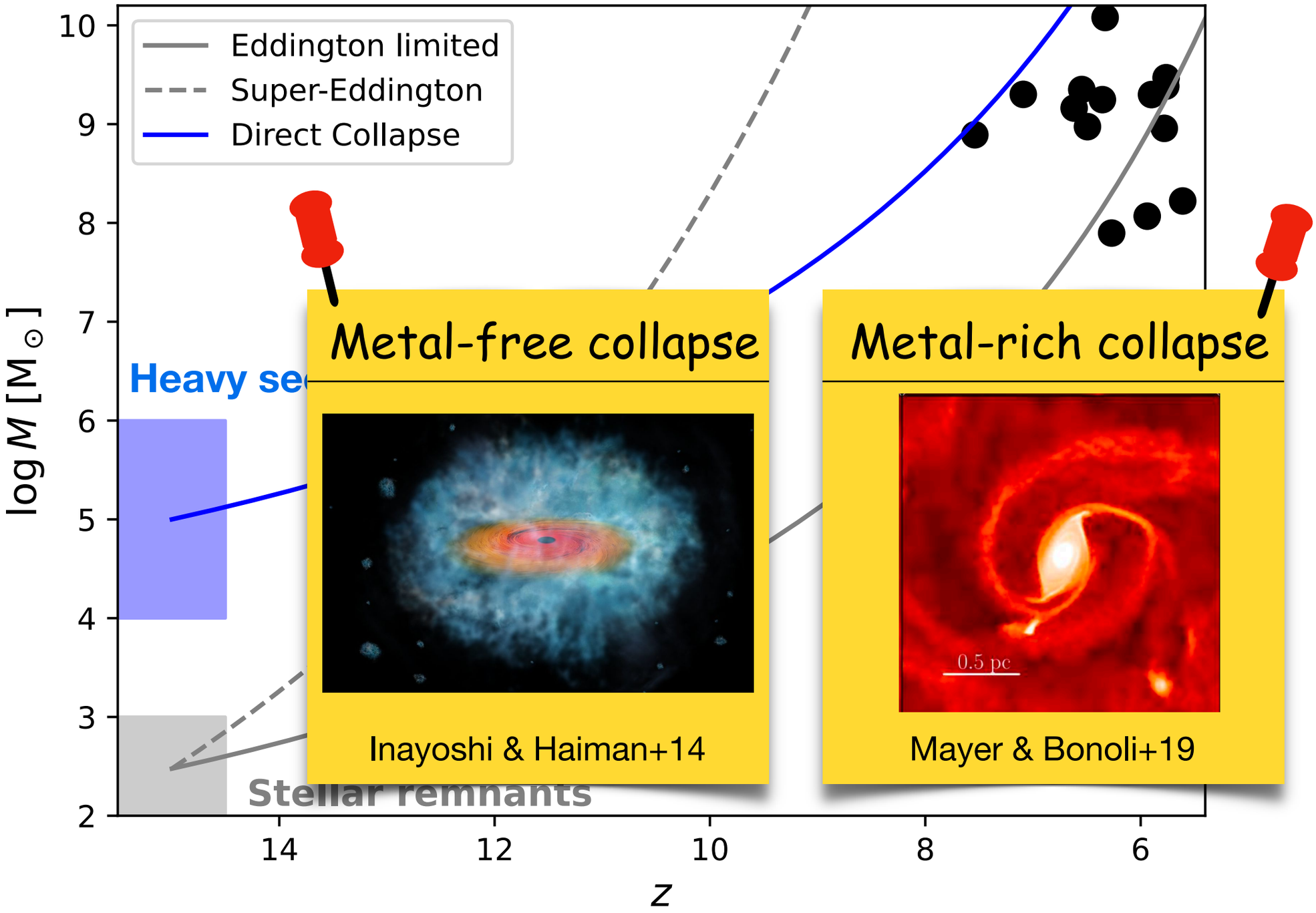
High redshift quasar problem



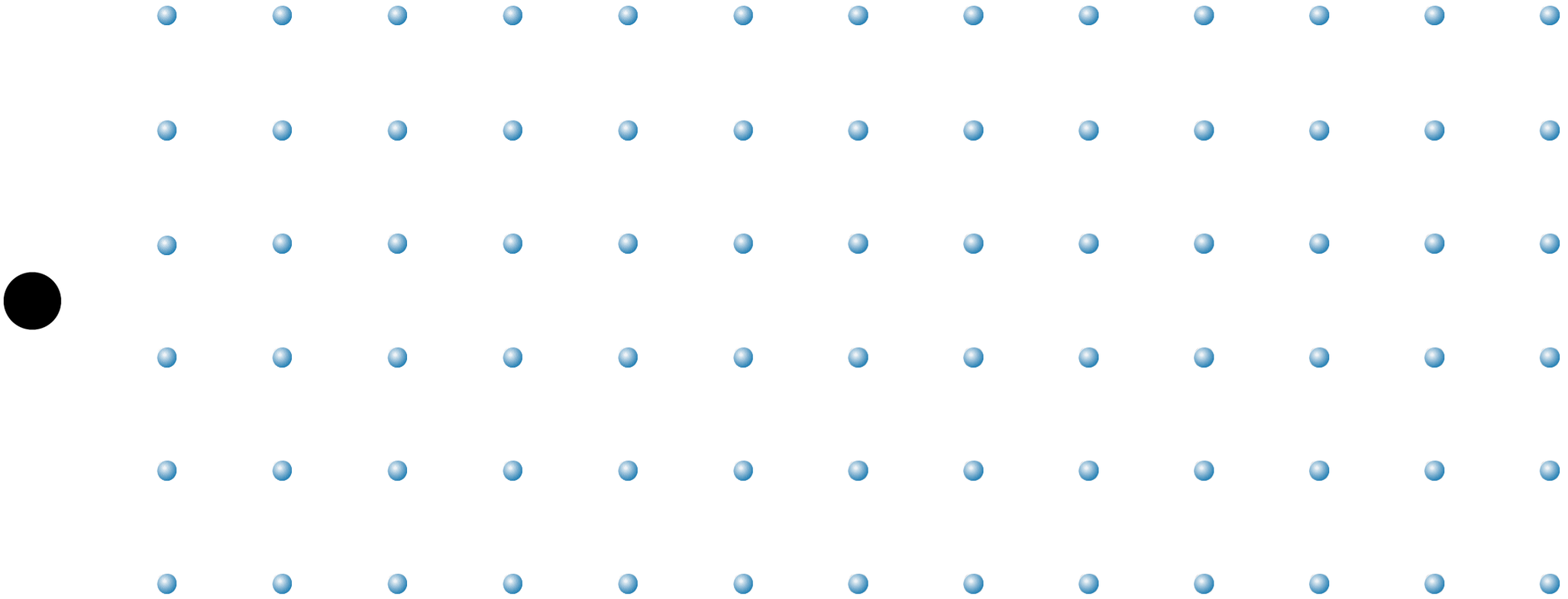
High redshift quasar problem



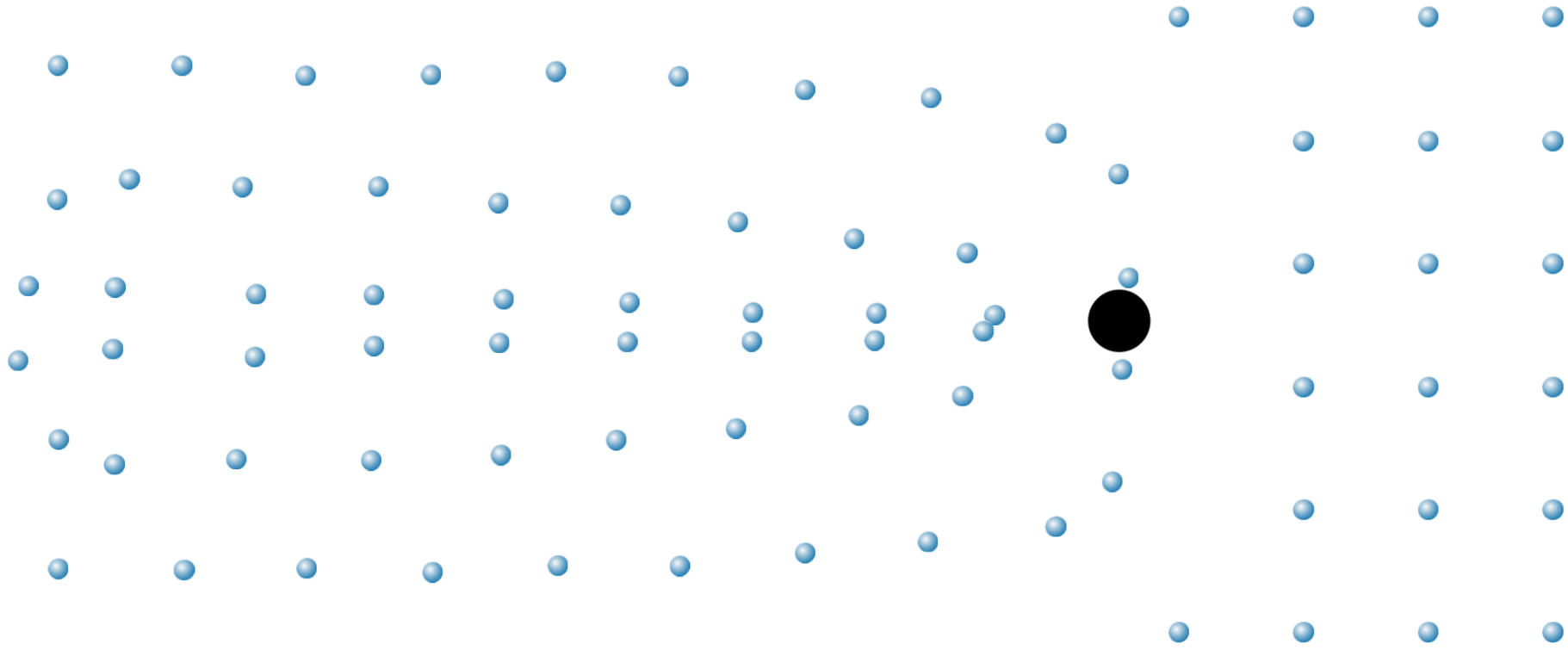
High redshift quasar problem



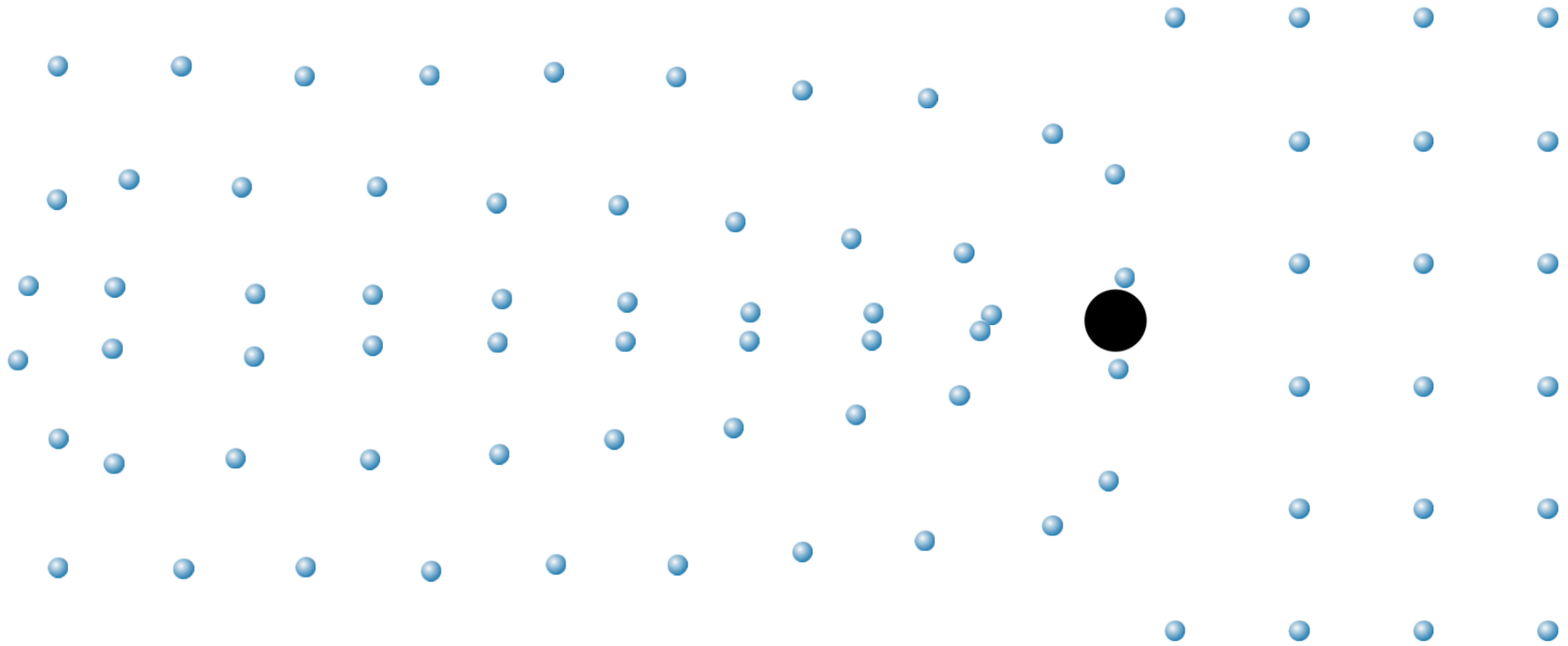
