Quenching Star Formation in Low-Mass Galaxies

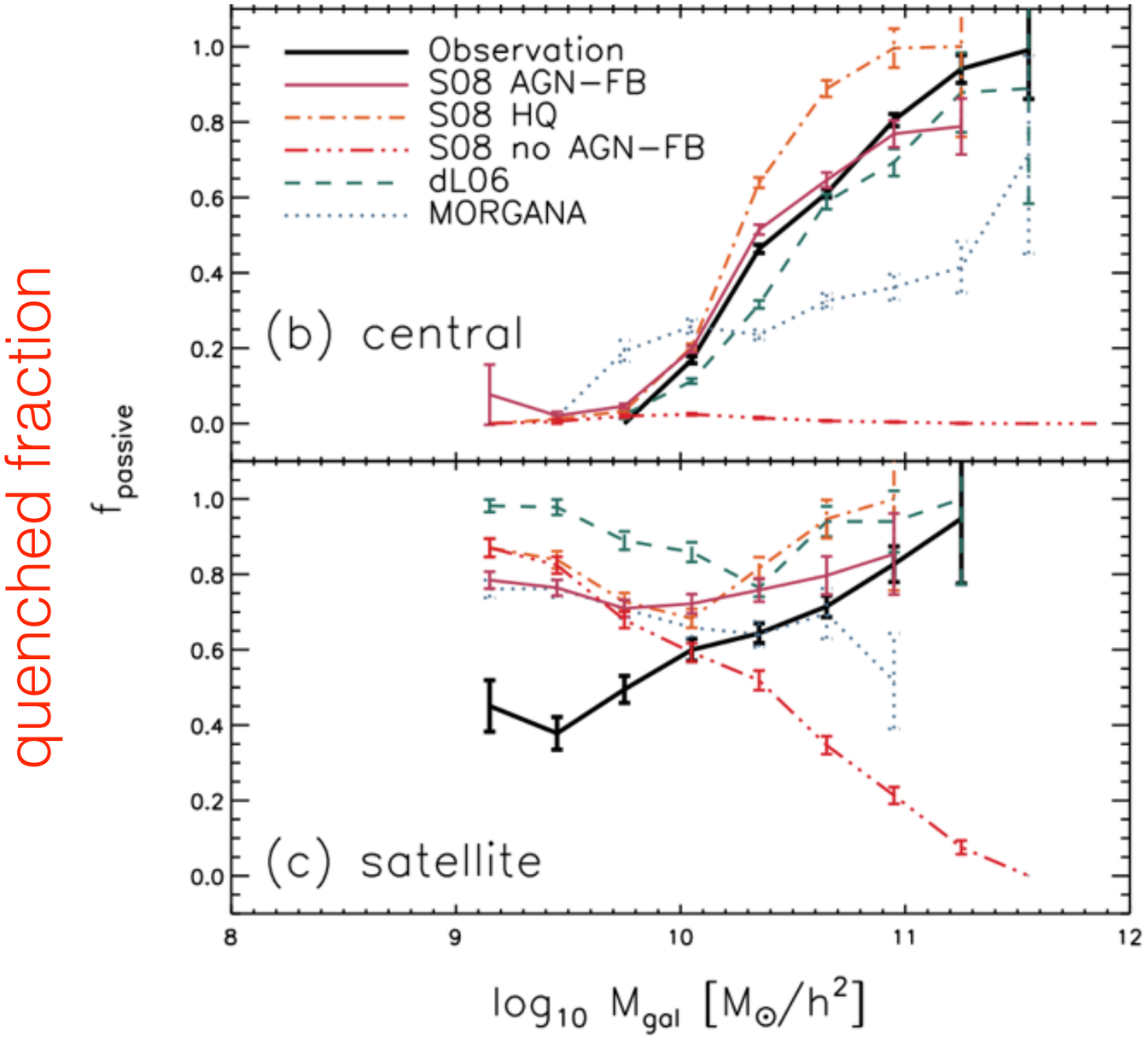
Mike Cooper
UC Irvine

Sean Fillingham (UCI), John Phillips (UCI), Coral Wheeler (UCI),
Shea Garrison-Kimmel (UCI), Mike Boylan-Kolchin (Maryland),
James Bullock (UCI)

Modern Models Fail at Low Masses

- Modern models overpredict the number of quenched low-mass galaxies.

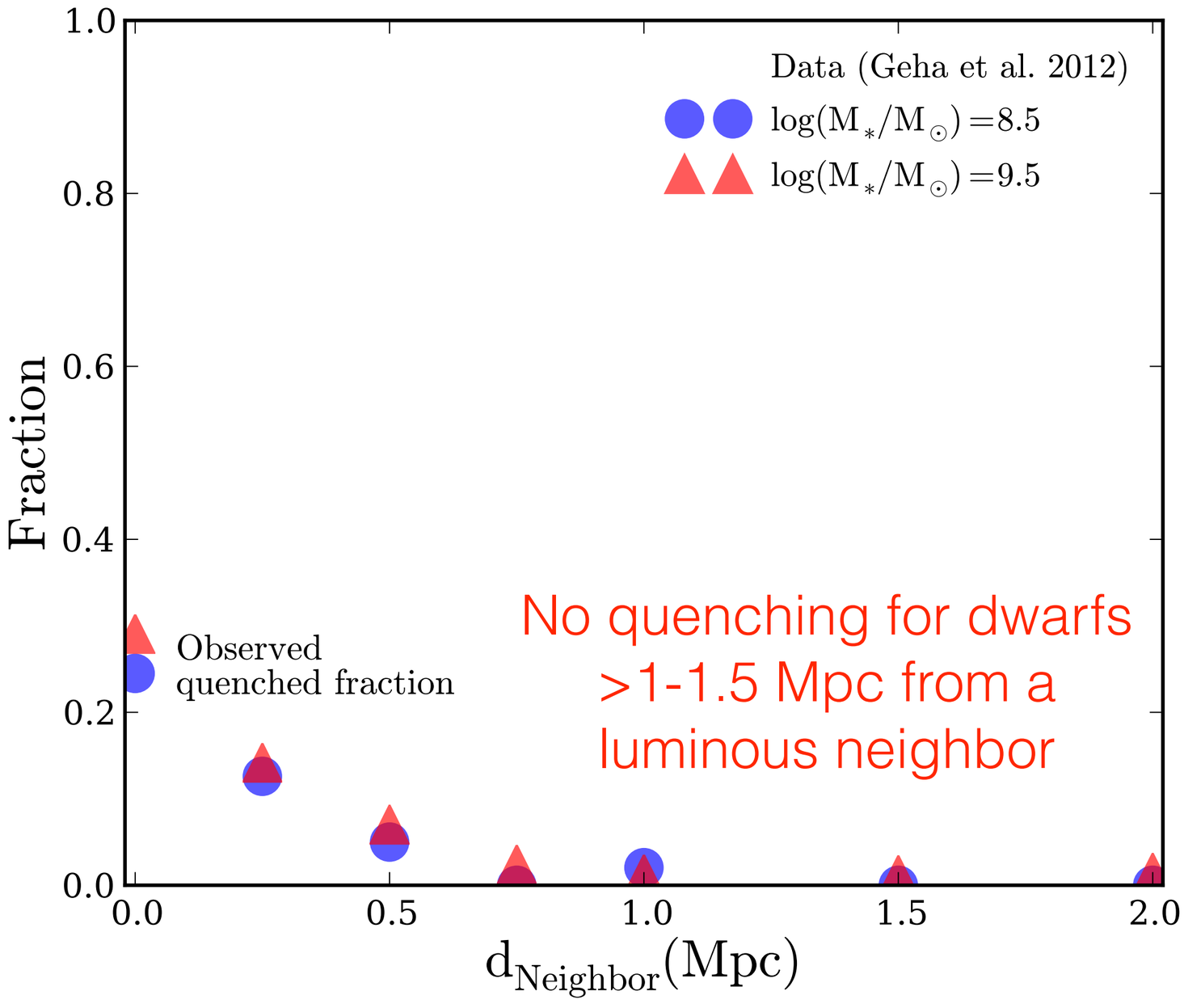
➡ This is driven by a failure to understand satellite quenching.



