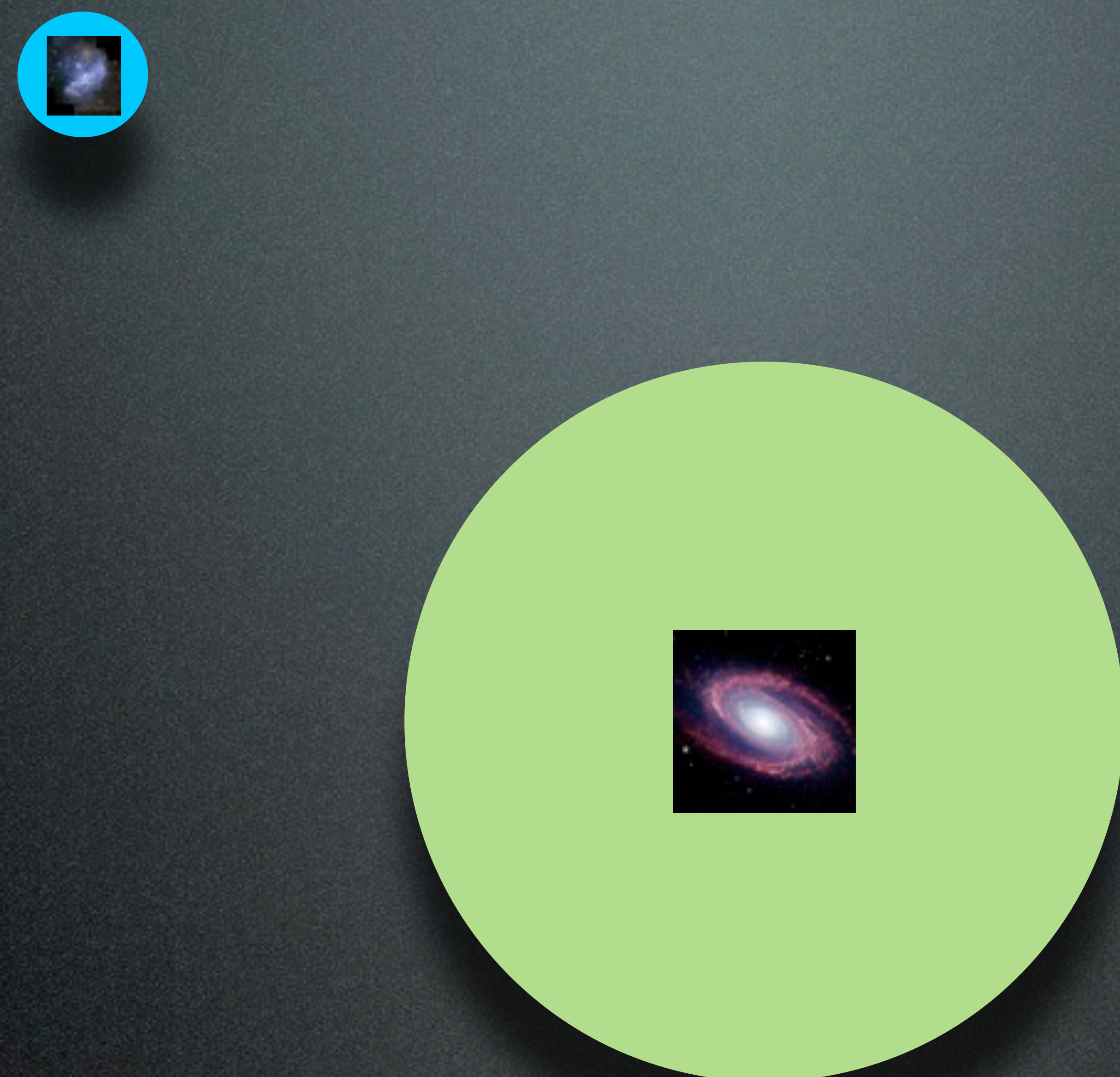
2013 Santa Cruz Galaxy Workshop
August 12-16, 2013

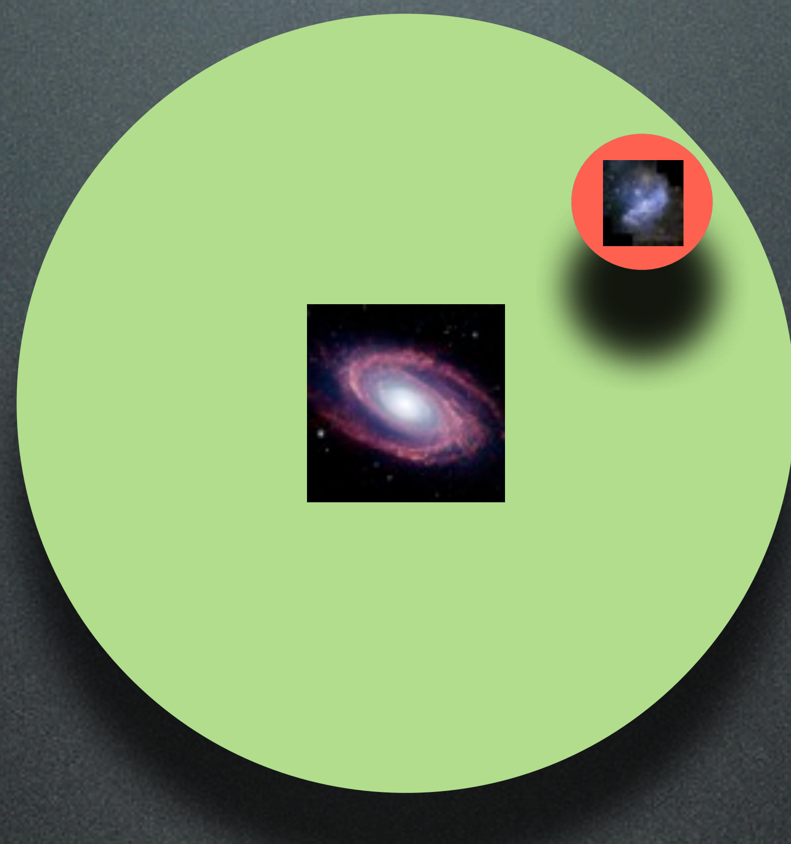
To quench or not to quench: an investigation of star formation in satellite galaxies

Coral Wheeler
UC Irvine

Collaborators:
John Phillips (UCI)
Mike Boylan-Kolchin (Maryland)
Mike Cooper (UCI)
James Bullock (UCI)
Erik Tollerud (Yale)

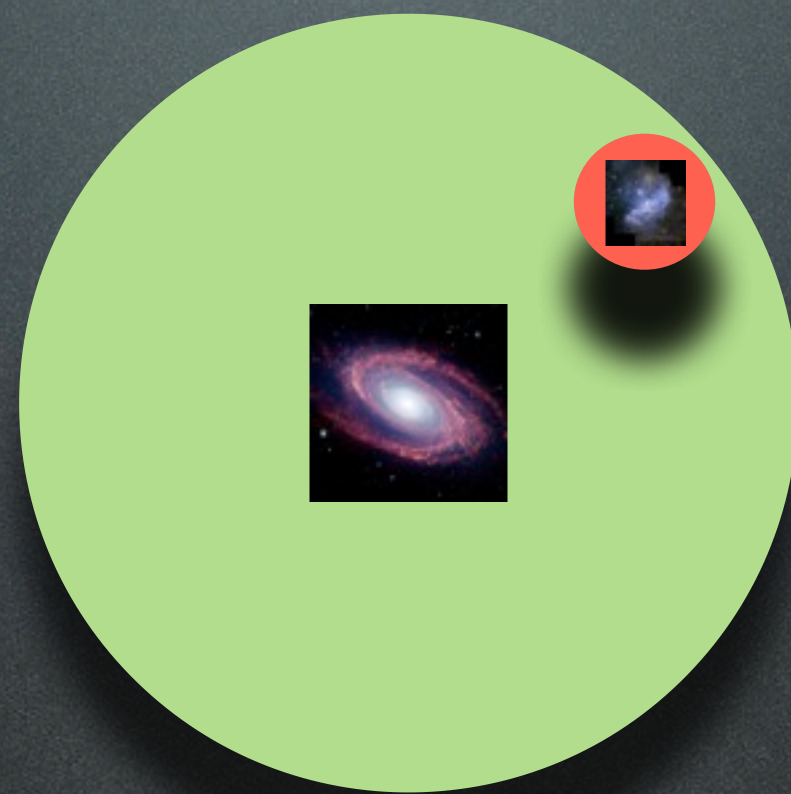
Southern California CGE Center for Galaxy Evolution





How fast?

How efficient?

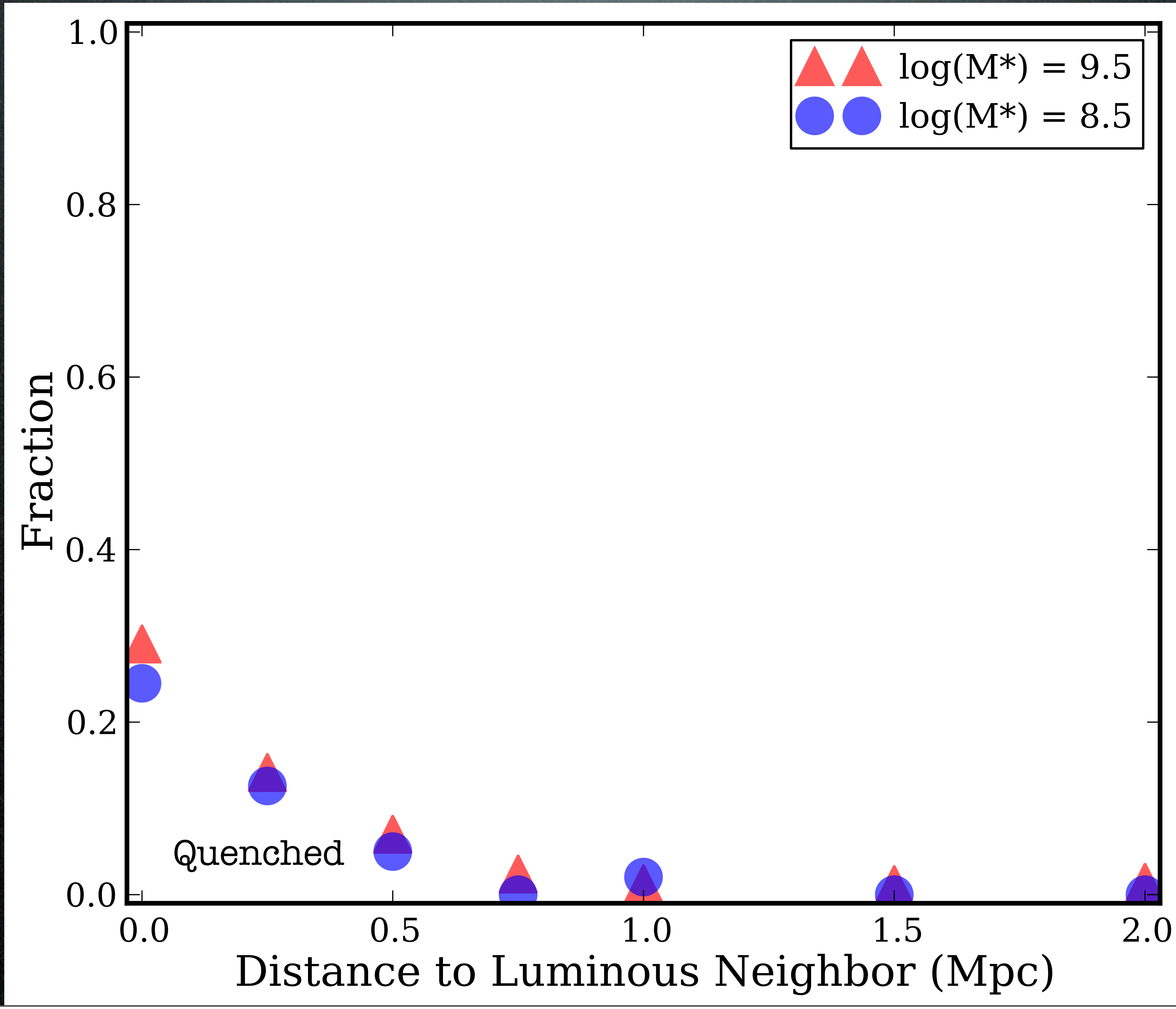


What situations?

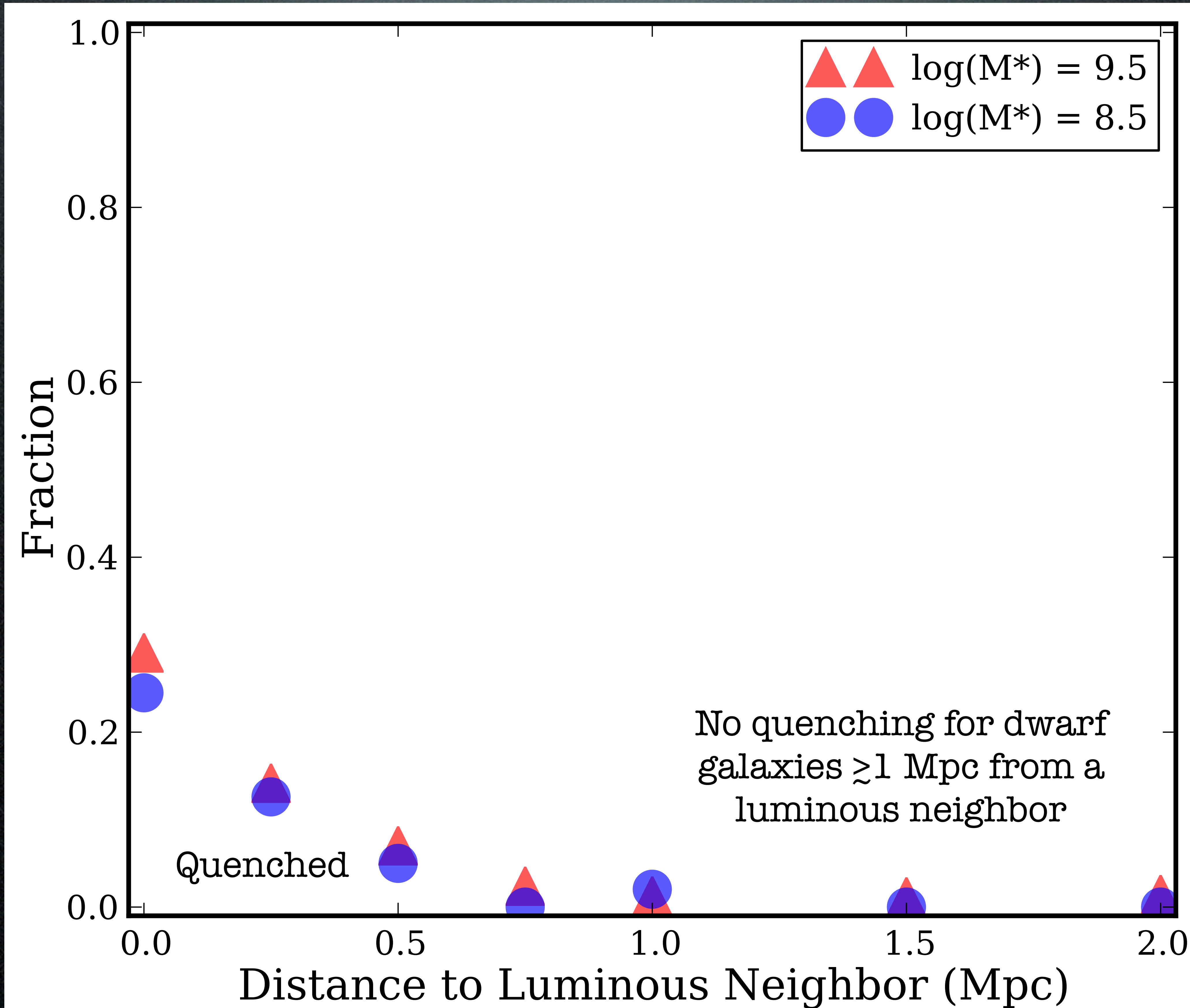
Observational Sample

- Sample comes from Geha et al. 2012
- 'Dwarfs': 9,399 galaxies with stellar mass 10^8 - 10^{10} $M_\odot$ from the NASA Sloan Atlas (NSA)
- 'Luminous Neighbors': stellar mass > 10.4 $M_\odot$ from the 2MASS Extended Source Catalog
- We look specifically at dwarfs in two stellar mass ranges that span the sample: $10^{8.5}$ $M_\odot$ and $10^{9.5}$ $M_\odot$