Gaseous dynamical friction



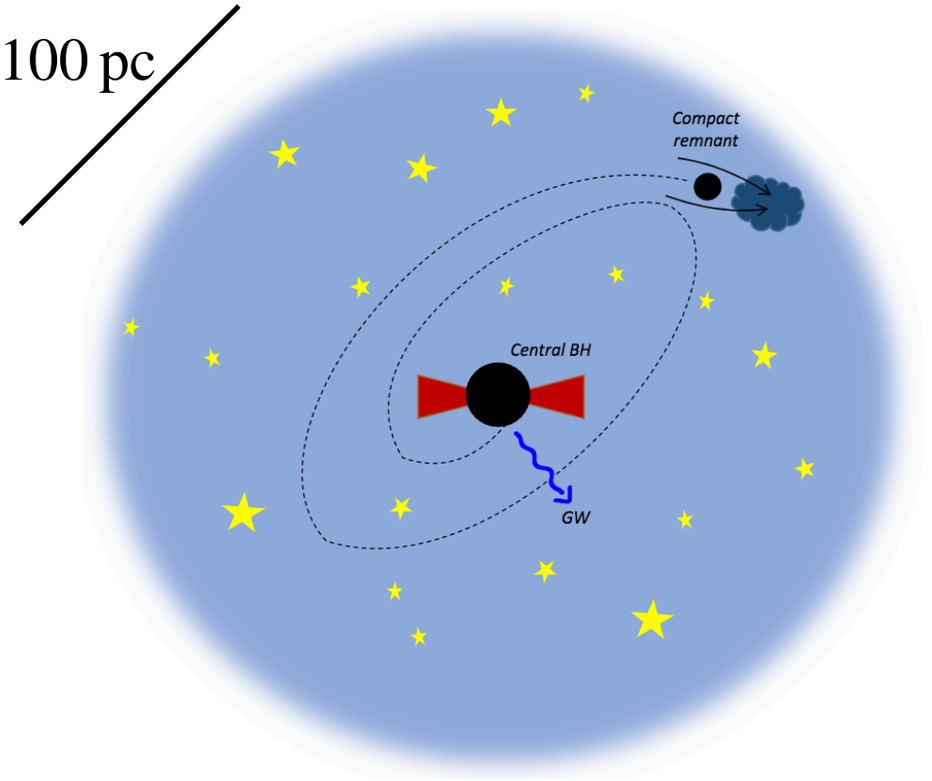
Gaseous dynamical friction



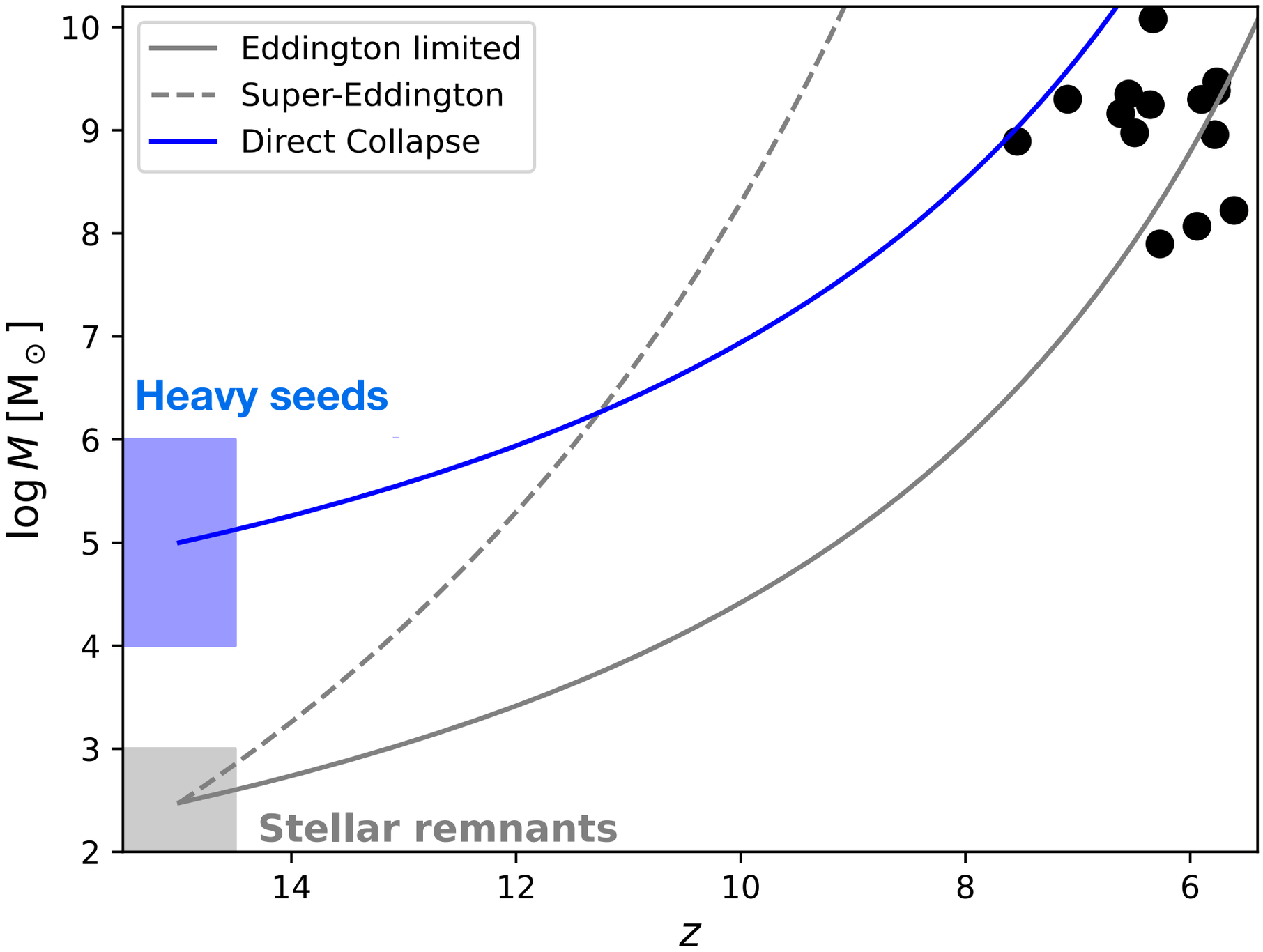
Gaseous dynamical friction



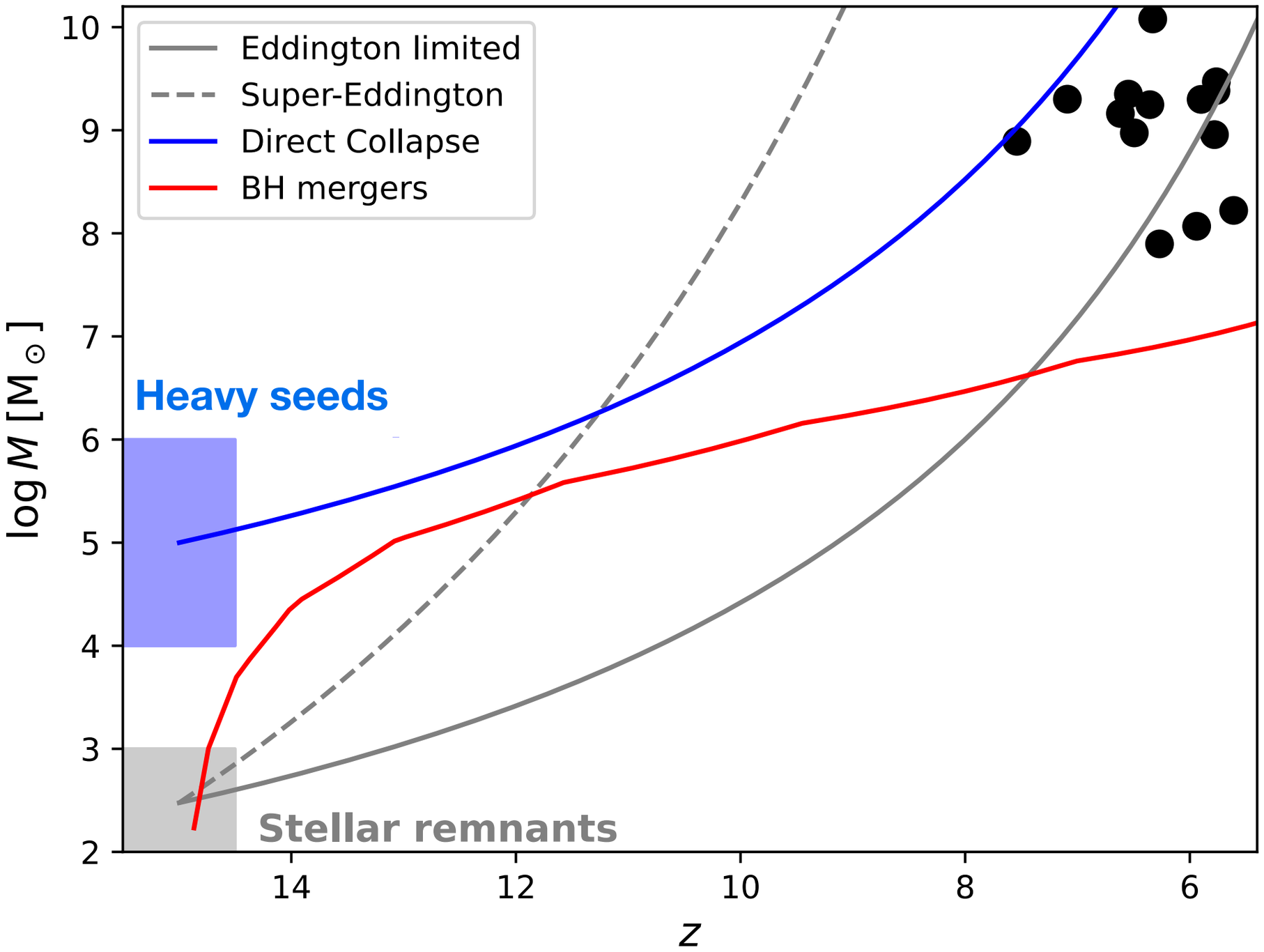
Dynamical friction between stellar BHs and gas