Kimm et al. (2009)
Weinmann et al. (2012)
Hirschmann et al. (2014)

No Quenching in the Field

quenched fraction



No quenching for dwarfs >1-1.5 Mpc from a luminous neighbor

distance from luminous neighbor

From NSA/2MASS: ~10k dwarfs around luminous neighbors with $M_\star > 10^{10.4}\ M_\odot$

i.e. at low masses, all quenching is driven by environment.

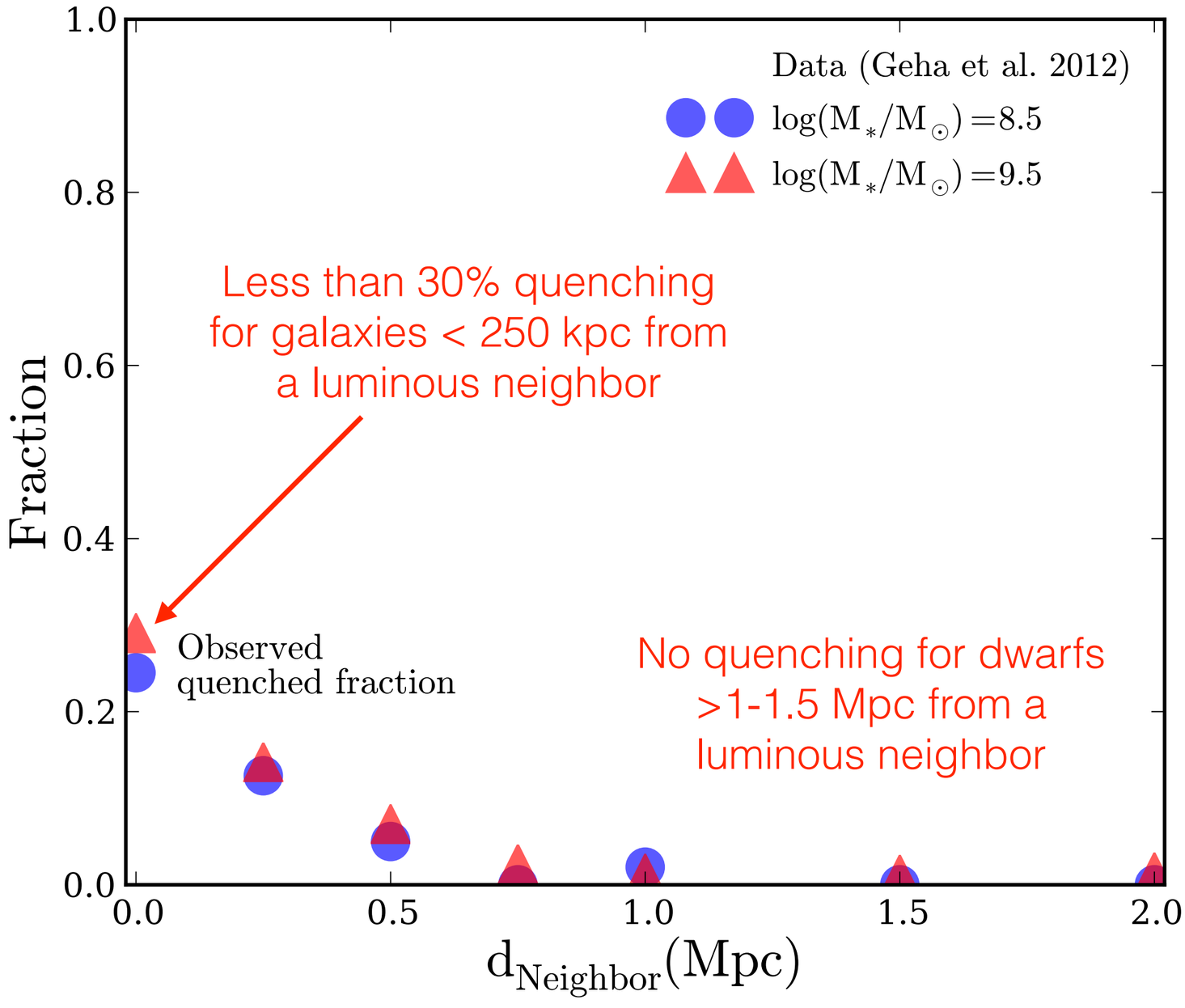
Ignoring the questions posted to the left…

⇒ What drives quenching in low-mass ~~galaxies~~ satellites?

- ✦ What physical properties of the host are best correlated with satellite quenching [i.e. in what situations does quenching occur]? (results suggest that efficiency of satellite quenching is correlated with halo mass, which may suggest that quenching occurs preferentially in the presence of a hot halo — e.g. Phillips et al. 2014a,b)

- ✦ What physical processes drive satellite quenching?
  What is the timescale for quenching?

