The Dependence of the Stellar Mass - Halo Mass Relation on Environment and Cosmic Time

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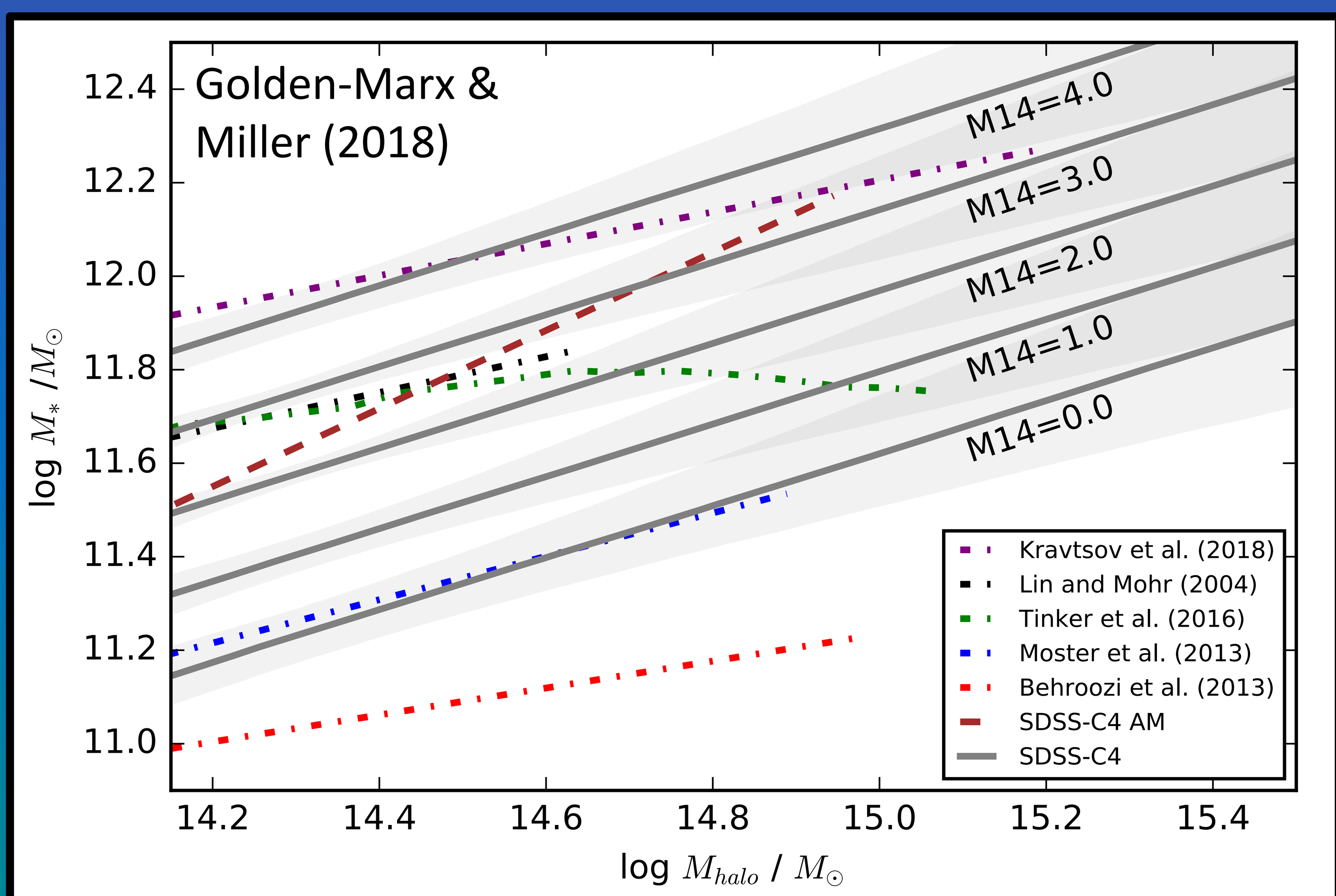
The Stellar Mass-Halo Mass (SMHM) relation provides insight into the galaxy-dark matter halo connection. In Golden-Marx & Miller (2018), we incorporate the magnitude gap (M14) into the cluster SMHM relation. We observe that at fixed M_{halo}, clusters with a higher M14 have a larger central galaxy M_*. This trend is also seen in semi-analytic simulations, which suggests that it can be explained by the hierarchical growth of centrals. Accounting for M14 significantly reduces the error on the inferred SMHM relation's slope and reduces the inferred σ_{int} to below 0.1 dex, thus strictly limiting the model space that can explain the stellar mass growth in centrals. Hierarchical growth also predicts that the central's M_* and M14 decrease with increasing lookback time. To test how this prediction affects the SMHM relation, we present our latest results using SDSS-redMaPPer to extend our analysis over the redshift range 0.1 < z < 0.3.