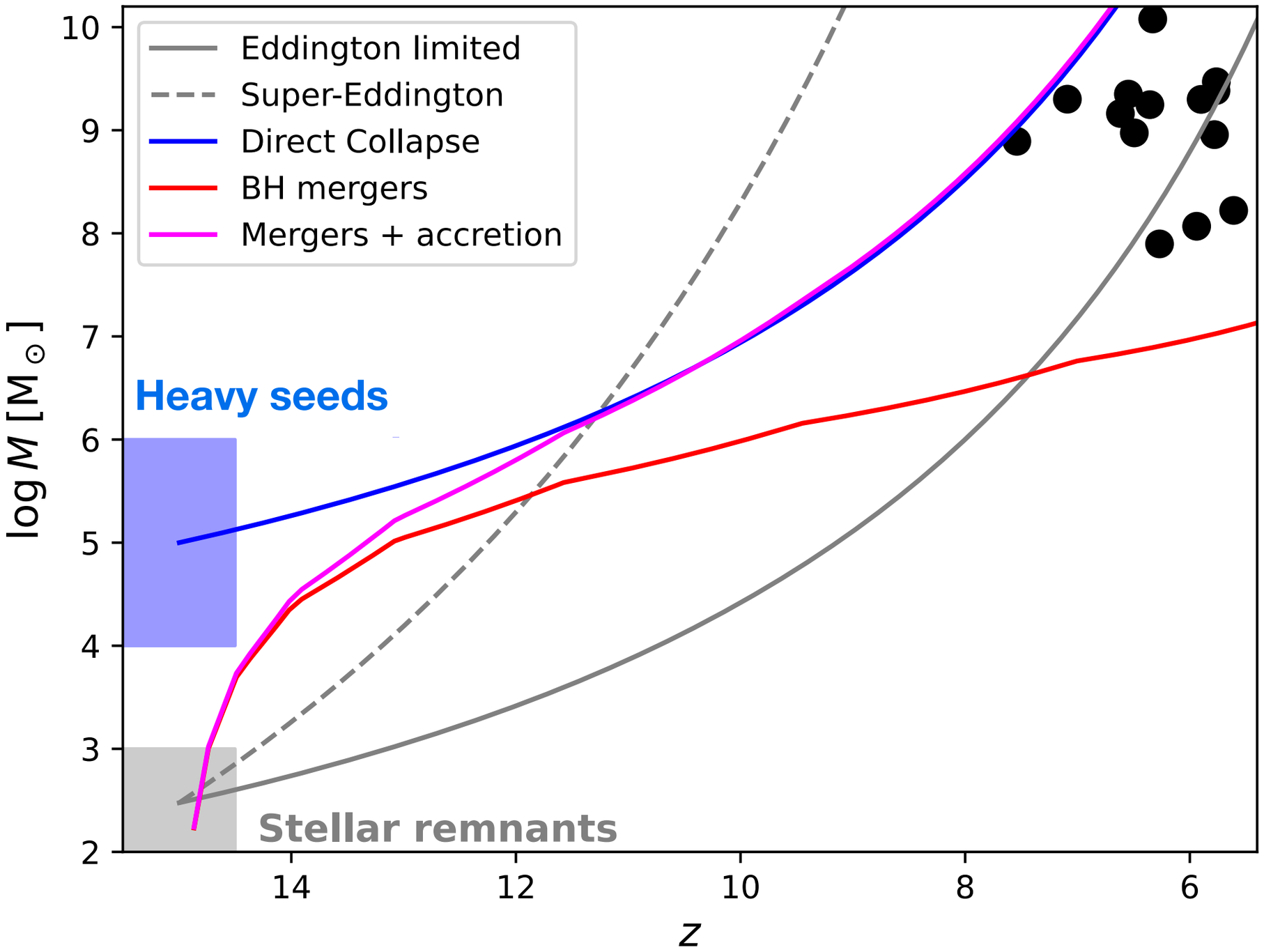
High redshift quasar problem



High redshift quasar problem

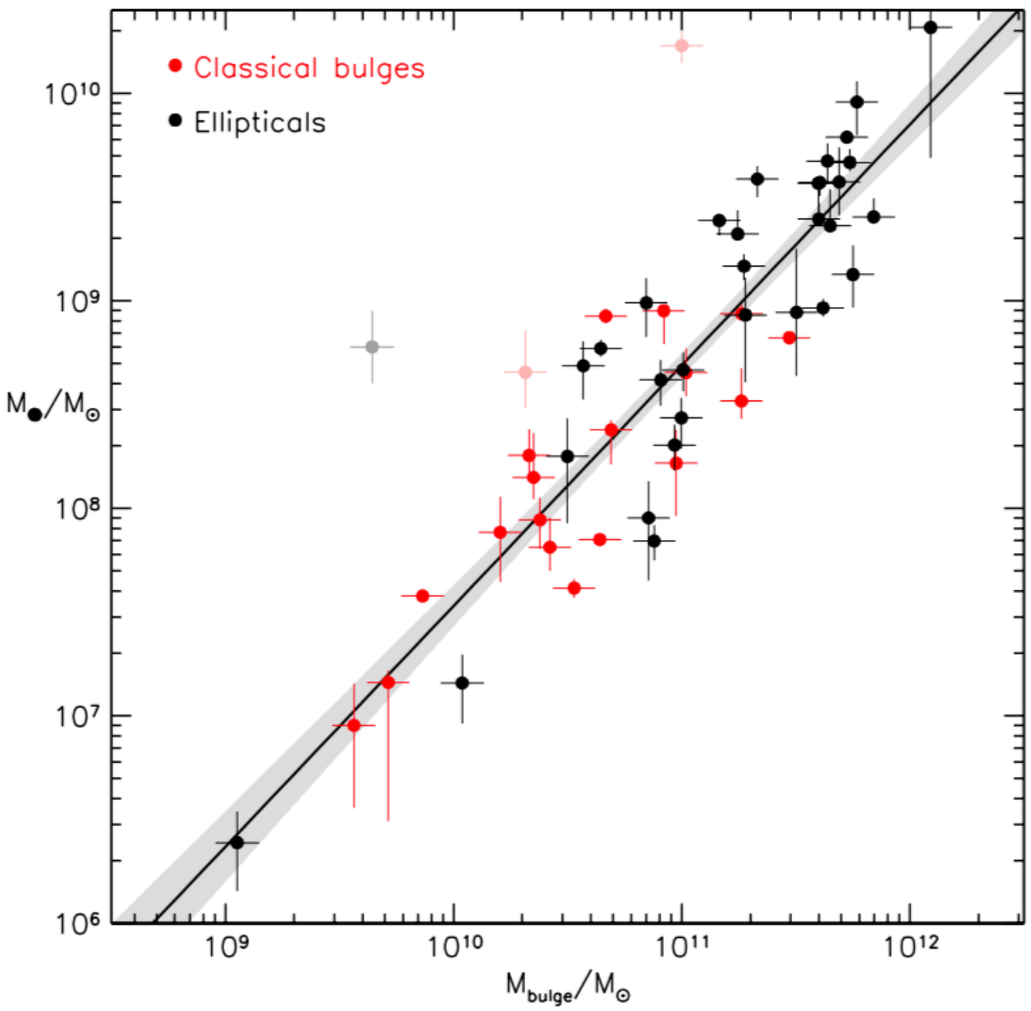


High redshift quasar problem



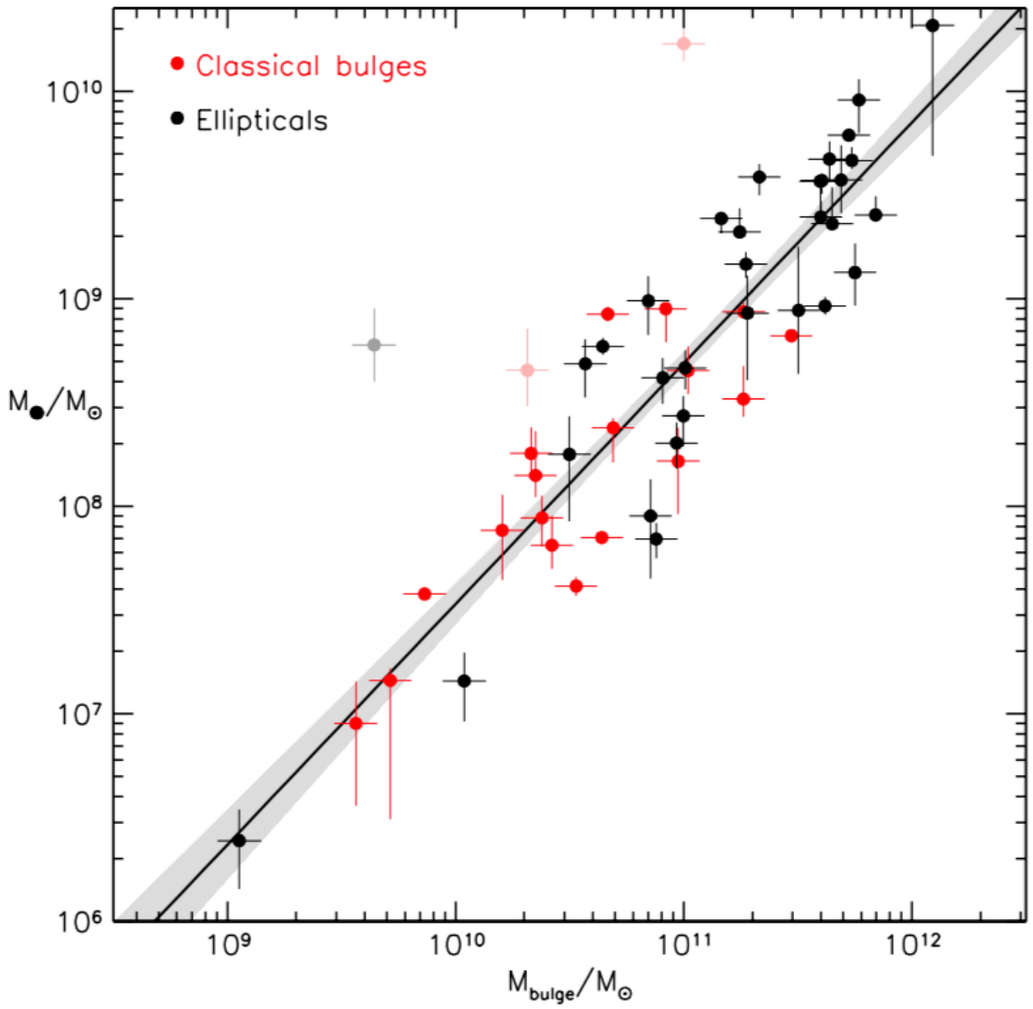
SMBH-galaxy coevolution