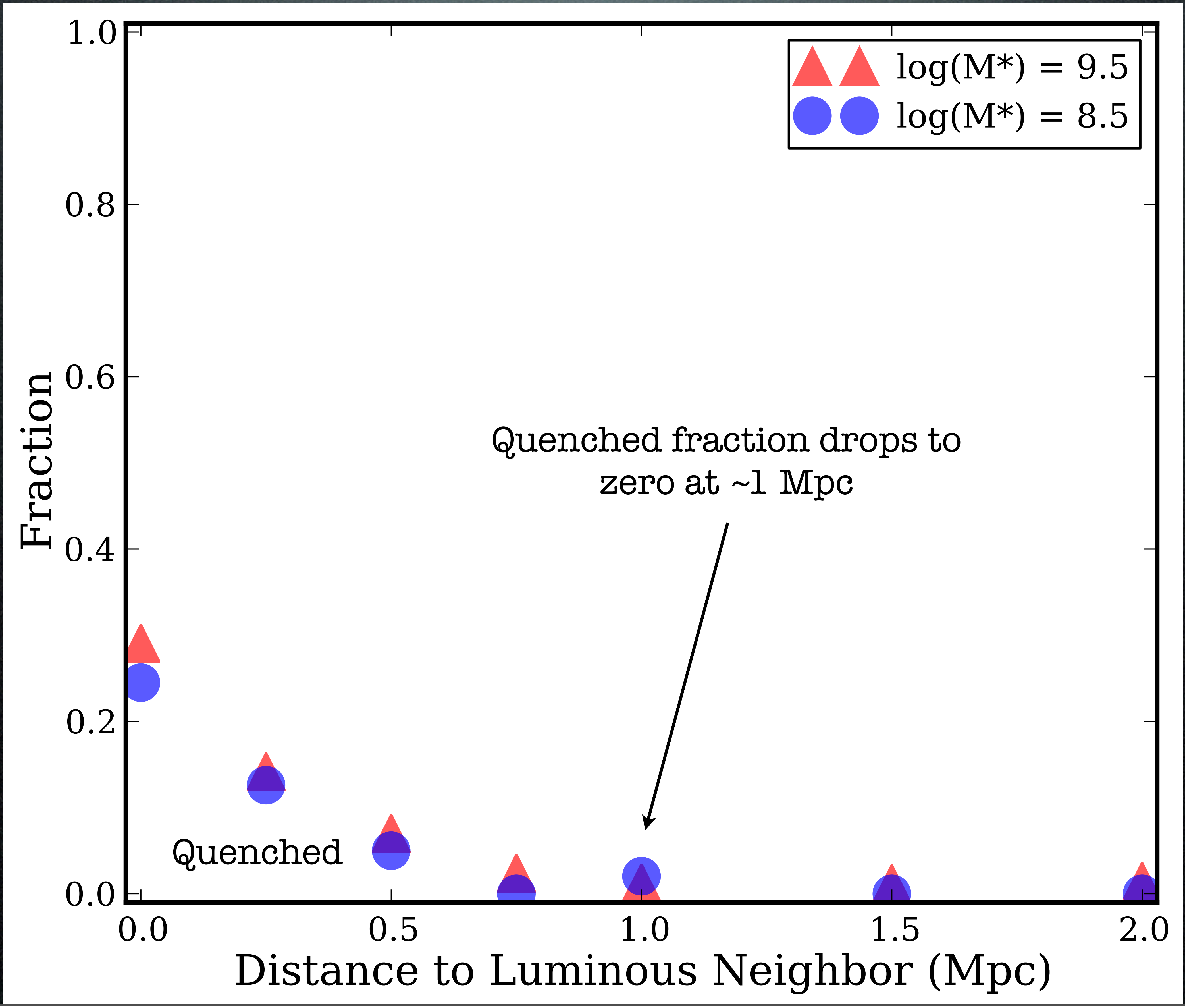
Observational Data



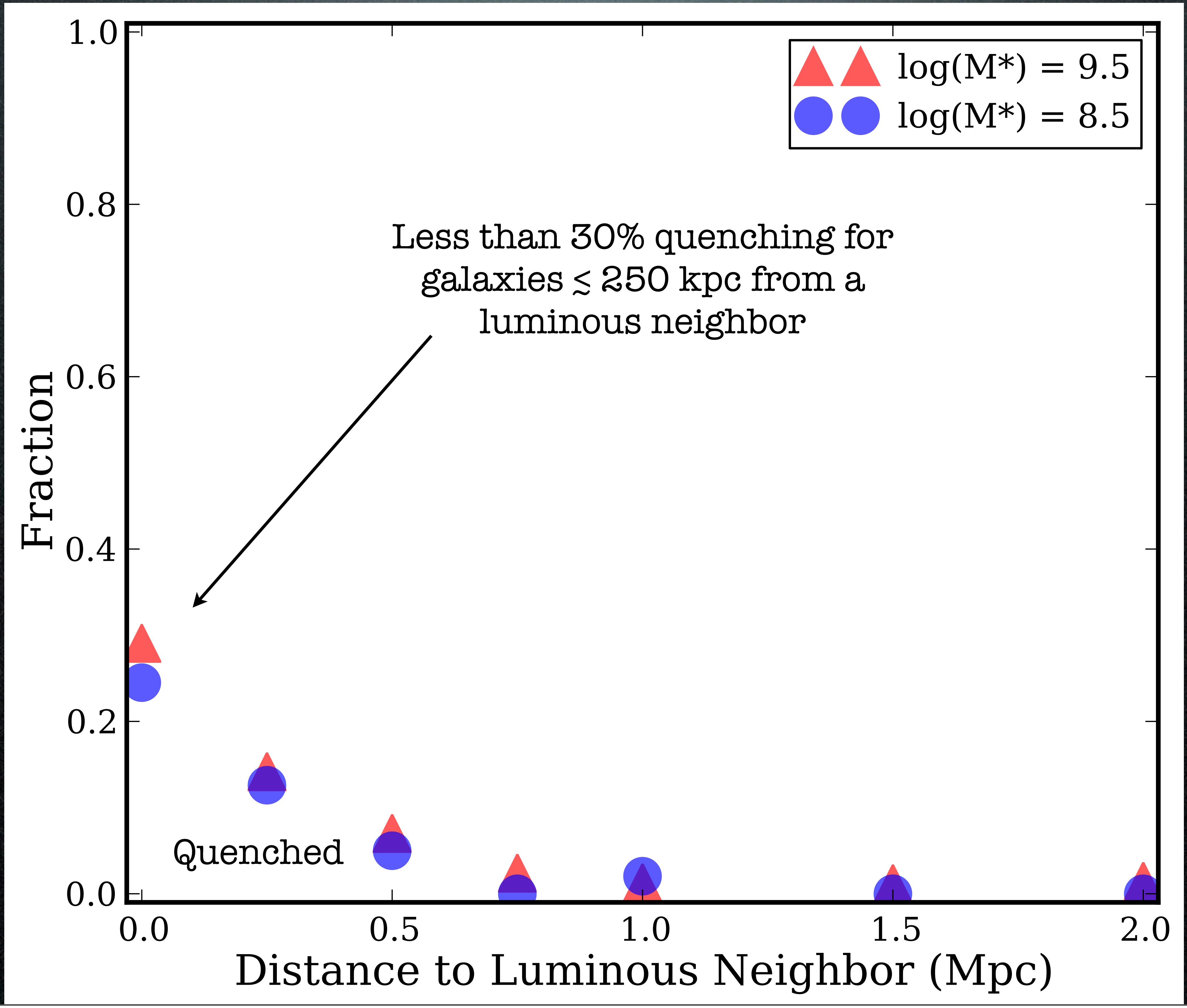
Observational Data



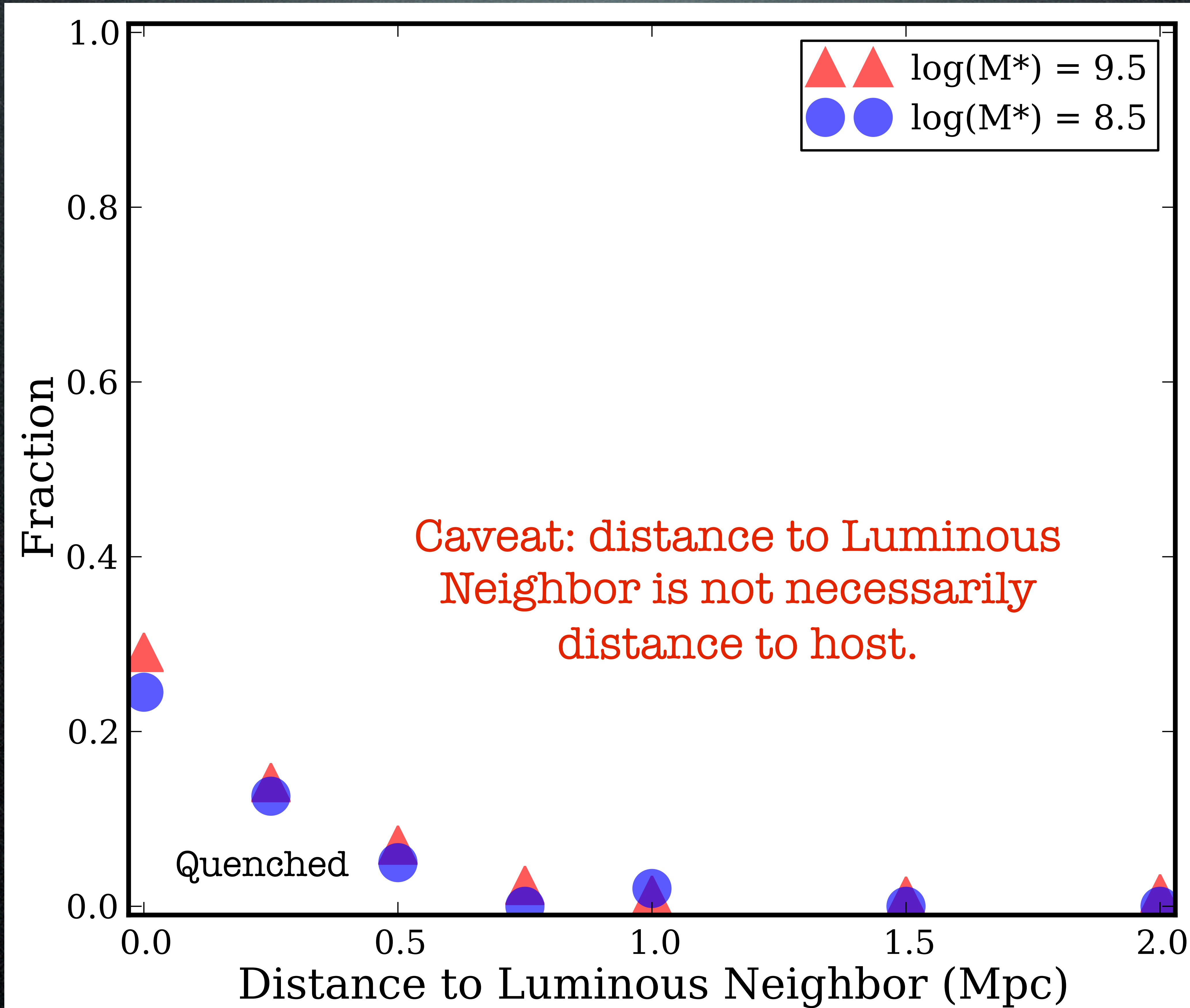
Observational Data



Observational Data

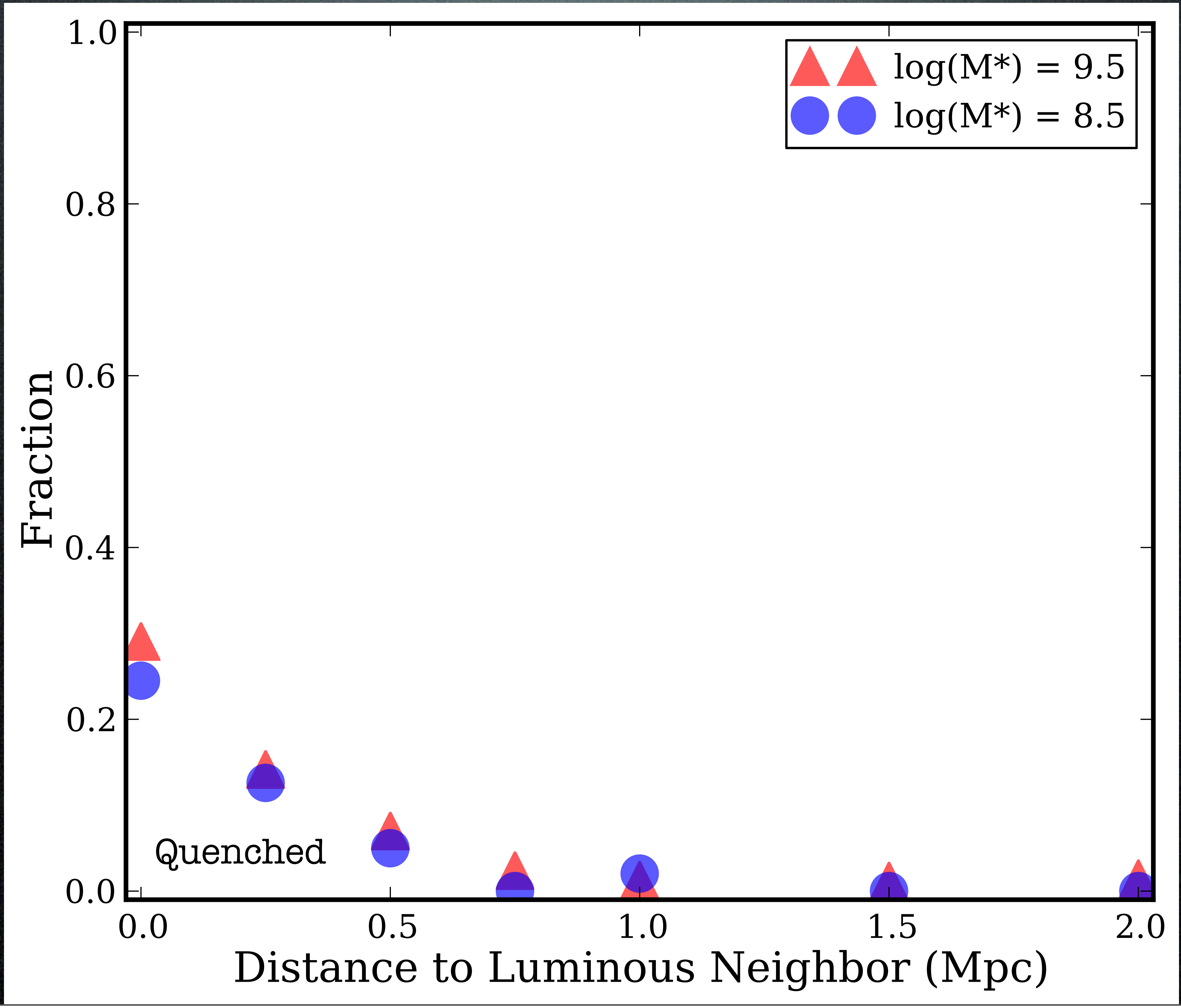


Observational Data

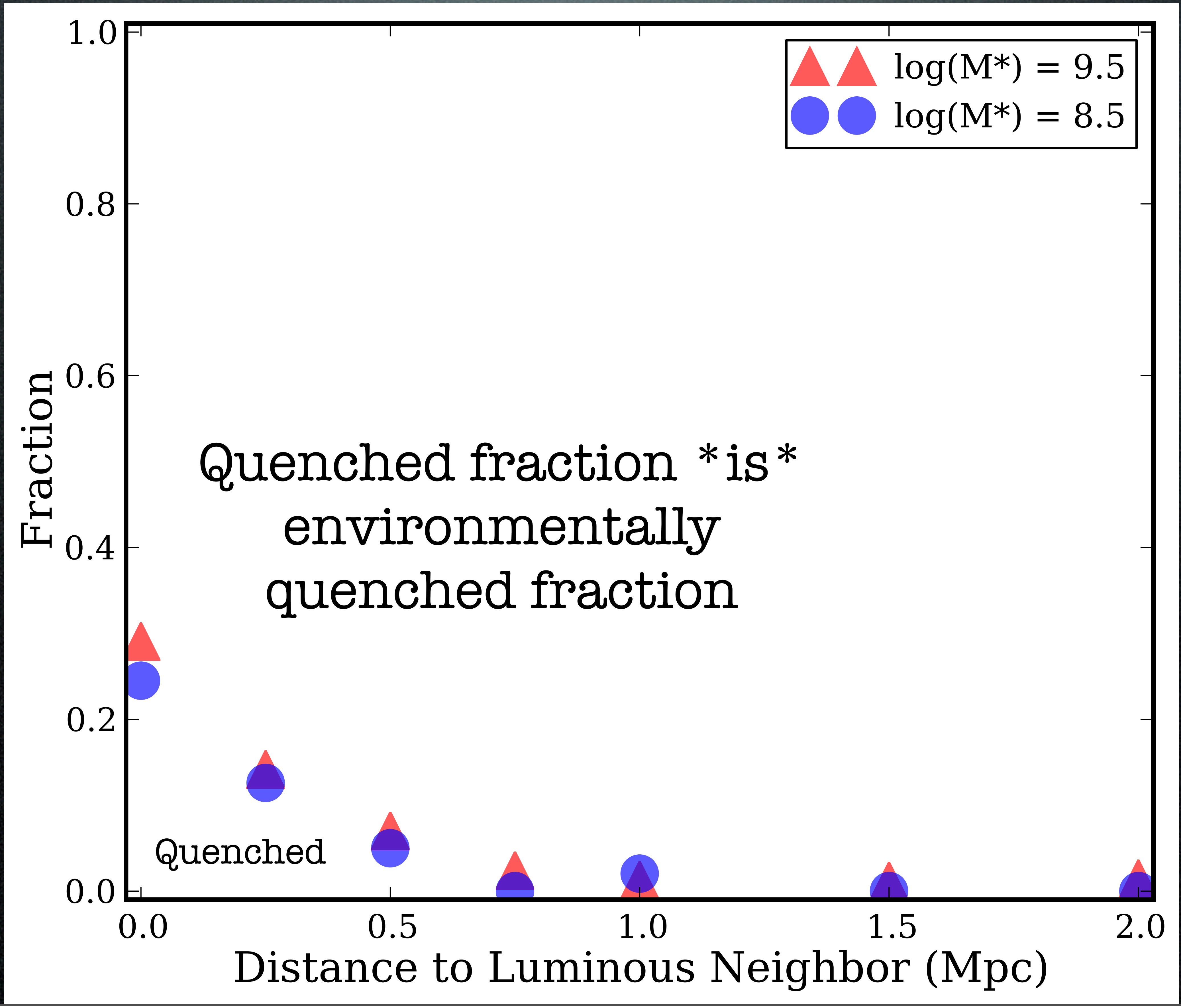


Simulated Sample

- Sample comes from Millennium II simulation (Boylan-Kolchin et al. 2009)
- Selected to match the observational sample via abundance matching
- Dwarfs: ~ 33,400 subhalos with 80 km/s V_{max} < 110 km/s
- 'Luminous' neighbors: V_{max} > 150 km/s
