Colour Population Drift

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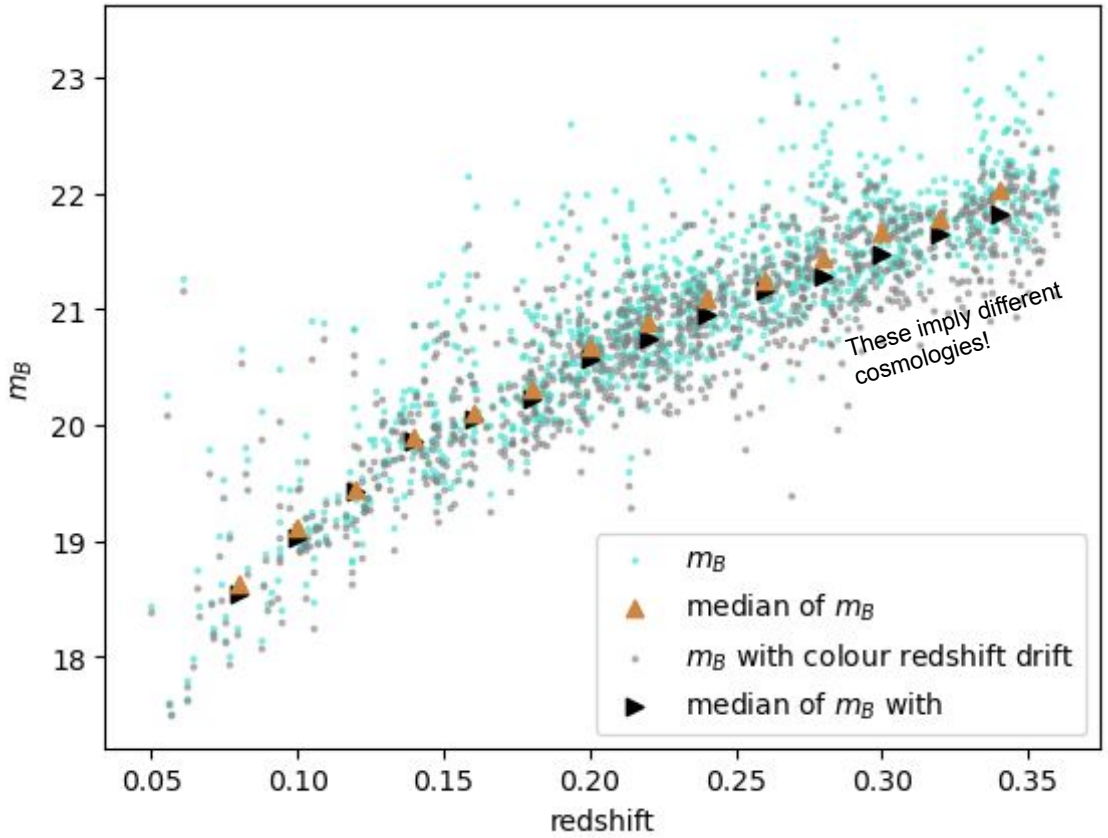
Why do we care if colour drifts?

I recently acquired a PhD in fitting curves, and I have learned that fitting curves is complicated.

Any redshift-dependent evolution is degenerate with cosmology.

Like, for instance, colour?