Largest SMBH are found in massive ellipticals

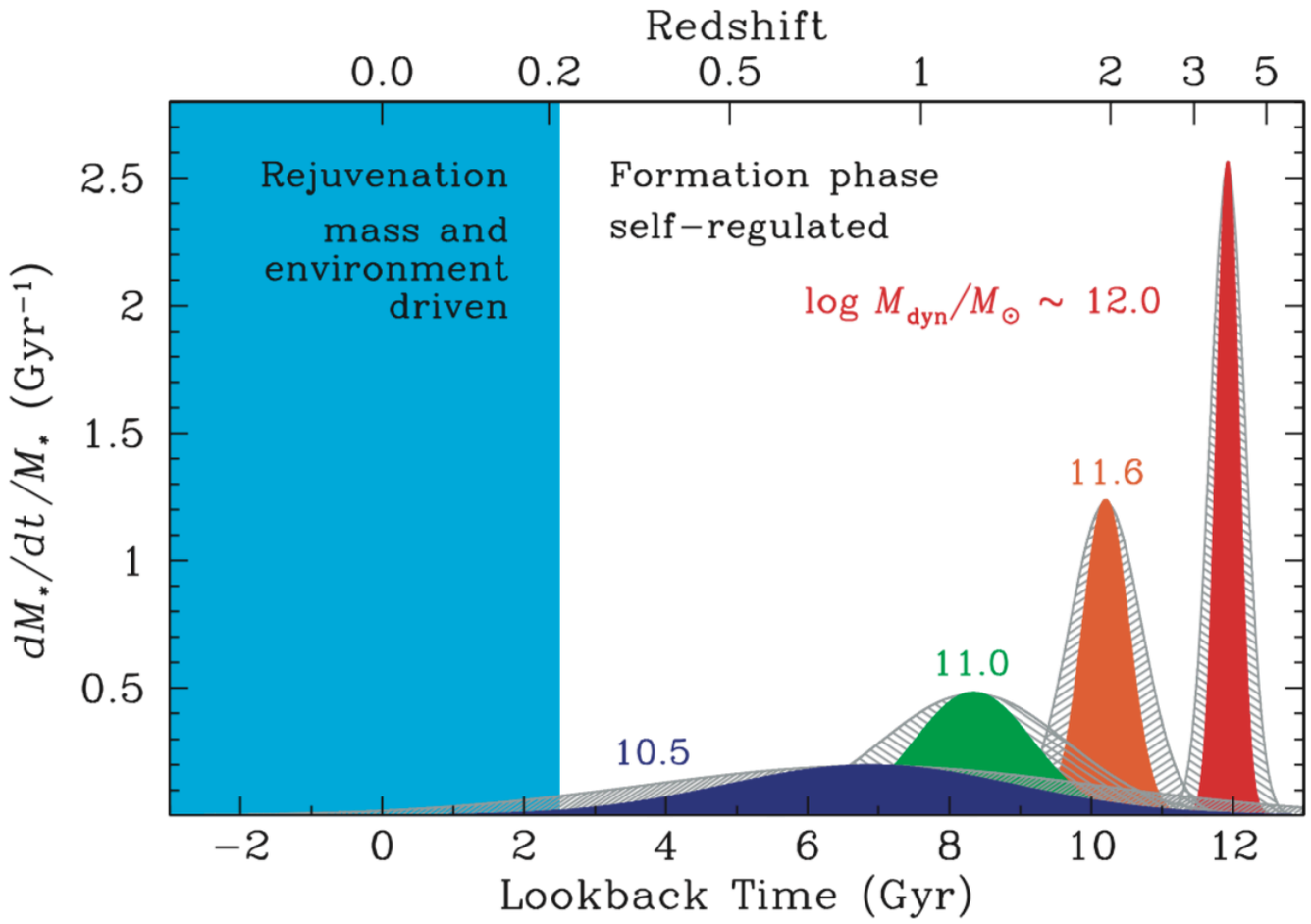


SMBH-galaxy coevolution

Largest SMBH are found in massive ellipticals



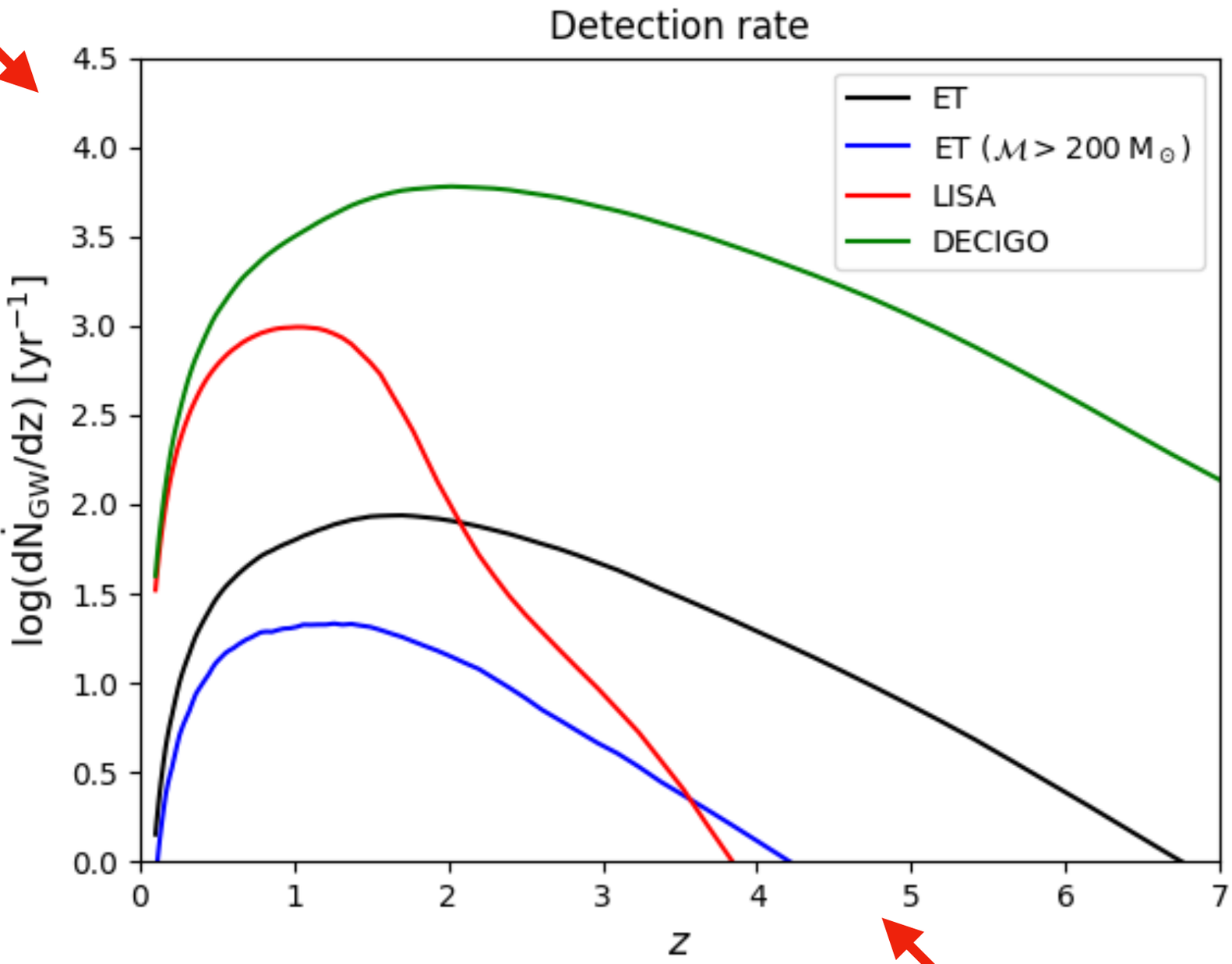
The life of large ellipticals is very short (< 0.5-1 Gyr)



