# Constraints on Physical Parameters of 21-cm Models from Cohen/Fialkov/Barkana

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January 24, 2018

## 1 Description

Here we present still preliminary constraints on physical parameters of 21-cm models from the team Aviad Cohen / Anastasia Fialkov / Rennan Barkana.

The constraints are obtained using a likelihood analysis. The probability distributions of 4 parameters are mapped. The parameters are:

1. $f_\star$: star formation efficiency.
2. $V_c$: minimum virial circular velocity. It is equivalent to the minimum virial temperature for ionizing galaxy formation. It parametrizes the cooling and feedback mechanism for galaxy formation.
3. $f_X$: x-ray efficiency.
4. $R_{\rm mfp}$: mean free path (radius) of ionizing photons from ionizing galaxies. This parametrizes emission properties of galaxies and absorption properties of the surrounding neutral IGM.

We sample 20 pixels evenly in linear or log scale over a realistic range for each parameter. This produces a total of $20^4 = 160,000$ models.

We have used the same EDGES High-Band integrated spectrum as in Monsalve et al. (2017), ApJ 847, 64.

First we show the nominal EDGES results for the physical parameters.

Then, we show constraints on the same physical parameters from two high-redshift quasar estimates for the average hydrogen neutral fraction, $x_{\rm HI}$. The estimates are from McGreer et al. (2015), MNRAS, 447, 499-505, and from Bañados et al. (2017), Nature, doi:10.1038/nature25180.

Then we show the combined EDGES+quasars constraints.

Finally, we show a large set of results for simulated EDGES spectra, to study how different properties of the real spectrum impact the results.

## 2 Nominal Results

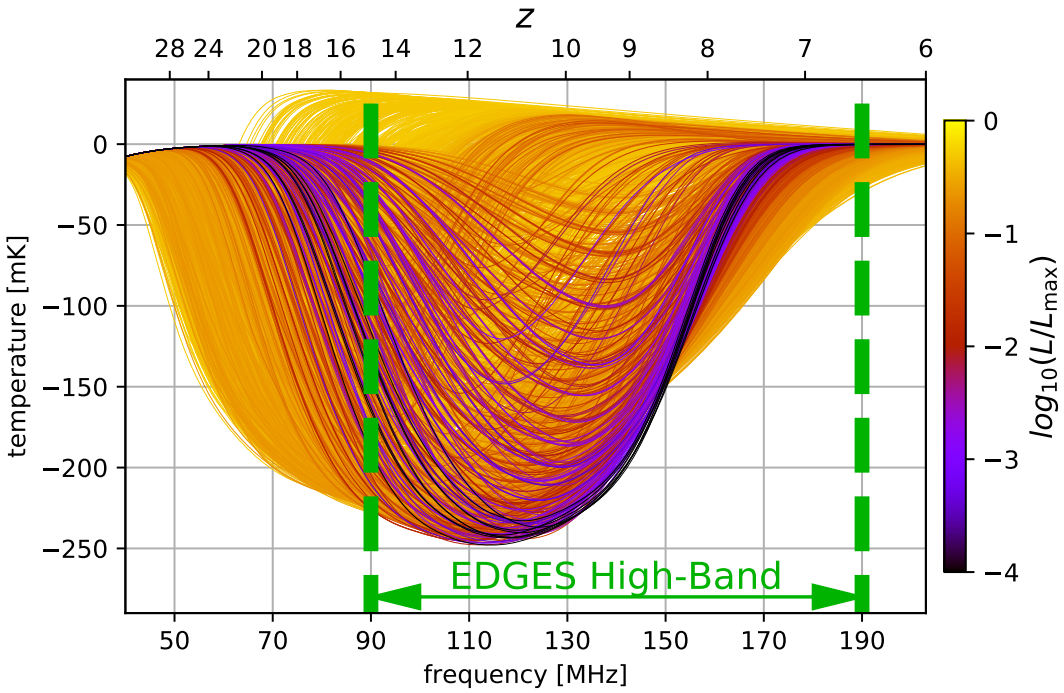


Figure 1: Sample of 3,000 models, out of the 160,000 models evaluated. The color scale represents the log of the normalized likelihood.

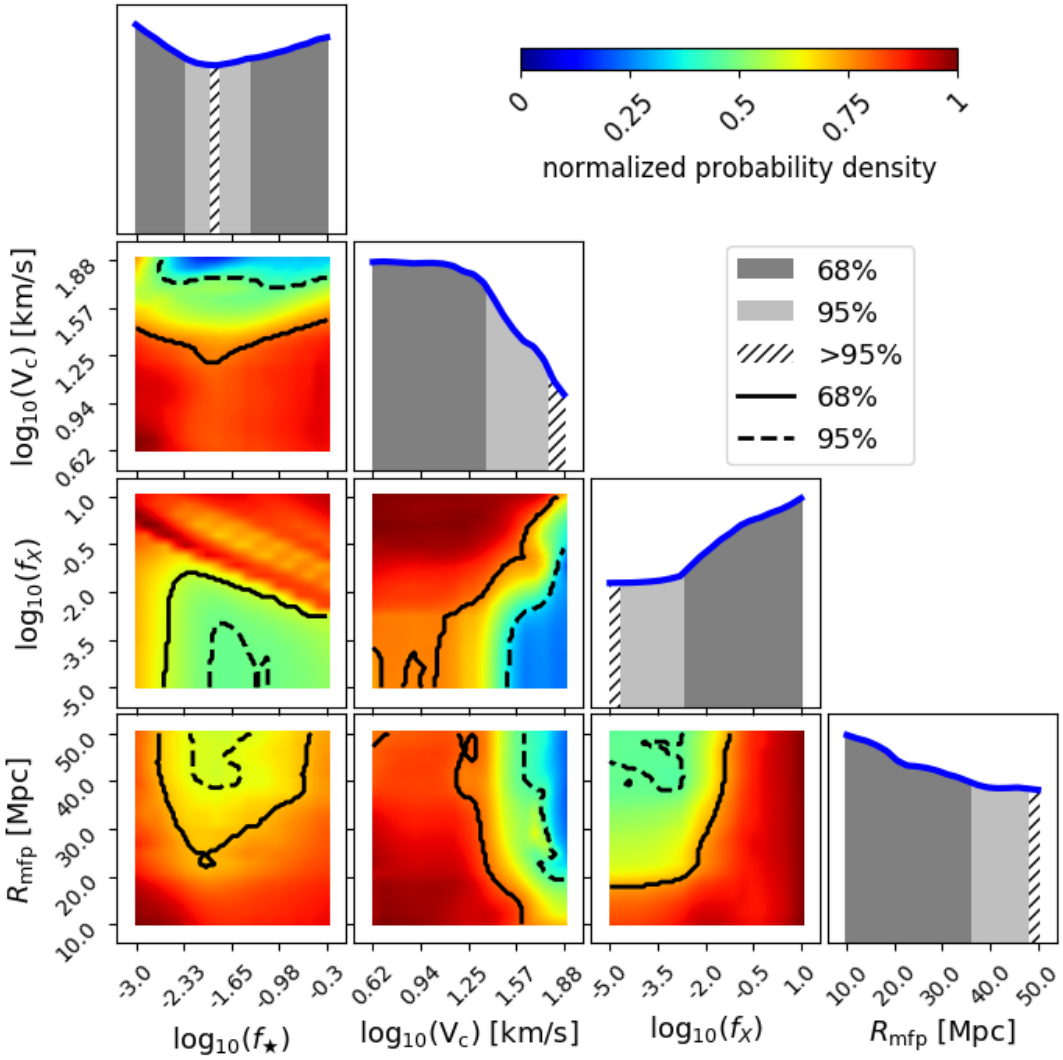


Figure 2: Nominal constraints of physical parameters from EDGES data only.

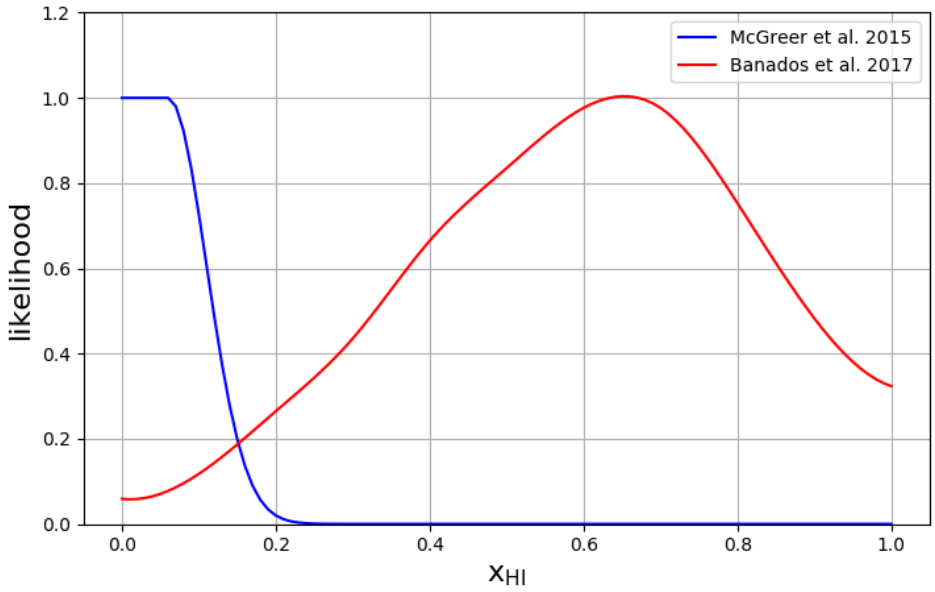


Figure 3: Likelihood for the average hydrogen neutral fraction $x_{\rm HI}$ from McGreer et al. (2015). and Bañados et al. (2017). The result from McGreer et al. (2015) is for $z = 5.9$. The result from Bañados et al. (2017) is for $z = 7.54$.

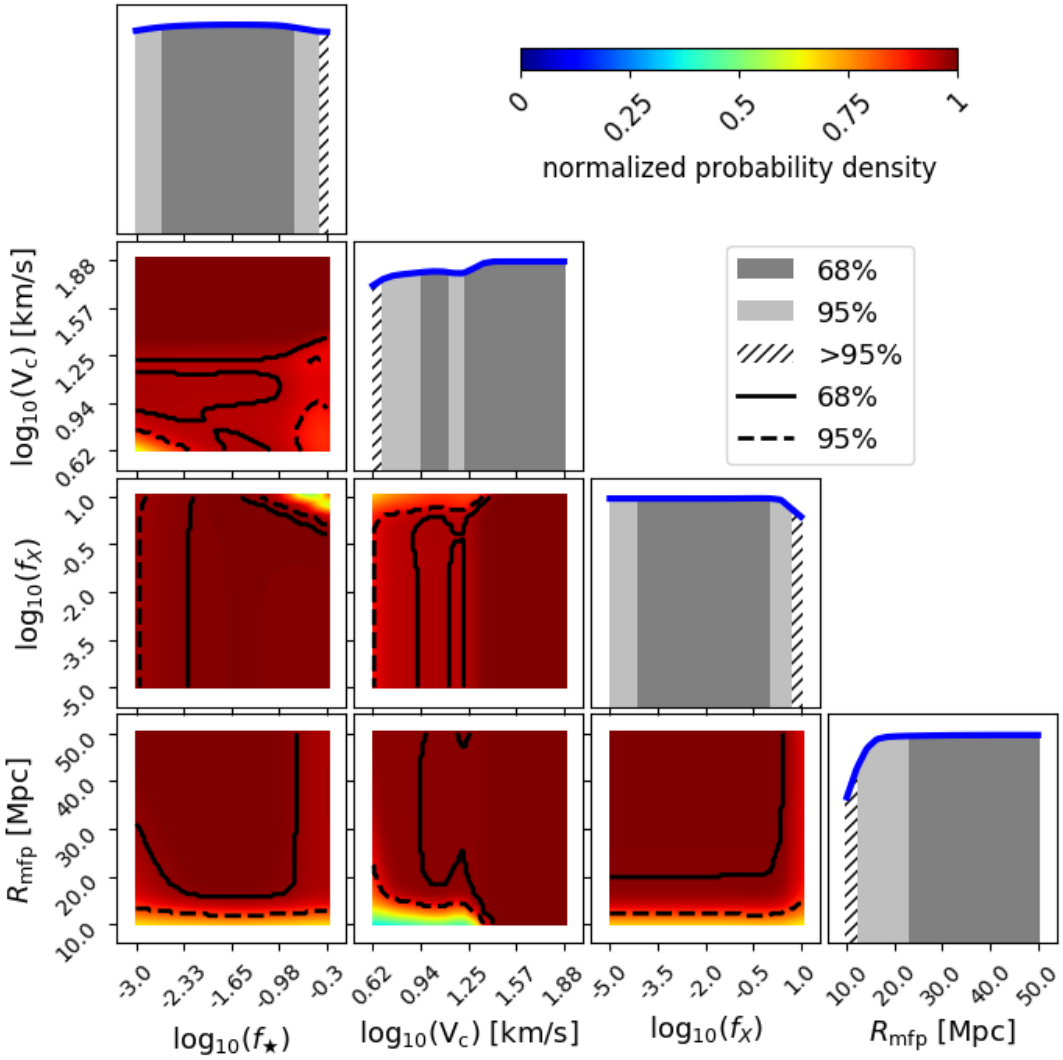


Figure 4: Constraints from the $x_{\rm HI}$ measurement by McGreer et al. (2015) at $z = 5.9$.