- 'Observe' simulation exactly like observation. Track the projected distance to closest 'luminous' neighbor with $|\Delta v|$ < 1000 km/s

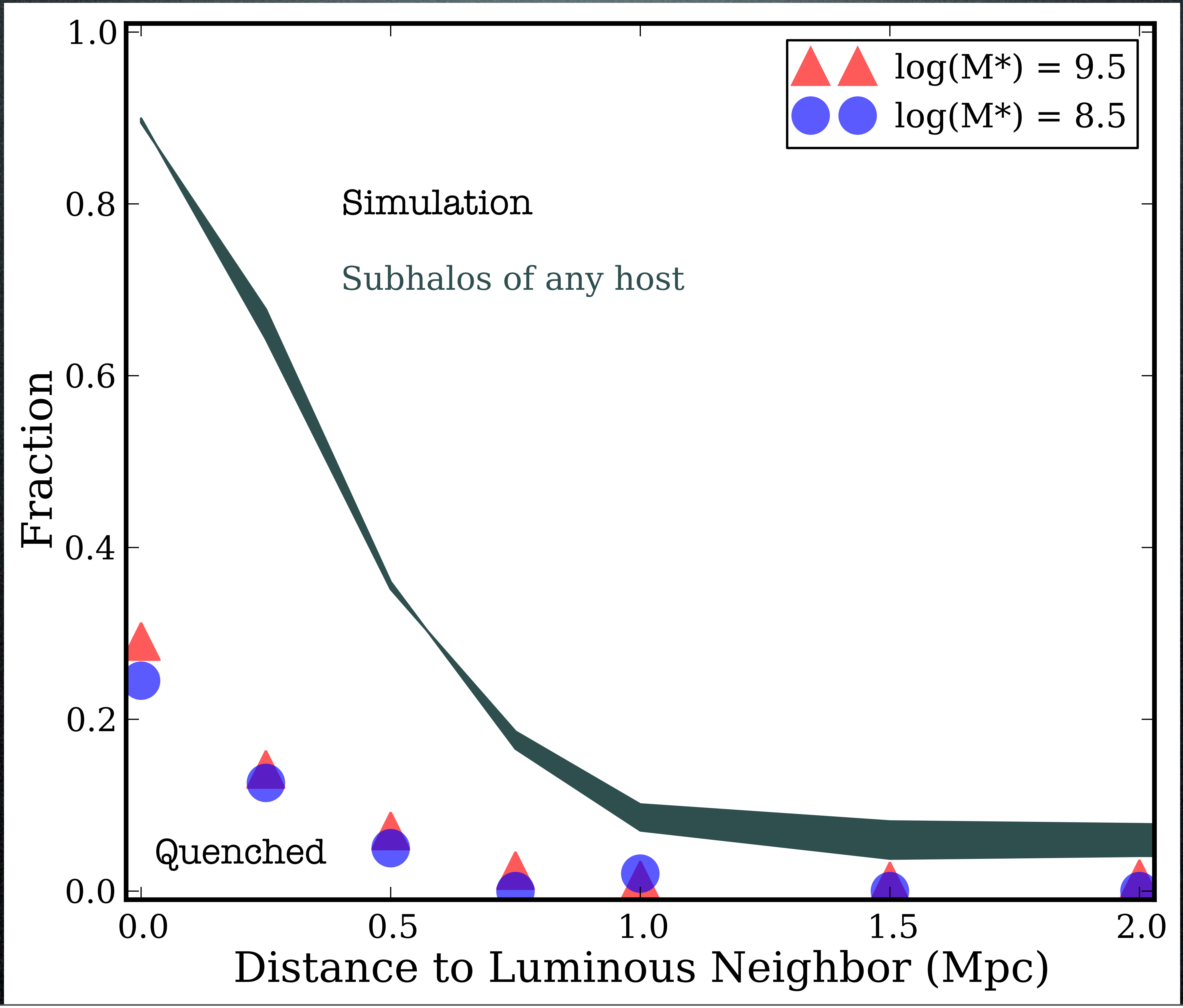


1.0
0.8
0.6
0.4
0.2
0.0
Fraction
log(M*) = 9.5
log(M*) = 8.5
Quenched
0.0
0.5
1.0
1.5
2.0
Distance to Luminous Neighbor (Mpc)

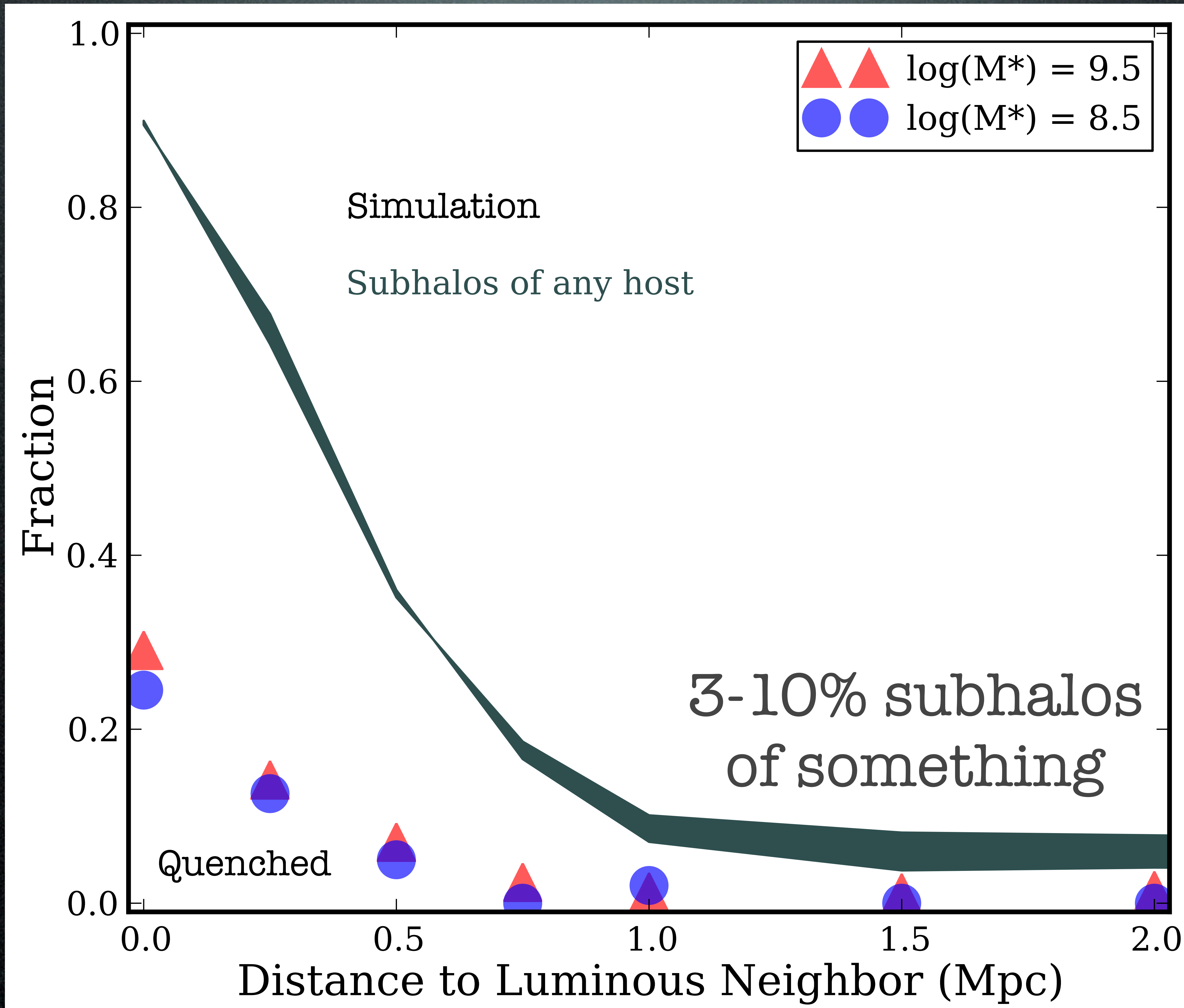


log(M*) = 9.5
log(M*) = 8.5
Fraction
Quenched fraction *is*
environmentally
quenched fraction
Quenched
Distance to Luminous Neighbor (Mpc)
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0