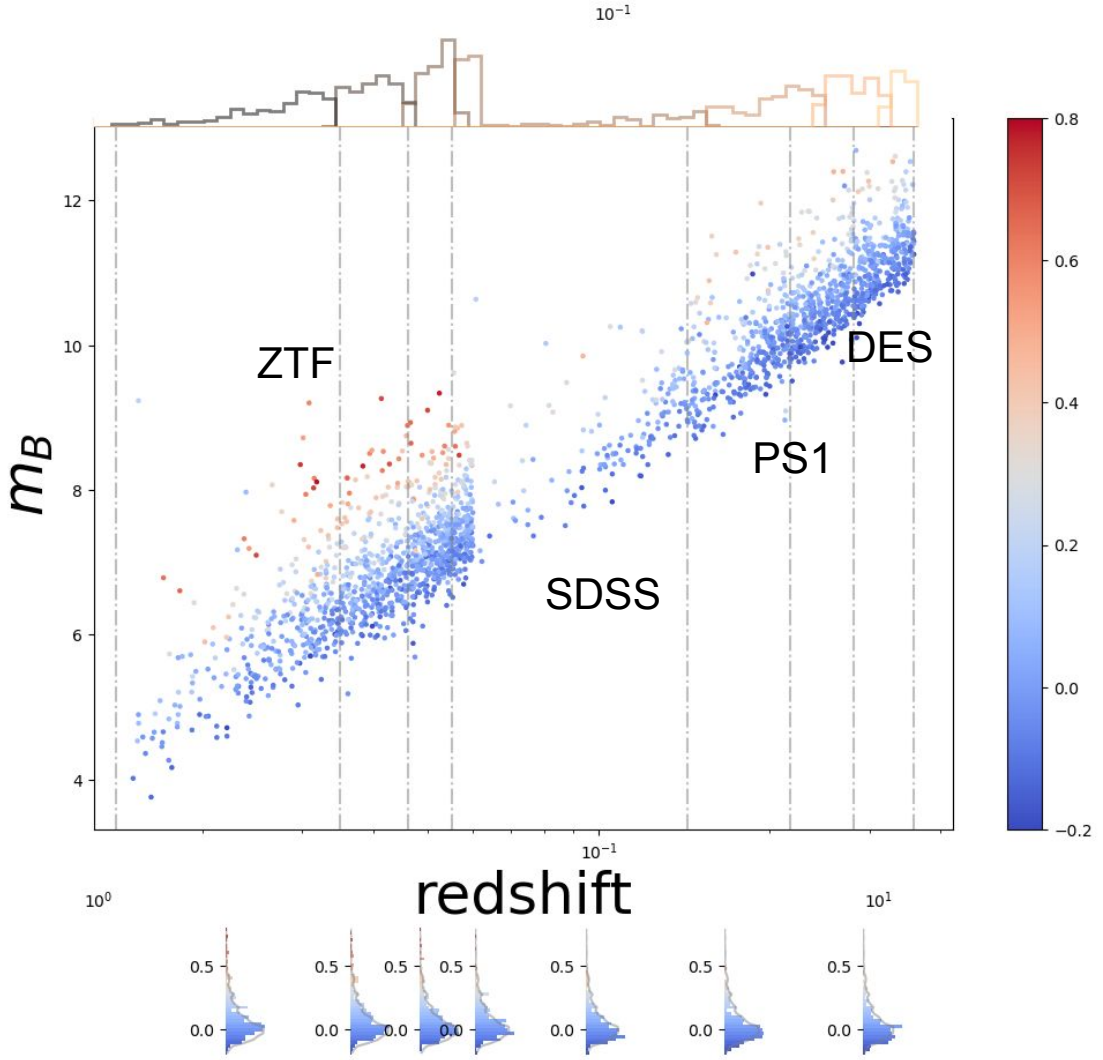


With ZTF, we finally have a large volume of data across redshifts

Even with very conservative cuts*, we have over 2000 SNIa from z = 0.015 to z=1.2!

This should be more than enough to begin investigating any potential population drift