The Inefficiency of Satellite Quenching



From NSA/2MASS:
~10k dwarfs around
luminous neighbors
with $M_\star > 10^{10.4}\ M_\odot$

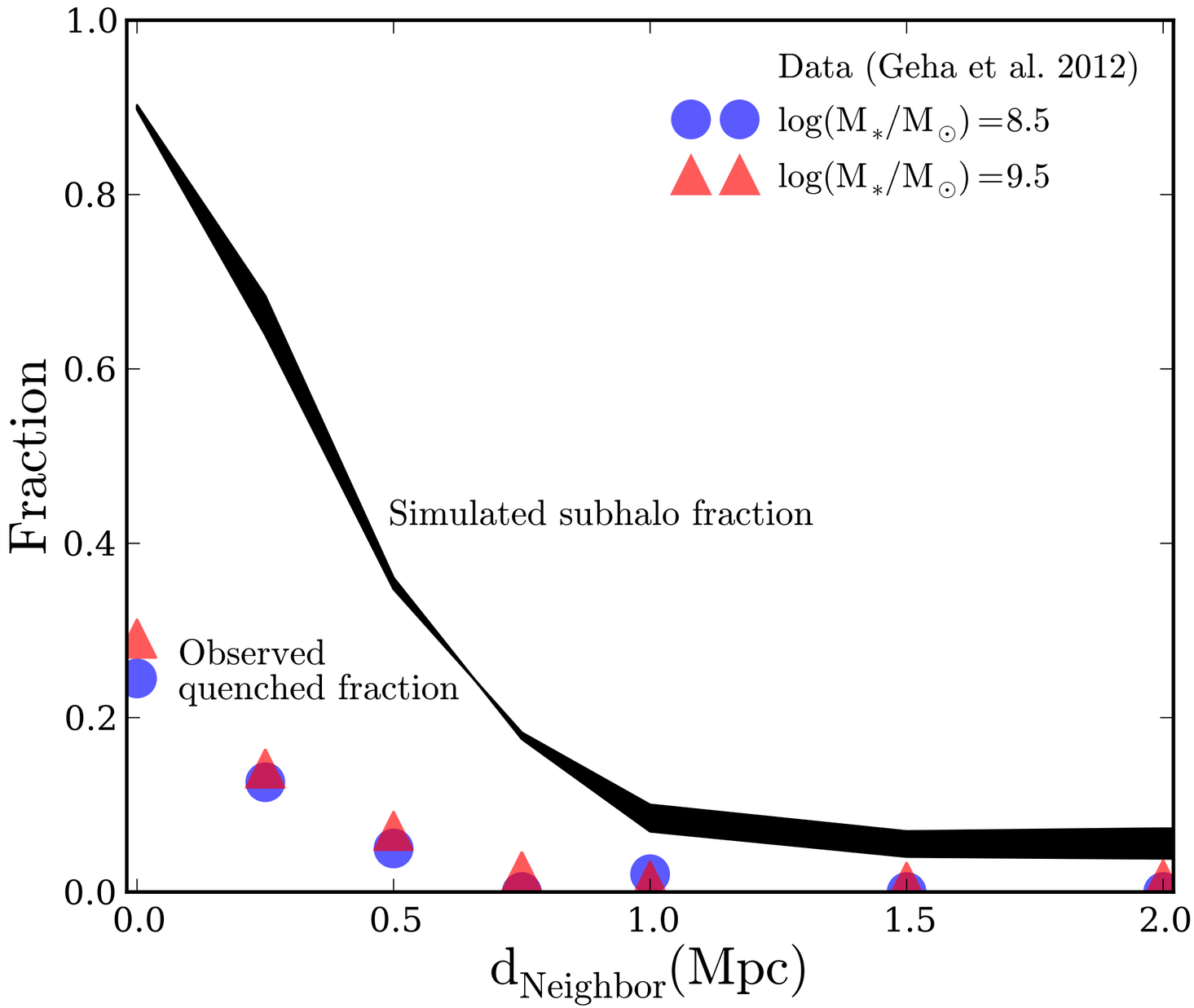
Wheeler et al. (2014)

Use Millennium II and ELVIS Simulations to test simple quenching models through comparison to observations at $z \sim 0$.

York et al. (2000)

Boylan-Kolchin et al. (2012)