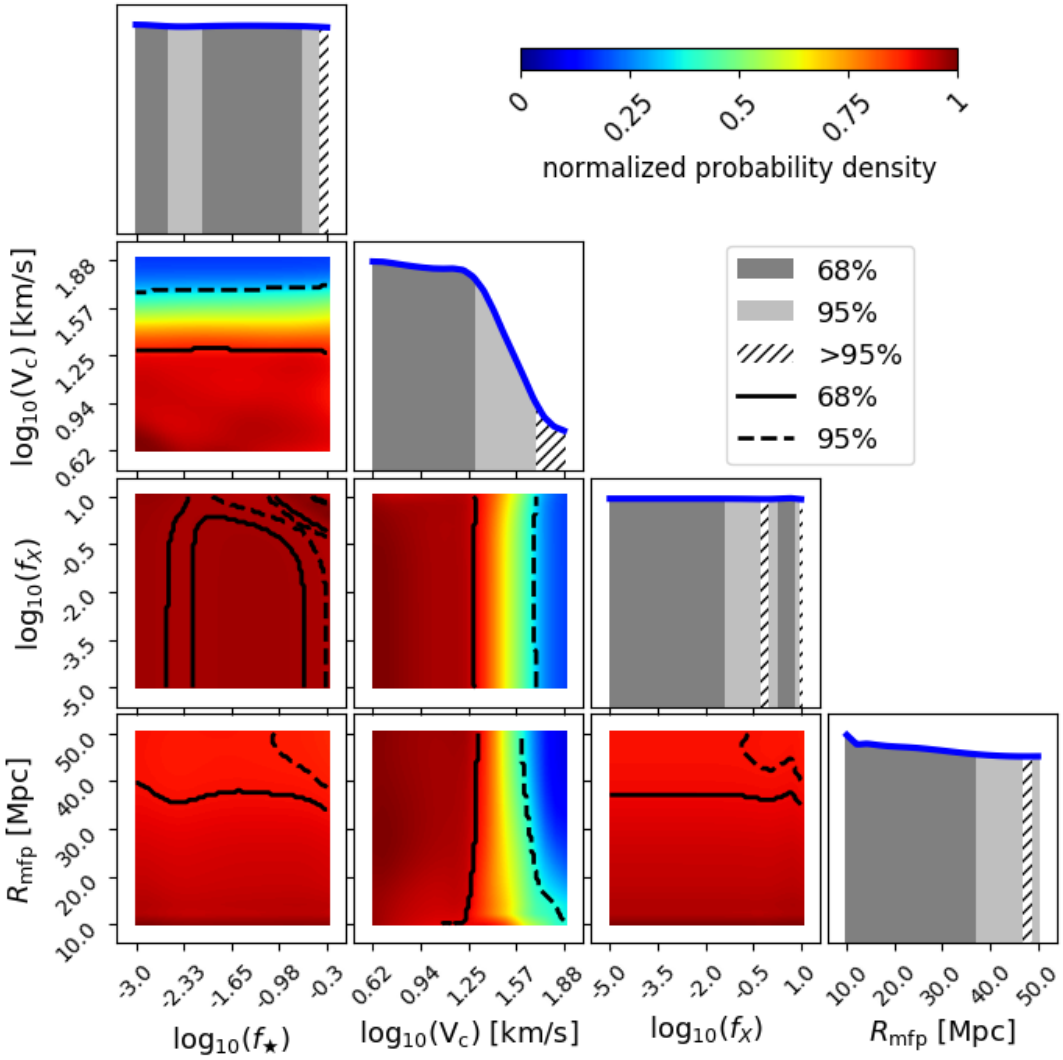


Figure 5: Constraints from the $x_{\rm HI}$ measurement by Bañados et al. (2017) at $z = 7.54$.

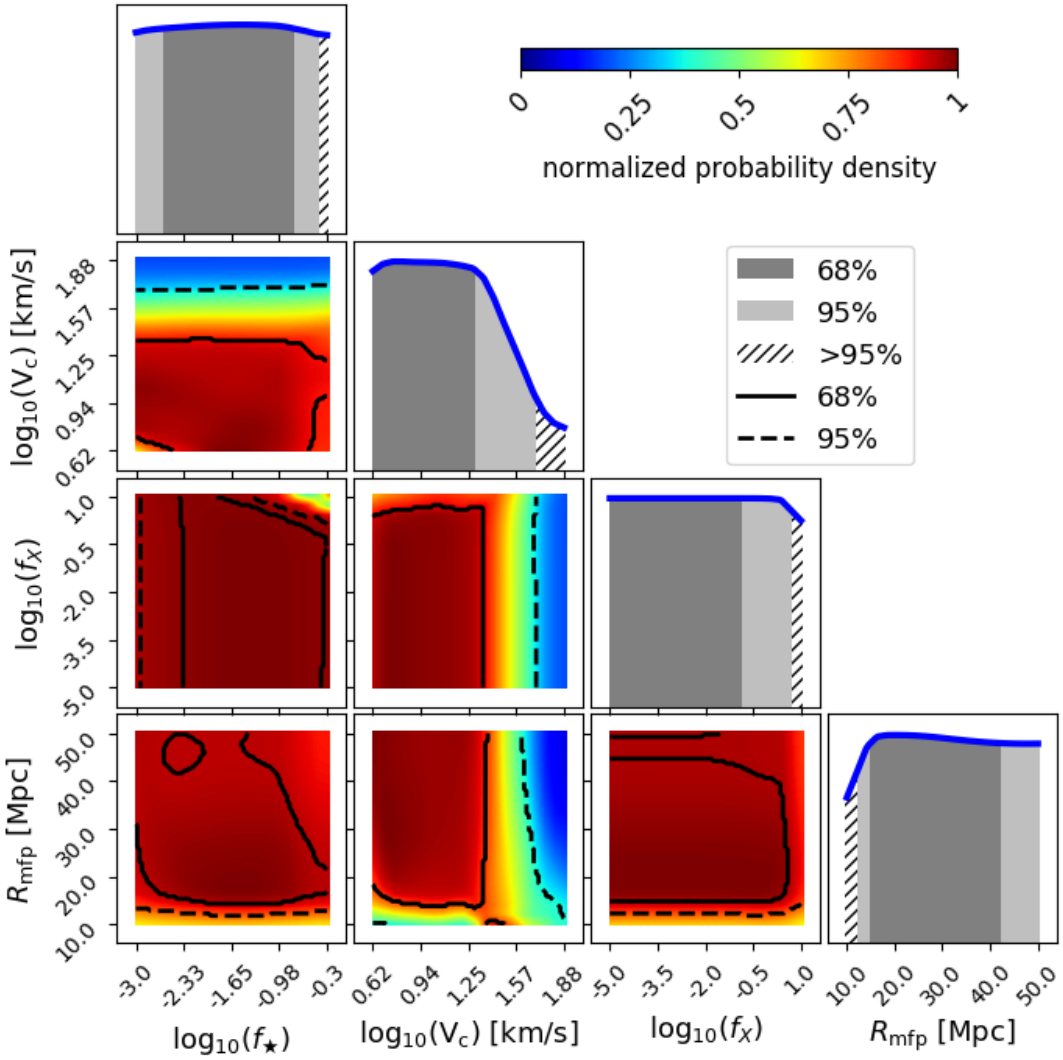


Figure 6: Constraints from both $x_{\rm HI}$ measurement, by McGreer et al. (2015) and Bañados et al. (2017).

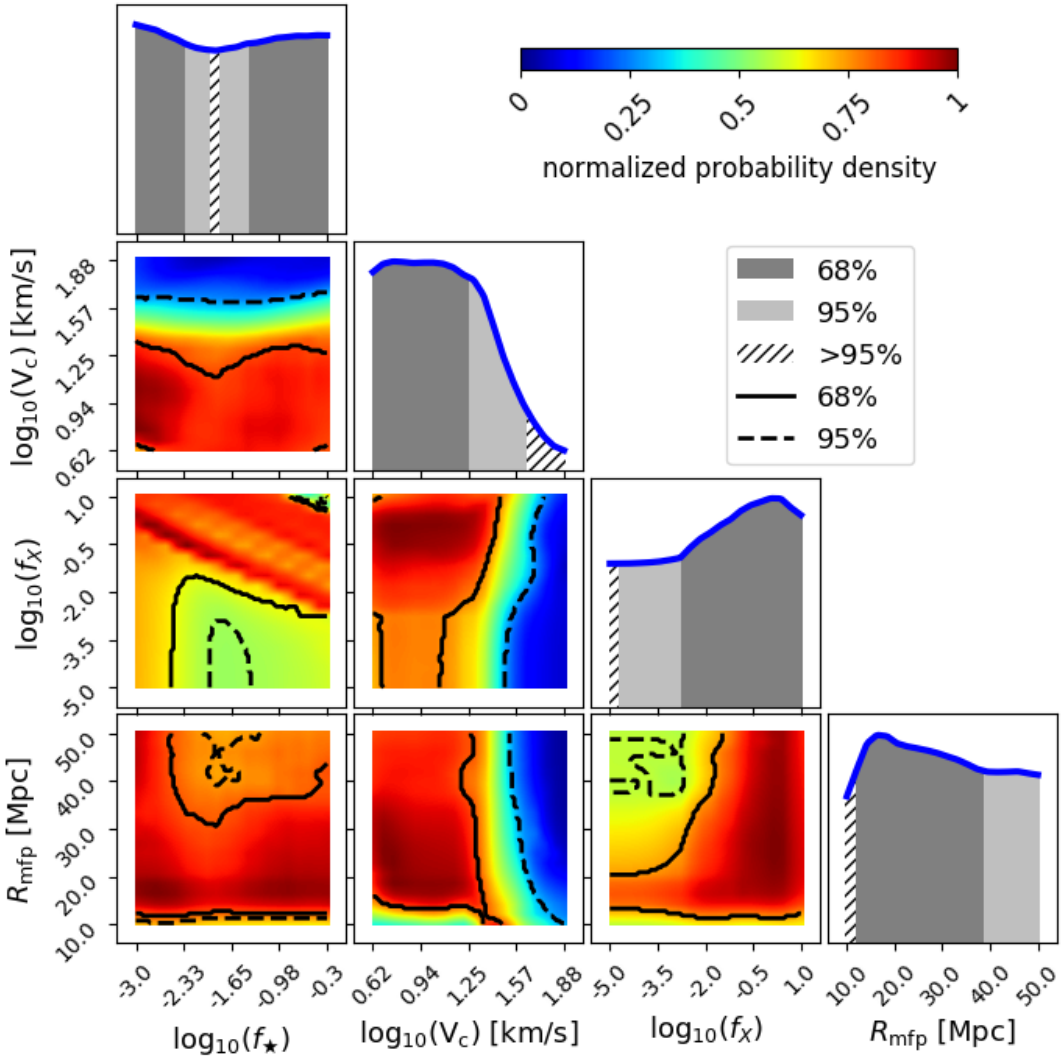


Figure 7: Constraints from both $x_{\rm HI}$ measurements and the EDGES High-Band measurement.