*Detailed in next slide



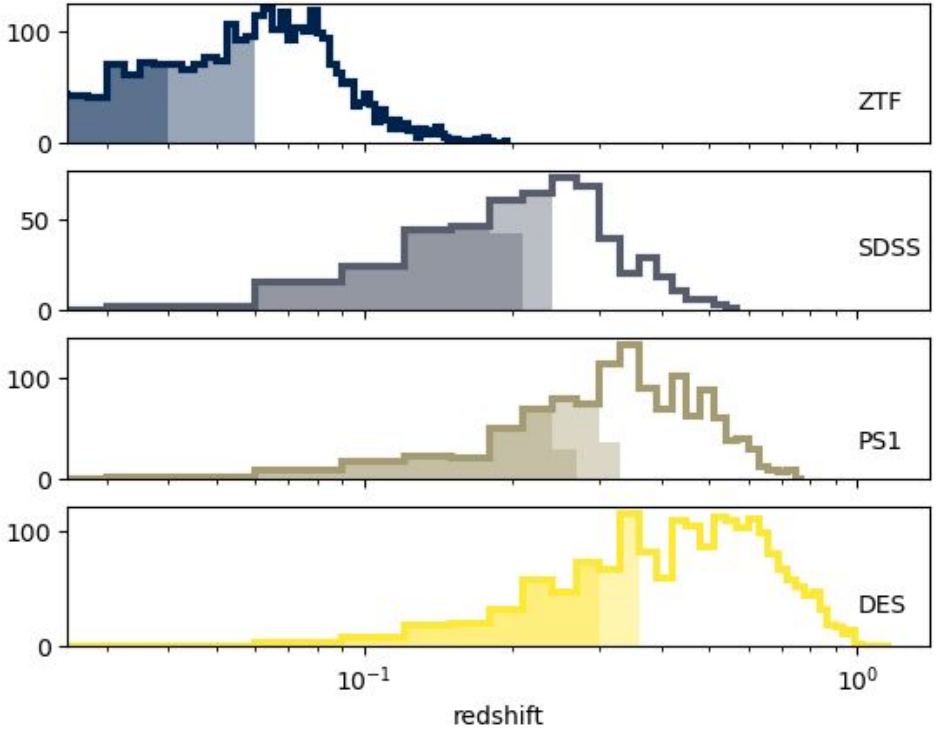
Selection Effects Can Cause Biases

We want to avoid any selection effects on our sample, since red SNIa are dimmer and less likely to be observed.

Following Nicolas et al. 2021, we will define two volume-limited samples that are “selection-free”:

Survey, conservative, fiducial		
ZTF:	0.04,	0.06
SDSS:	0.20,	0.24
PS1:	0.25,	0.31
DES:	0.30,	0.36

Additional cuts made on x1 and PKMJD errors

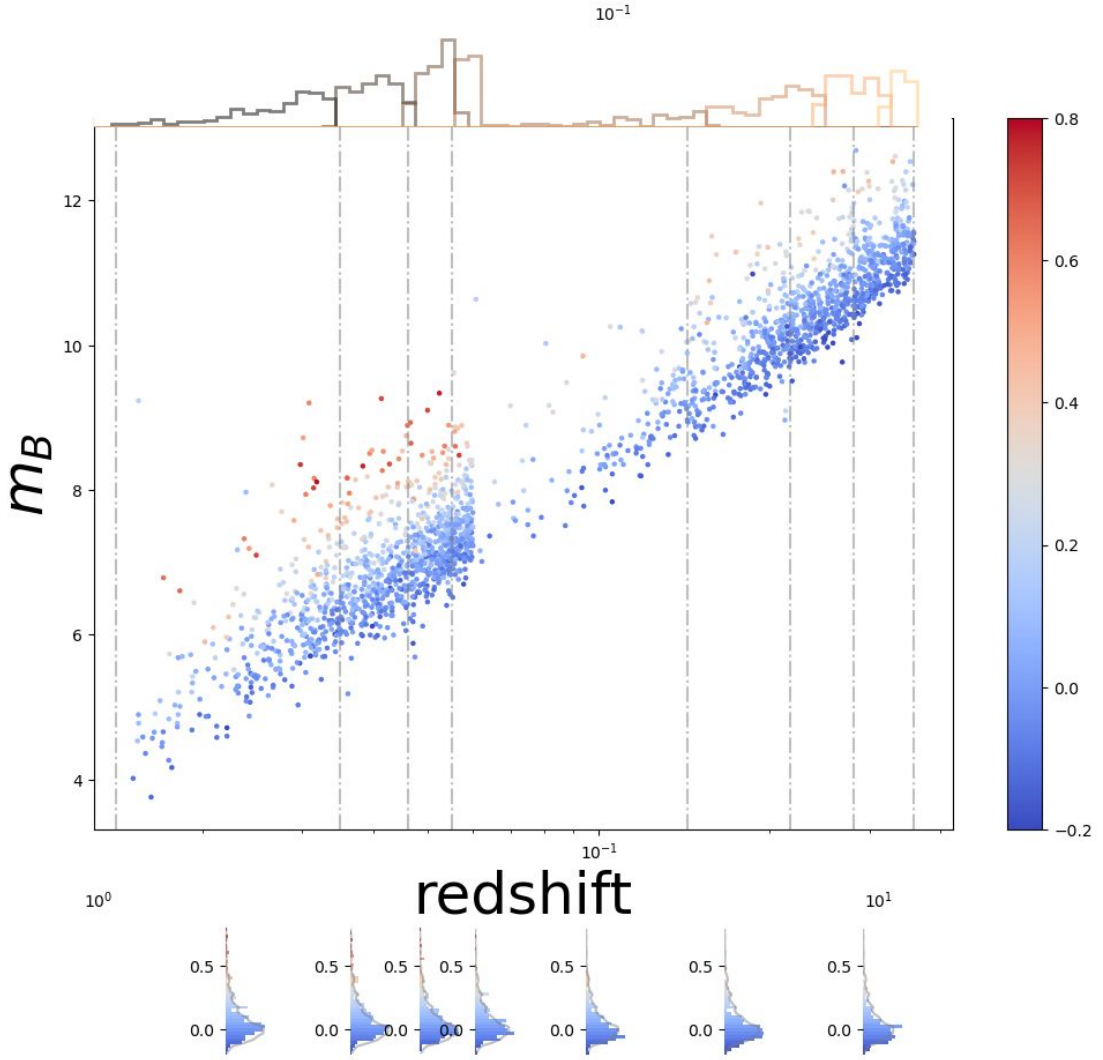


SDSS, PS1, and DES are photometric samples, but don’t worry about non-Ia contamination :)

