

Ultra-long Gamma-Ray Bursts from Supermassive Population III Stars

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Ref. T.Matsumoto et al. 2015, ApJ, 810, 64
T.Matsumoto et al. 2016, ApJ, 823, 83

Supermassive Black Holes @ $z \sim 7$

Marziani & Sulentic 2012

$$M_{\text{BH}} \sim 10^9 M_{\odot} \quad @z \sim 6-7$$

Fan 2006, Mortlock et al. 2011, Wu et al. 2015

Origin??

$$M_{\text{BH}}(t) = \underline{M_{\text{BH},0}} \exp \left[\frac{1 - \epsilon}{\epsilon} \frac{t - t_0}{0.45 \text{Gyr}} \right]$$

1. Population III stars (First stars)

$$t_0 \sim 0.18 \text{ Gyr} (z = 20), M_{\text{BH},0} \sim 10^2 M_{\odot} \rightarrow M_{\text{BH}}(t) \sim 10^7 M_{\odot}$$

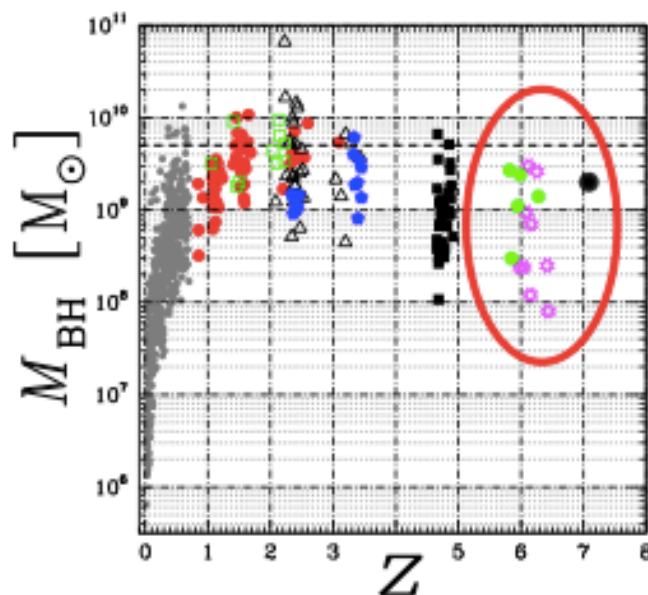
2. Supermassive Population III stars (SMSs)

$$t_0 \sim 0.75 \text{ Gyr} (z = 15), M_{\text{BH},0} \sim \underline{10^5 M_{\odot}} \rightarrow M_{\text{BH}}(t) \sim \underline{10^9 M_{\odot}}$$

But, SMSs have never observed...

⇒ We study the detectability of SMSs

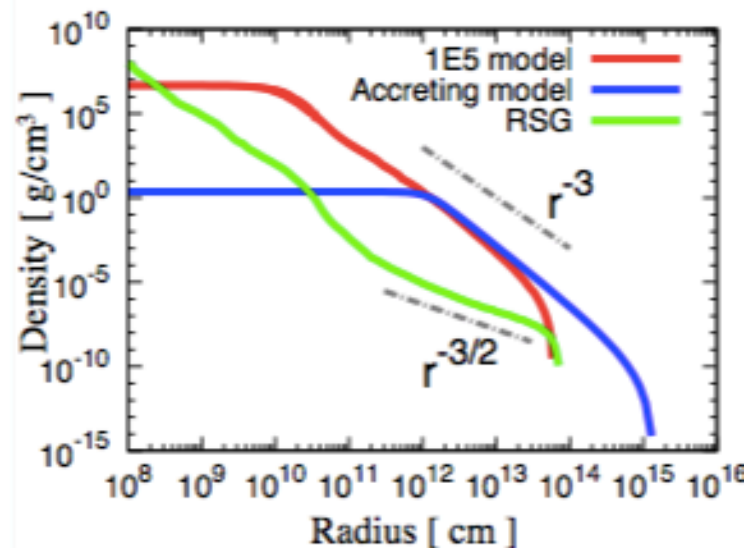
focusing on Gamma-Ray Bursts produced by collapses of SMSs.



Gamma-Ray Bursts from SMSs

- * Jets can break out of large envelopes!
- ⇒ **Ultra-long GRBs**

$$\delta t_{\gamma} \gtrsim 10^5 \text{ s}$$



- * **Ultra-Luminous Supernovae** associate with GRBs!

- * A target of NIR telescopes

$$M_c \simeq 10^3 M_{\odot} t_{d,7}^2 v_{ph,10}^3$$

Estimate of the progenitor mass

Emission from Cocoon Fireballs