Incorporating M14 as a 3rd parameter in the SMHM relation explains discrepancies between prior results

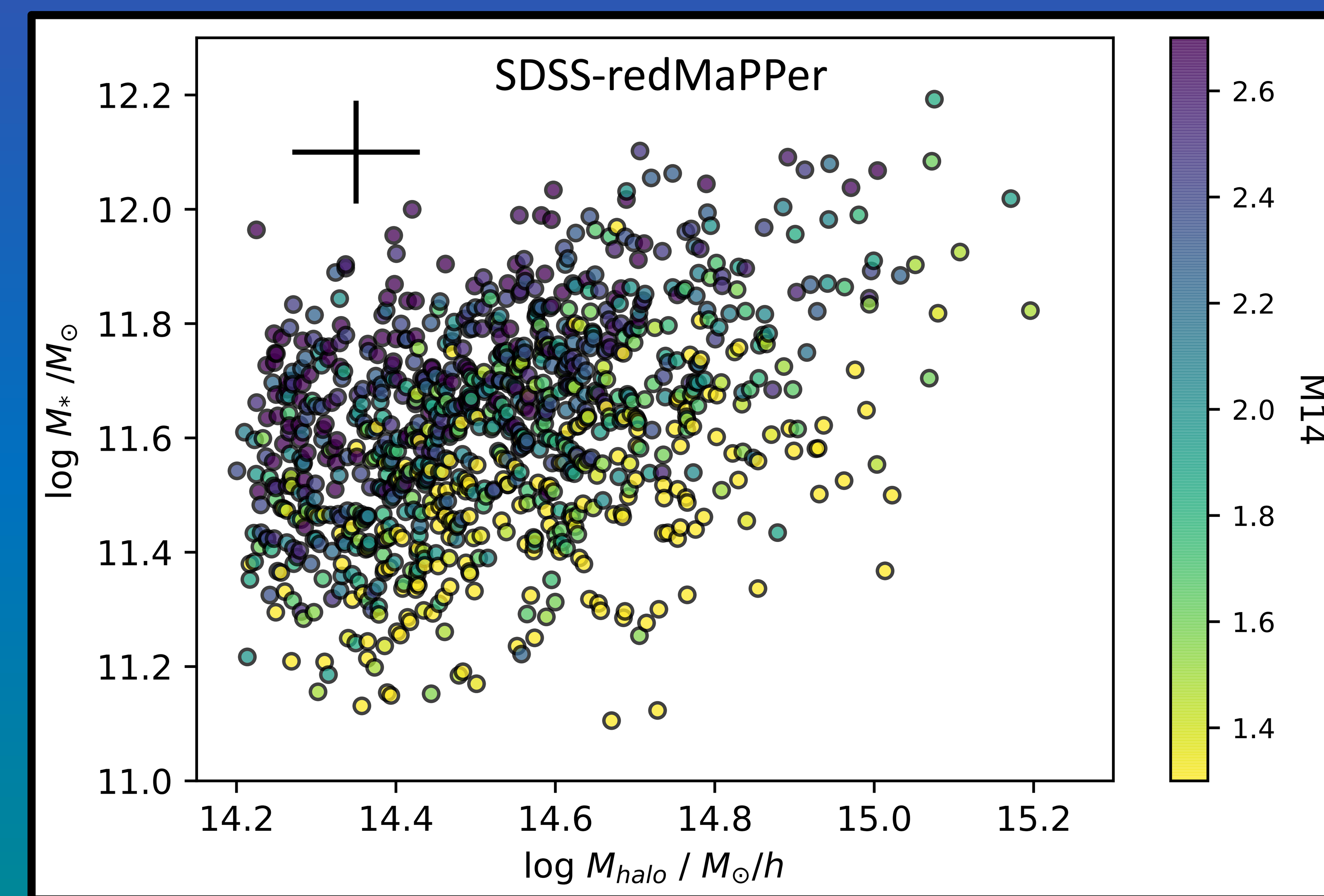
SDSS-redMaPPer Data

(Rykoff et al. 2014)

- 912 galaxy clusters (0.1 < z < 0.3)
  - 4+ members with $P_{Mem} \geq 0.984$ and $R < 0.5\ R_{vir}$
- M_{halo} estimated via Mass-Richness relation (Rykoff et al. 2012)
  - $\log_{10}(M_{halo\text{-}Richness}) > 14.2$
- Color dependent M_* estimated from EzGal (Mancone & Gonzalez 2012)
- R_{vir} based on richness