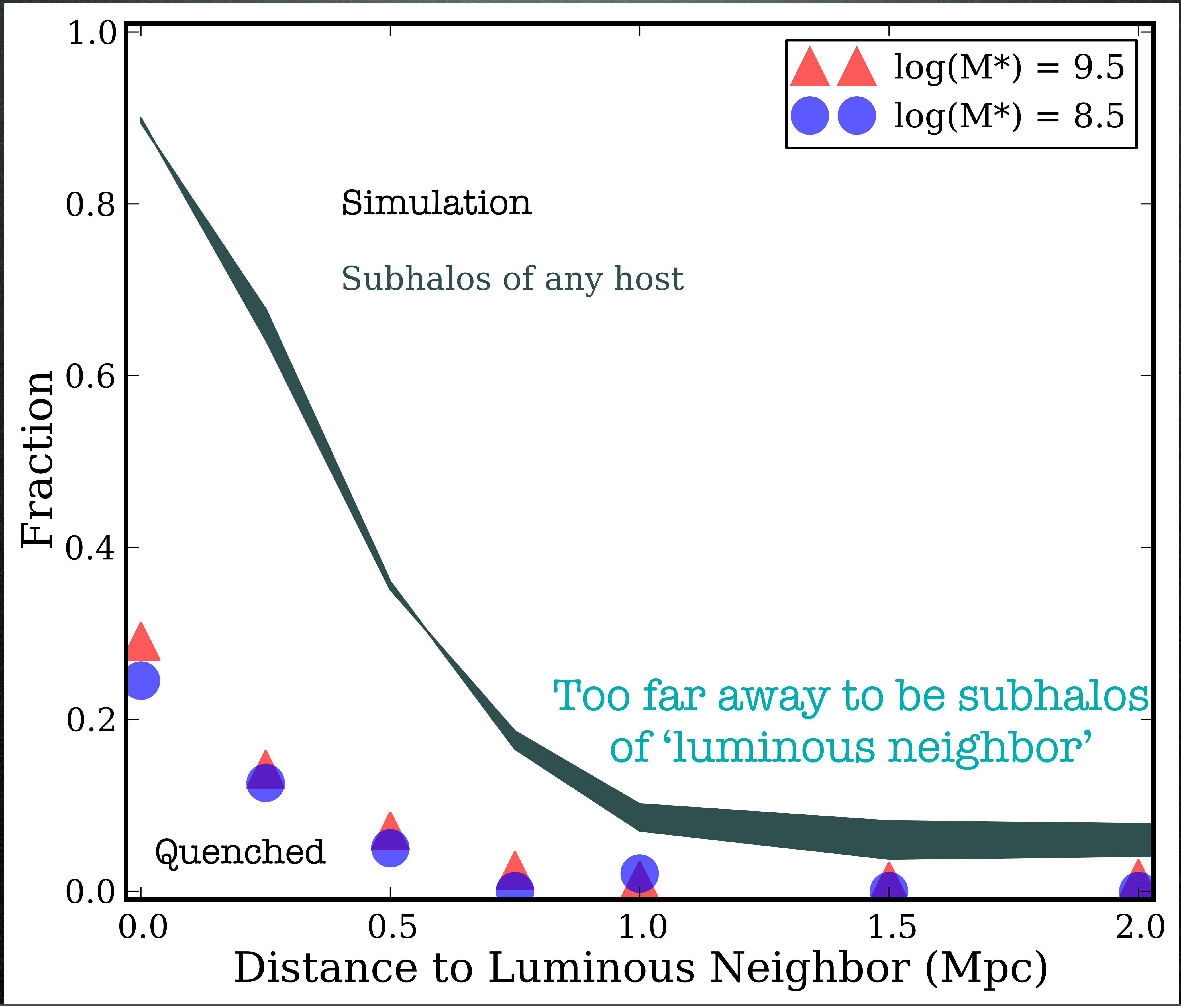
Infall Model



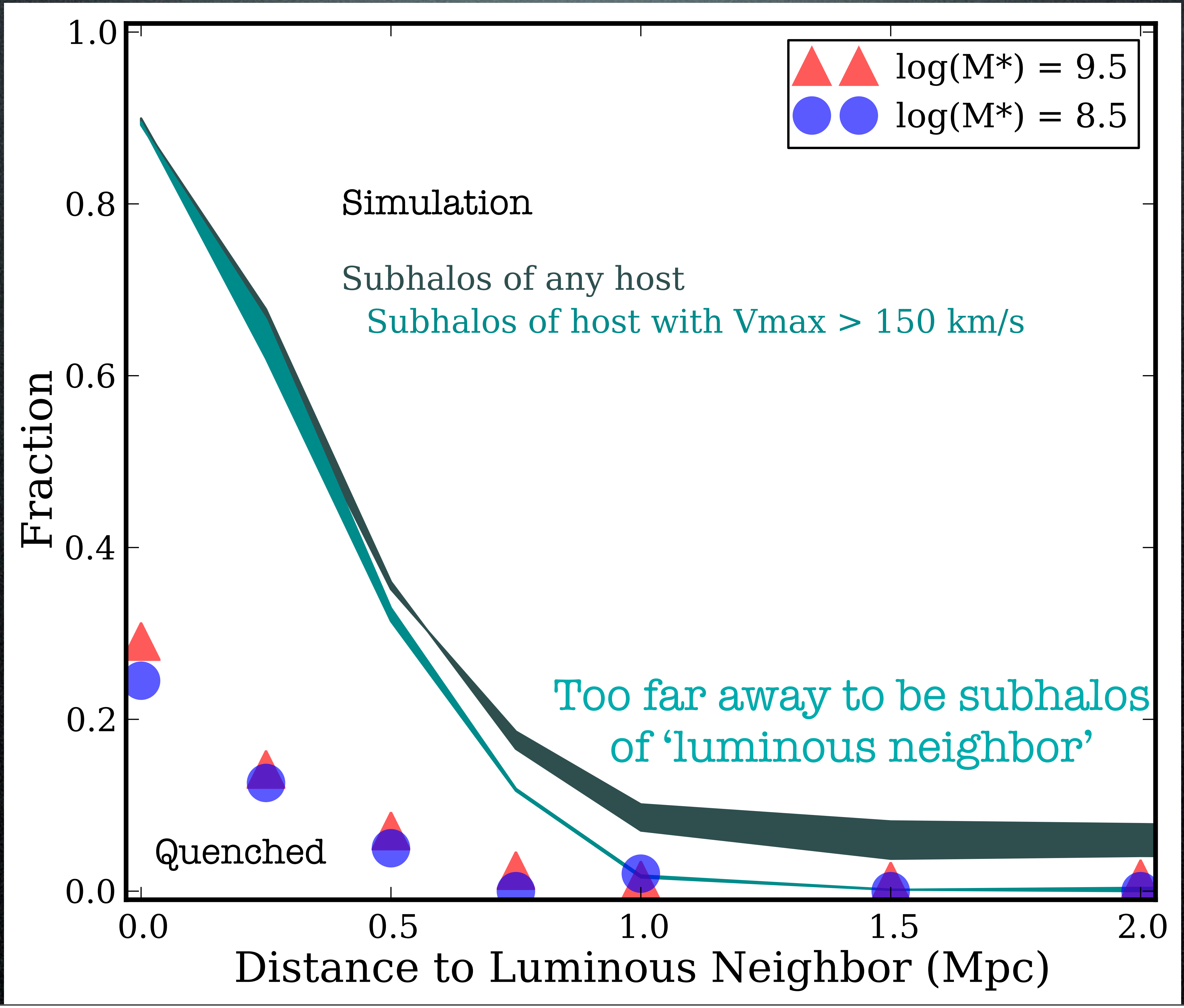
Infall Model



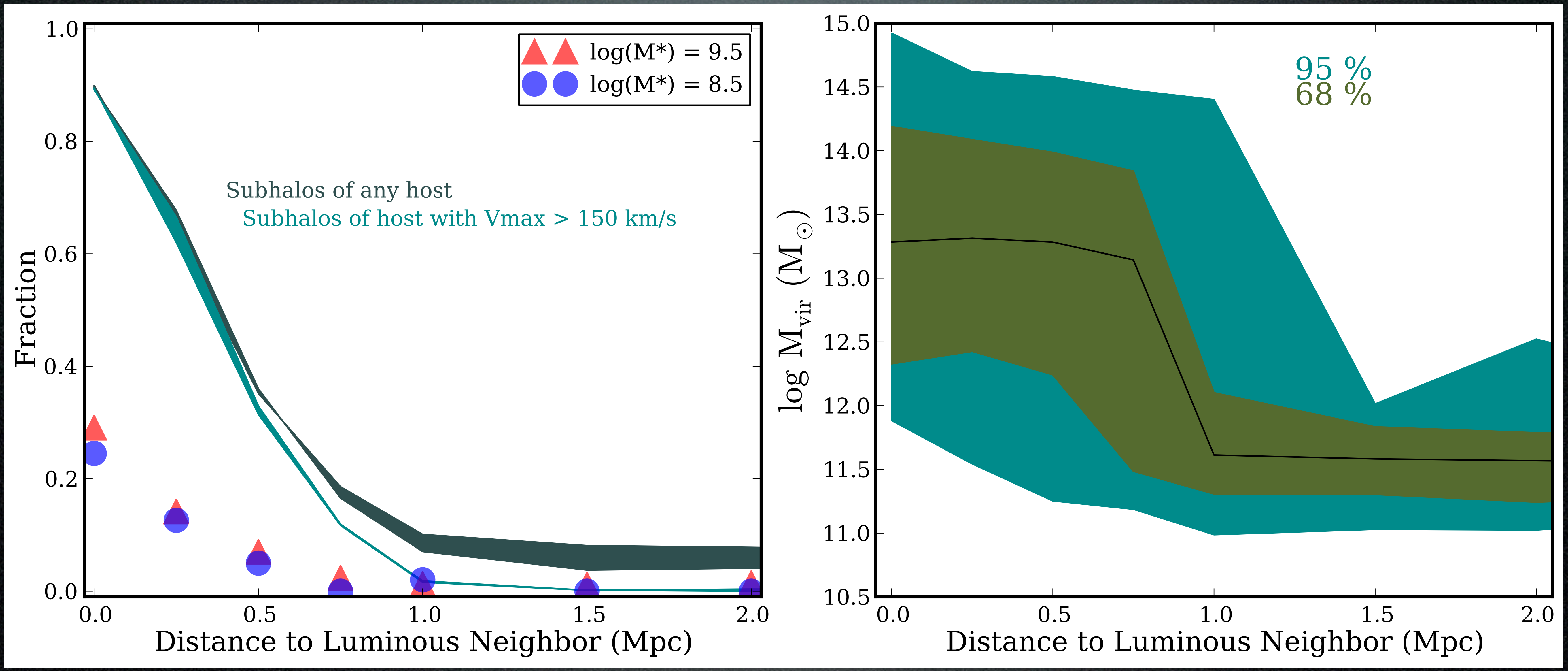
Infall Model



Infall Model

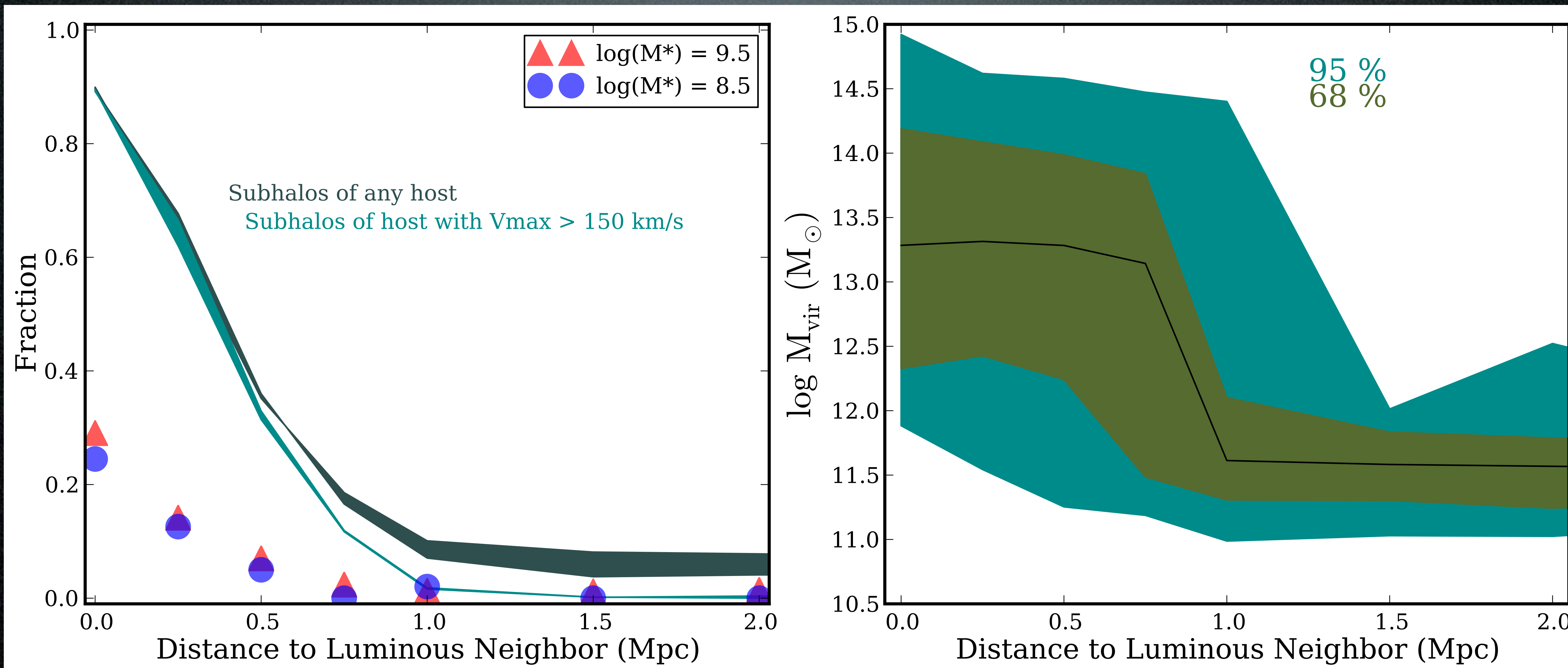


Infall Model



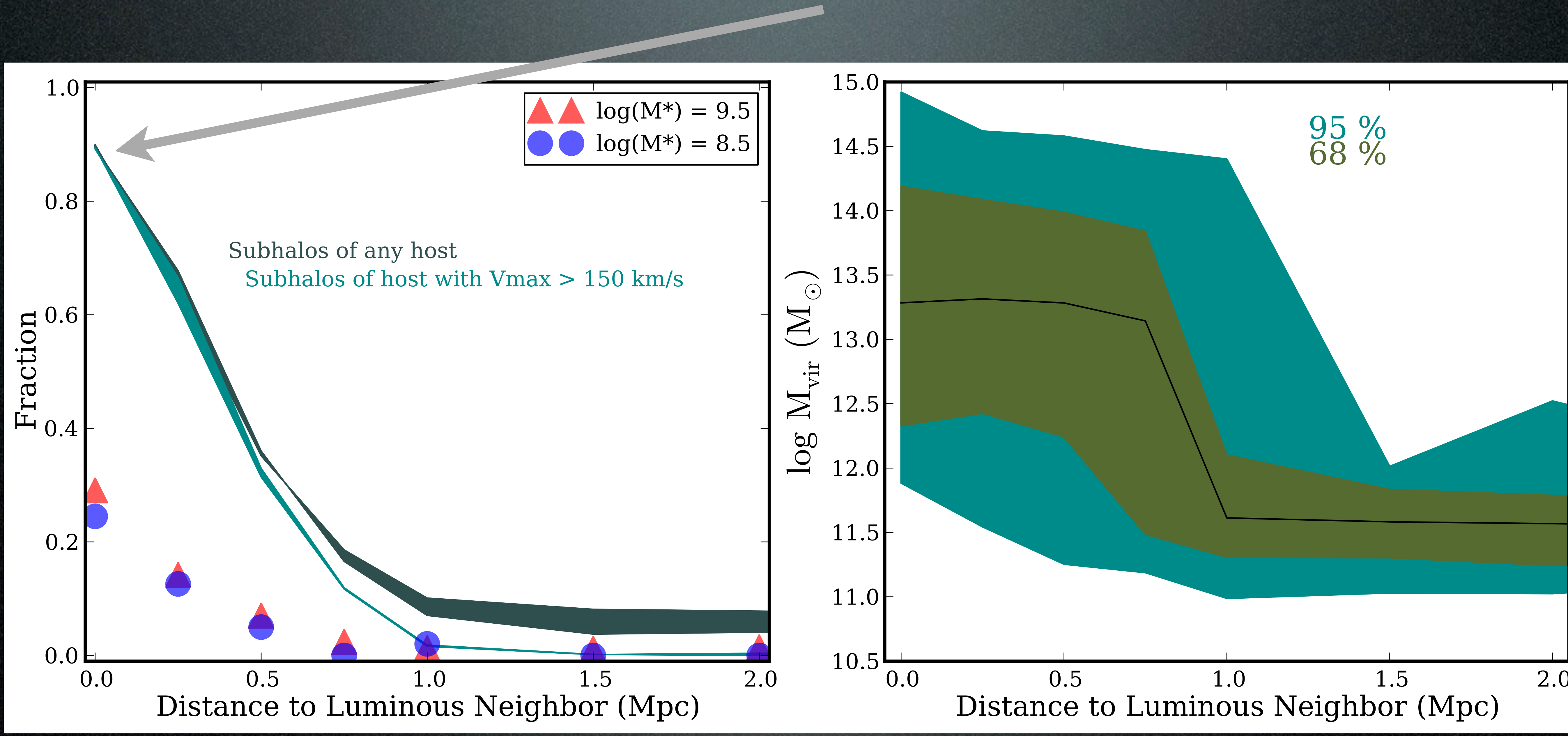
Infall Model

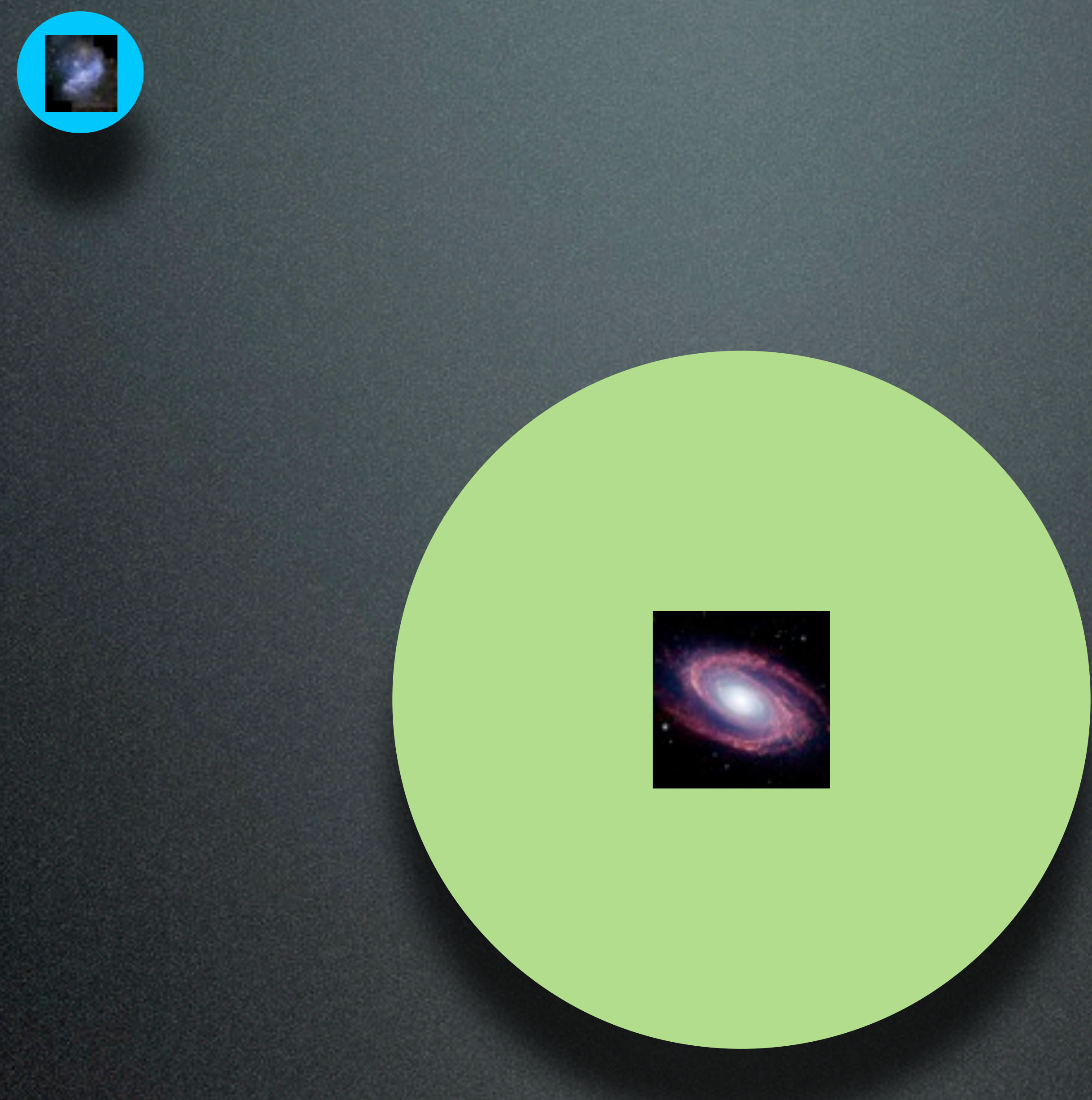
Dropoff in quenched fraction set by virial radius of typical cluster