# 3 Simulations

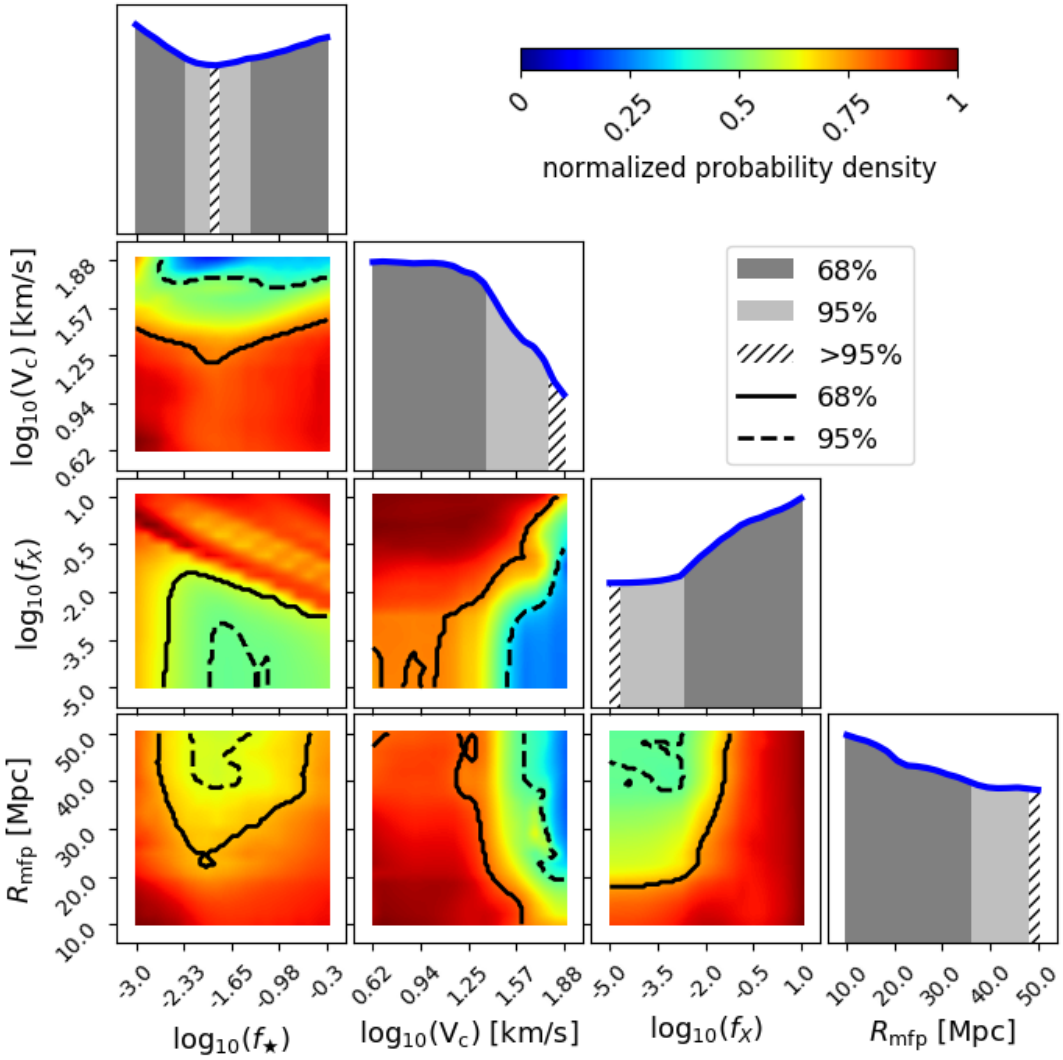


Figure 8: Nominal constraints of physical parameters from EDGES data only. Shown again for reference.

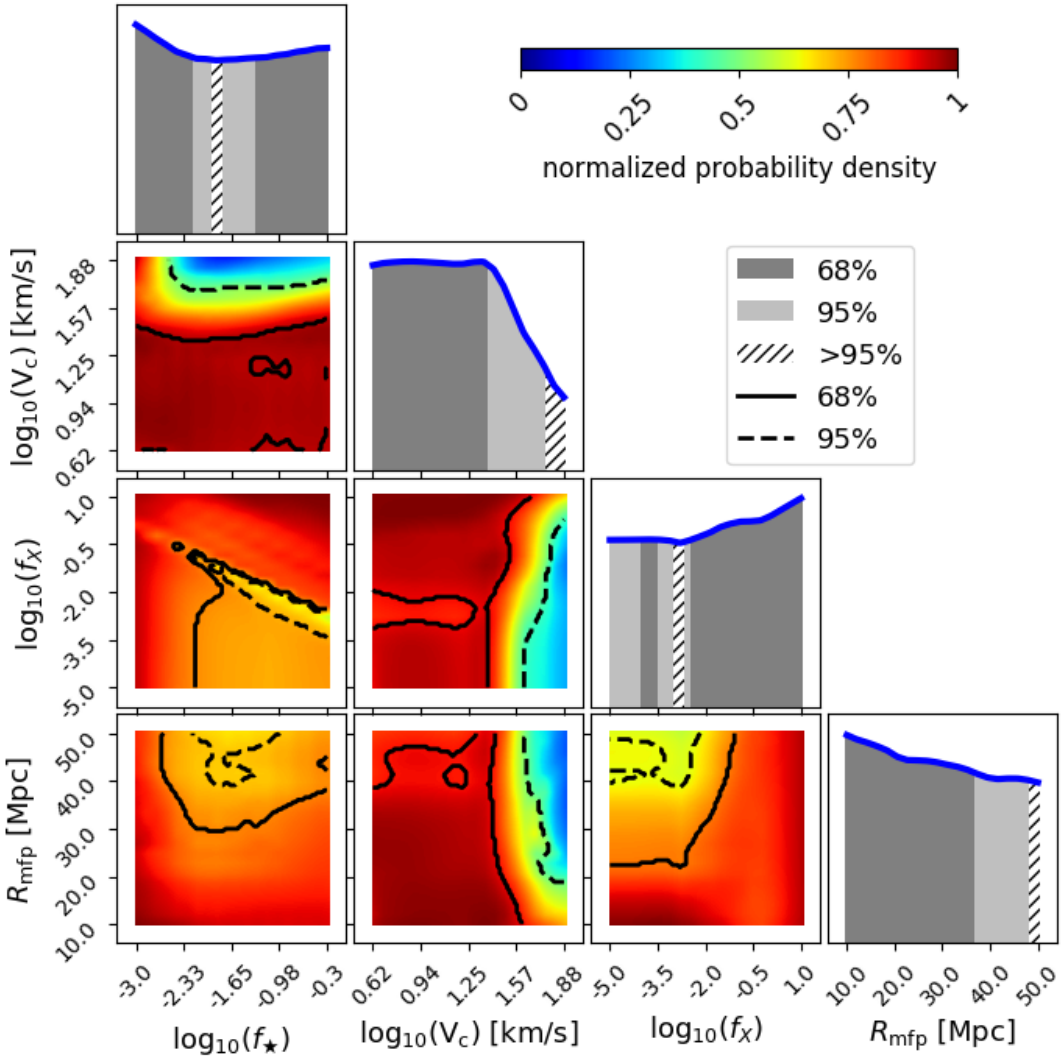


Figure 9: Simulation using 5-term EDGES polynomial plus noise, over 90-190 MHz.

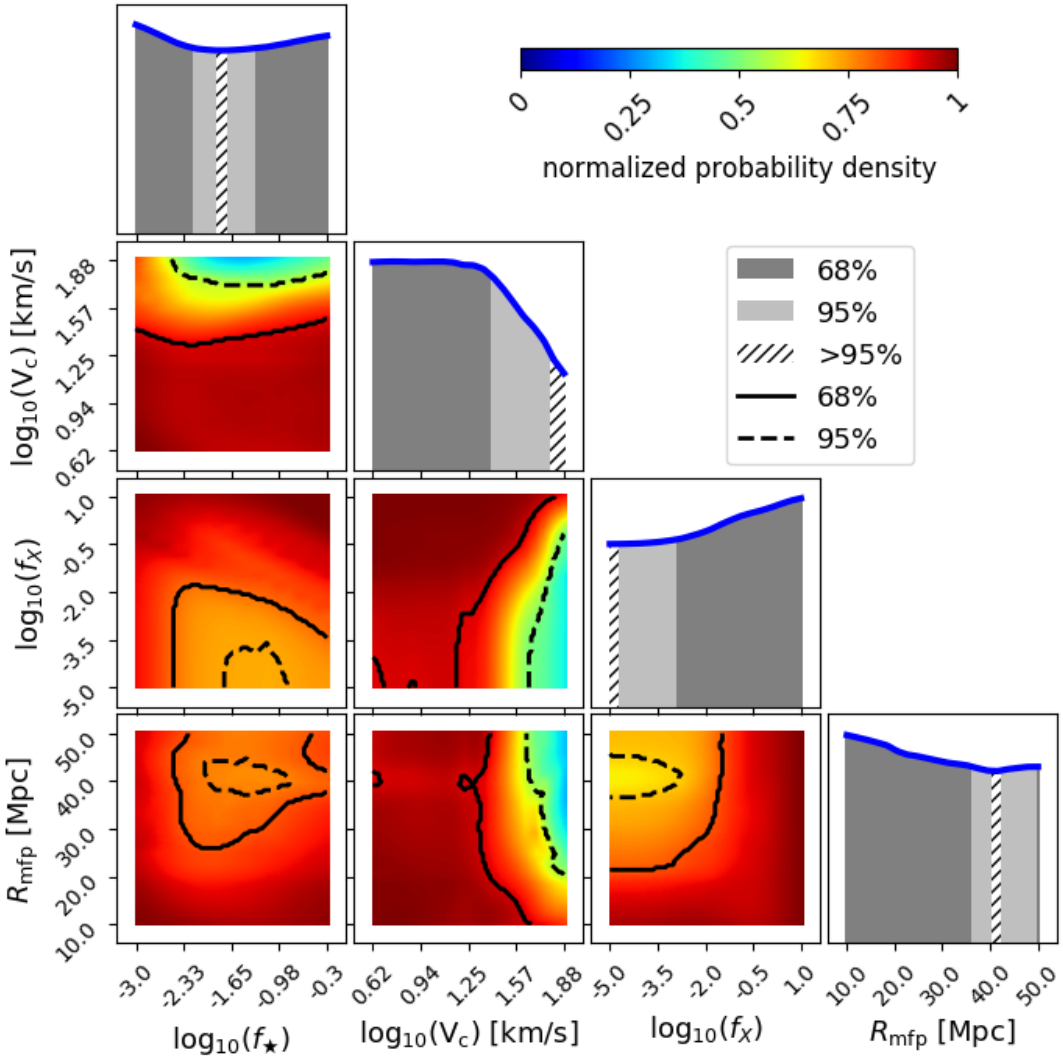


Figure 10: Simulation using 5-term EDGES polynomial plus noise, over 100-190 MHz.