ZTF has a noticeably redder tail

We split the data into quantile bins that are evenly filled with ~270 SNIa per bin.

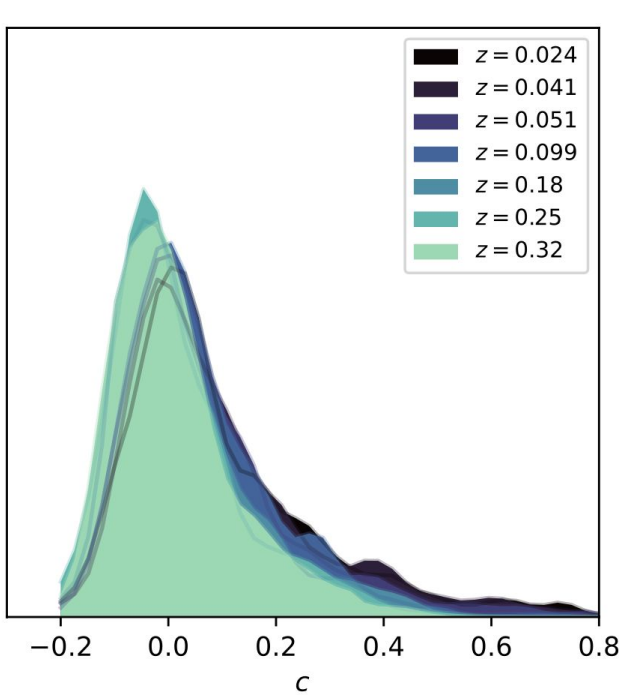
The ZTF sample has a noticeably redder tail, but other than that we see a pretty consistent distribution of mB with redshift!

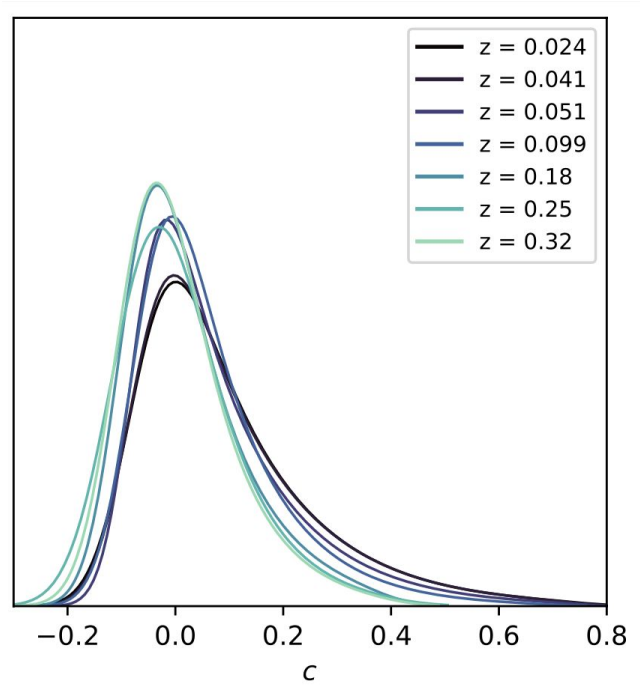


We fit colour in each redshift bin as a convolution of exponential dust and a Gaussian intrinsic population

We model the observed colour distribution a Gaussian distribution that is skewed by an exponential.