SMBH should form in <1Gyr even at lower z

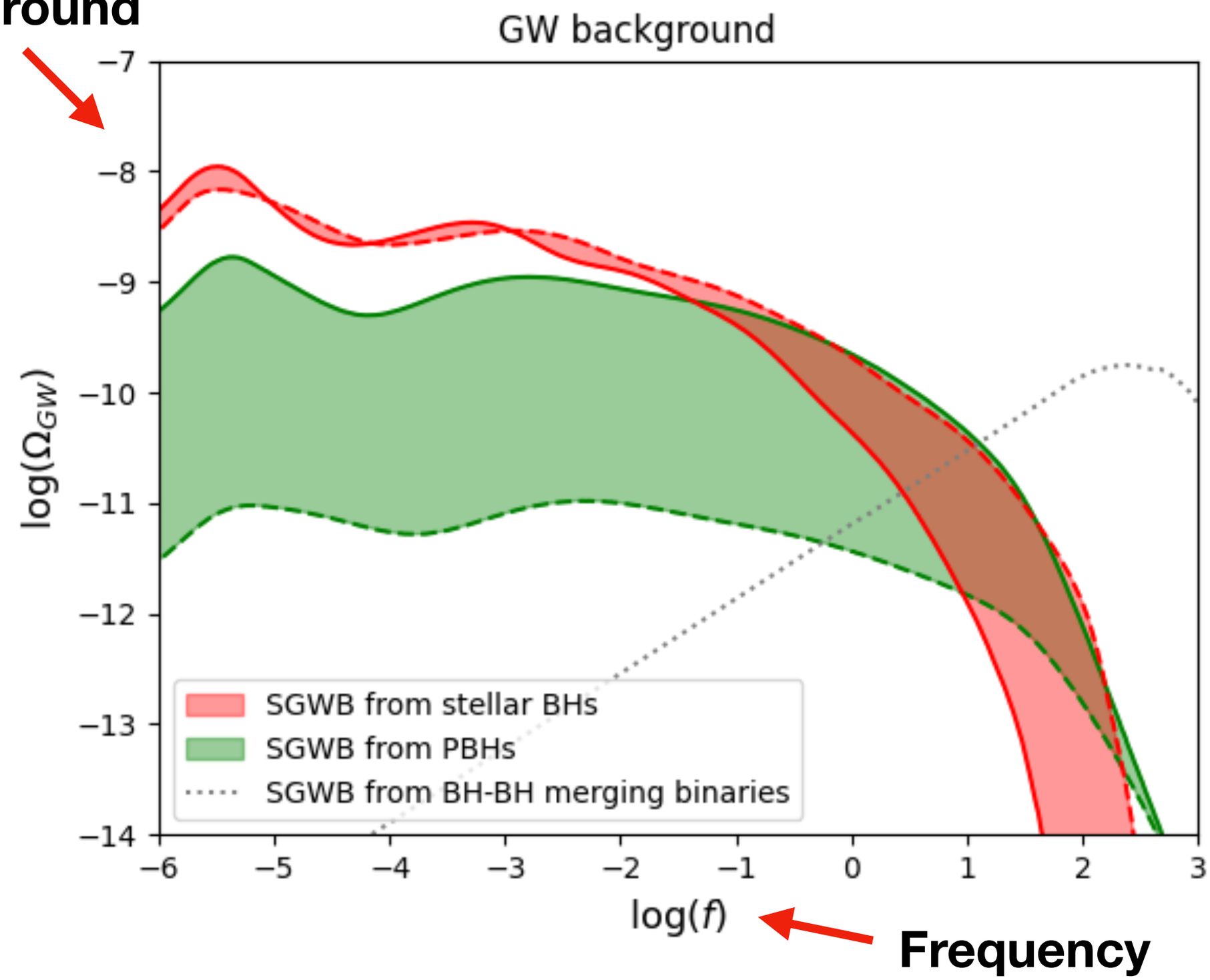
GW detection rate

GW detection Rate



GW Background

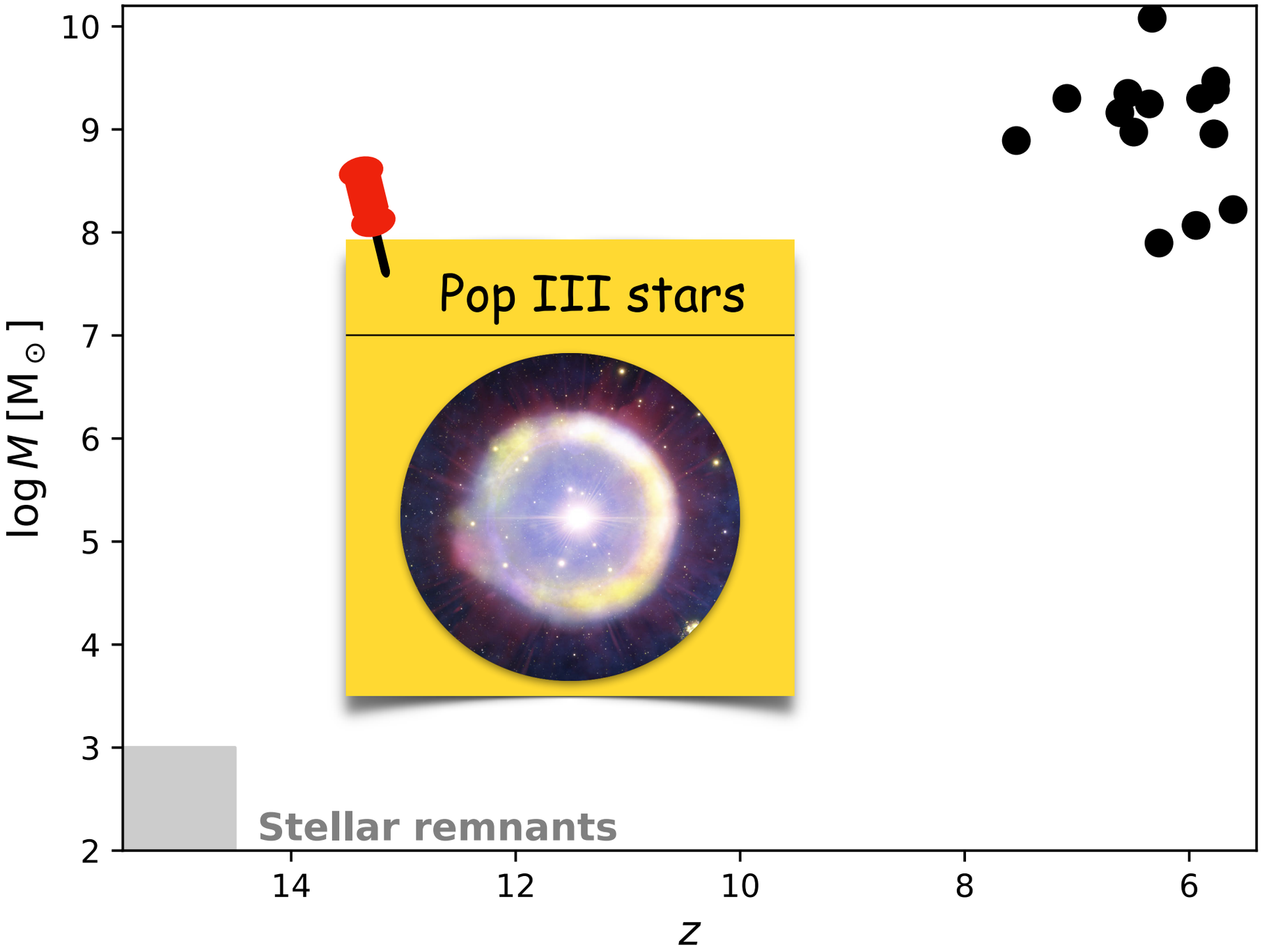
Stochastic GW Background



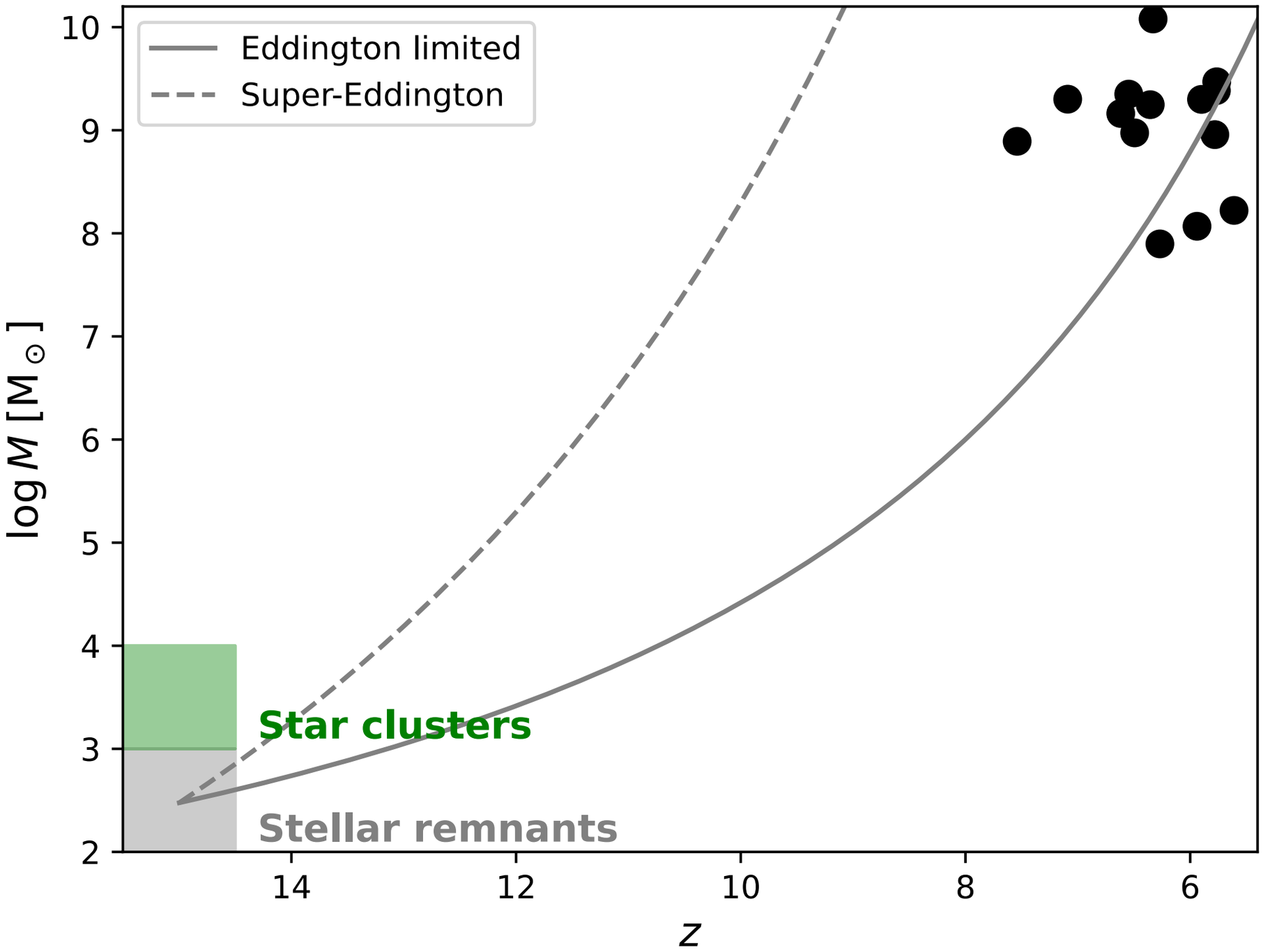
Frequency

Thank you!