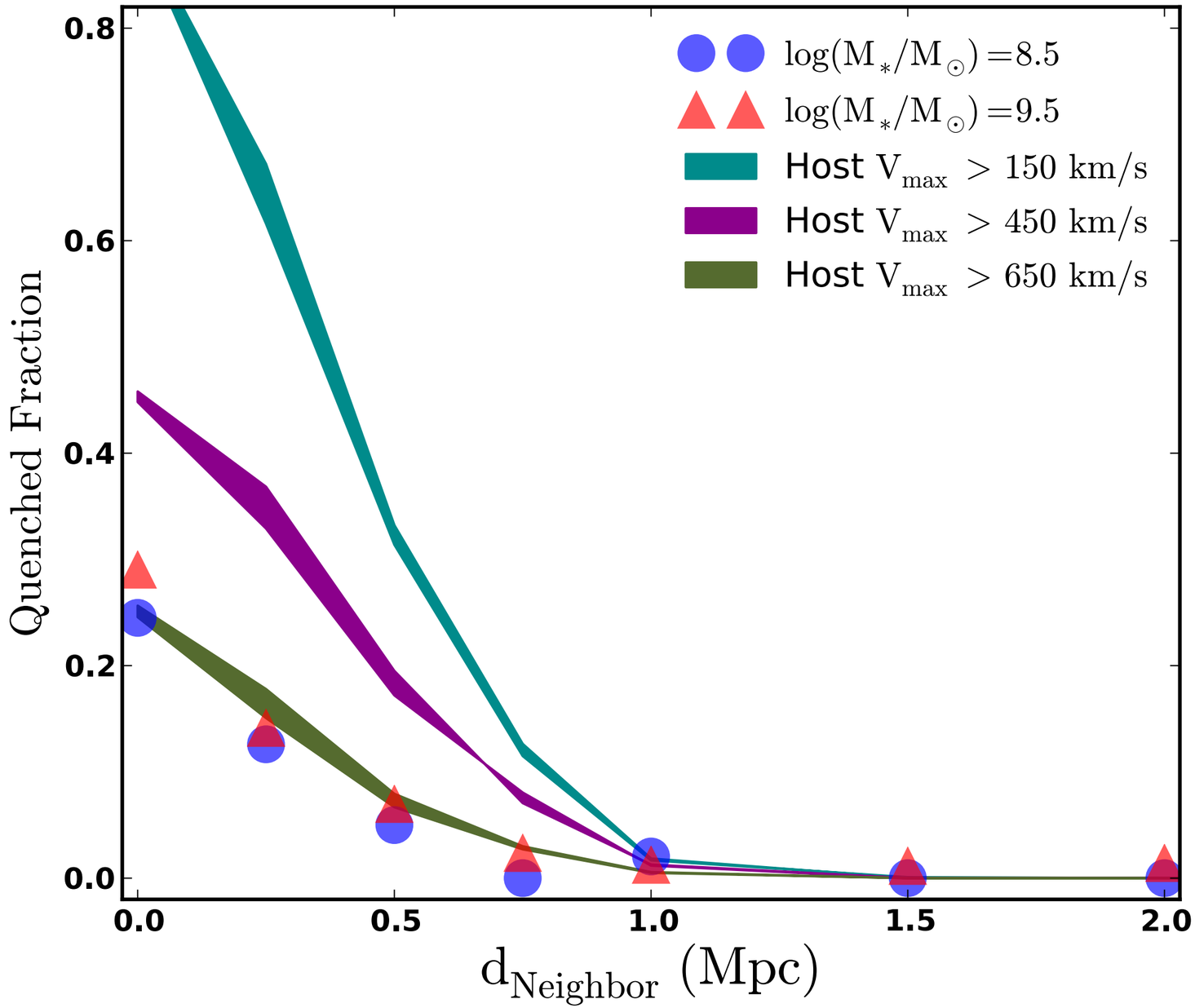
The Inefficiency of Satellite Quenching



Quenching efficiency is far less than 100% for dwarf satellites.

Wheeler et al. (2014)

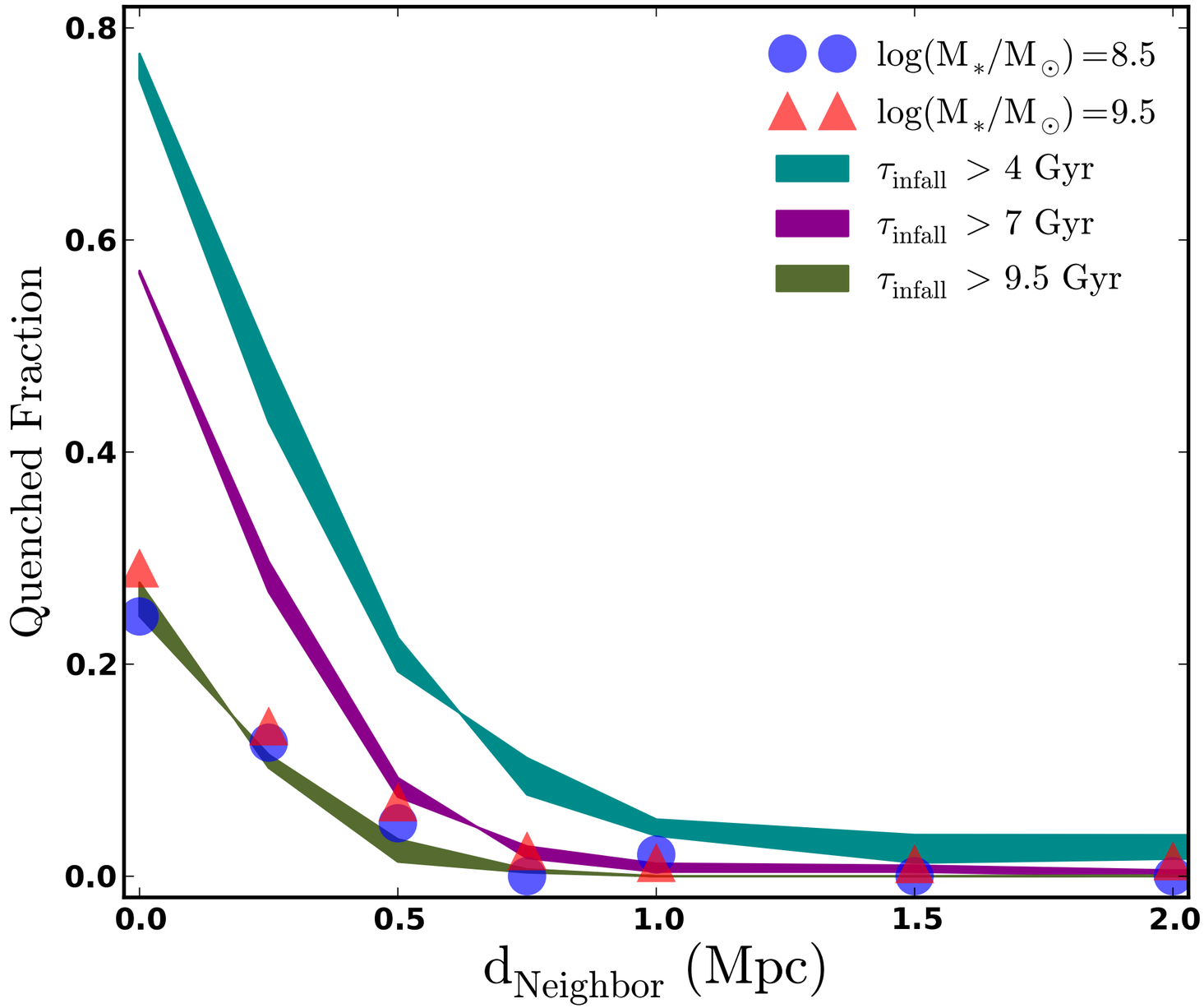
A Critical Halo Mass Model for Quenching



To match observations, we must limit quenching to clusters in this model.

Wheeler et al. (2014)