This *can* be interpreted as an intrinsic distribution that is skewed by dust





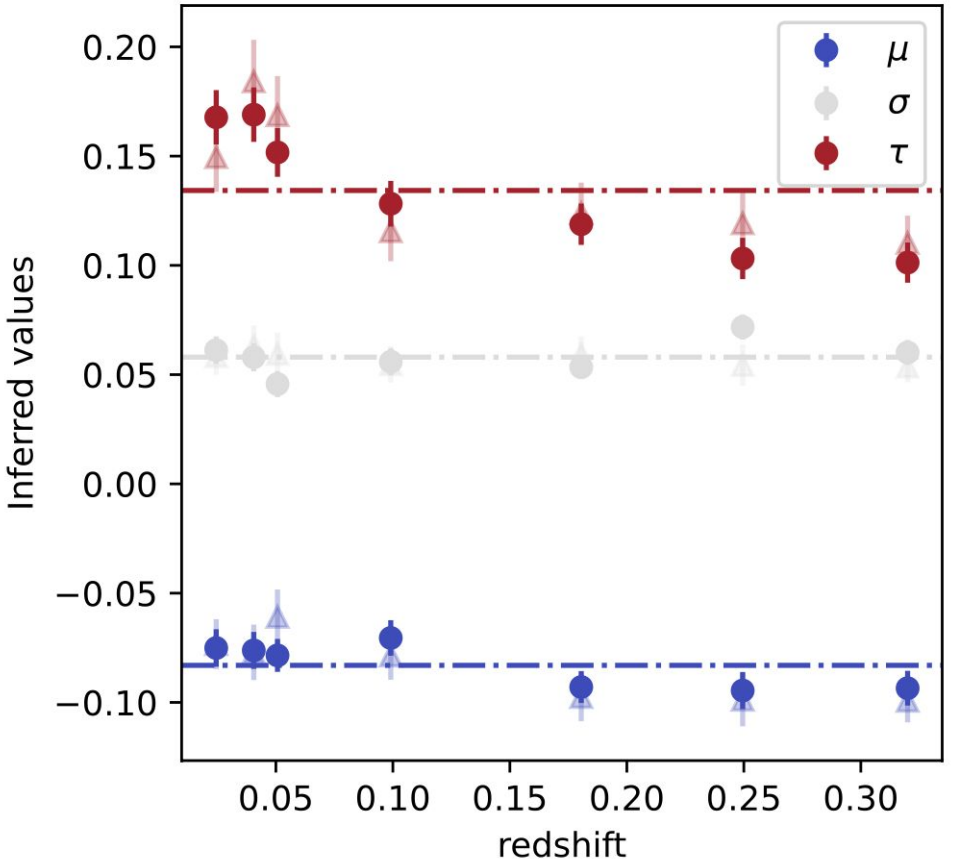
Interesting Preliminary Results

We take the parameters from the previous slide and plot them as a function of redshift.

The circles are our fiducial sample, triangles are the conservative one.

Signs of higher tau at low redshifts

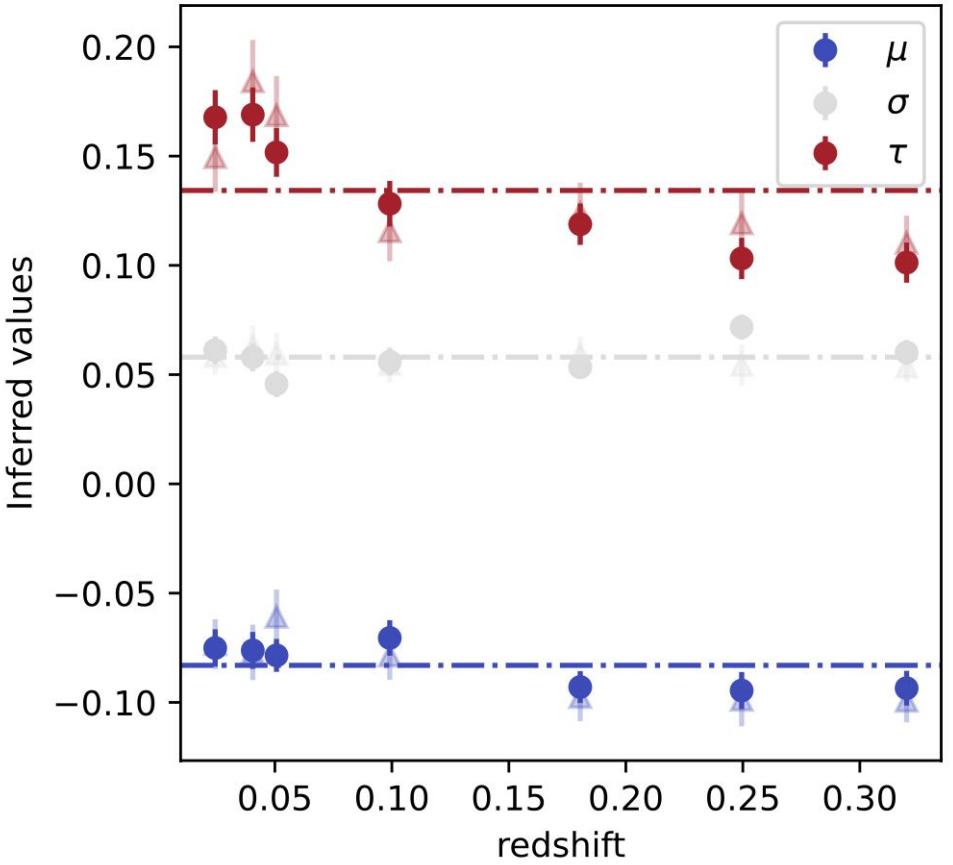
$$c_{\rm obs} = c_{\rm int} + E_{\rm dust} + \epsilon$$