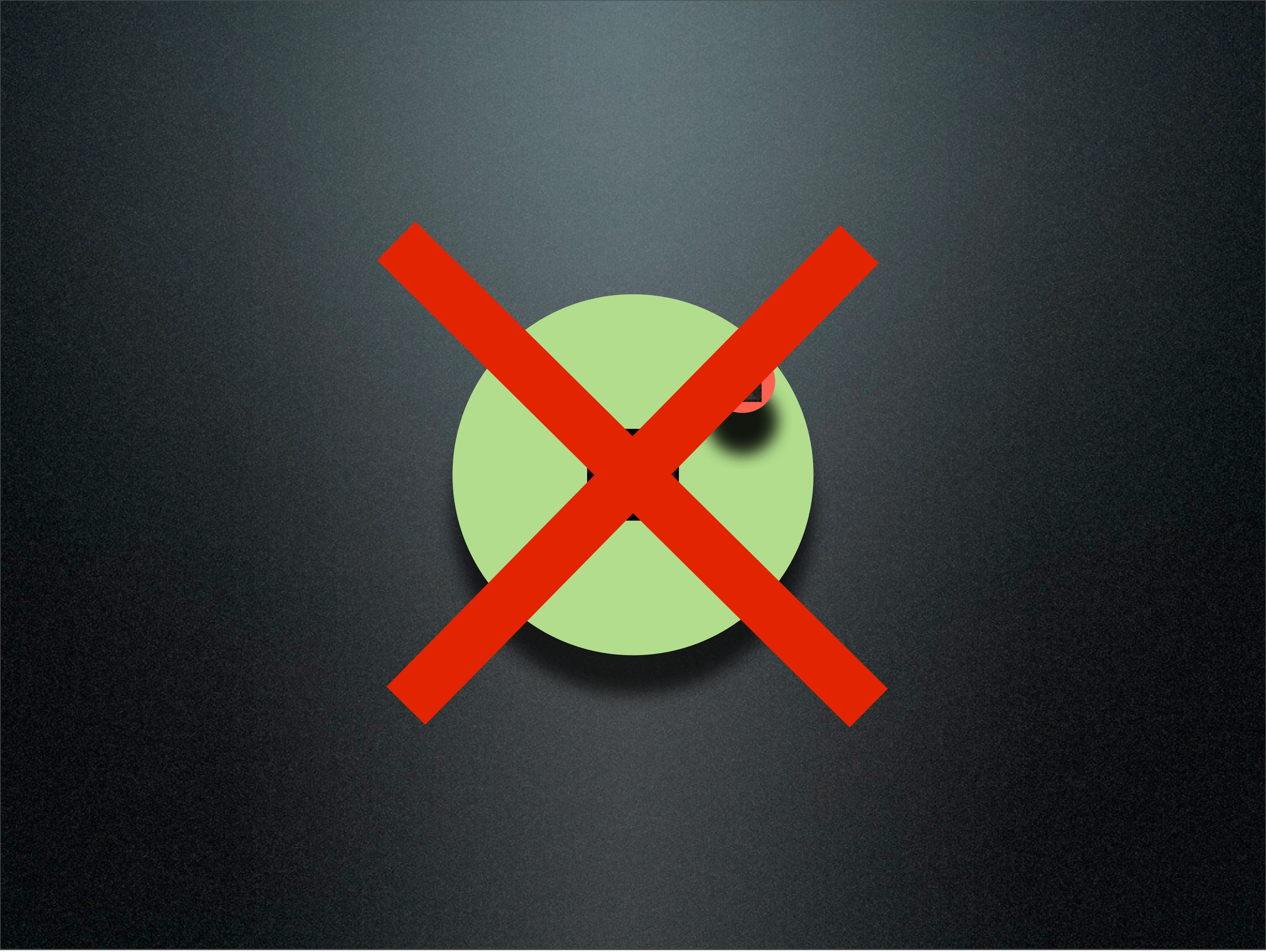


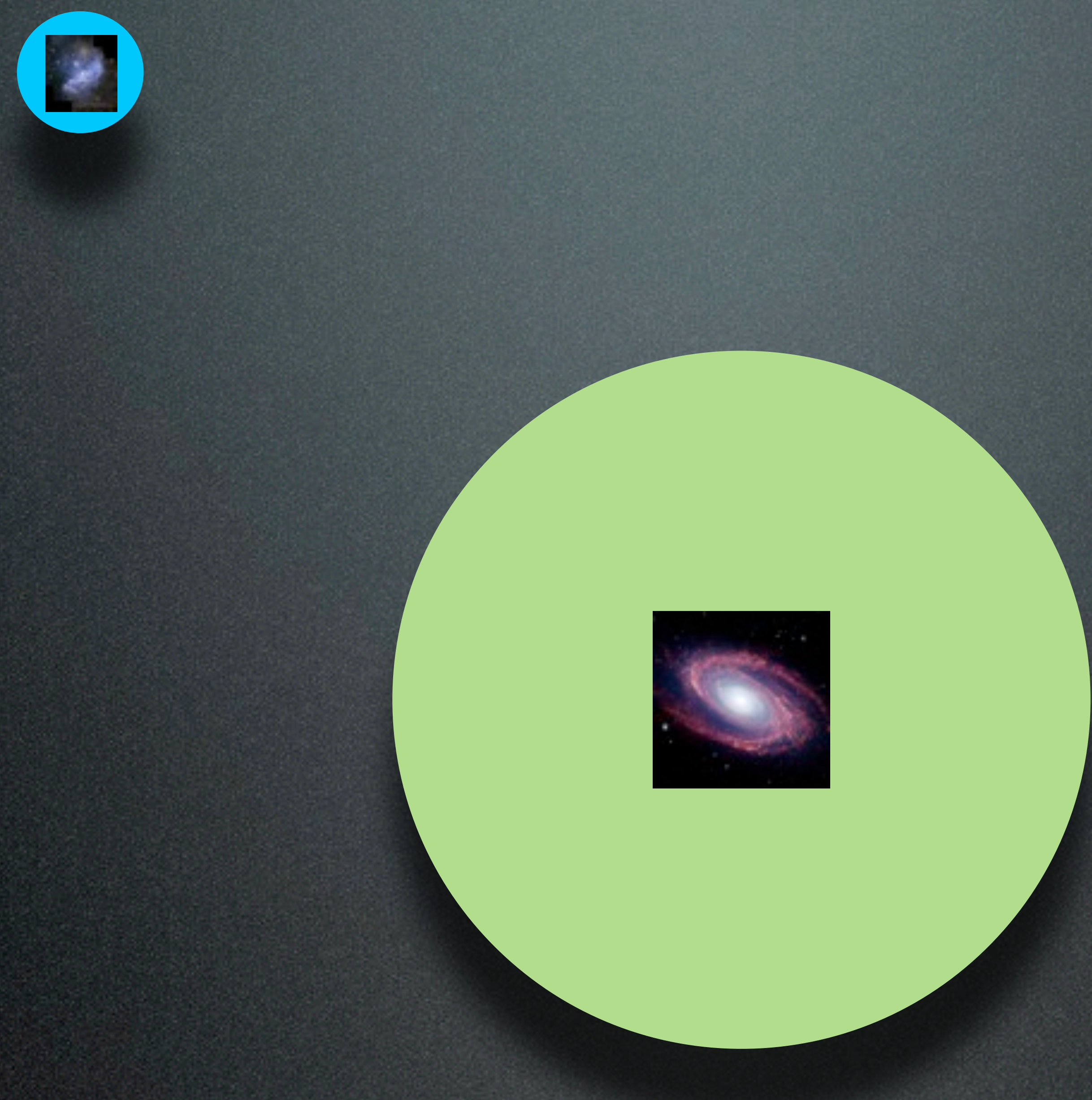
Infall Model

If being a subhalo quenched galaxy, would get 90% f_{quench} in inner bin

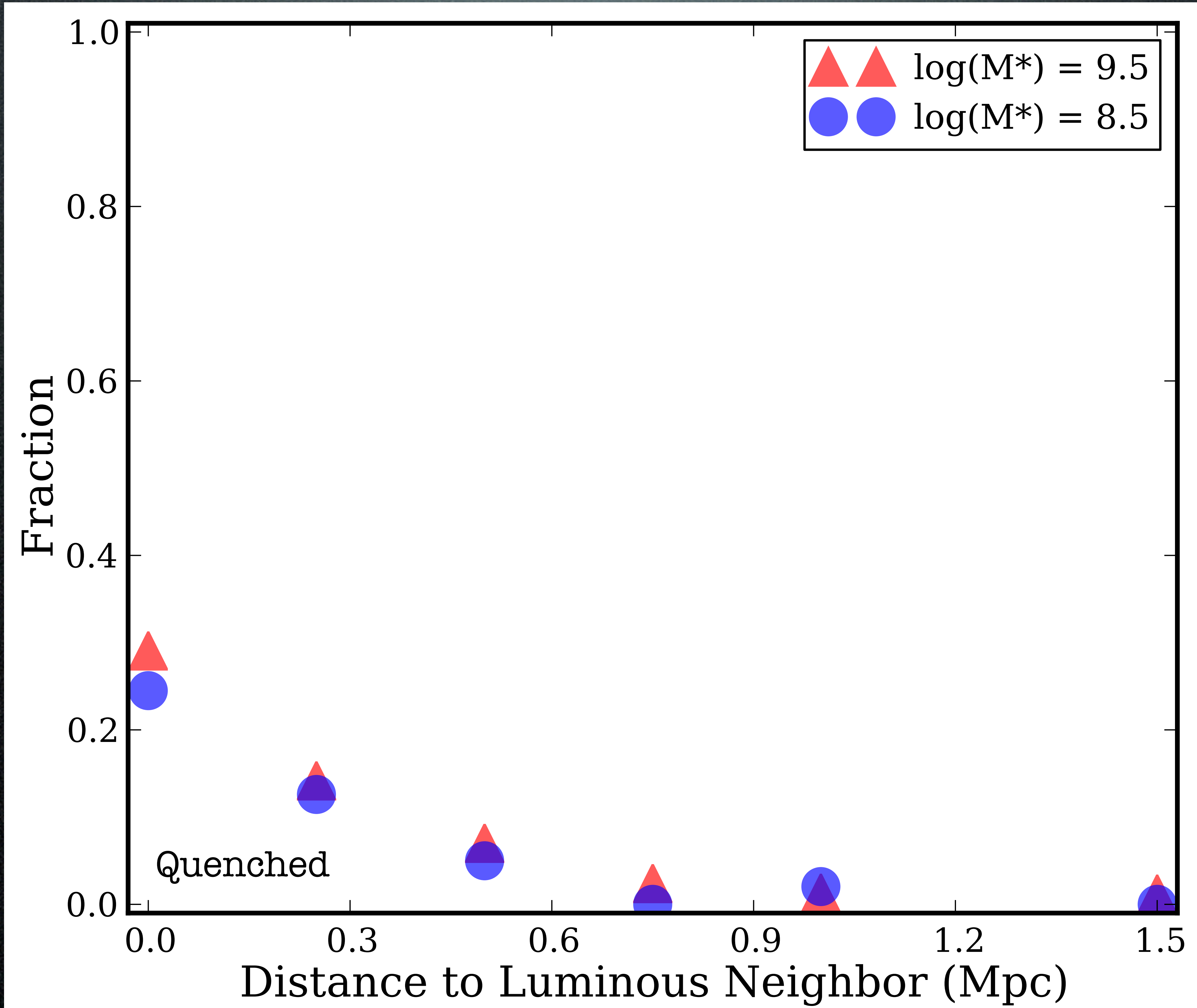




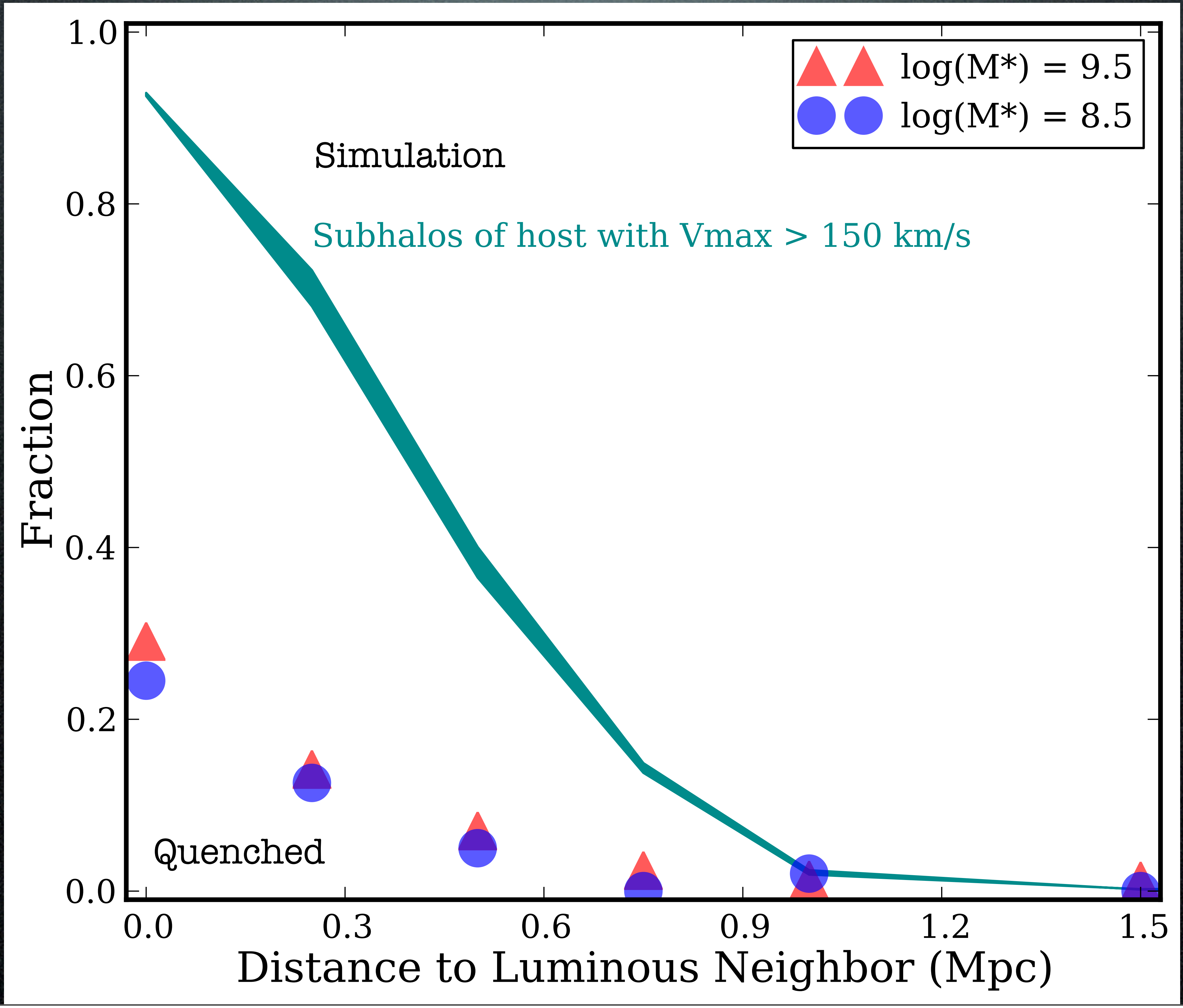




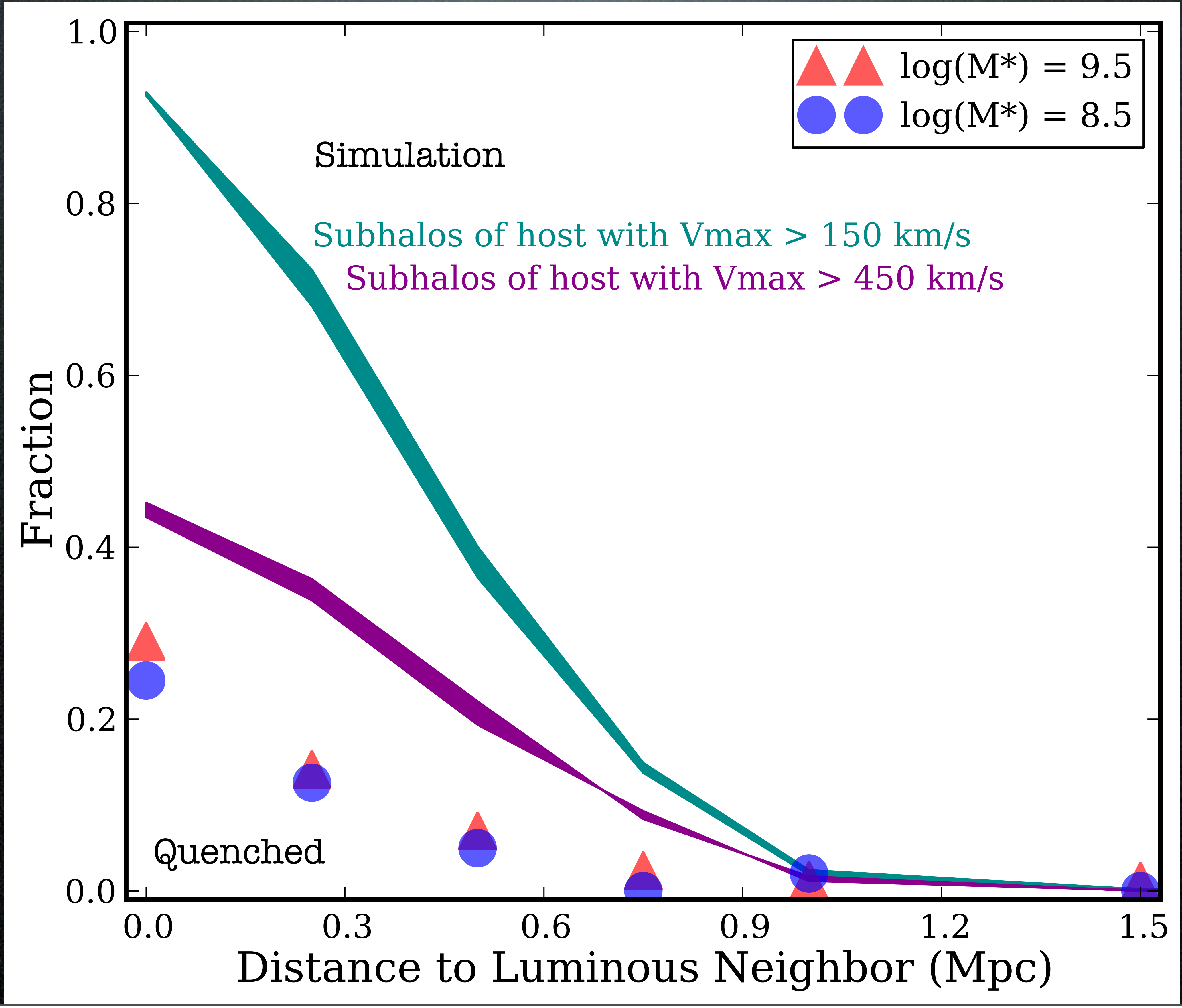
Minimum Host Mass



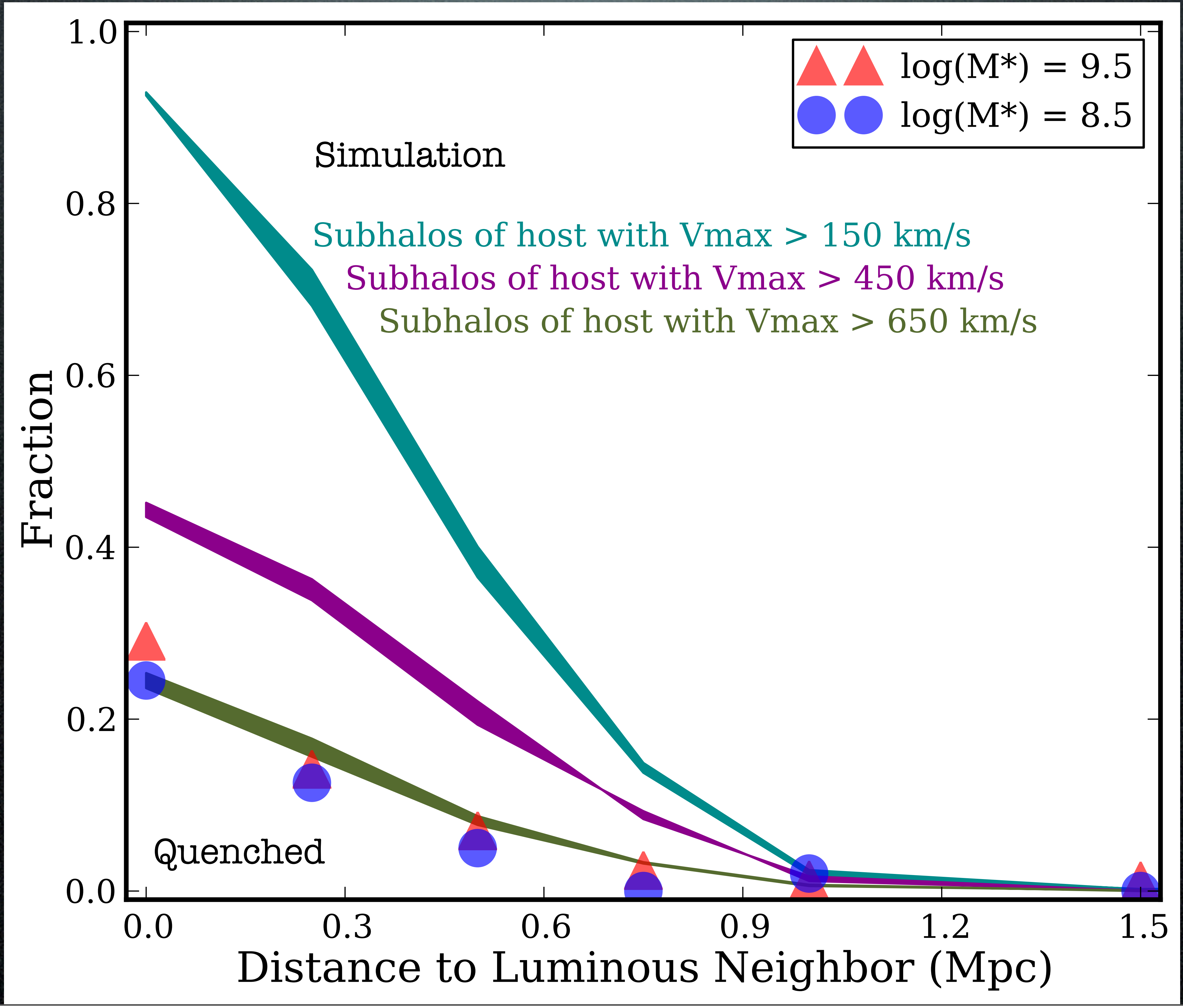
Minimum Host Mass



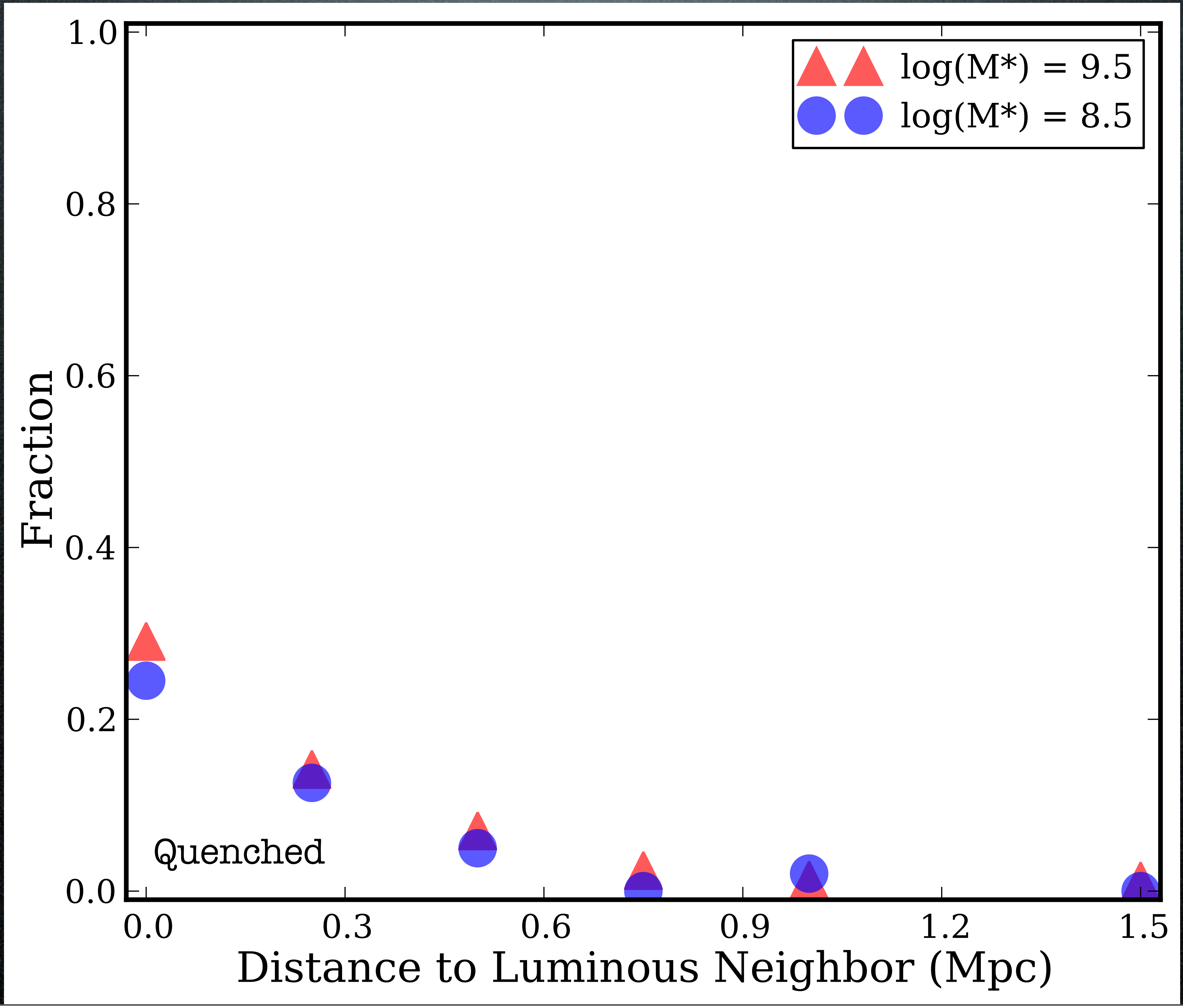