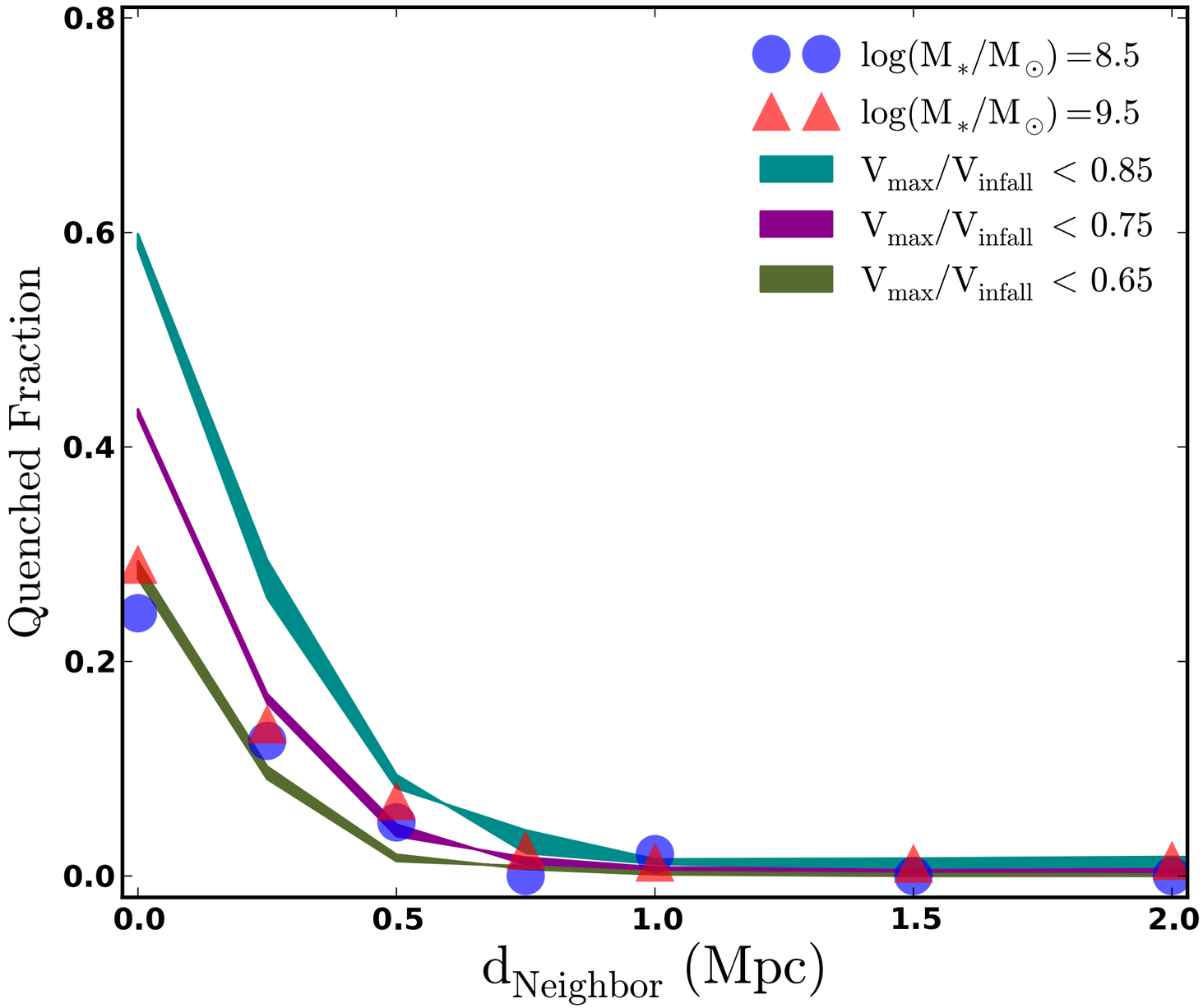
A Critical Timescale for Quenching



To match observations, quenching must take ~70% of t_H at these masses.

Wheeler et al. (2014)

What about tidal stripping?



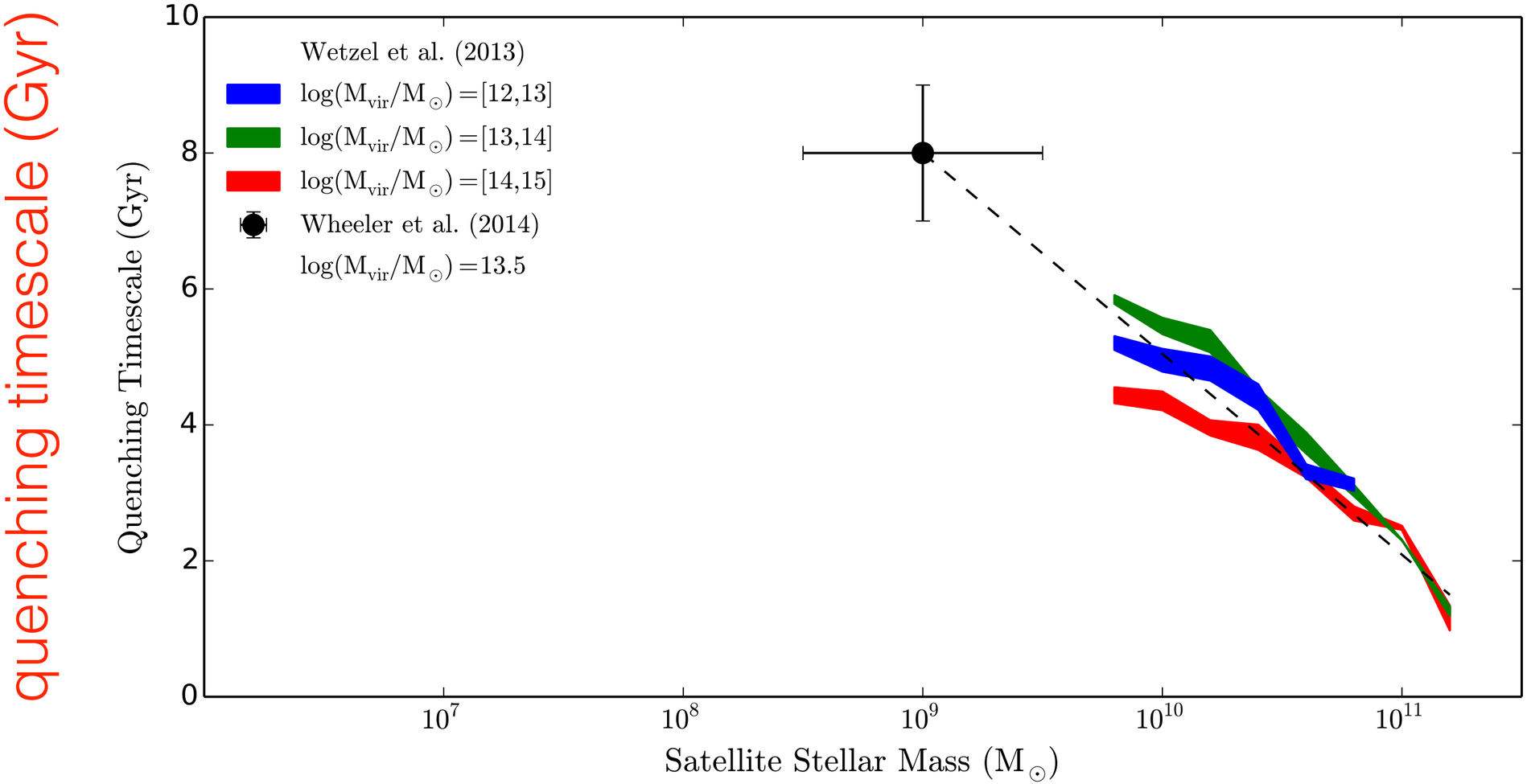
To match observations, quenched systems must lose ~70% of their mass.

Systems significantly stripped have typically spent 8-9 Gyr in the host halo.