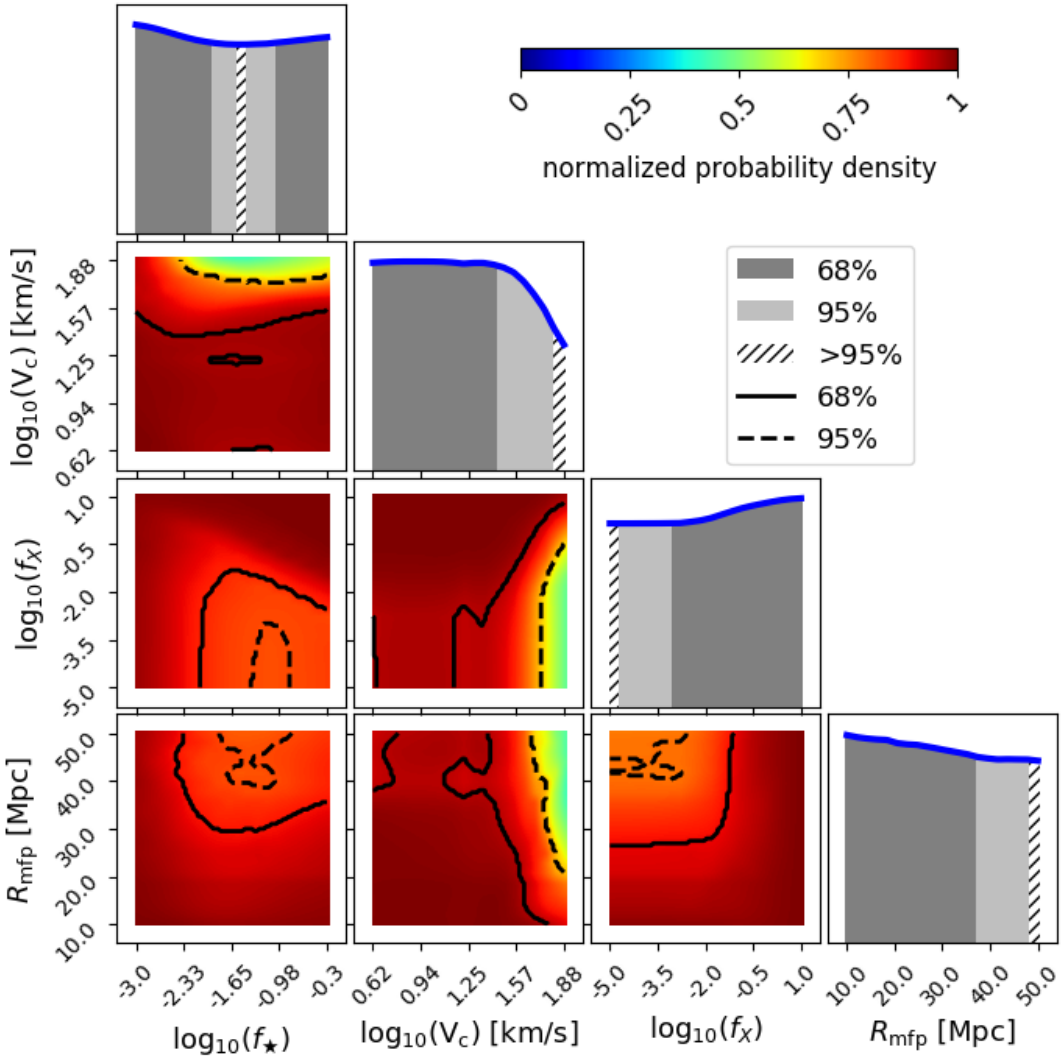


Figure 11: Simulation using 5-term EDGES polynomial plus noise, over 110-190 MHz.

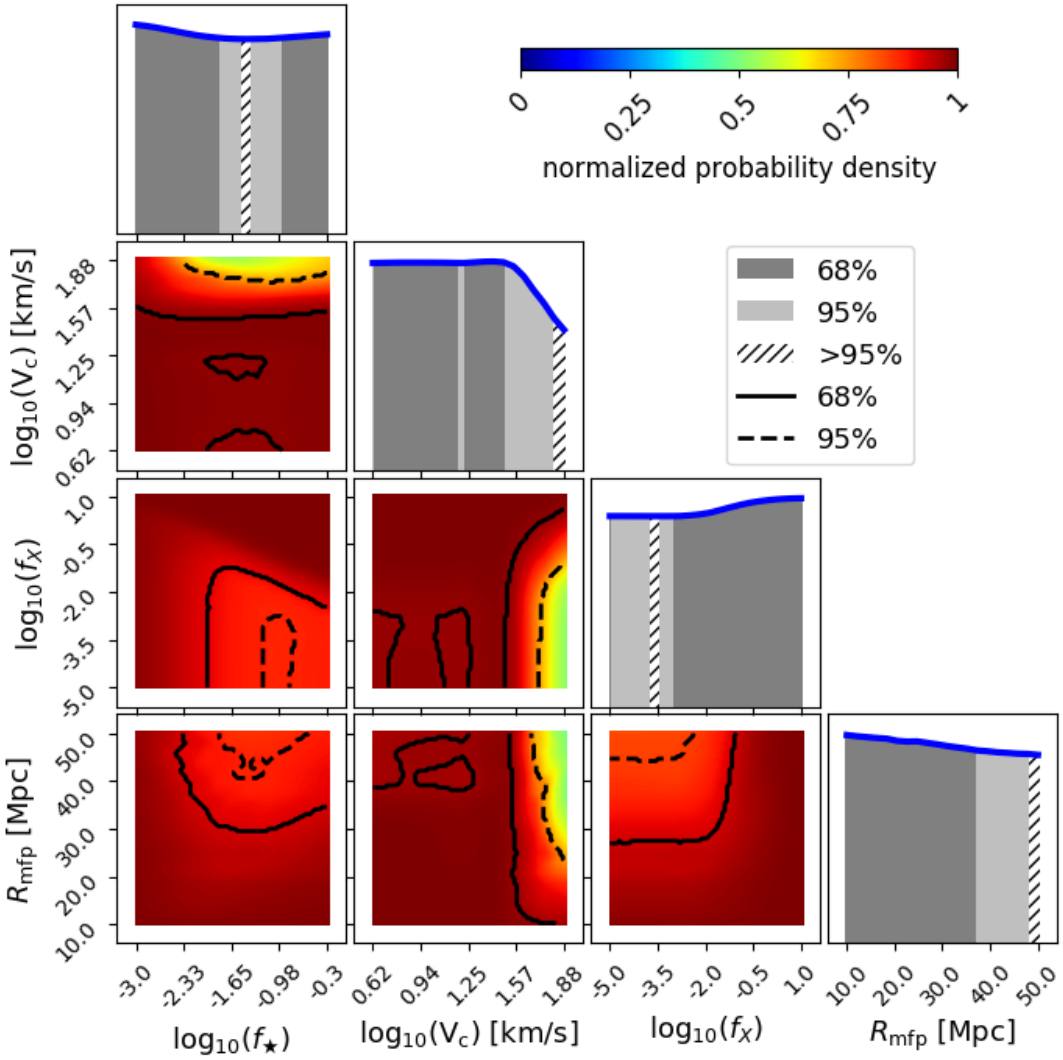


Figure 12: Simulation using 5-term EDGES polynomial plus noise, over 120-190 MHz.

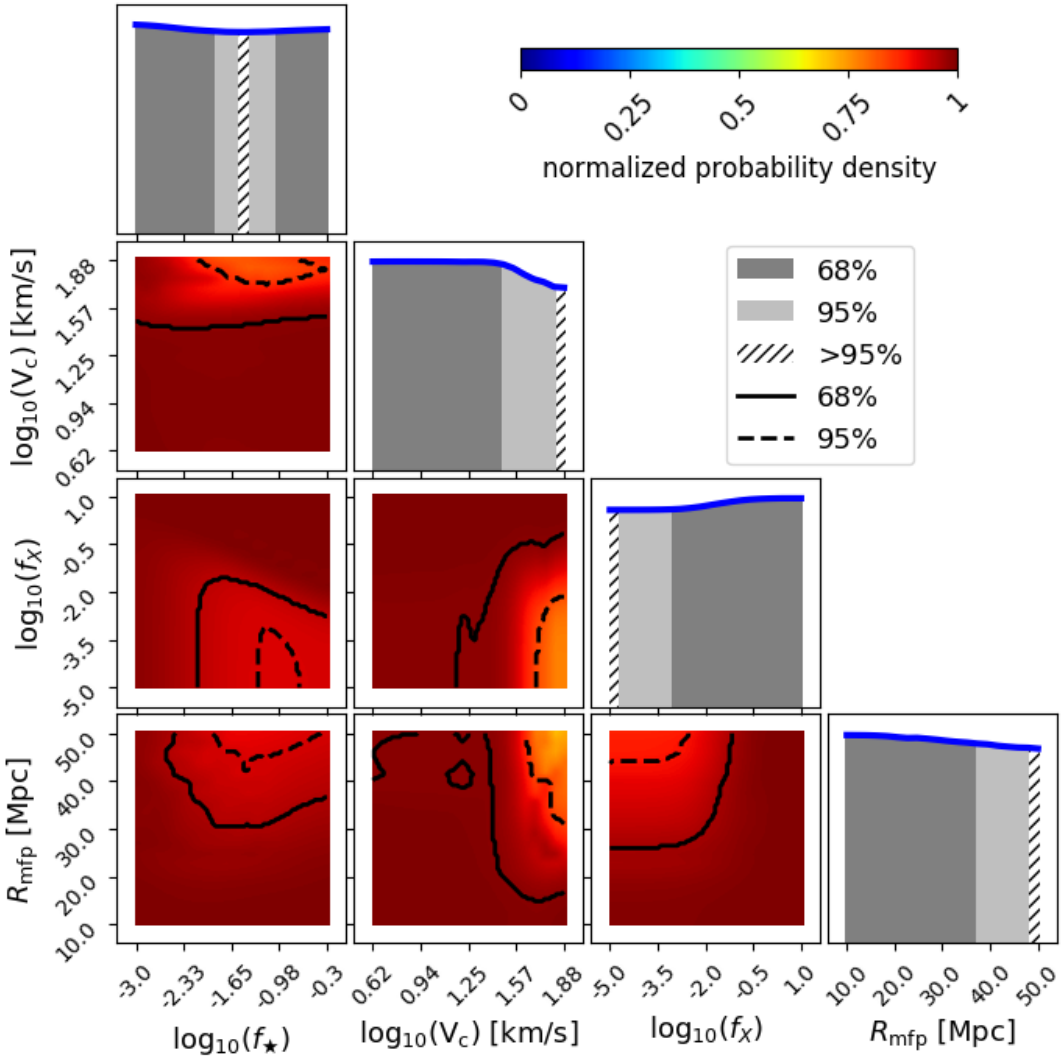


Figure 13: Simulation using 5-term EDGES polynomial plus noise, over 130-190 MHz.

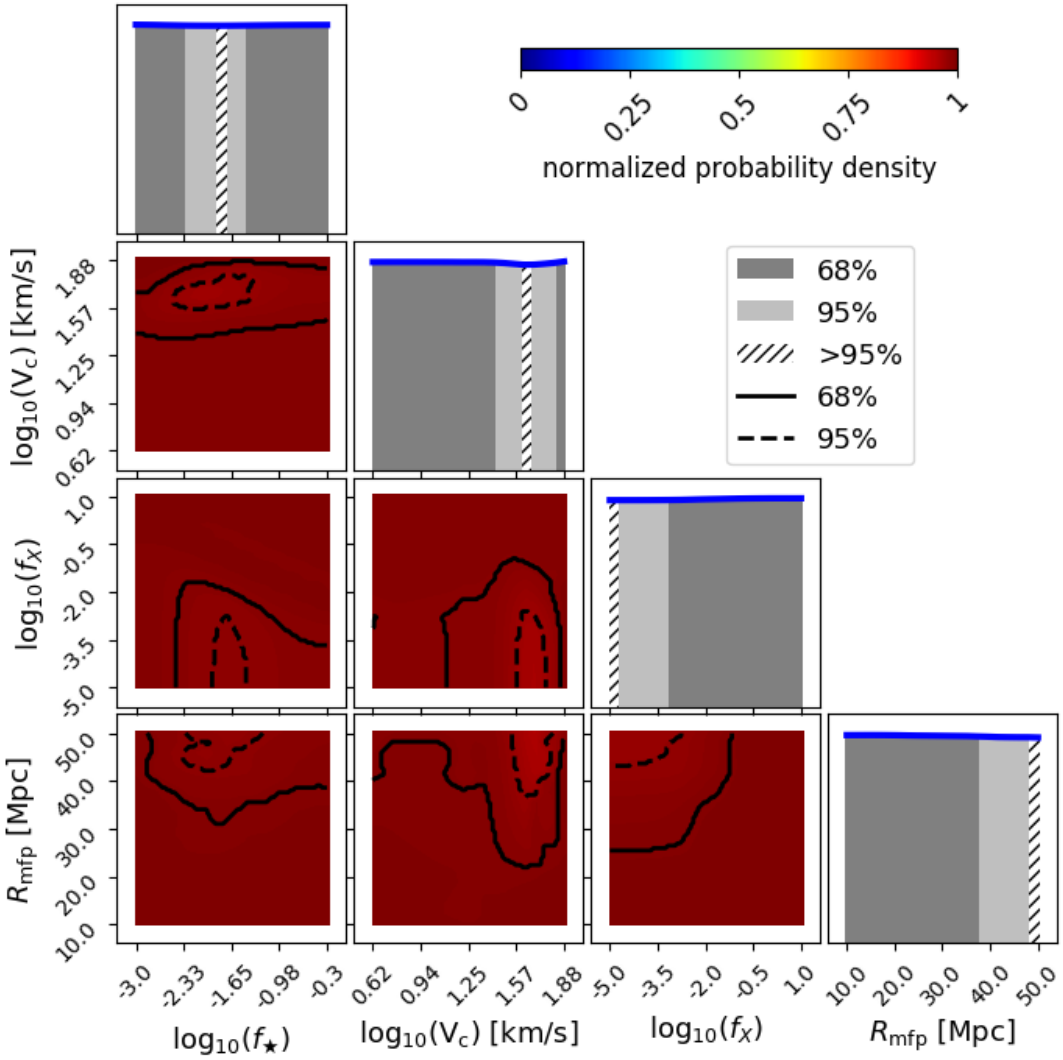


Figure 14: Simulation using 5-term EDGES polynomial plus noise, over 140-190 MHz.