Minimum Host Mass



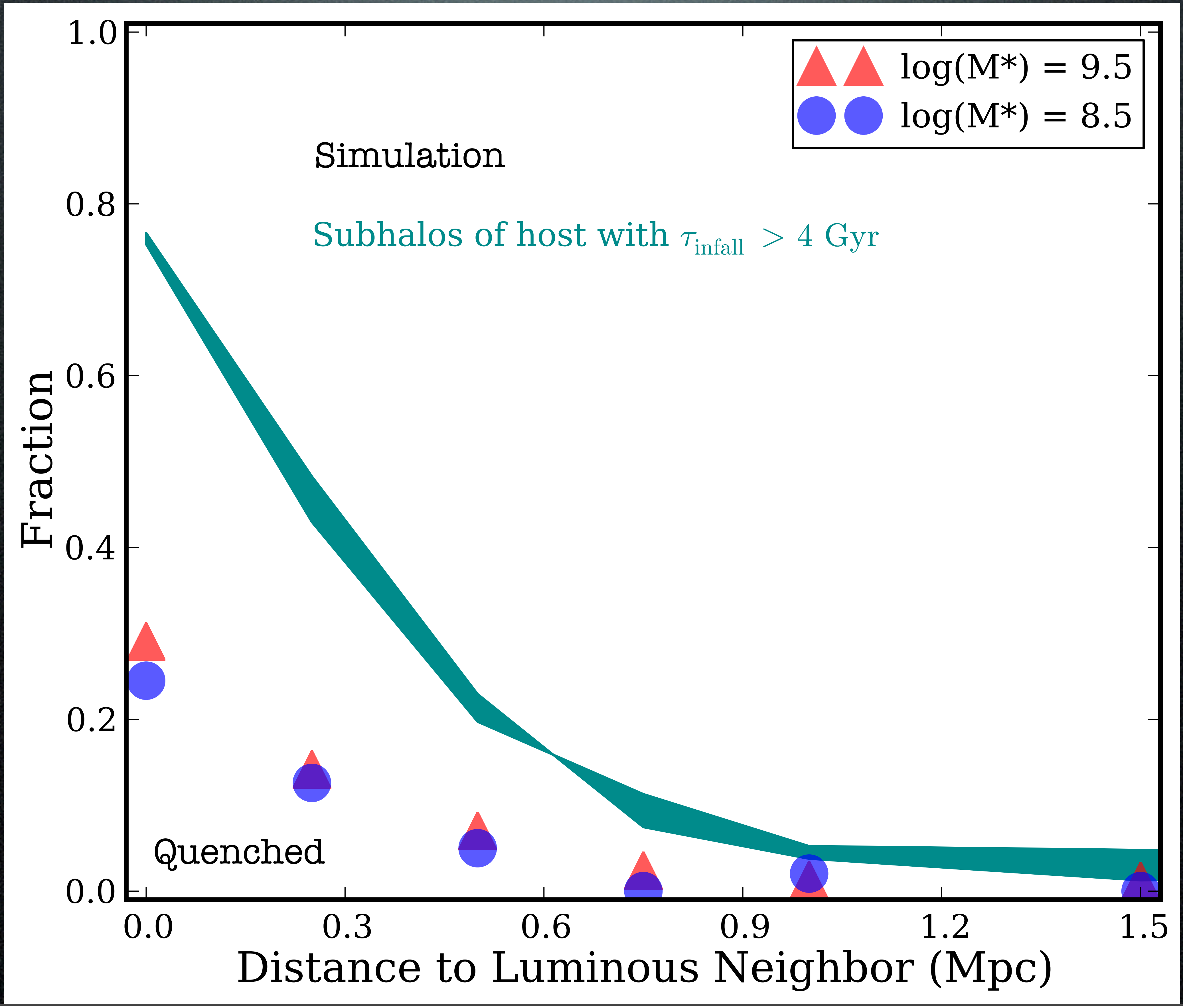
Minimum Host Mass



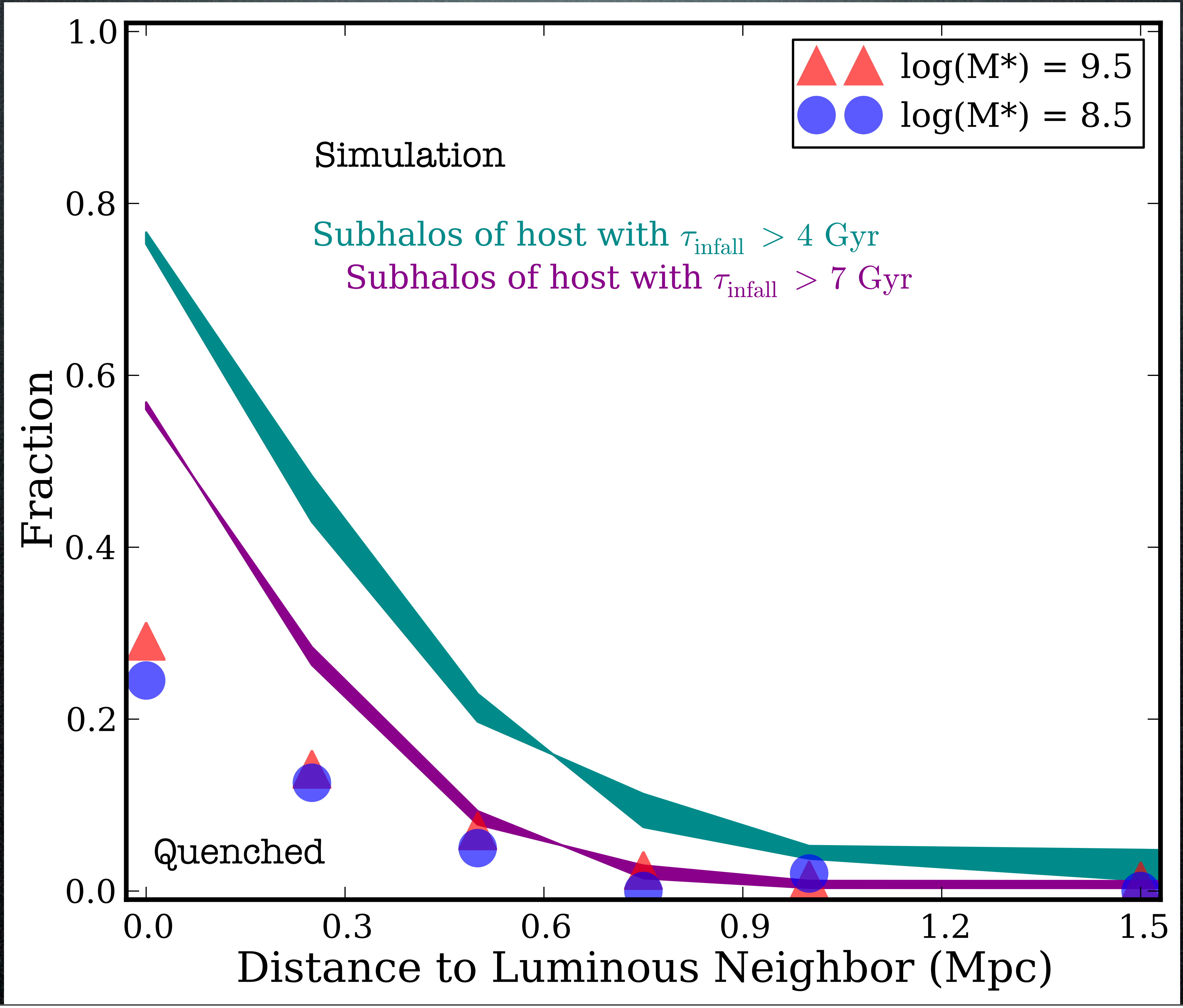
Minimum Infall Time



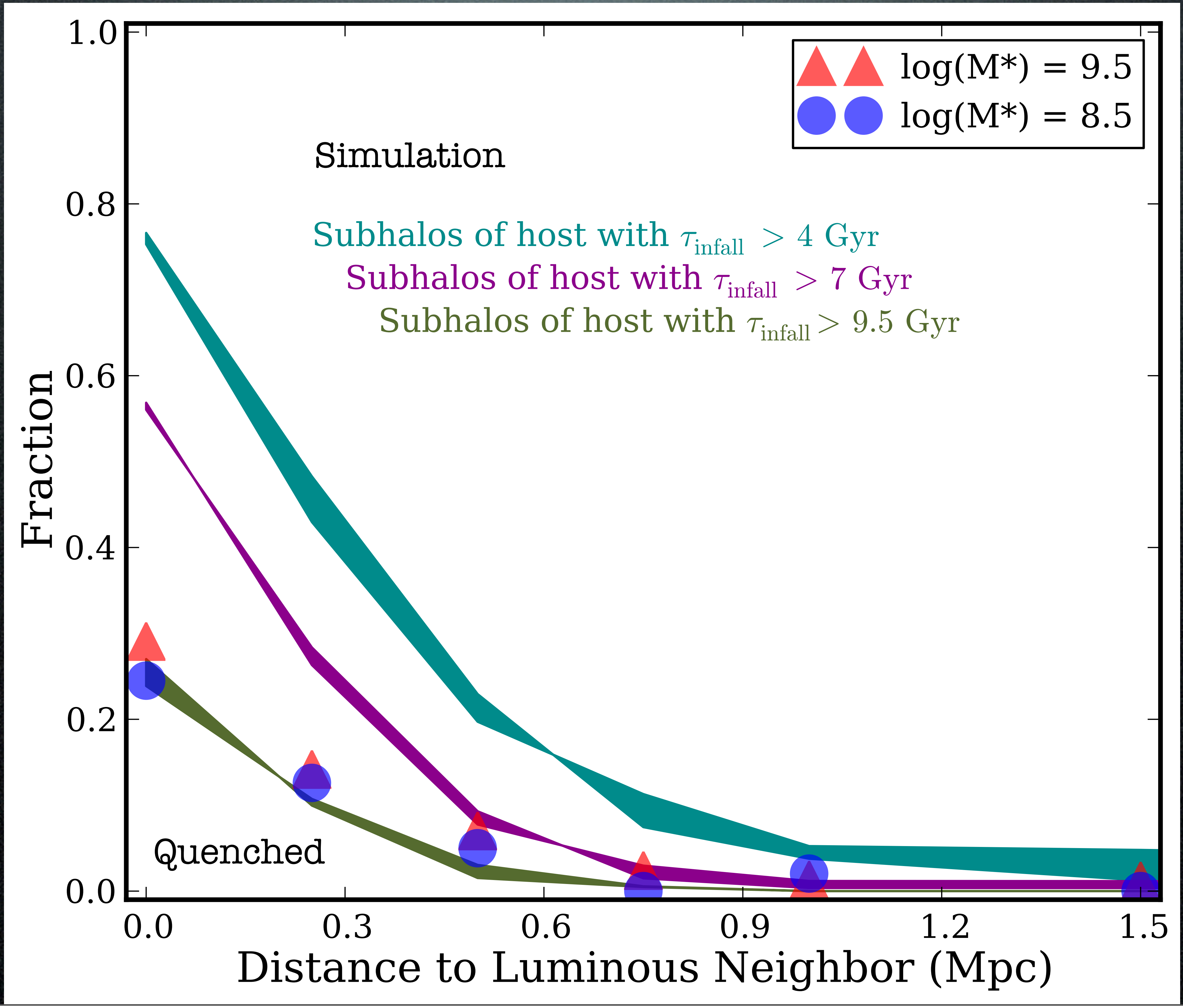
Minimum Infall Time



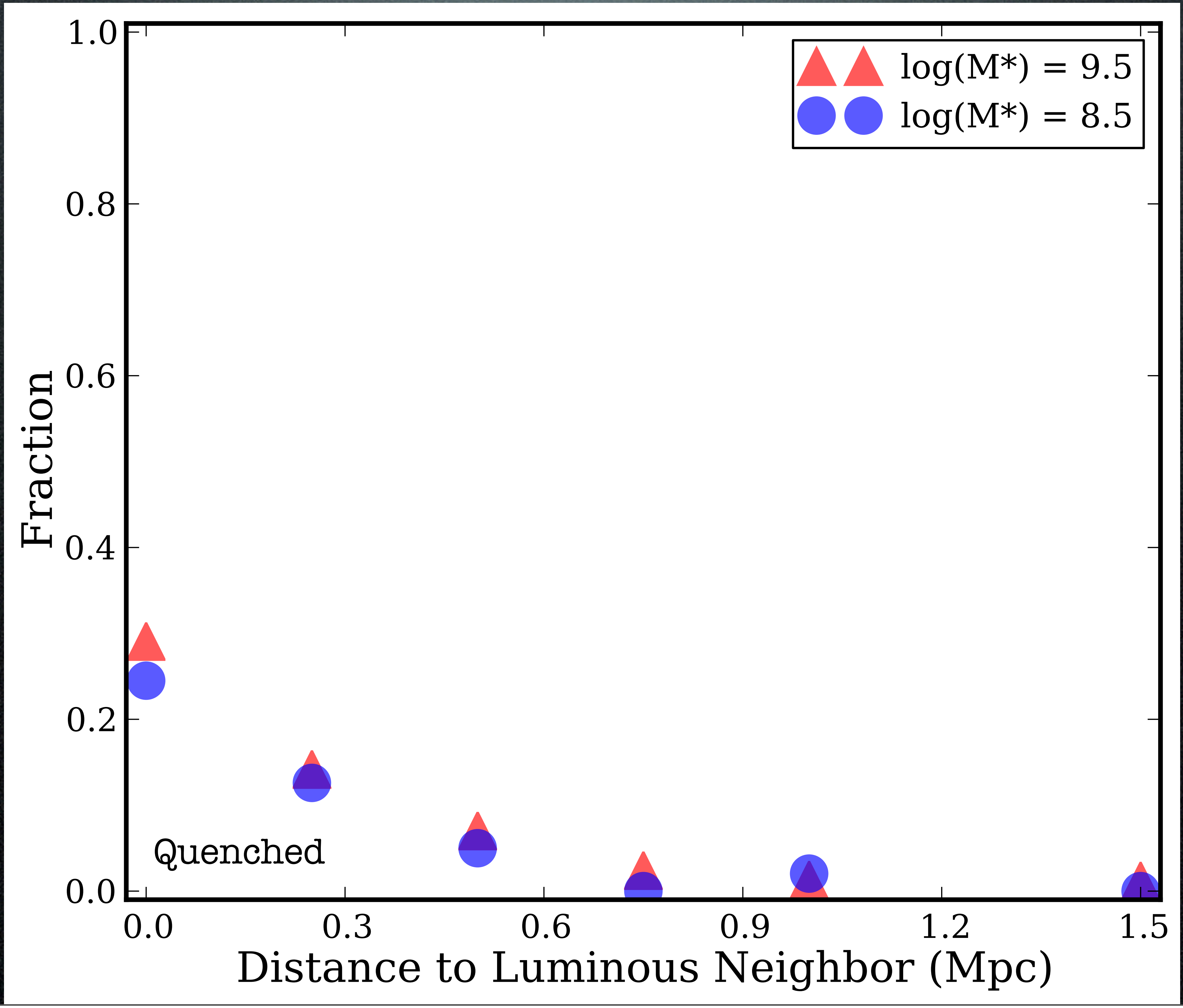
Minimum Infall Time



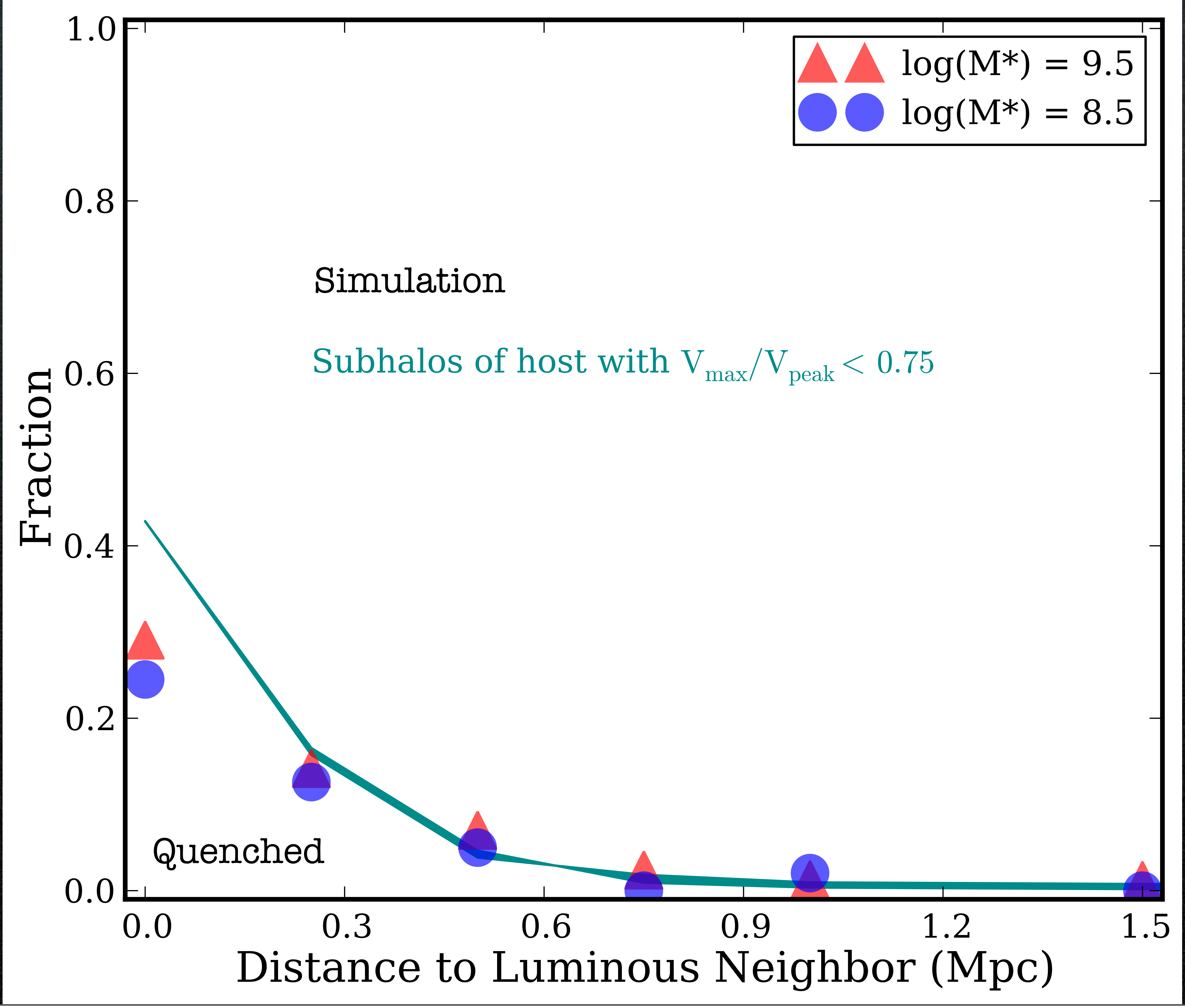
Minimum Infall Time



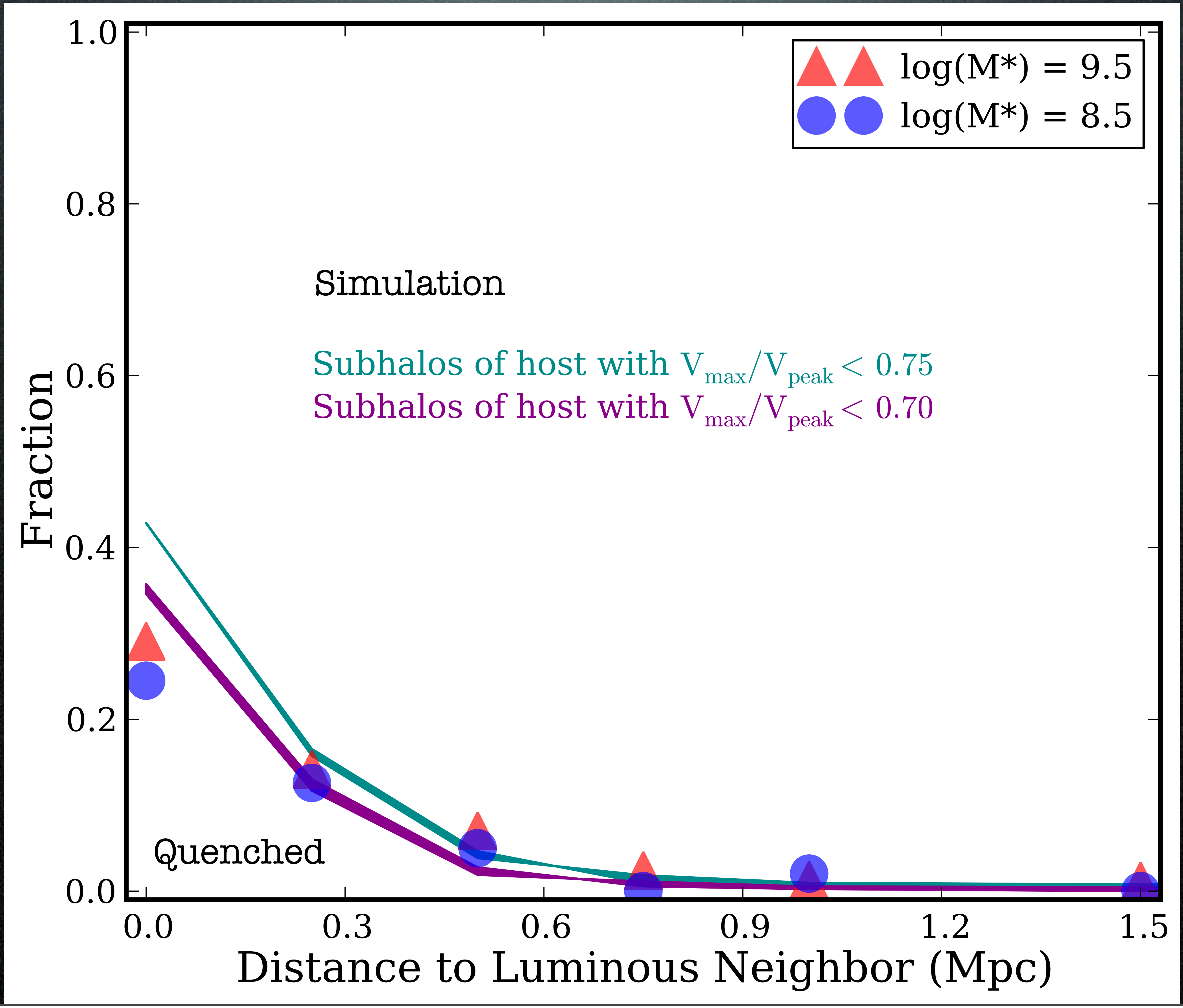
Shredded Satellite (V_{max} / V_{peak})