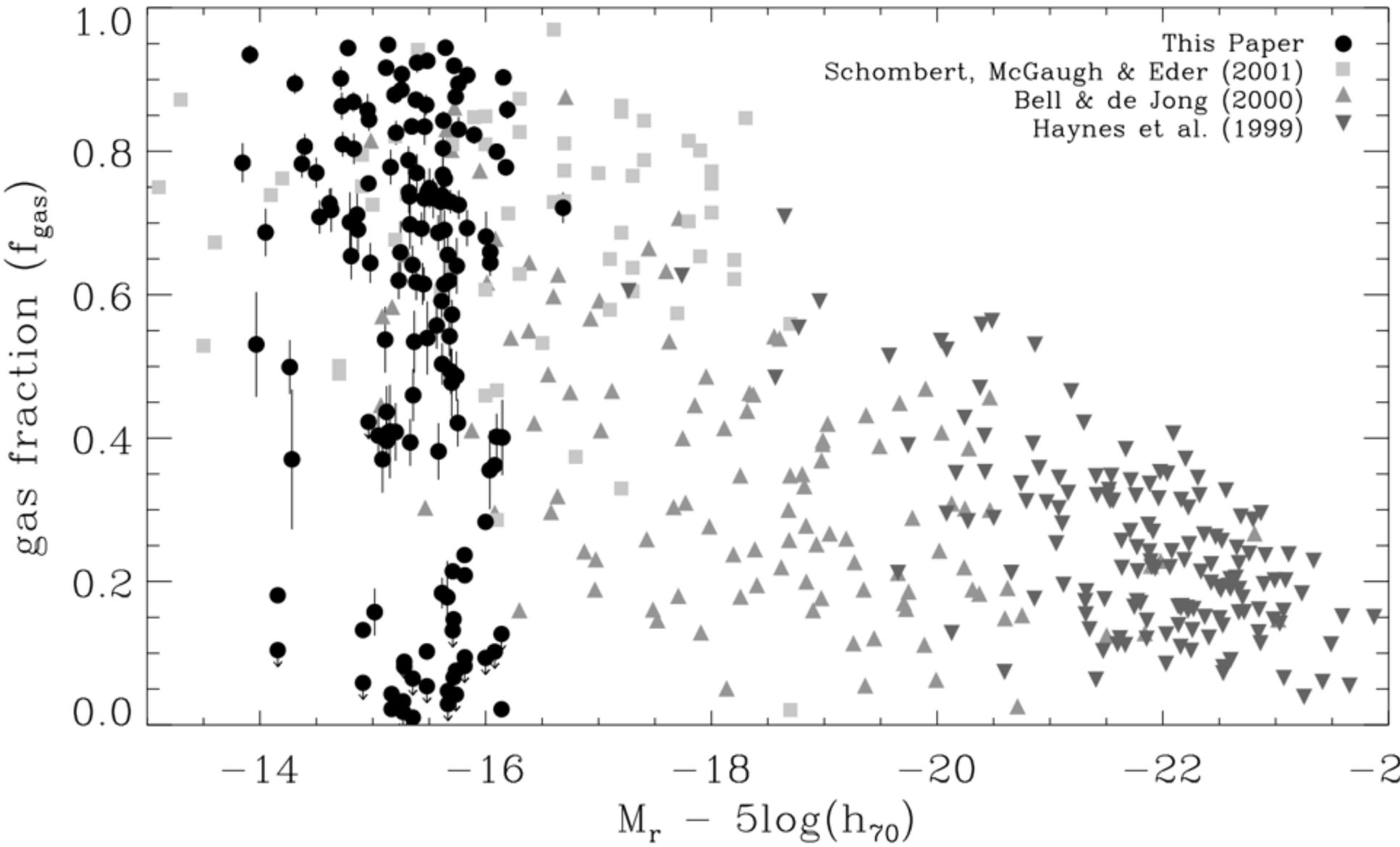
Wheeler et al. (2014)

The timescale for satellite quenching

Observations suggest that massive satellites quench via strangulation (i.e. having their supply of cold gas cut-off).



Does the fuel for prolonged star formation exist in low-mass systems?



Geha et al. (2006)
Leroy et al. (2010)
Saintogne et al. (2011)
Boselli et al. (2014)
Bothwell et al. (in prep)

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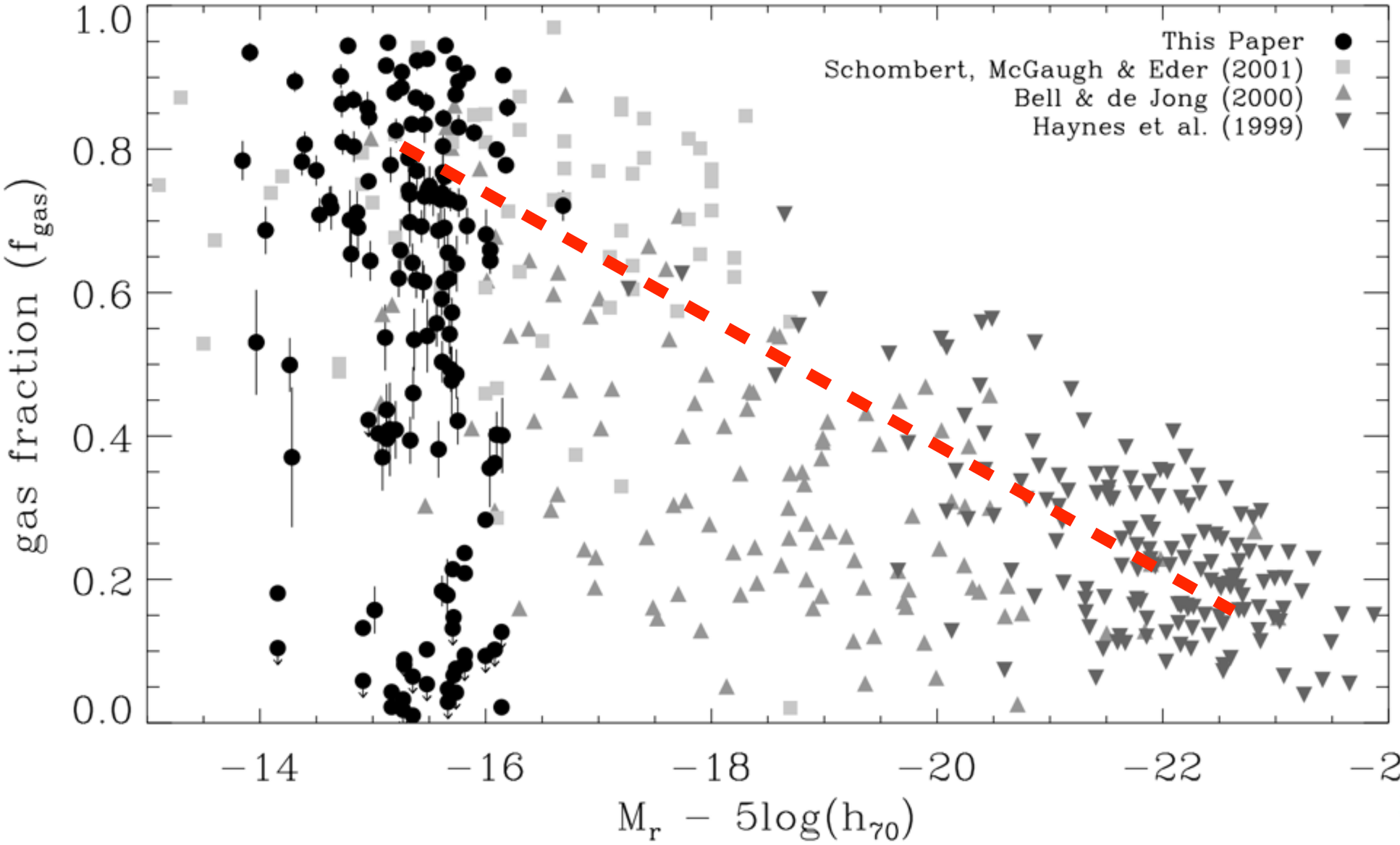