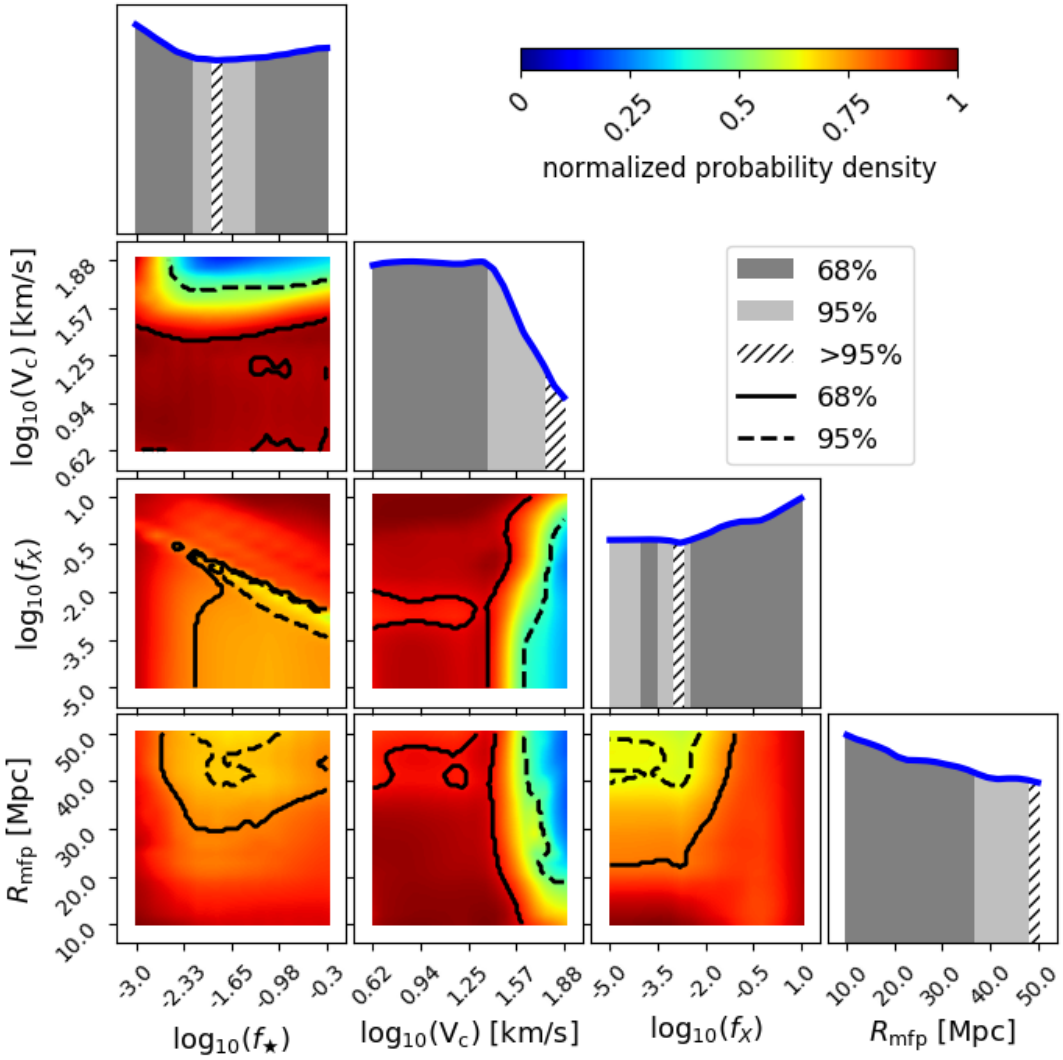


Figure 15: Simulation using 5-term EDGES polynomial plus noise, over 90-190 MHz.

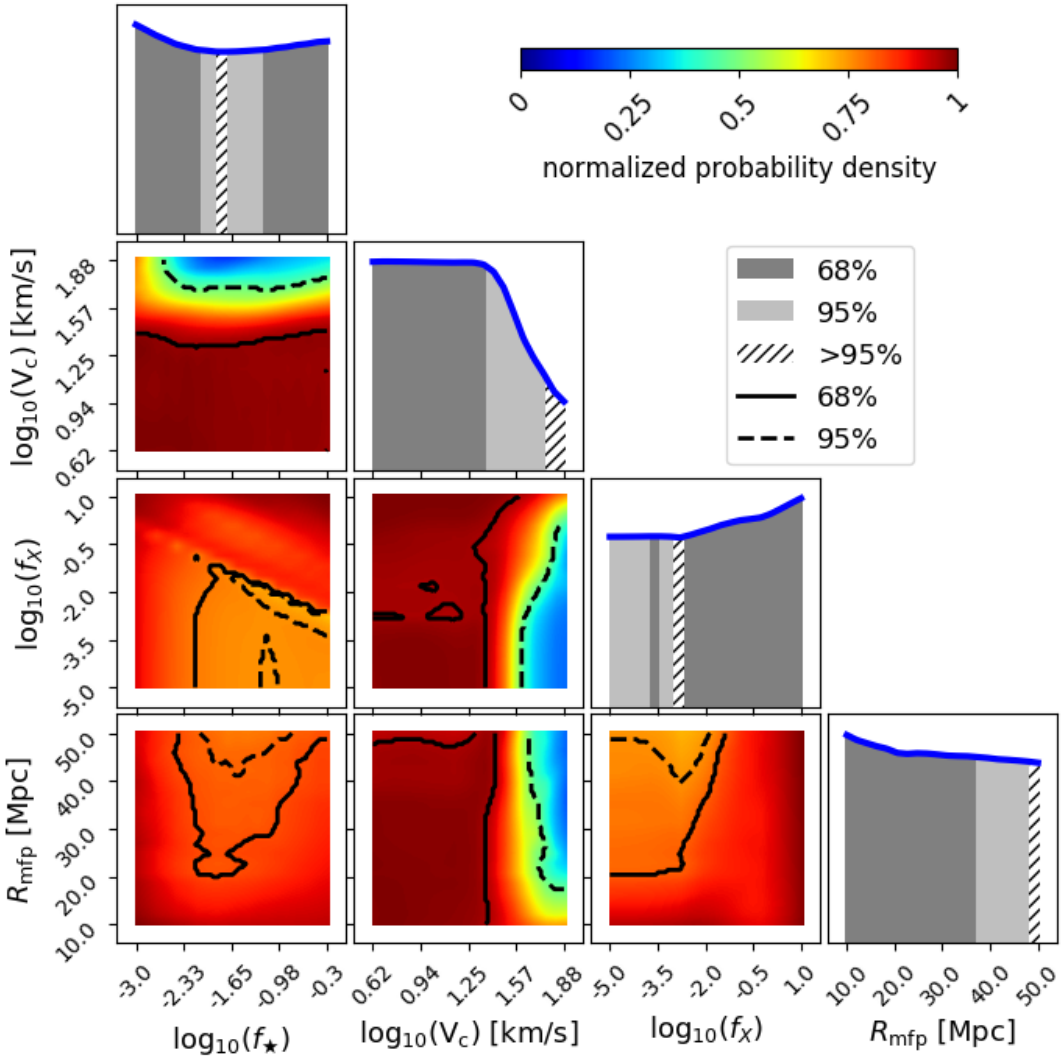


Figure 16: Simulation using 5-term EDGES polynomial plus noise, over 90-180 MHz.

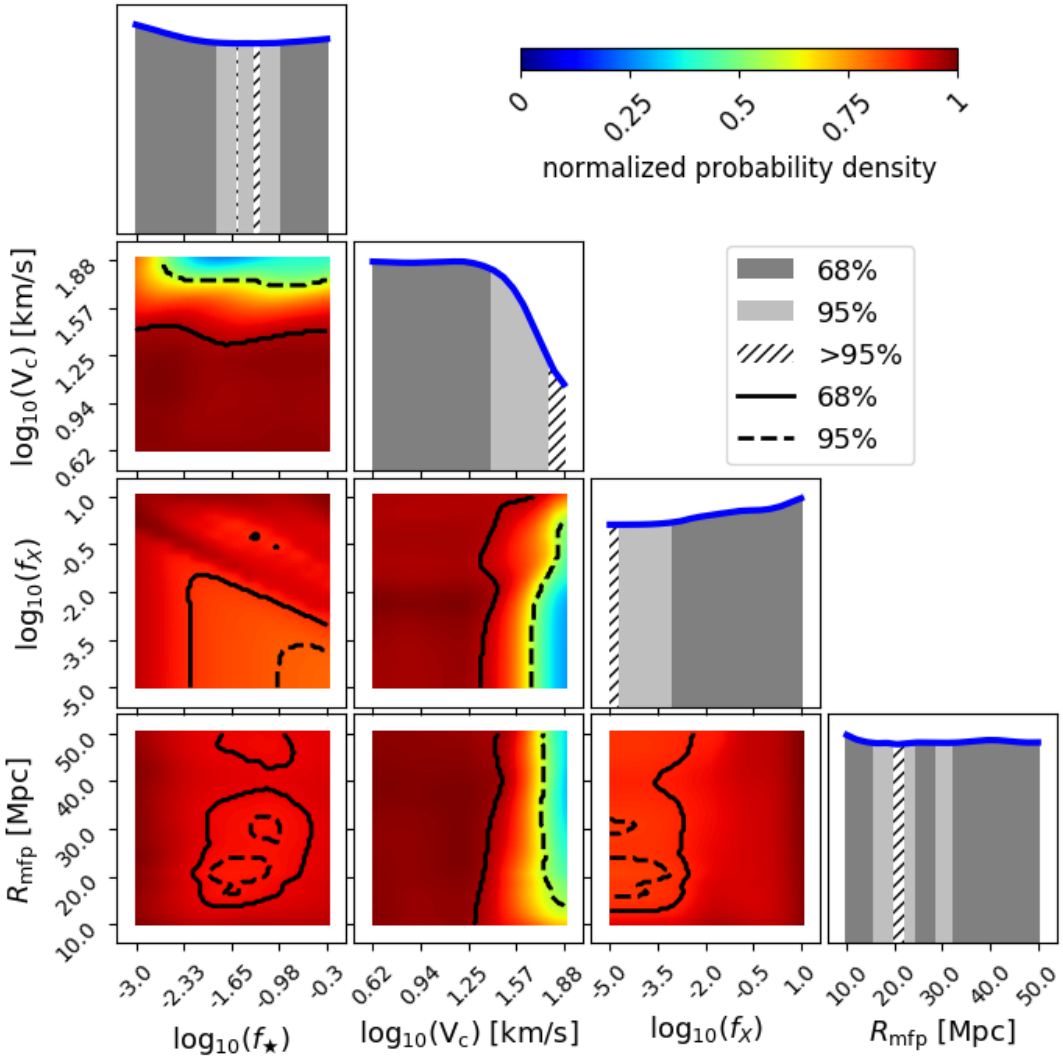


Figure 17: Simulation using 5-term EDGES polynomial plus noise, over 90-170 MHz.

