Subject: Re: beta / Upsilons covariance
From: Danielle Leonard <danielll@andrew.cmu.edu>
Date: 7/1/19, 7:51 PM
To: Shadab Alam <shadaba.roe@gmail.com>

Hi Shadab,

As usual things are busy and taking longer than expected to get round to stuff ... a quick question to clarify the info you sent last time (see below in-line):

On Thu, Jun 6, 2019 at 4:31 PM Danielle Leonard <danielll@andrew.cmu.edu> wrote:
> Hi,
>
> Awesome, thank you! I will put these details into practice and let you know when I have something to report (hopefully next week).
>
> Cheers,
> Danielle
>
> On Thu, Jun 6, 2019 at 4:46 AM Shadab Alam <shadaba.roe@gmail.com> wrote:
>> Hi Danielle,
>>
>>
>> On Tue, Jun 4, 2019 at 10:31 PM Danielle Leonard <danielll@andrew.cmu.edu> wrote:
>>> Hi Shadab,
>>>
>>> This is amazing, thank you so much! Sorry for the slow reply; I was catching up after getting back from travel.
>> I hope you had a wonderful travel time :) .
>>>
>>> I started trying to construct a "hybrid" covariance matrix which combines your jacknife covariance and my analytical covariance to account for shape noise, and I realized I do have a couple more questions to make sure I am comparing apples to apples:
>>> - What simulation volume are you using?
>> The box size is 1380 Mpc/h.
>>>
>>> - What units are you using for Upsilon_gm and Upsilon_gg?
>> The distances are in Mpc/h (comoving) and the amplitude are just clustering amplitude. For gm I didn't scale things by critical density therefore it is just the galaxy matter correlation.
>> We need to scale upsilon_gm by appropriate factor of critical density if you need to get things in physical units.

What I understand from this is that, in what you've sent me, the units of both Upsilon_gg and Upsilon_gm are Mpc/h. Is that right?

Thanks!

Danielle

> > Also: is there a reason you said not to take rmin below 2? I usually see r0~1.5
> > and your r values go well below 2 so just wondering if there's something
> > special about that value.
>
> There is no particular reason. I think given r0=1.5 I just thought its safe to use
> scale slightly above r0. So, actually you should be able to use scales upto 1.5.
>
> Thanks,
> Shadab
>
> > Thanks a lot,
> > Danielle
> >
> > On Wed, May 22, 2019 at 2:02 AM Shadab Alam <shadaba.roe@gmail.com>
> > wrote:
> > > Hi Danielle,
> > >
> > > Sorry, It took me some time to get through all the steps but I think now I
> > > have what you need.
> > >
> > > Here is what I have done:
> > > First I have looked at DESI LRG in the Buzzard mock between redshift 0.7-0.8
> > > and then obtain HOD which matched the bias of this measurement.
> > > So, this basically gives us a sample pretty close to DESI LRG as per current
> > > understanding.
> > > I then use RunPB simulation snapshot at redshift=0.75 to populate the
> > > Rockstar halo catalogue.
> > > These are then used to measure multipoles which I then fit using 100
> > > jackknife realization between scale 30-80 Mpc/h using the CLPT model and
> > > obtain f and bias.
> > > Finally, I have measured upsilon_gg and upsilon_gm using the galaxy and
> > > subsampled particles.
> > >
> > > Here is a plot of the final measured correlation matrix.
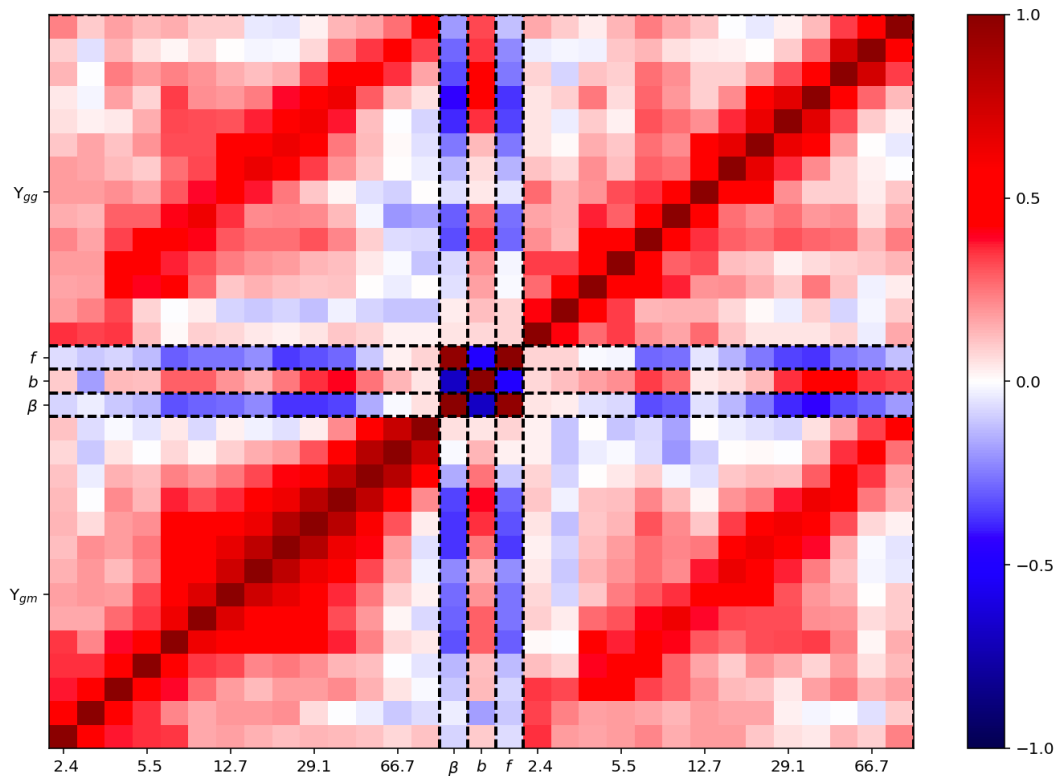
I am attaching a folder containing three files for beta, upsilon_gg and upsilon_gm.
I am also attaching a python script which can read these files and return the correlation matrix between the parameters in the requested order.

