echoIA Kick-off Live Notes

Day 1

Welcome & Introduction

Slides

Review Talks

Measurements (R. Mandelbaum) - slides

Questions/discussion:

1. Benjamin: Do you agree we will always have a big gap between direct-IA galaxy samples and weak lensing samples? How can we extrapolate most reliably from one to the other?

    a. Harry: it may be permanent, since we are unlikely to have LoS resolution for a deep AND flux-limited AND wide-area sample, right? Maybe the shear samples themselves need to be used, and what we need is numbers?
    b. Rachel: I think we will always have a gap, though we may have some opportunities to reduce it. One question in my mind is whether our model for IA in WL measurements needs to have explicit color/luminosity dependence to assist with this extrapolation.
2. Jonathan: Properties beyond luminosity? What else is important (as far as we are aware now)
    a. Rachel: color. :) For models that go inside of halos - e.g., a halo model - we need better constraints on central/satellite behavior, though the papers I mentioned are a good start on that.
3. Jonathan: should we use the same shape measurement as the lensing, or the one that maximises IA signal?
    a. Rachel: it's tempting to say the latter, to get high S/N constraints on the IA model, and simply propose to marginalize over the alignment amplitude. What worries me about this is that we don't yet know whether trends with redshift/luminosity/environment are the same or similar with shape measurements used for lensing vs those that maximize the IA signal. That's why I am tentatively leaning towards the former, but it's a good topic for further discussion.
4. Joachim: is there hope that IA will become subdominant to other effects?
    a. A: with e.g. shape measurement, we can understand the residual uncertainty. That's harder for IA - there will always be some extrapolation. So we will need to be somewhat conservative. We will reduce uncertainty, but it won't go away.
5. Elisa: shape-shape correlations or higher-order stats?
    a. A: definitely good to include density-shape and shape-shape together in the modeling, if S/N is decent and the relevant null tests pass. Does require modeling lensing terms in shape-shape in addition to those in density-shape. Higher order stats: need to think through how to model the lensing terms but could be useful if that turns out to be feasible.

Notes:

1. Not intended to be totally comprehensive. Missing some interesting studies.
2. Bridging the gap: want to understand IA as a contaminant (needed for precise weak lensing cosmology), but we can make direct measurements on a different sample where IA dominates. E.g. See large magnitude gap between GAMA and HSC lensing sample.
3. Getting a reliable IA model and priors on params is thus quite challenging.
4. Process: select a sample, measure shapes and redshifts, measure a summary statistic, interpret in terms of a model. Think of MadLibs! Each of these components can be chosen independently.
5. Spectroscopic samples are often selected in quite an "extreme" way, e.g. to optimize for BAO. Very much NOT typical. E.g. LRGs, ELGs. Even flux-limited samples are limited to relatively bright galaxies. But spectroscopic redshifts allow for a "clean" direct IA measurement (although still have other effects which need to be modeled)

6. High-quality photo-z samples. More control over the sample. Can go fainter and more complete than spec-z samples. Need to project along longer los separation, thus contaminating with additional effects (e.g. ggl)
7. Discussion of different spec-z samples: LOWZ, WiggleZ are both pretty weird. Challenges in interpretation.
8. Understanding trends using subsamples can be important to constrain/understand the model. But also complicated by correlations between subsamples.
    a. LOWZ luminosity trend: NLA (large-scale) amplitude seems to follow power law. Singh+
    b. Fortuna+ Brings together many samples. Is the luminosity trend a single power law or a flattened power law? Needs multiple samples to investigate
9. Centrals and satellites behave differently.
10. How do you measure galaxy shapes? Alignment strength *may* depend on the shape measurement method. Outer isophotes more aligned? (e.g. Singh+). Other work (Georgiou+) found mild passband dependence.
11. IA estimator? Different treatments of spherical symmetry
12. Modeling: on what scales is the model valid? Results are often quantified with a single number. But we need access to the data vector to look at a new model. We may need homogenization, etc for re-interpretation.
13. Nonlinear bias, other effects, may need to be included.
14. DES Y3: Important to look at how the data actually responds to the modeling.

Modeling (E. Chisari) - slides

Questions/discussion:

1. Jonathan: observational evidence for primordial vs instantaneous?
2. Ziang: the Catelan+ (2001) linear model for IA seems pretty similar to gamma_1 for cosmic shear. What is the difference? In addition, should it be dependent on choise of x-y coordinates?
3. Sven: Why is the NLA model (replacing the linear PS by the non-linear PS) not physically motivated? I seem to have mis-understood something.
4. Jonathan: can we group SPT/EFT terms with similar scale dependence? Do we really need a complete basis to be accurate enough?
5. Jonathan: order of projection? Does it make a difference at the observable level?
6. Harry: what do we need to strengthen halo model parameter priors?