Interesting Preliminary Results

We see a 4 sigma signal that the “tau” parameter changes with redshift, and no signal of the Gaussian parameters changing with redshift (<1 sigma)

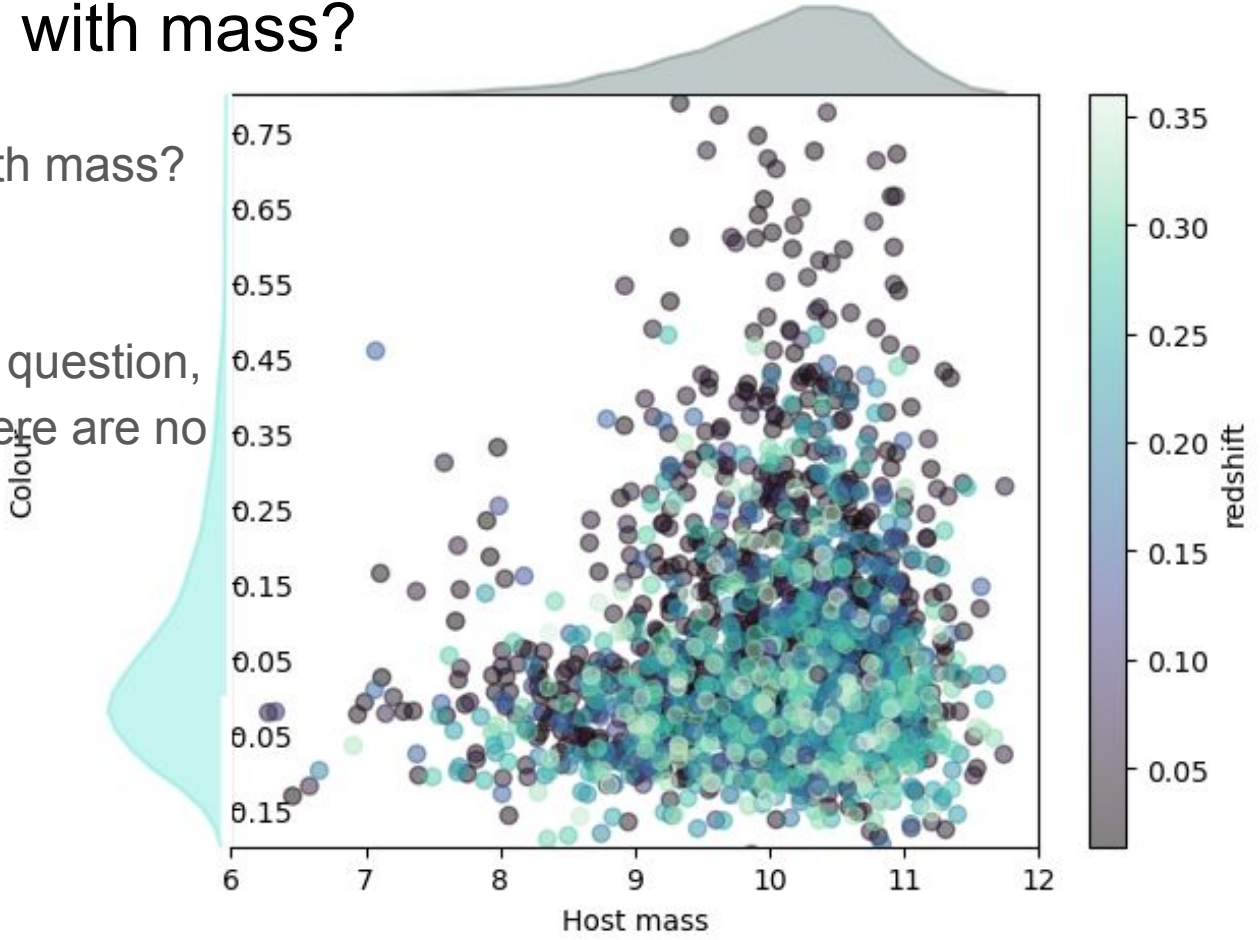
$$c_{\rm obs} = c_{\rm int} + E_{\rm dust} + \epsilon$$



Is colour correlated with mass?