For example if you want the correlation matrix between upsilon_gm and beta then run like this:
python cov_script.py gm beta

for upsilon_gg, beta, upsilon_gm run like this:
python cov_script.py gg beta gm

It basically has one python function which you should be able to call from any other code and returns a dictionary containing correlation and covariance matrix.
covdic=evaluate_correlation_matrix(stat_list=
['gm','beta','bias','f','gg'],rmin=2.0,plots=1,data_dir=data_dir)

where data_dir gives you the ability to provide the path to the attached folder.
If you don't want plot then set plots=0
stat_list is the list of things you need correlation of.
rmin should be at least 2 but can be larger if you don't want smaller scale.

Feel free to adapt it as per your need to get the correlations.
Let me know if something is not clear.

Cheers,
Shadab

On Tue, May 14, 2019 at 5:42 AM Danielle Leonard
<danielll@andrew.cmu.edu> wrote:
  Hi,

  On Thu, May 9, 2019 at 9:11 AM Shadab Alam <shadaba.roe@gmail.com>
  wrote:
    Hi Danielle,

    On Tue, May 7, 2019 at 10:23 PM Danielle Leonard
    <danielll@andrew.cmu.edu> wrote:
      Hi Shadab,

      That's great that you managed to sort through the issues and have got
      some first results!

      To address your last point first, about the plan for the project: what I
      am interested in is understanding the trade-offs between testing
      gravity with E_G and with a multi-probe approach. The specific
      scenario which I want to focus on is LSST (sources) and DESI (lenses /
      RSD). So to me, the goal of the stuff you are working on would be to
      get the covariance between Upsilon_{gm} and Upsilon_{gg} with beta
      for samples like LSST and DESI.
    I see, by trade-off you mean precision and biases of the two approach?

  Right. Also related questions, like how well do we need to pin down sources
  of uncertainty at small scales (like scale-dependent bias) to get unbiased
  results in both cases. I think I must have sent this to you at some point
  before but there is a work-in-progress draft here on overleaf which gives
  more details in terms of the motivation.