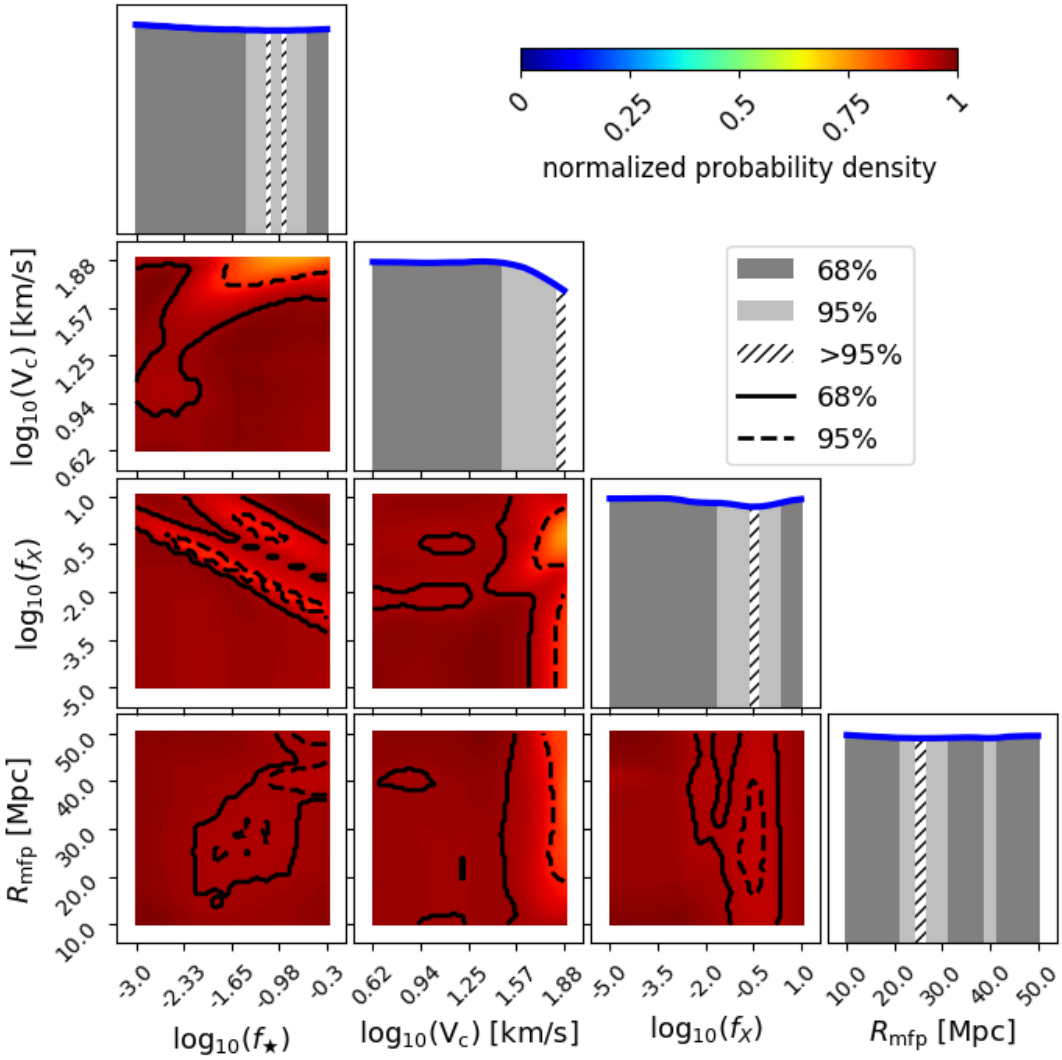


Figure 18: Simulation using 5-term EDGES polynomial plus noise, over 90-160 MHz.

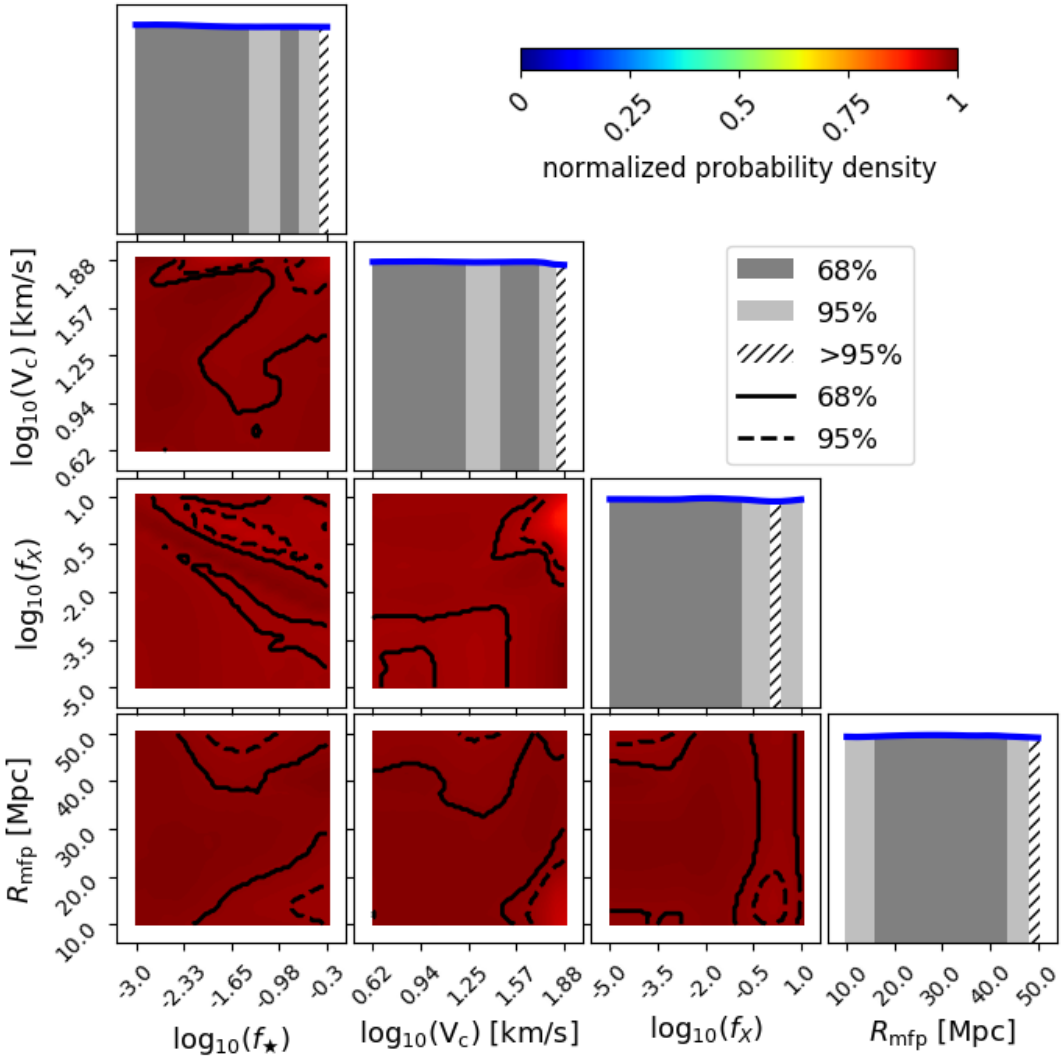


Figure 19: Simulation using 5-term EDGES polynomial plus noise, over 90-150 MHz.

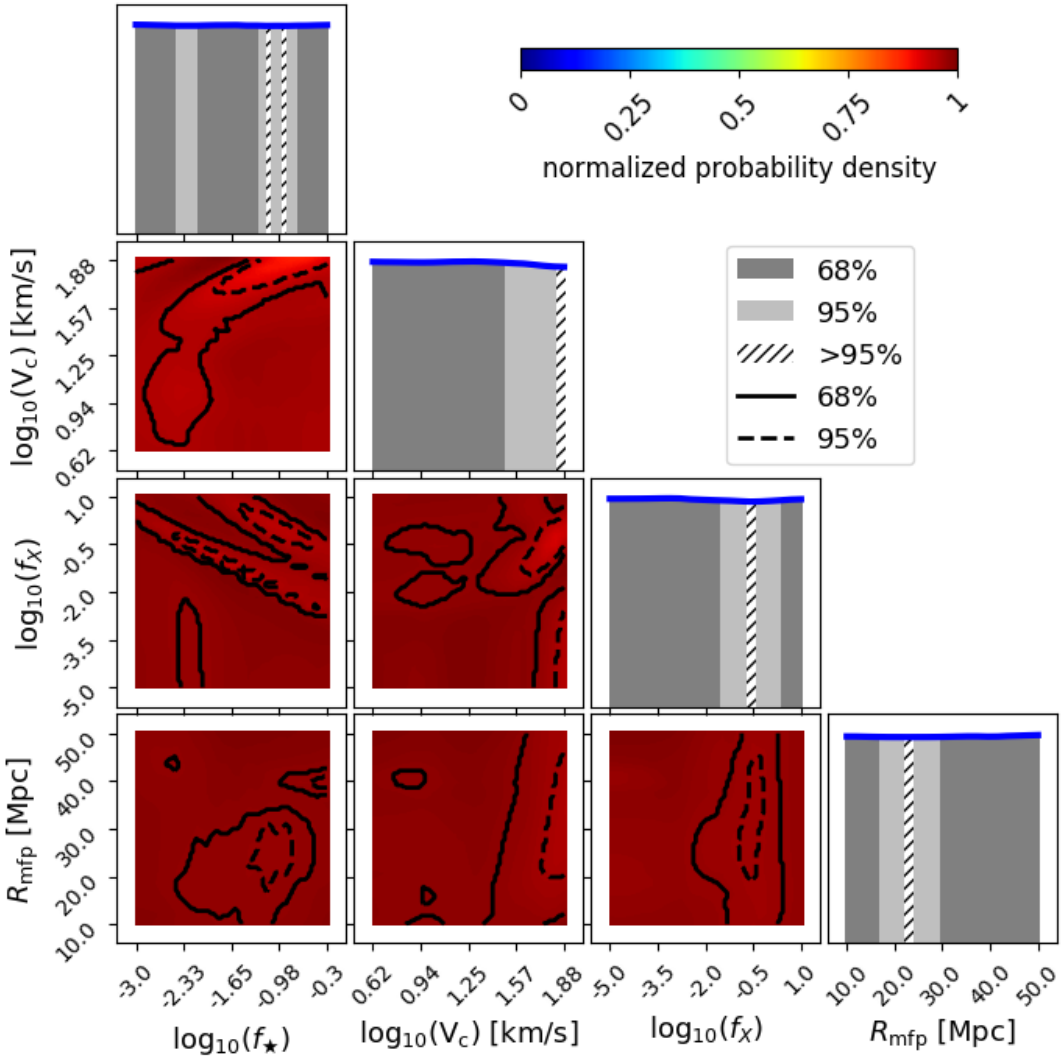


Figure 20: Simulation using 5-term EDGES polynomial plus noise, over 90-140 MHz.