Does our data correlate with mass?

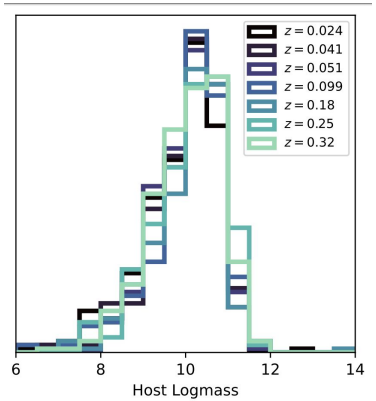
Before we can answer this question, we'll need to make sure there are no external correlations

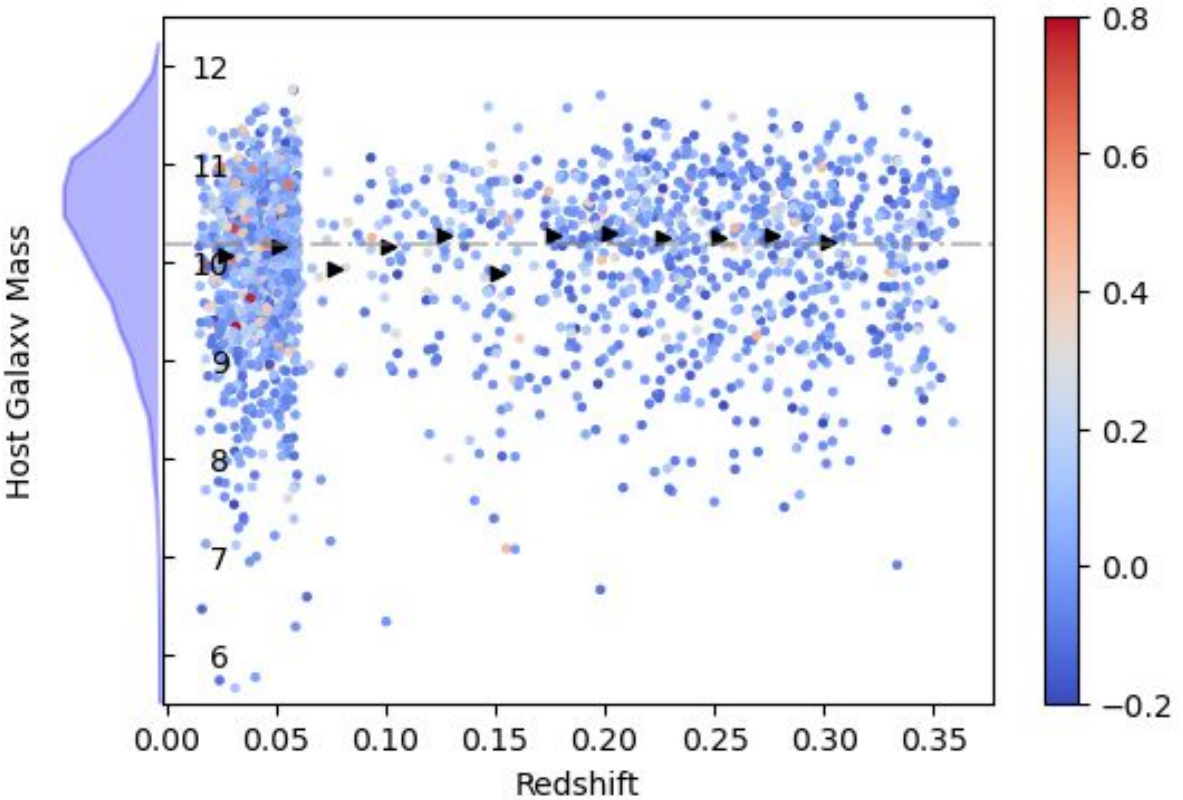


Does the host galaxy mass change with redshift?