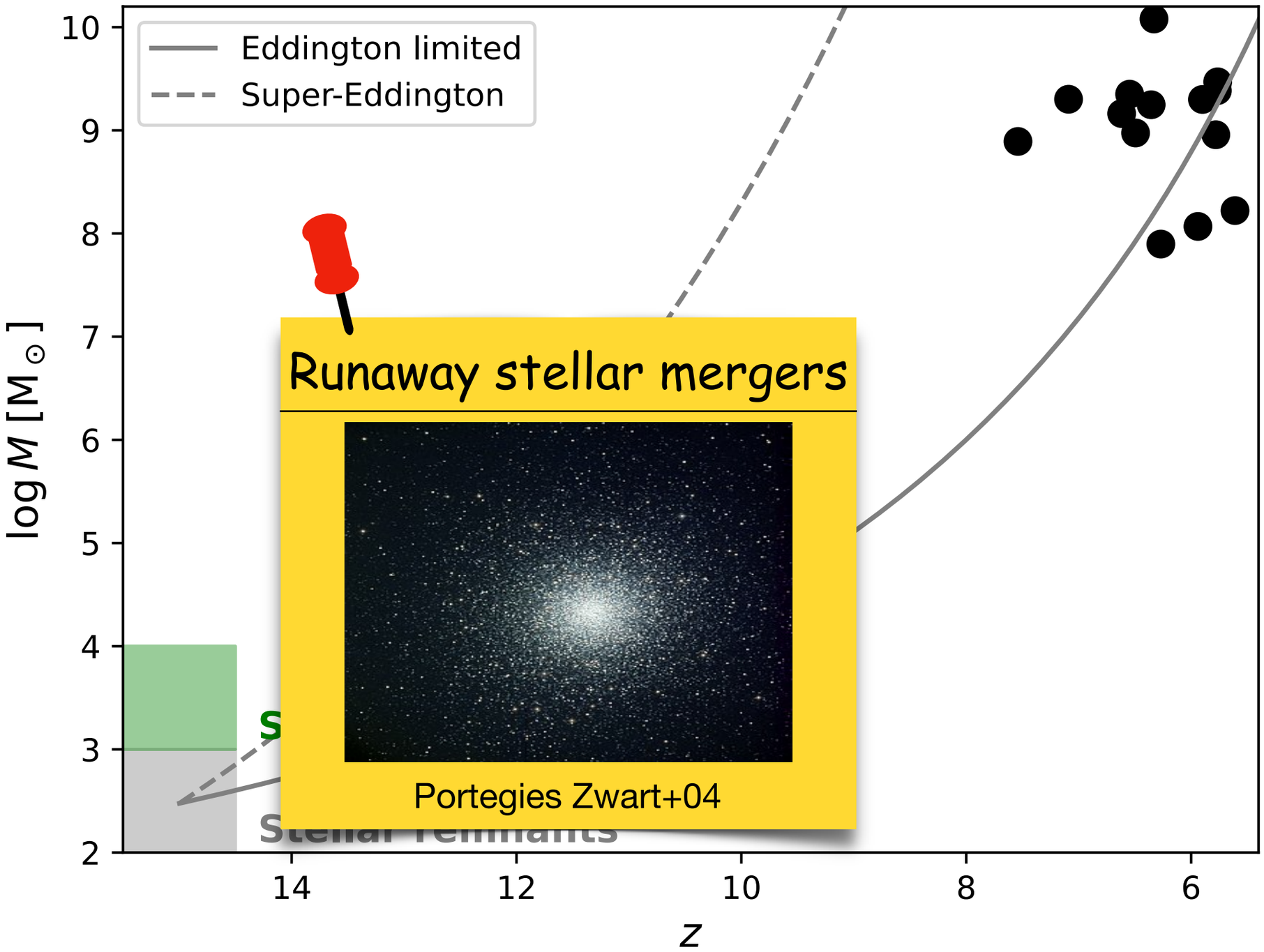
High redshift quasar problem



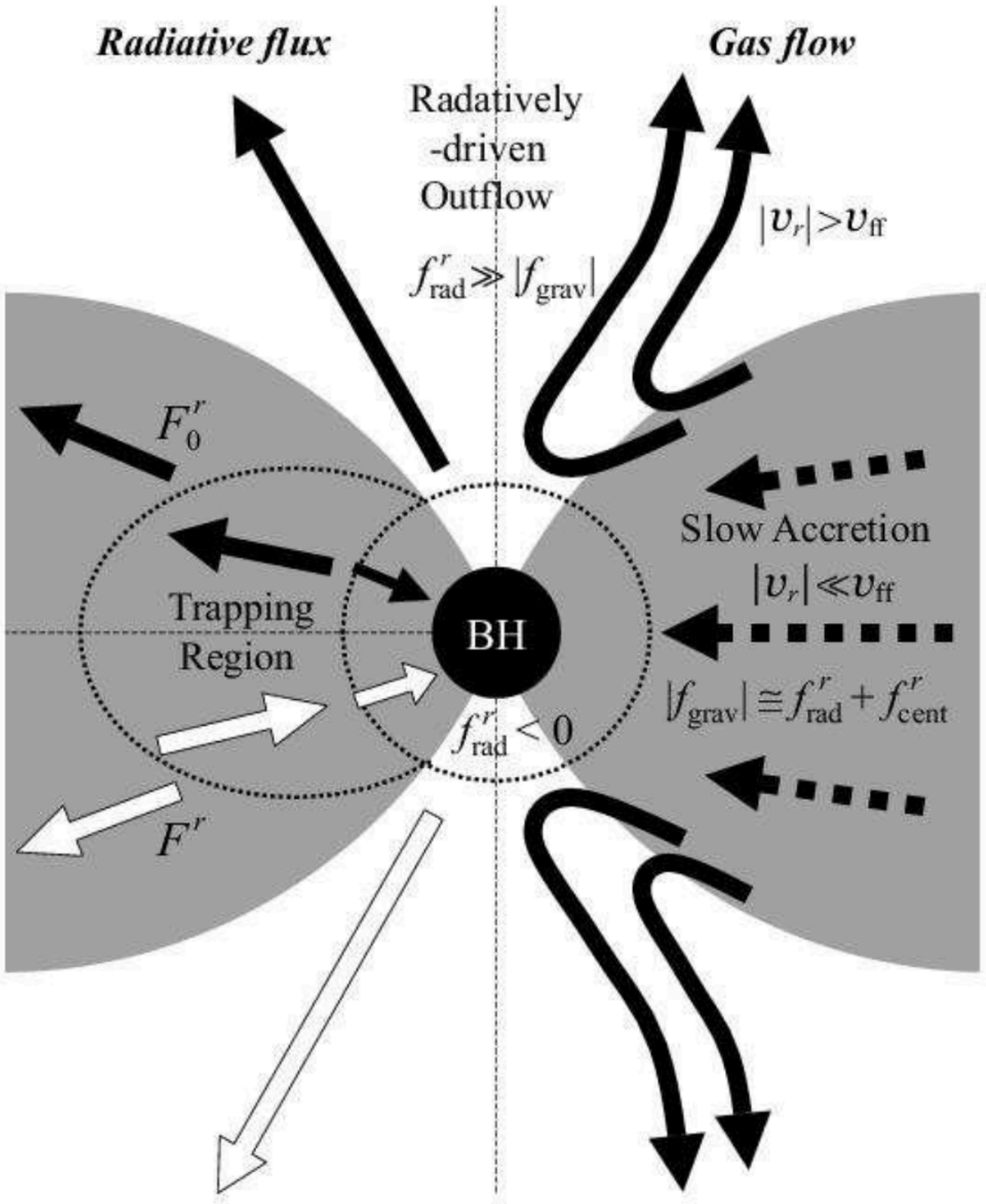
High redshift quasar problem



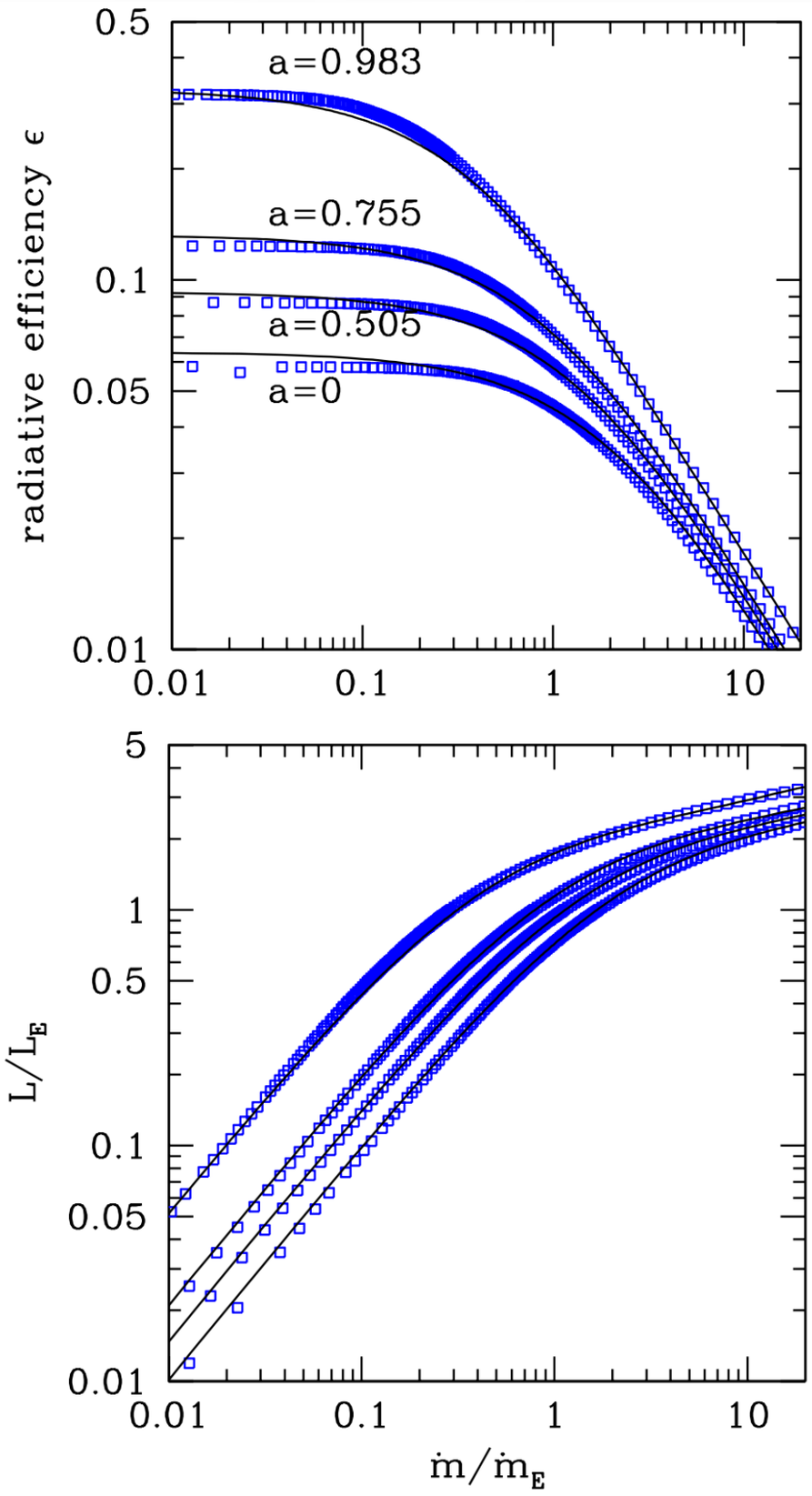
High redshift quasar problem



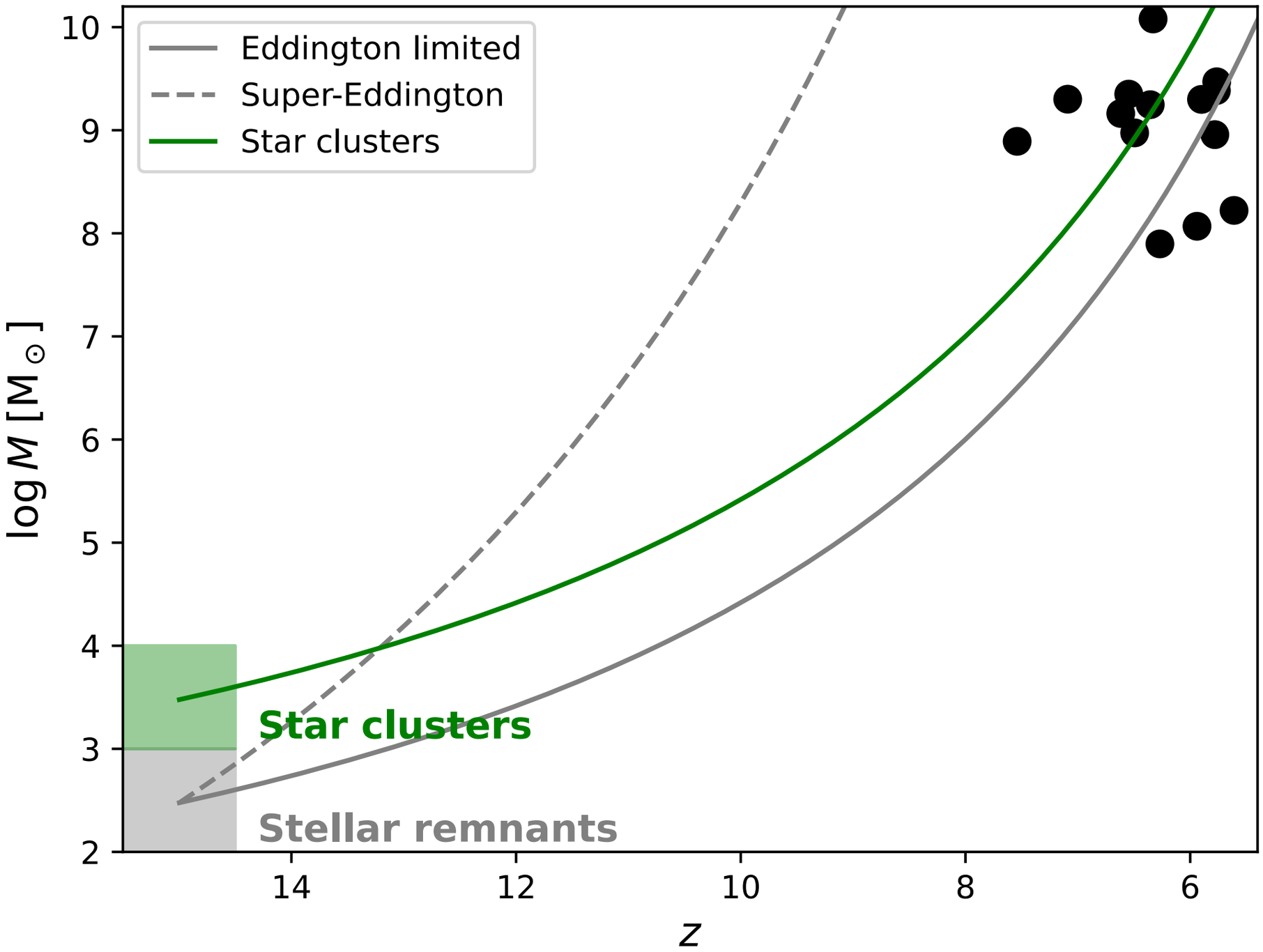
Super-Eddington



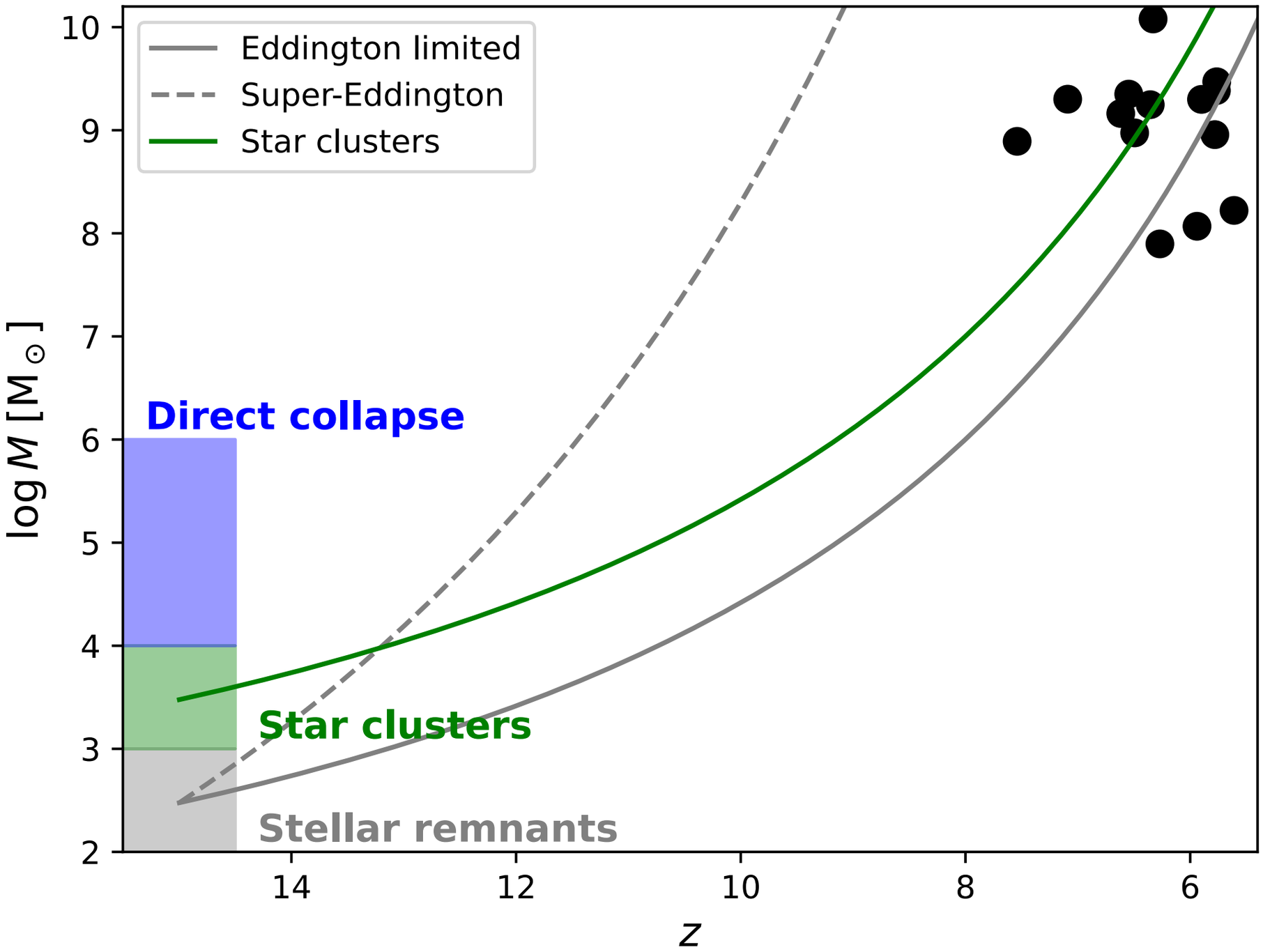
Ohsuga+07, Madau+14, Lapi+14



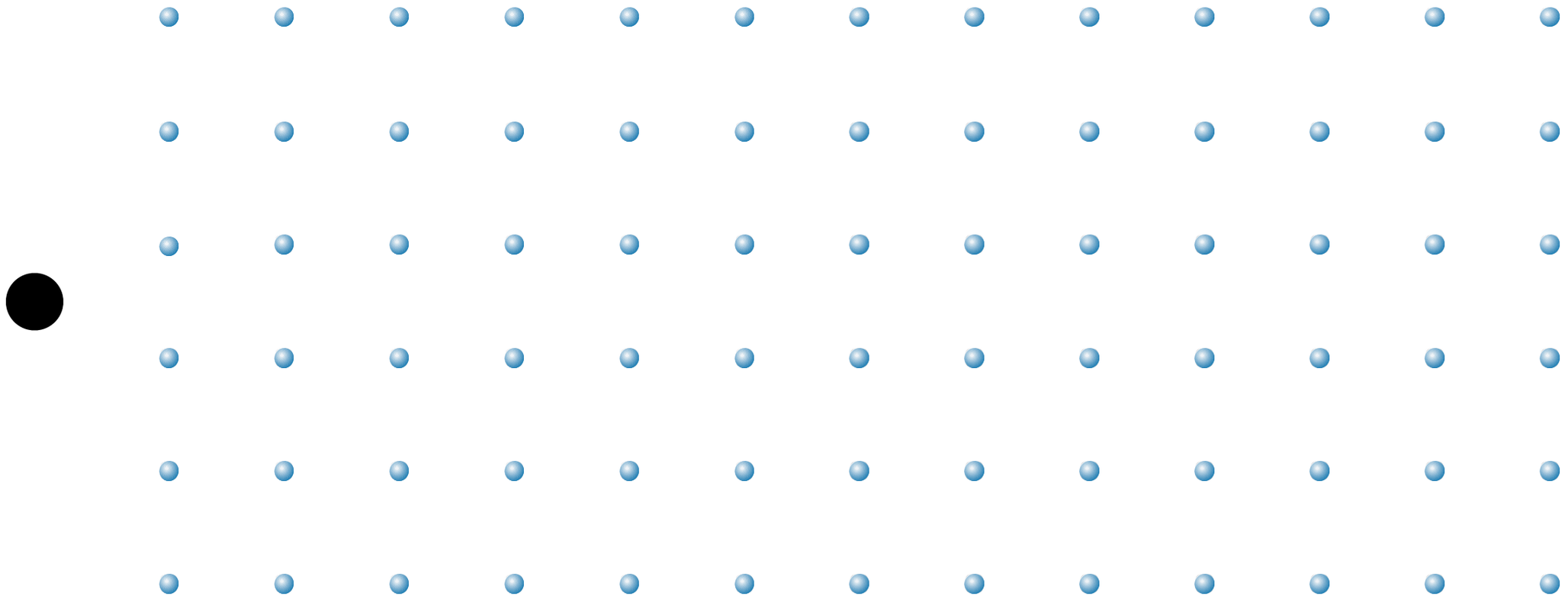
High redshift quasar problem



High redshift quasar problem

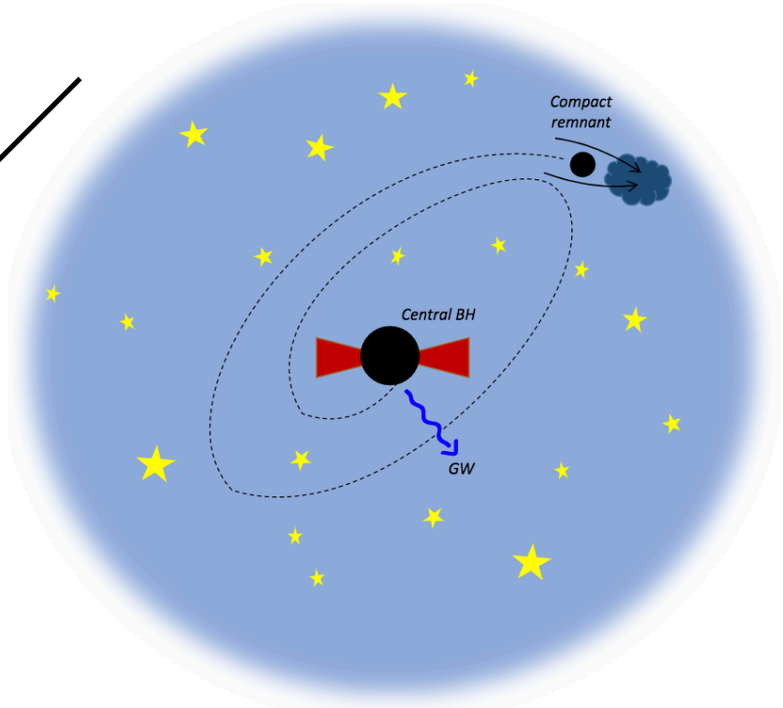


Gaseous dynamical friction