Geha et al. (2006)
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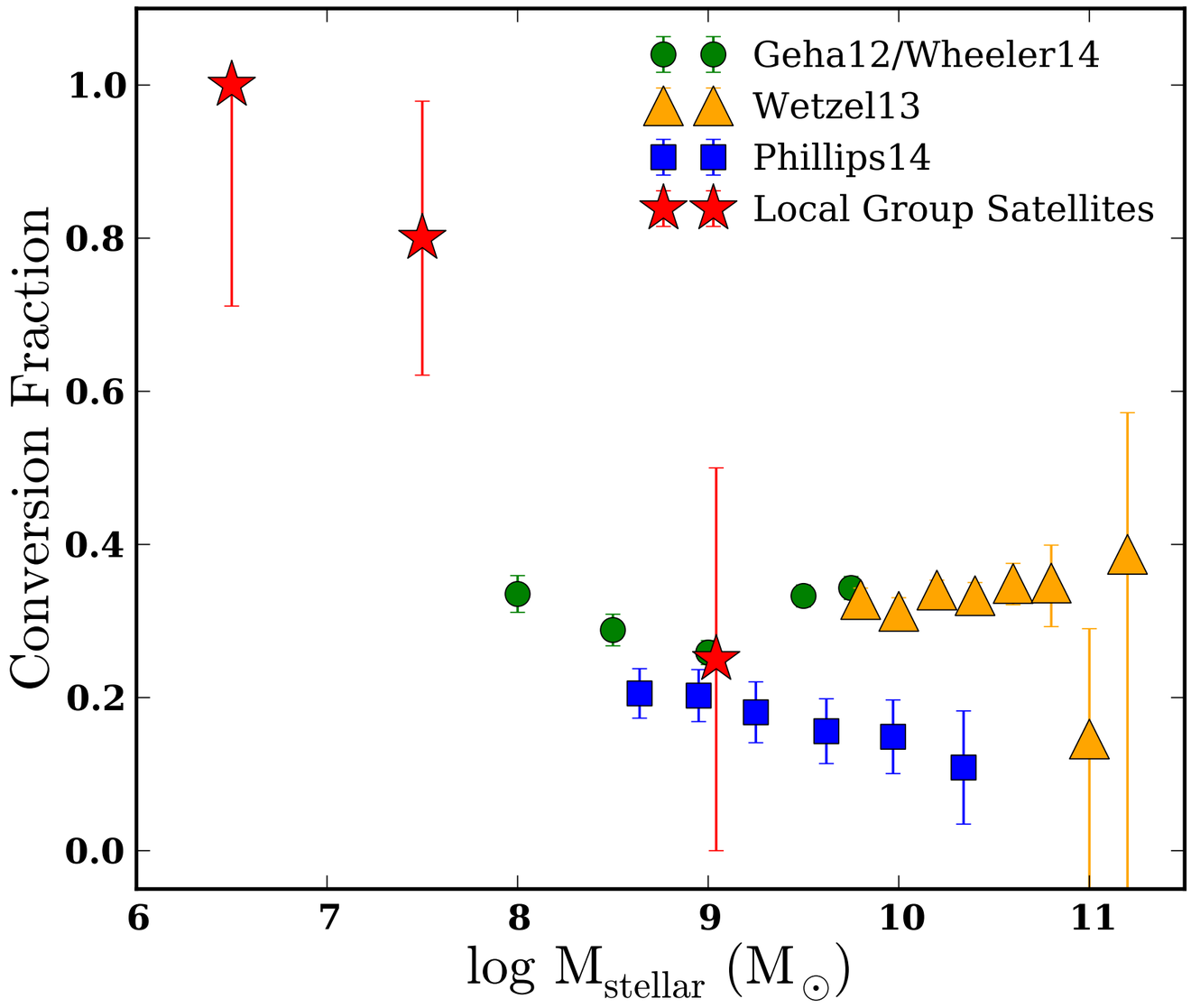
A critical scale for satellite quenching?