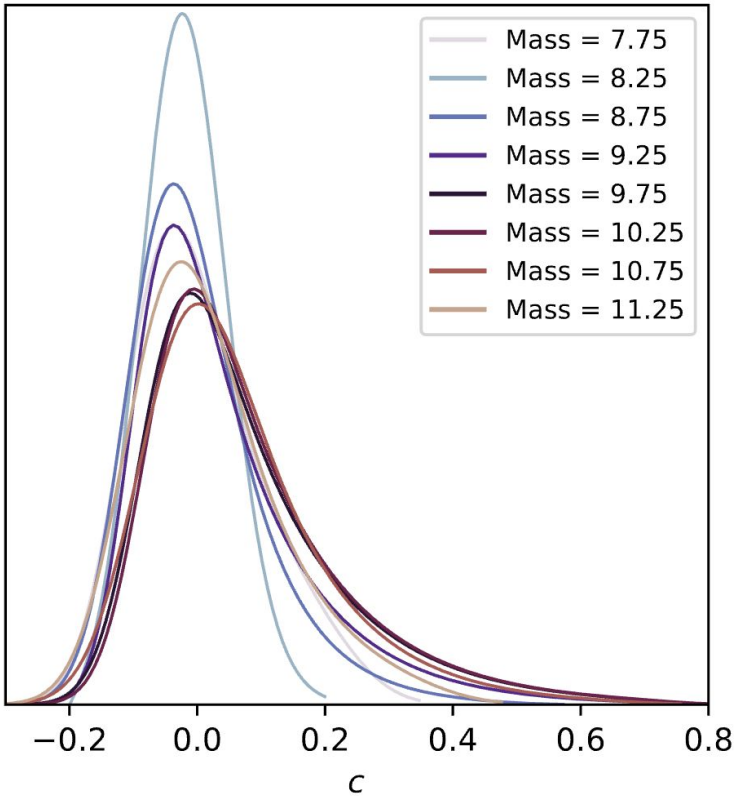
Even for our fiducial sample, there's no major evolution of the host galaxy mass with redshift.

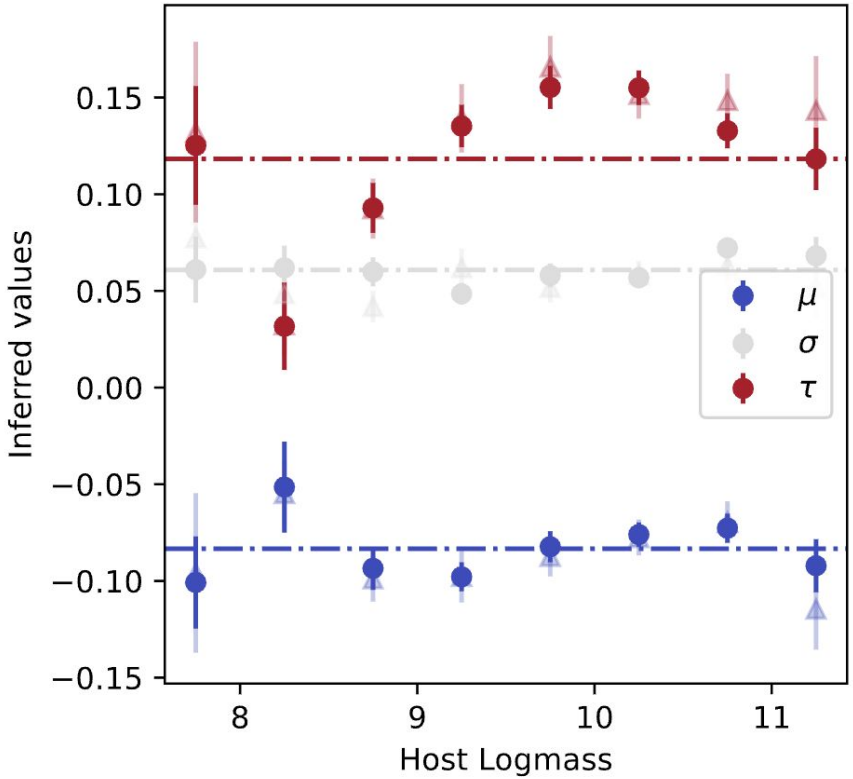
The median nor shape really change with z





Noisier signal in mass evolution of SNIa colour





But beta seems to evolve with mass

Even for the conservative sample, high-redshift SNIa seem to indicate a trend of decreasing beta with host galaxy mass…