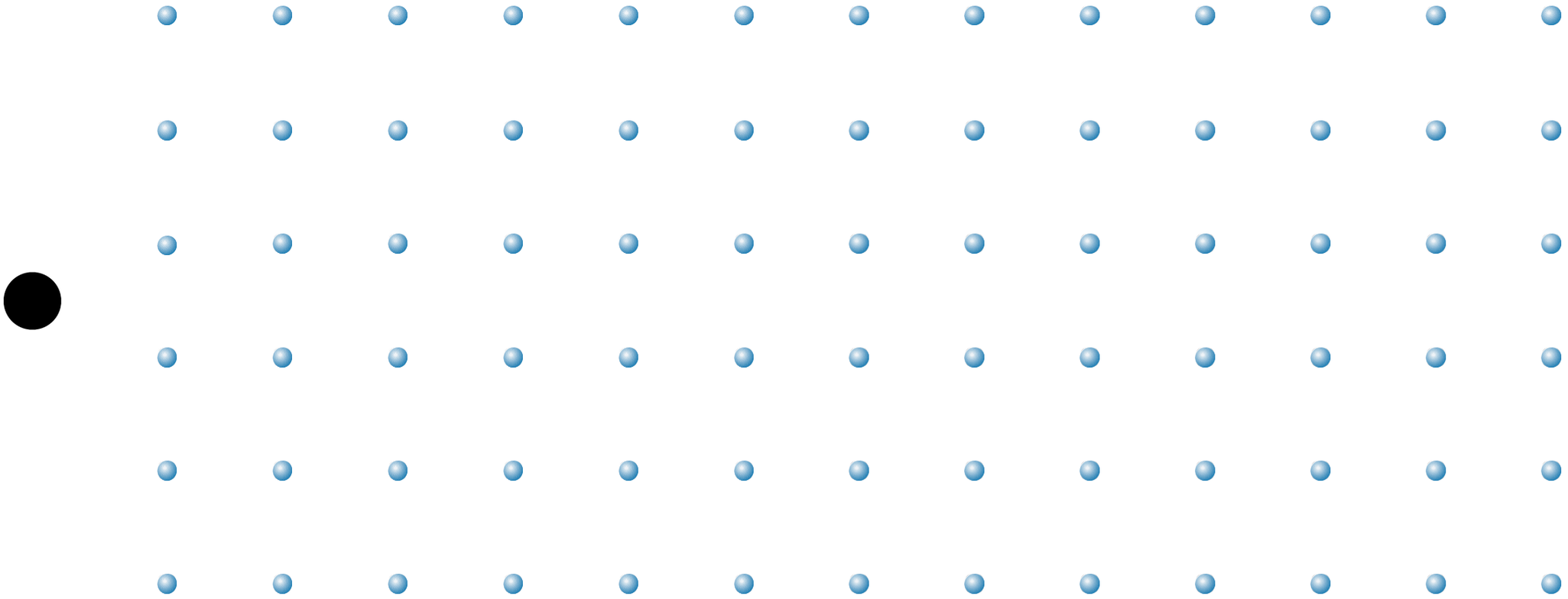


Dynamical friction between stellar BHs and gas

~ 100 pc



Gaseous dynamical friction



$$F_{\mathrm{DF}} = \frac{4\pi G^2 m_\bullet^2 \rho}{v^2} f(\mathscr{M})$$

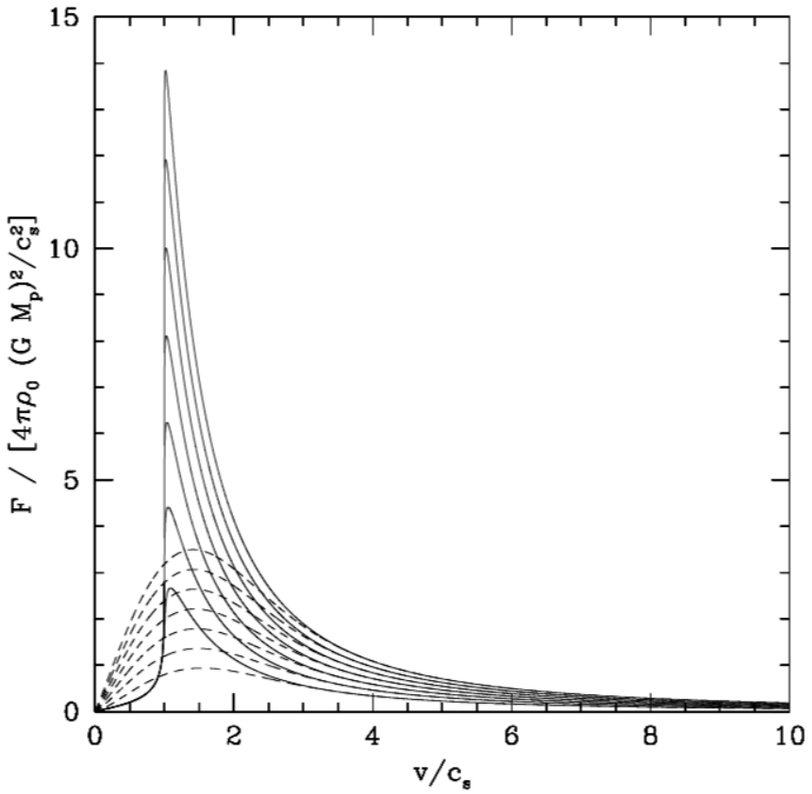
Ostriker 1999, ApJ, 513:252-258

Sanchez-Salcedo et al. 2001, MNRAS, 322, 67

Escala et al. 2004, ApJ, 607, 765

Chapon et al. 2013, MNRAS, 429, 3114

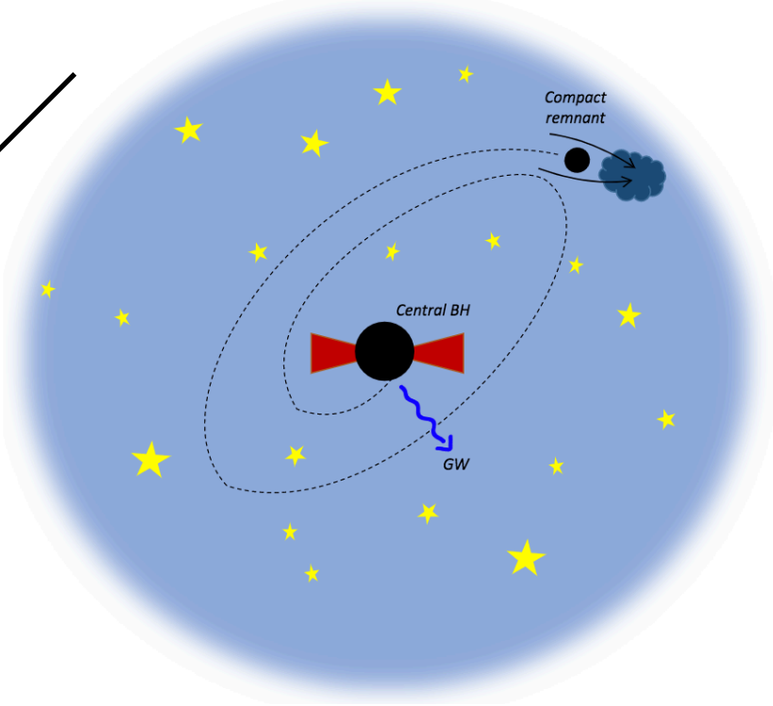
Tagawa et al. 2016, MNRAS, 462, 3812



Dynamical friction timescale