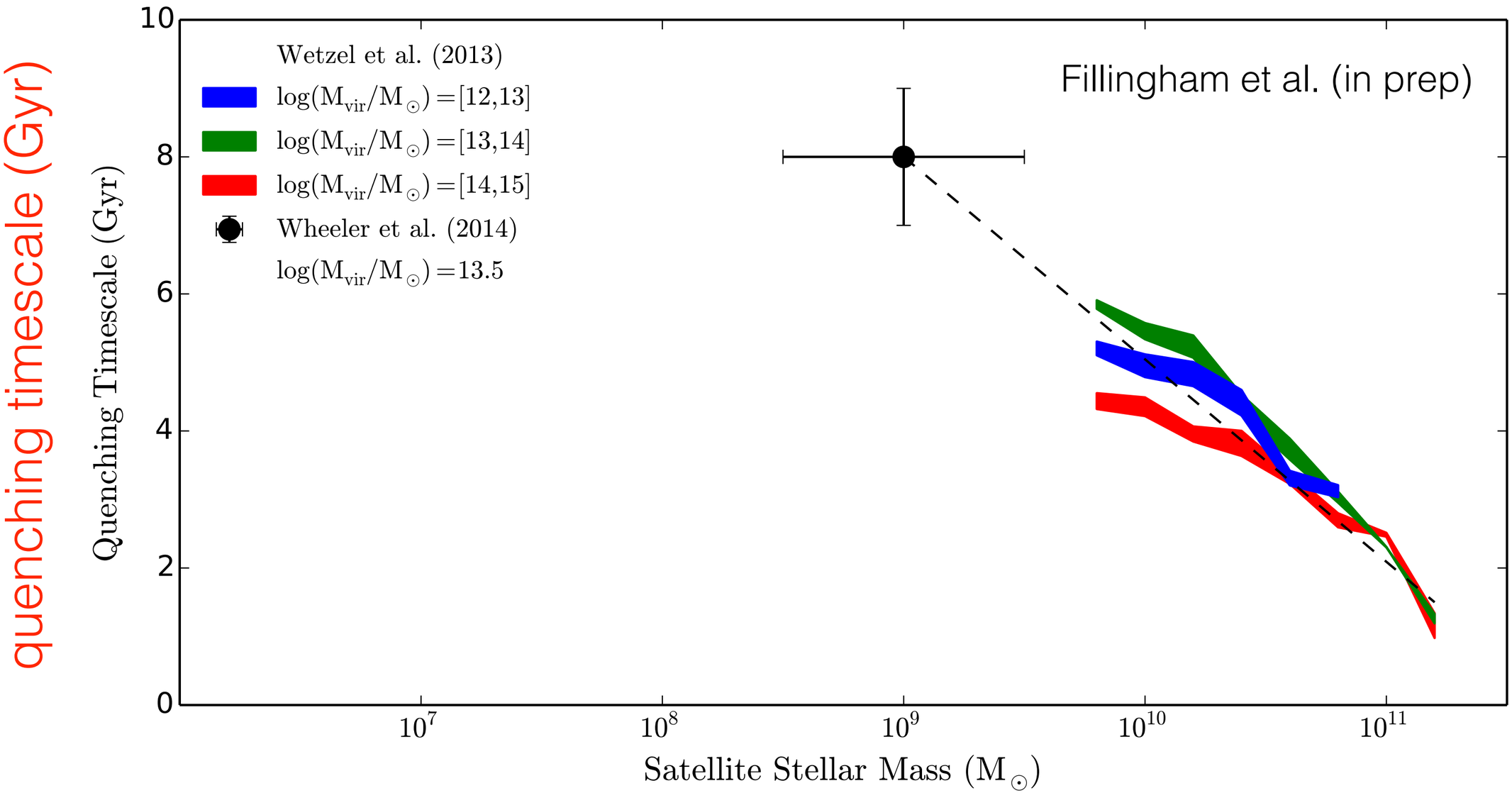
environmentally quenched fraction



Possibly a critical scale for satellite quenching at ~10^8 $M_\odot$

Wheeler et al. (2014)
see also Phillips et al. (2014b)

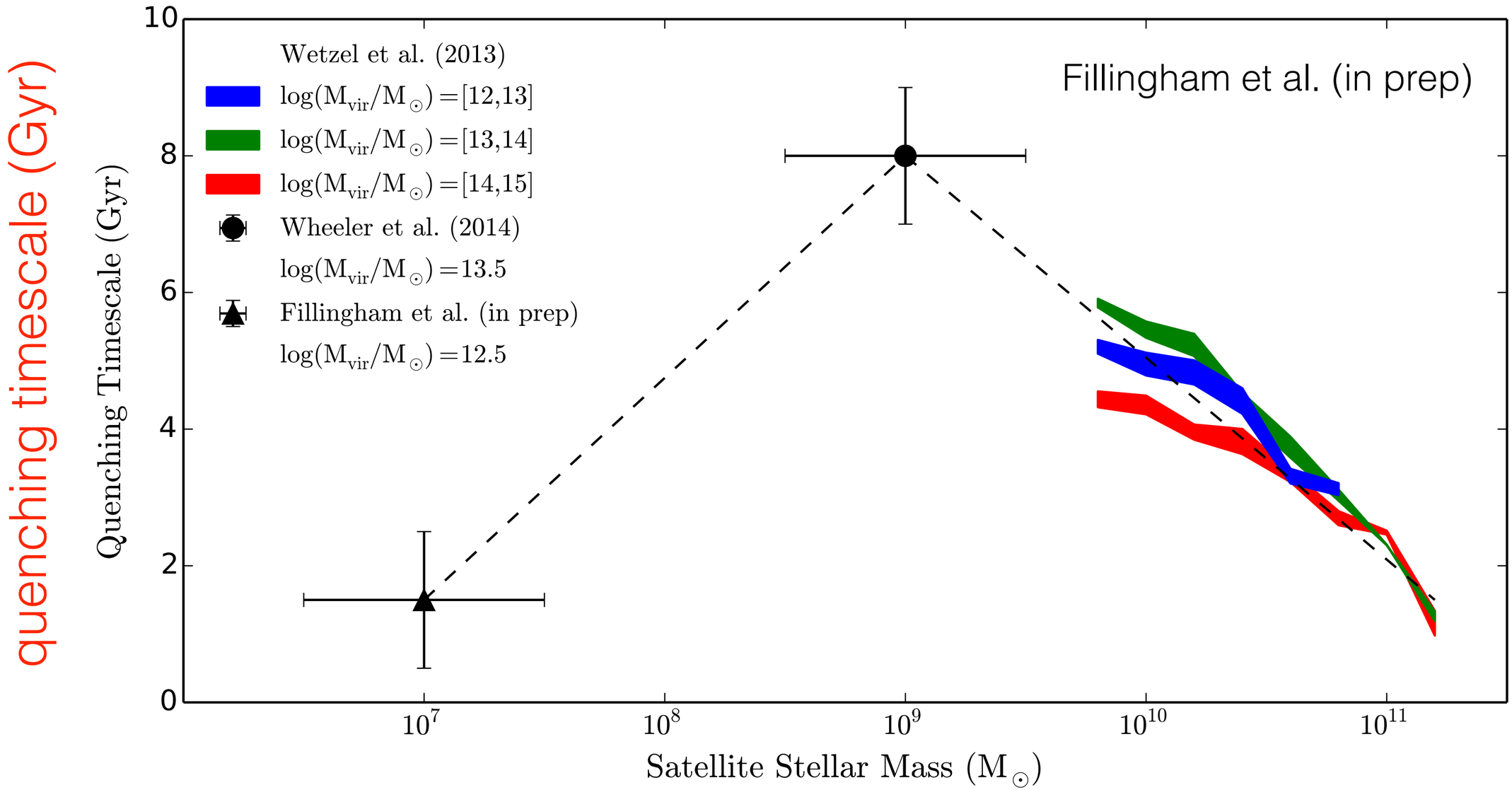
The timescale for satellite quenching



quenching timescale (Gyr)

satellite stellar mass

The timescale for satellite quenching



quenching timescale (Gyr)

satellite stellar mass