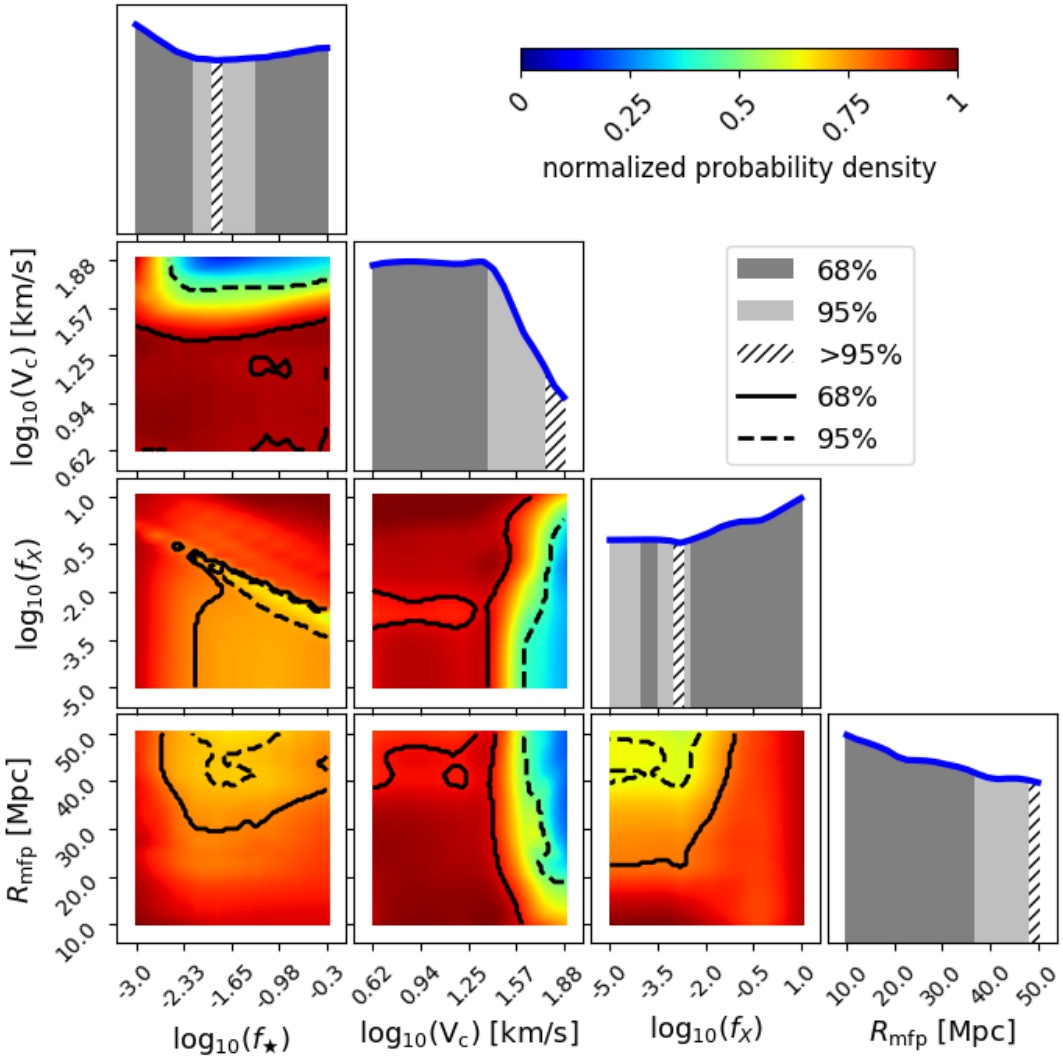


Figure 21: Simulation using 5-term EDGES polynomial plus noise, over 90-190 MHz.

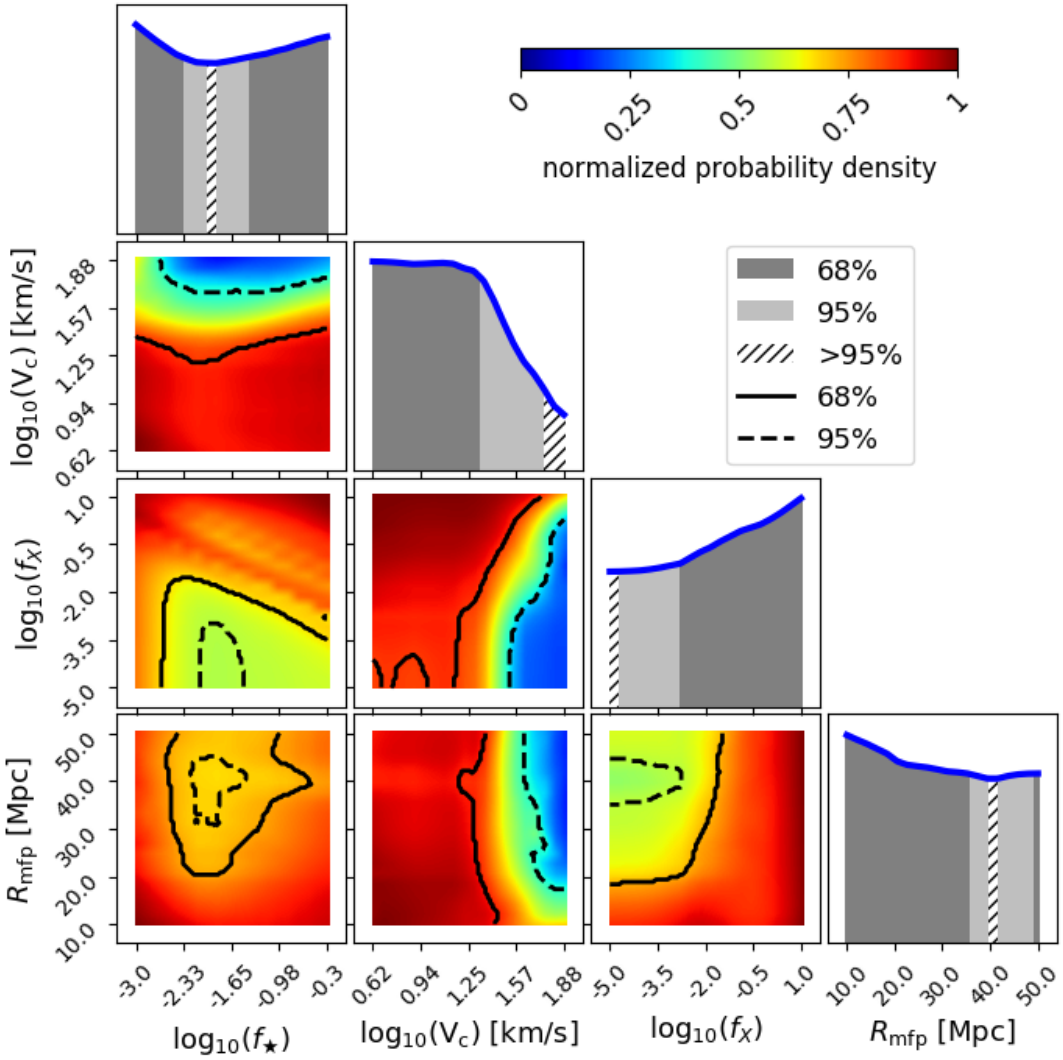


Figure 22: Simulation using 5-term EDGES polynomial plus noise, plus 25% of real ripples, over 90-190 MHz.

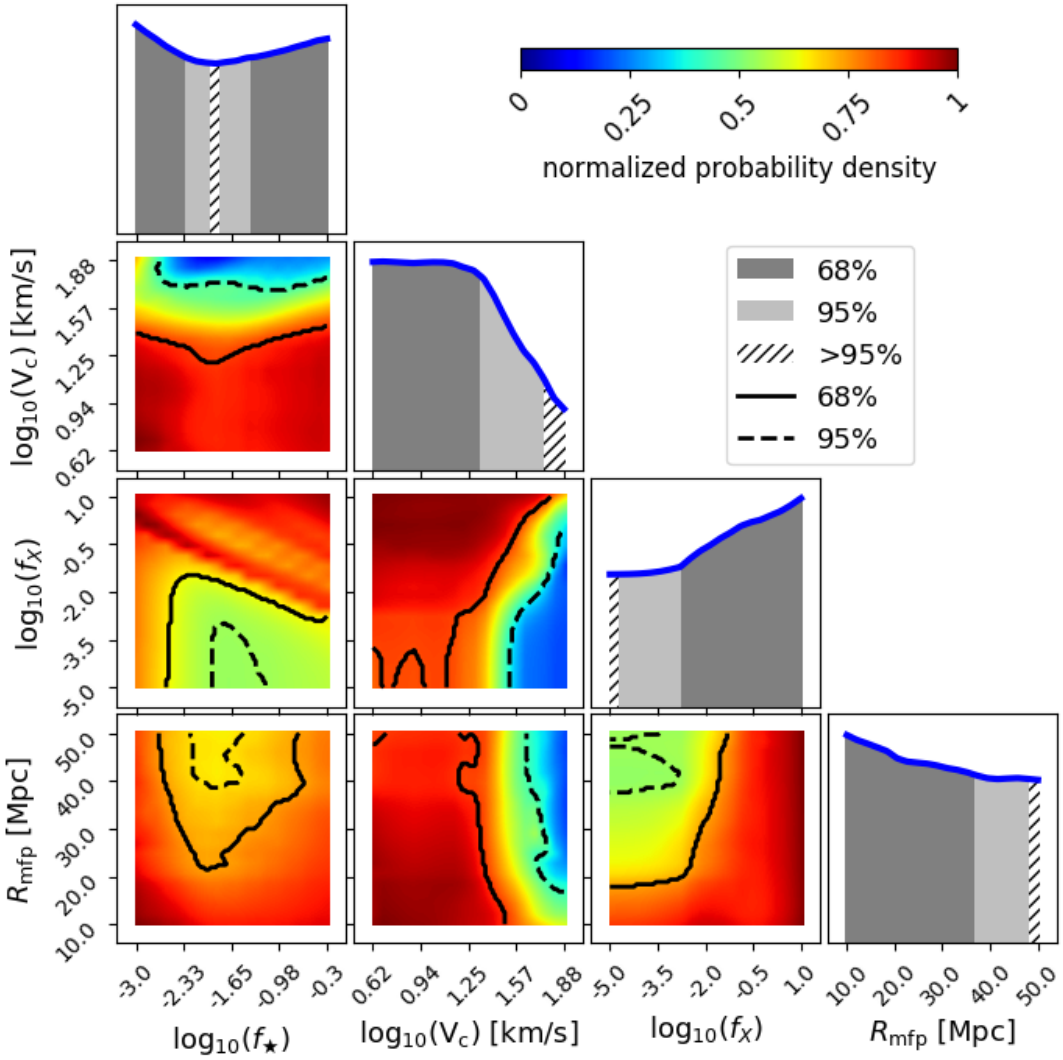


Figure 23: Simulation using 5-term EDGES polynomial plus noise, plus 50% of real ripples, over 90-190 MHz.

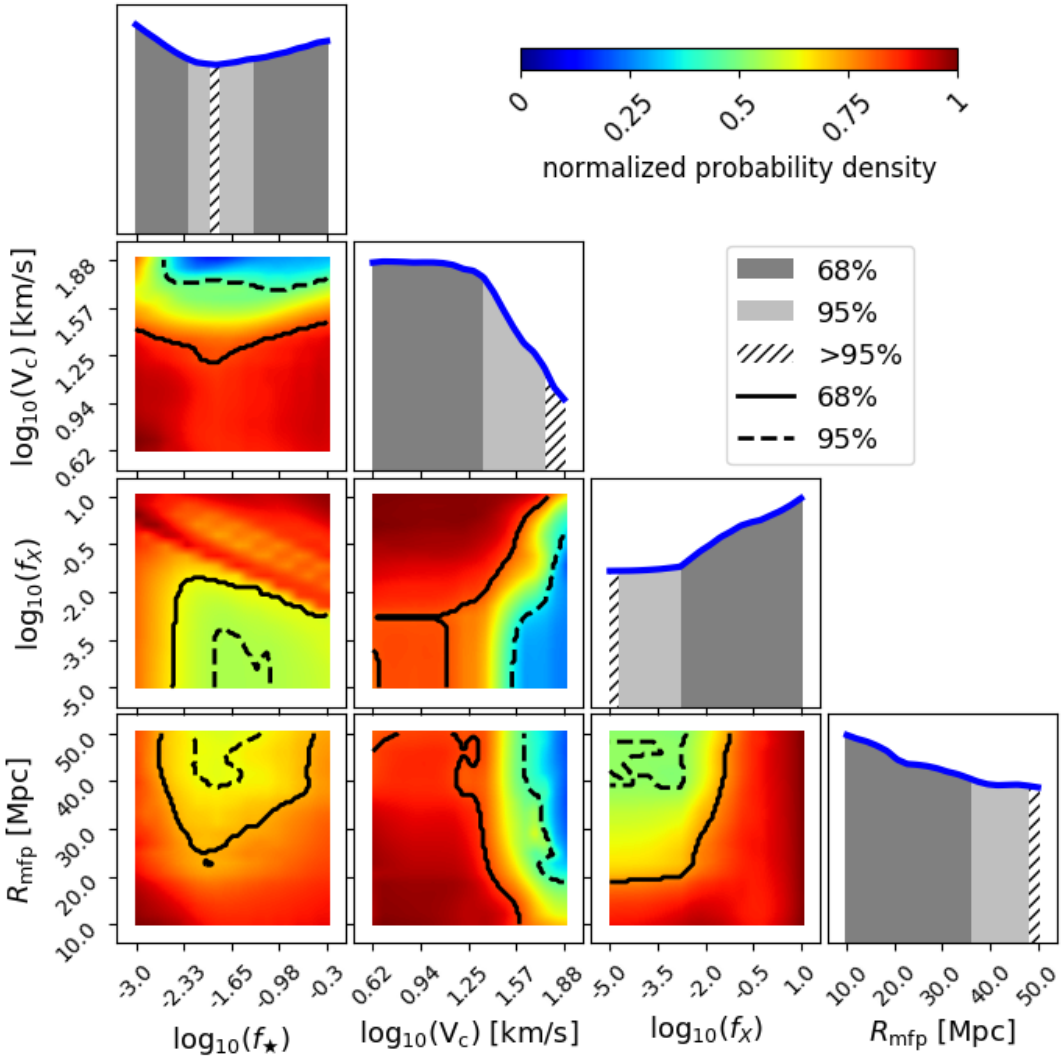


Figure 24: Simulation using 5-term EDGES polynomial plus noise, plus 75% of real ripples, over 90-190 MHz.