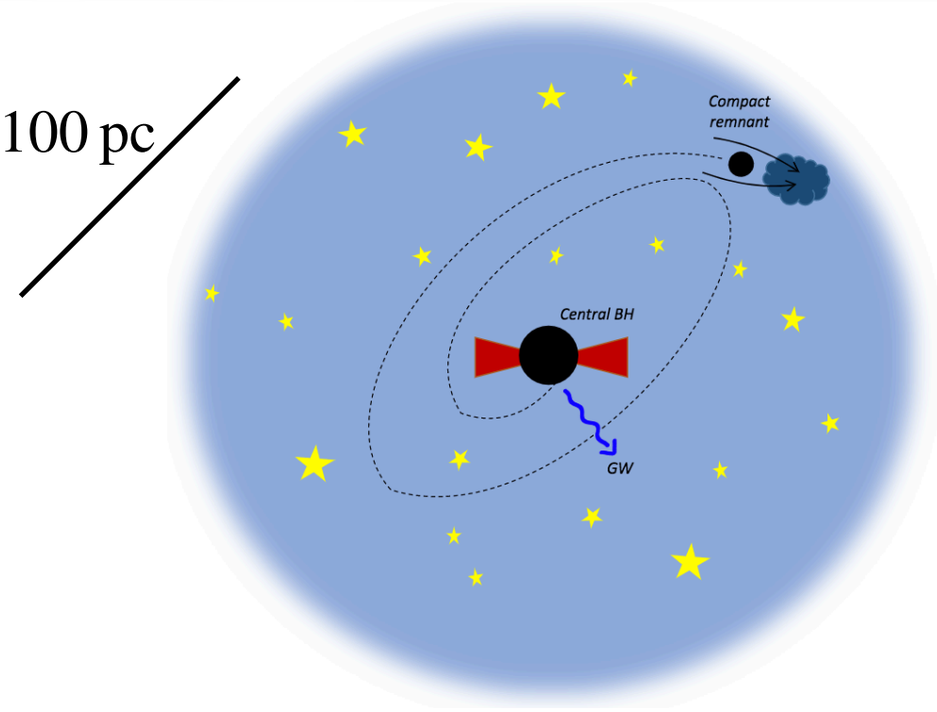
Dynamical friction between stellar BHs and gas

~ 100 pc



Dynamical friction timescale

Dynamical friction between stellar BHs and gas



$$\tau_{\rm DF} \sim N(n,\alpha)\left(\frac{m_\bullet}{100M_\odot}\right)^{-1}\left(\frac{M_{\rm gas}}{10^{11}M_\odot}\right)^{1/2}\left(\frac{R_{\rm e}}{1{\rm kpc}}\right)^{(\alpha-3)/2}\left(\frac{r_{\rm c}(e)}{10{\rm pc}}\right)^{3-\alpha/2}\left(\frac{j}{j_{\rm c}(e)}\right)^{1.5}$$

$$N \sim 3\times 10^8 {\rm yr}$$

Typical dynamical friction timescale