      I have a few questions about what you sent:
      - You said you populated the simulations with an HOD - what HOD and
      what fit did you use? I would guess something like a fit to CMASS
      would be the best kind of DESI-like thing but you may have other
      ideas.
    I used something close to CMASS, I am updating this with CMASS, it
    might be done in few days. DESI sample will be quite different from
    CMASS in terms of galaxy bias. There will be three tracer, QSO, LRG and
    ELG.
    I think with the current simulation I am using I can definitely model LRG
    and probably push to QSO but not ELG. It is mostly about resolution of
    simulation.

> > > I have used another simulation (MDPL2) which has good enough resolution but I need to check if particle data is available for lensing calculation.

> True that DESI will be different from CMASS in terms of galaxy bias. I wasn't specific enough in my last email – I've been thinking about the DESI LRG sample. So, it's good if you think you can model that with the current simulation. Is that a lot of additional work for you to do?

> > > - You used a slice at z=0. How easy would it be for your to use a slice at a higher redshift? Specifically I think the relevant redshift for DESI LRGs is around 0.77, is it possible to use a slice somewhere around that?

> > I have one snapshot at 0.75 so that can be done for the current simulation which can match LRG,QSO from DESI but for ELG I need to again check particle data availability

> Cool, that's great that that redshift slice exists.

> > > - I understand from your description of your methods that this correlation measurement is only sensitive to the signal part of the covariance. But, at certain scales shape noise will be important (for Upsilon_gm). Is it correct that you are neglecting that so far, and do you have any ideas on including it? I talked about it with Rachel and she is thinking about ideas also.

> > Yes, I am ignoring shape noise and intrinsic alignment as well. This is pure signal part.

> > I think the full co-variance will require such terms but if you were to use this only for the terms relevant for cross correlation between upsilon_gg and beta then we don't need that as shape noise will be uncorrelated with beta.

> > I can imagine having full co-variance of your multi-probe method estimated analytically and then adding this terms separately.

> > I had a little bit thinking about this with some discussion with Linc (you probably know him). And we were thinking something like lets say if shape noise effectively scatter the gamma field then it will effectively introduce scatter in the density field.

> > One way I can add this is by adding a weight to dark matter particles mimicking noise in density field. One can start by saying that the weights will be sampled from gaussian with some width (where width needs to be evaluated from more sophisticated existing simulation. One key question will be that should the scatter in the weight depend on local density field or the halo mass in the region? This can be tested and calibrated using one of the hydro-sim I guess Massive Black II but will require lot more work.

Okay, good point that the shape noise will be uncorrelated with beta. Right now I actually don't think there's any need to try to model the shape noise within the simulation; like you said that could be a lot of work and also we know how to get that analytically. So what I would say is, if you could send me the numerical covariance matrix when you have it, I could add the analytic shape- and shot- noise terms to the appropriate elements, and that would enable us to calculate a correlation matrix which accounts for shape- and shot- noise to get a better idea of the relative importance of the Upsilon x beta signal covariance at different scales. Does that sound reasonable to you?

> - Are you able to do the same for Upsilon_gg in addition to
> Upsilon_gm?
Yes, that can be done.

Great.

> - Could you send the correlation matrix as values in addition to the
> plot? Just because I find it difficult to interpolate with my eyes :)
Sure, I will send you the files soon.