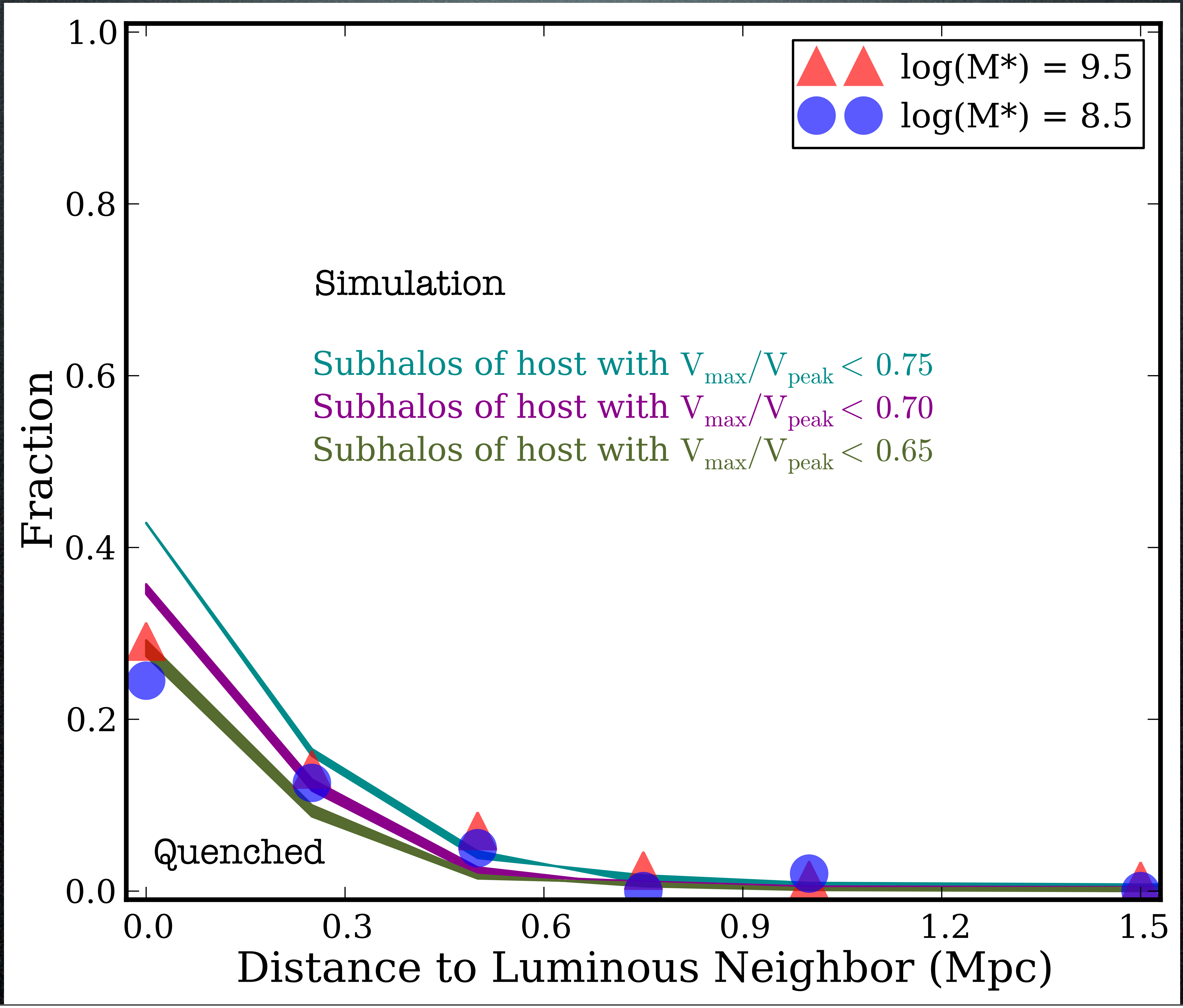
Shredded Satellite (V_{max} / V_{peak})



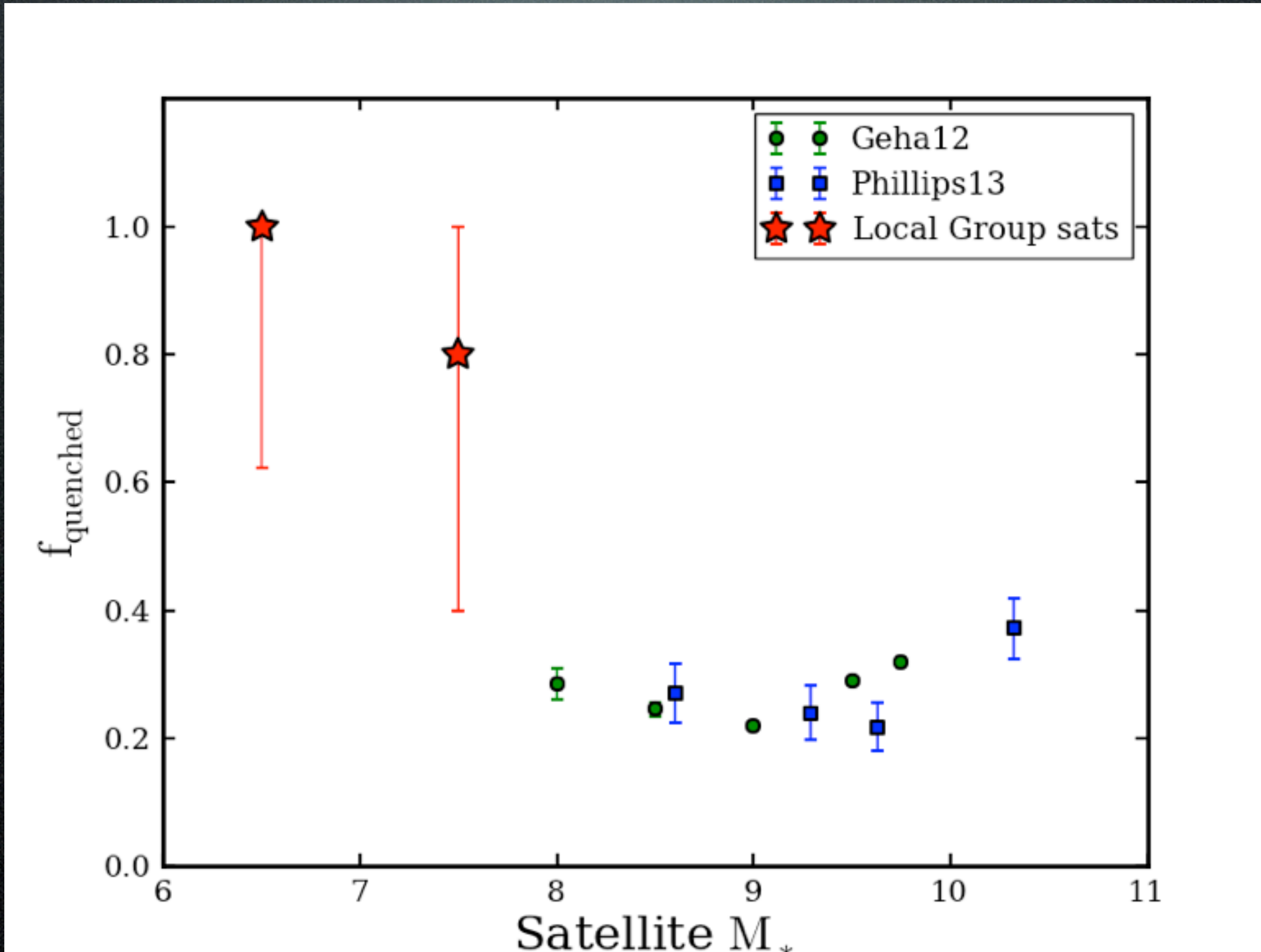
Shredded Satellite (V_{max} / V_{peak})



Shredded Satellite (V_{max} / V_{peak})



Quenched Fraction vs Stellar Mass



Phillips et al. 2013 in

Conclusions

- Environmental quenching is too inefficient to be caused by merely falling into the virial radius of a larger host halo.

- Models that tie satellite quenching to a minimum host V_{max} require unreasonably high V_{max} (650 km/s).

- Only t_{infall} > 9.5 Gyr can reproduce observed quenched fractions.

- The best single proxy for satellite quenching in this mass scale is the ratio of the satellite's current to peak V_{max}.

- Only ~30% of $10^{8.5}\,M_\odot$ galaxies are quenched, and yet basically *all* of $10^7\,M_\odot$ galaxies in the Local Group are quenched. (What's up with that?)