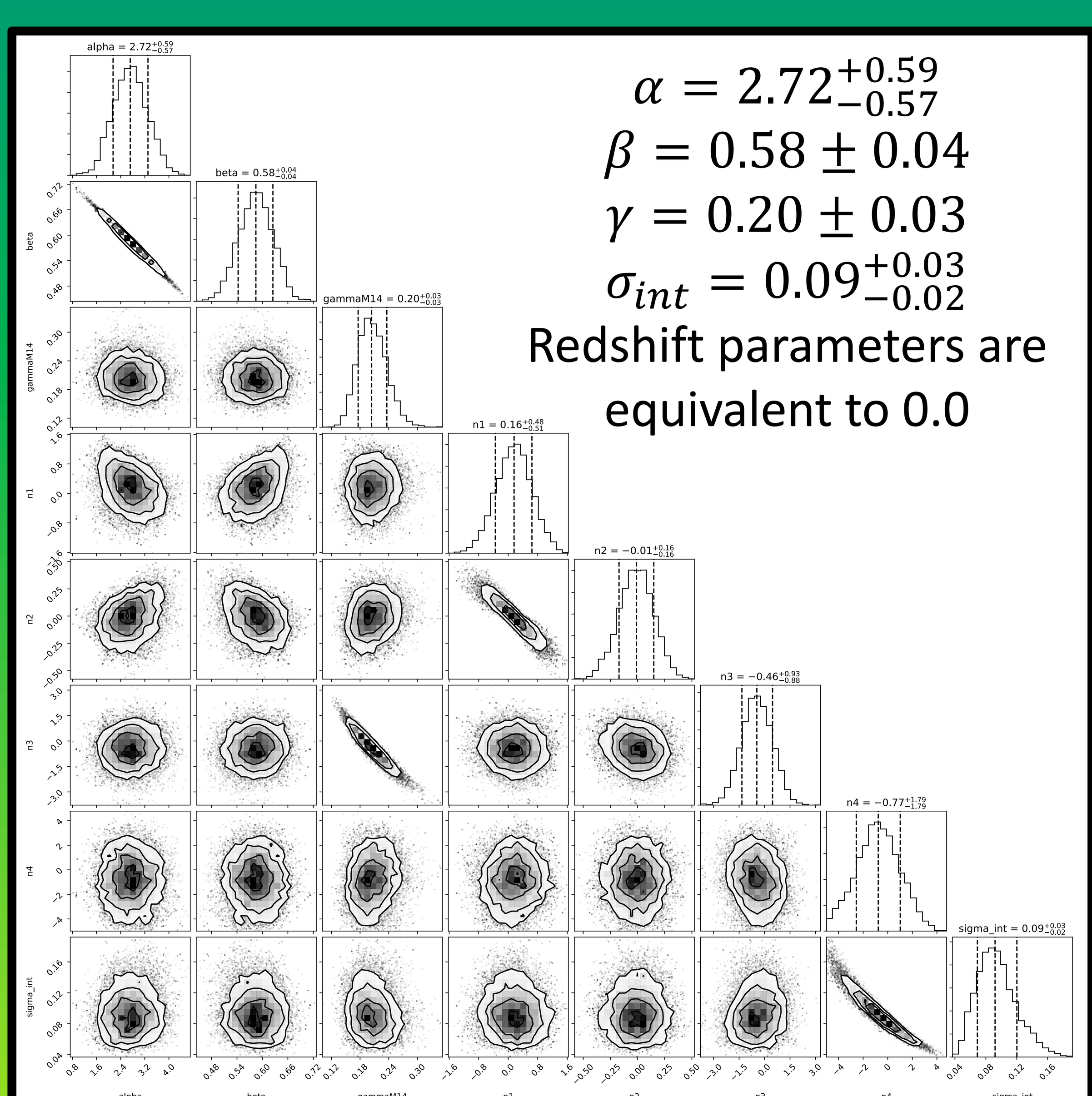
Guo et al. (2011) MILLENNIUM Simulation

- z = 0.089, 0.116, 0.142, 0.175, 0.208, 0.242 simulation boxes
- M_{Halo} and M_* come from the simulation
- Cluster members and M14 based on x, y, z position and red sequence



At fixed M_{halo}, clusters with a higher M14 have a larger BCG M_*

$$\log_{10} M_* = N(\alpha(1+z_{phot})^{n_1} + \beta(1+z_{phot})^{n_2}(\log_{10} M_{halo}) + \gamma(1+z_{phot})^{n_3}(M14), ((\sigma_{int})(1+z_{phot})^{n_4})^2)$$



Bayesian MCMC Model

- Model observed M_*, M_{halo}, and M14 as $N(\mu, \sigma^2)$
- Error modeled as beta distributions centered on the measured value
- Posteriors determined α, β, γ, σ_{int}, n_1, n_2, n_3, & n_4

The SMHM relation does not evolve over the redshift range 0.1 < z < 0.3

- Over 0.1 < z < 0.3, the BCG M_* does not evolve with respect to M_{halo}
  - In agreement with observations, the BCG M_* does not grow in this redshift range (e.g., Lidman et al. (2012), Lin et al. (2013), Oliva-Altamirano et al. (2014), Burke et al. (2015), Inagaki et al. (2015), Bellstedt et al. (2016), Zhang et al. (2016), Cooke et al. (2018))
- BCG growth halts or slows at z < 0.5 (e.g., Lin et al. 2013)
- Intra-cluster light (ICL) grows by a factor of 4-5 in this redshift range (Burke et al. 2015)
- The discrepancy between observations and the Guo et al. (2011) prescription of the MILLENNIUM simulation occurs because the ICL is mostly built up by z=1.0 in the Guo et al. (2011) prescriptions (Zhang et al. 2016)
- Over 0.1 < z < 0.3, M14 does not evolve with respect to BCG M_*, in agreement with hierarchical growth