Thanks,
Shadab

Thanks,
Danielle

> Thanks! This is really great, sorry for all the questions.
> Cheers,
> Danielle
>
> On Mon, May 6, 2019 at 6:32 PM Shadab Alam
> <shadaba.roe@gmail.com> wrote:
> > Hi Danielle,
> >
> > I finally managed to find some time to resolve my issues and finish
> > running the first set of measurements.
> > So, I have taken one of the simulation snapshots at redshift =0,
> > populated this with HOD and the measure multipoles moments with
> > 100 jackknife split.
> > The RSD fits for bias and f was performed in each
> > jackknife realization.
> > I then measure upsilon using galaxy matter correlation in the box.
> > Finally, I measured the correlation matrix between upsilon, f, bias
> > and beta.
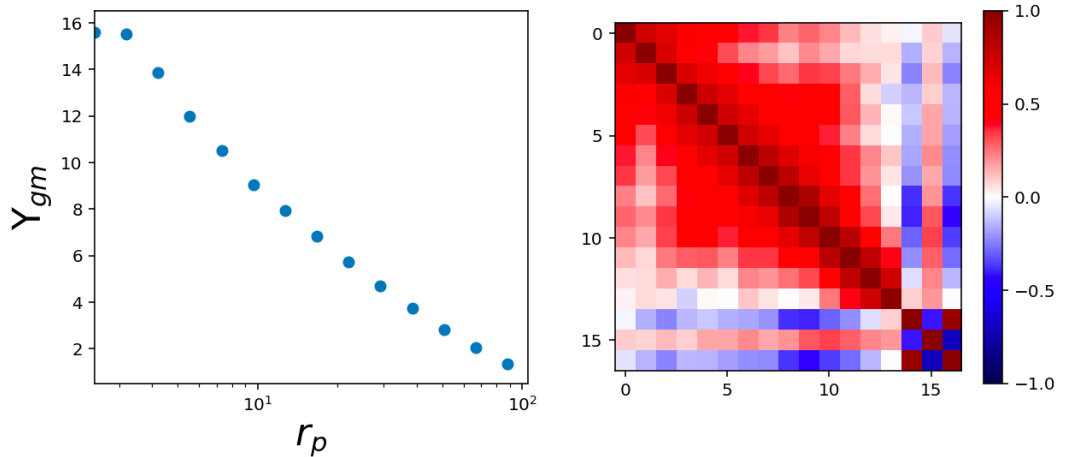
The left panel shows measured upsilon and the right panel shows the measured correlation matrix.
In the right panel the last three row/columns are f,bias and beta.
We note that f is negatively correlated with upsilon at intermediate scale whereas bias is positively correlated and beta again negatively correlated.
These are essentially my first result and we should scrutinize this for errors!!

One can notice that the strength of correlation between f and upsilon is almost twice that bias and upsilon.
I would have naively thought that the correlation between beta and upsilon is probably dominated by the correlation between bias and upsilon, But it seems the correlation between f and upsilon is giving a higher contribution in the correlation between beta and bias.
Therefore this is probably coming more from how inherent dark matter field is correlated with velocity field.

We briefly discussed this in Edinburgh but I am unsure of our plan again. Could you tell me what exactly you might want to probe further?
I remember we discussed looking at this correlation for different bias and different shot-noise sample. If yes then should I try doing that and in case do you have a preference for redshift, bias and shot-noise levels we should look at.

Cheers,
Shadab

Thanks,
Shadab

On Thu, Apr 25, 2019 at 5:51 PM Shadab Alam <shadaba.roe@gmail.com> wrote:
  Hi Danielle,

Yes, I think my application went through and so I should be an LSST DESC member now.

Regards,
Shadab

On Wed, Apr 24, 2019 at 2:35 PM Danielle Leonard <daniell@andrew.cmu.edu> wrote:

> Hi Shadab,
>
> Cool, no worries on being silent, I obviously was also silent. Looking forward to seeing what you come up with when revisiting this now.
>
> BTW I guess you are officially an LSST DESC member now?
>
> Cheers,
> Danielle
>
> On Wed, Apr 24, 2019 at 6:21 AM Shadab Alam <shadaba.roe@gmail.com> wrote:
>
>> Hey Danielle,
>>
>> Apologies for being silent for so long.
>> After our discussion, I did create HOD catalogue for this test and were preparing for RSD fit.
>> But, i was having trouble with some code crash and left things at that point.
>> I am sorry, I should have got back to it long ago.
>> I will try to spend some time this week to see if I can resolve this failure and get measurements of beta on this set of mock.
>>
>> Thanks,
>> Shadab
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>> On Tue, Apr 23, 2019 at 3:43 PM Danielle Leonard <daniell@andrew.cmu.edu> wrote:
>>
>>> Hi Shadab,
>>>
>>> Hope you're doing well. I wanted to check in on whether you had made any progress at any point about estimating the covariance of beta and Upsilon_gg / Upsilon_gm from simulations. I know it's been quite a while since we spoke about this during the hack week in Edinburgh, sorry for not

following up on this sooner. It's okay if the answer is "no, I completed forgot about it", just wanted it see where things stand.

Thanks,
Danielle

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