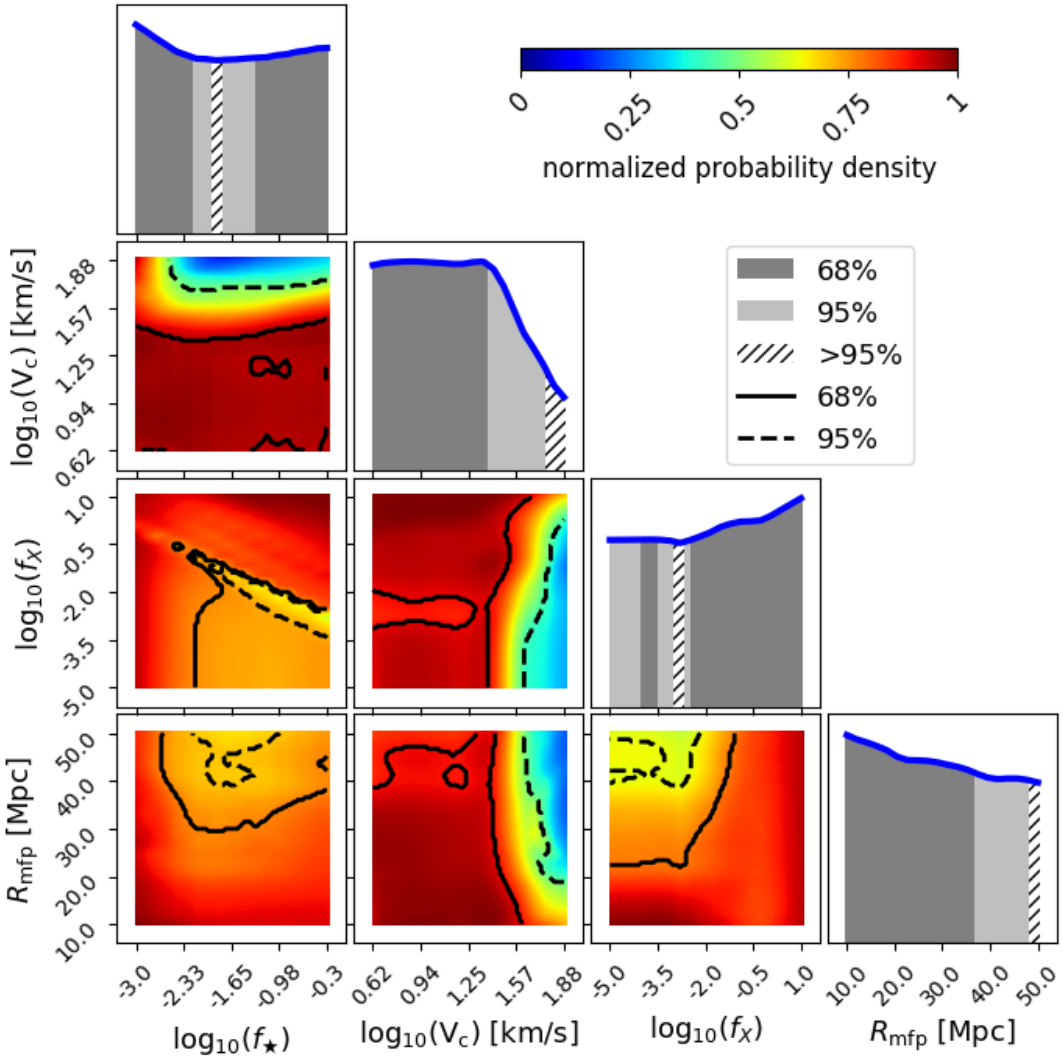


Figure 25: Simulation using 5-term EDGES polynomial plus noise, over 90-190 MHz.

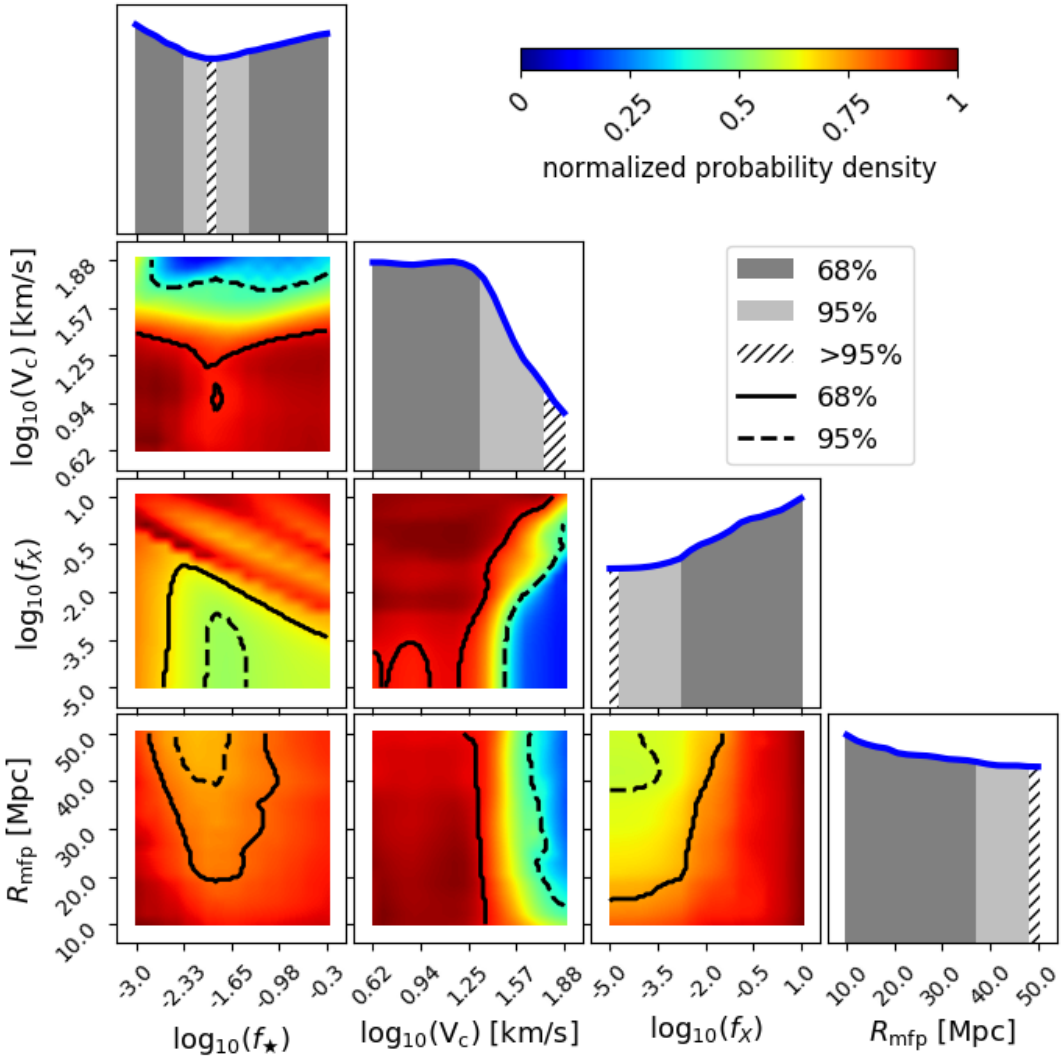


Figure 26: Real data below 125 MHz, simulated data (only polynomial and noise, no ripples) above 125 MHz.

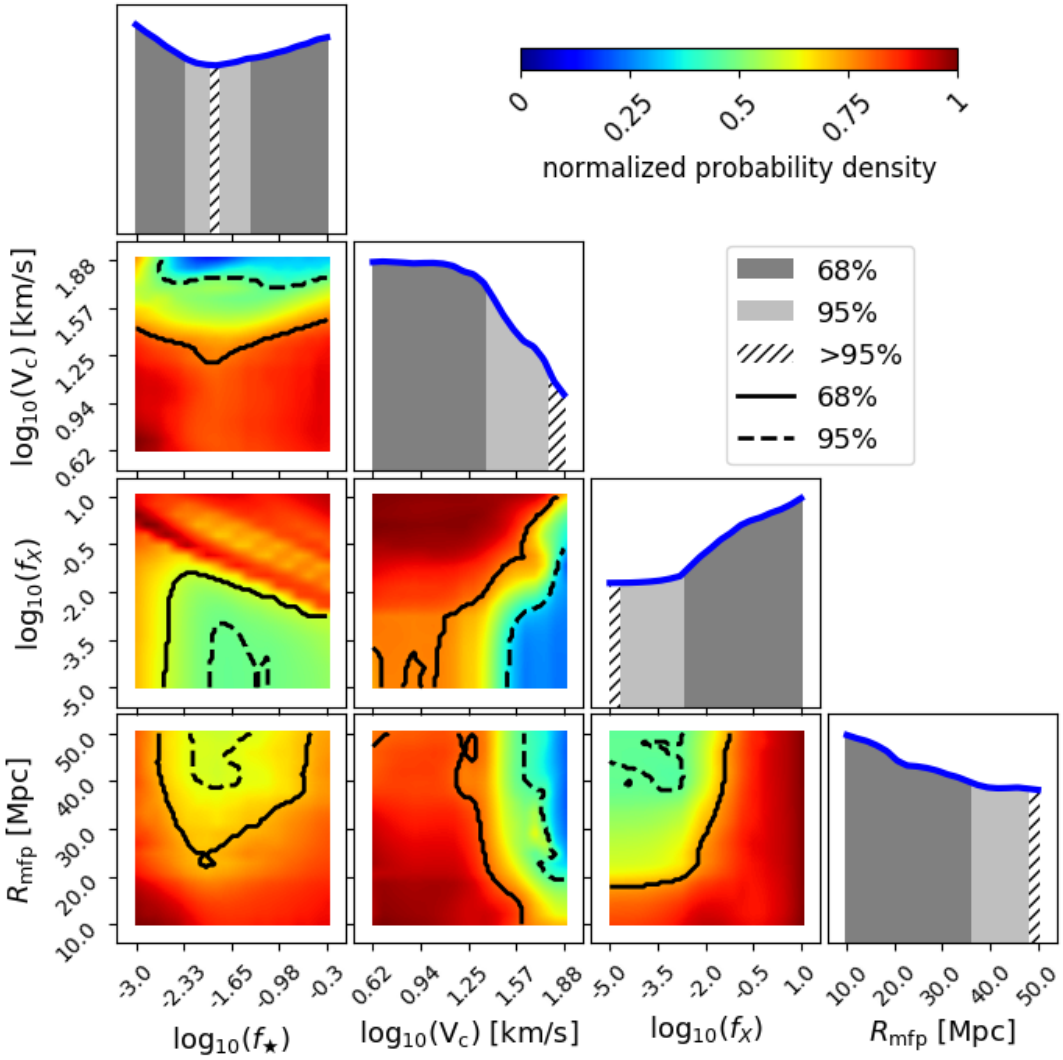


Figure 27: Nominal constraints of physical parameters from EDGES data only. Shown again for reference.