Notes:

1. Not covered here: spin/web alignments, model-agnostic approaches (“self-calibration”)
2. Want to model: II (can be directly measured); GI via gI, i.e. galaxy - shape alignments
3. Linear alignment (LA) model: galaxy shape proportional to projected tidal gravitational field. Works for red galaxies and above scales of 10 Mpc/h.
4. Galaxies cannot instantaneously align because IA signal amplitude would be too small. LA model often assumes primordial alignment.

5. “Non-linear” linear alignment model (NLA). Empirical modification for small scales - it works.
6. IA amplitude can acquire a sample dependence on luminosity and redshift. Usually modelled as power laws.
7. Halo model: adds alignment for satellites within a parent halo. Standard assumes spherical haloes; shapes can follow the density profile of the halo. On larger scales complemented by LA model or similar. Only option for going deeply non-linear.
8. Perturbative models: standard perturbation theory (SPT) for shapes (tensors); effective field theory (EFT) for shapes.
9. EFT works for 3D shapes, then projects to 2D; EFT preserves symmetry.
10. PT models can be slow; accelerated by FFTLog algorithm.
11. All models need better priors.

Simulations (R. Paviot) IAhydro

Questions/discussion:

1. Rachel: What value is there in the use of merger trees to better trace time evolution in simulations and understand the physics? (c.f. The evolution of galaxy intrinsic alignments in the MassiveBlackII universe - NASA/ADS, which was somewhat limited by the unrealistic disc fraction in MB-II)
    a. Benjamin suggests we should do this and could better learn about the impact of primordial vs instantaneous alignments.
    b. Harry points out that methodology for sample selection is particularly challenging in connection with mergers. Suggests identifying merger population across simulations
2. Benjamin: Romain mentioned high redshift disk alignment - there are zero/marginal alignment detections for disks at low z, nothing at high z - is this something eg LSST should worry about? Consensus answer: yes.
3. Harry: here is a (the?) paper that found suggestions of proto-galaxy alignments at high-z in simulations: Can intrinsic alignments of elongated low-mass galaxies be used to map the cosmic web at high redshift? - NASA/ADS

Notes

1. Need simulations to explore nonlinear scales where lensing signal is strong but NLA/PT models aren’t valid. Alternative is halo model approach.
2. 4 HD simulations most frequently used for IA studies - different characteristics.
3. Current status: HD simulations have tested/confirmed various features eg redshift and luminosity dependence, alignment of LRGs, alignment amplitude for disks consistent with observations.
4. Anisotropic satellite distribution in sims inconsistent with halo model
5. TATT model consistent with observations - color/luminosity/galaxy type.

Reviews & Introduction session recording

Meeting Recording:

https://ucl.zoom.us/rec/share/LyN1JfVDc8L0KJu6fvLoctzqy4tCuG1YMM5AEUZkjF4VWwyklc3iVjBIyaCDS-cV.irY6iayvE7CRRRAF

Access Passcode: #ech01A#

Simulation focus pitches & discussion

Yesukhei: Dependence of IA on disk fraction / Learning IA with graph neural networks

Q&A
Benjamin: Interesting that bulges show similar alignment amplitude to ellipse - does this support mergers being important?
Yesukhei: Yes, bulges are like tiny ellipses
Rachel: Eager to explore GAN proof of concept in survey-agnostic context, but could also apply to making non-parametric mock catalogs for survey collaborations.

Leonel: IA infusion
Q&A
Benjamin: distinguishing features of infusion?
Mustapha: use mass sheets to generate tidal fields, then calculate explicit components of IA
Jonathan: how many methods do we need? - eg in range from infusion to no parameters at all to halo-based models
Francois: not all techniques work with all simulations, but infusion is generally very easy to implement
Mustapha: suggest we should err on the side of multiple methods
Benjamin: Infusion generates signals we understand, so good for validation - get out what we put in
Jonathan: if looking at more complicated stats, which are non-trivial to understand, infusion may still provide extra insights, so useful for more than validation.

Tomasz IA with AI:

1. Train NNs by passing maps. Currently using NLA IA maps.
2. Analysis in progress.
3. Potentially substantial gain using CNN analysis. So worth doing the map-level analysis.
4. Cosmogrid. Light cone sims spanning wCDM. IA in cosmogrid?
5. **Who is interested in constraining IA with forward modeling, training with models more advanced than NLA?**

6. Jonathan: what is included in terms of IA maps?
   T: do IA maps on the fly, projected light cone and some halo info - can do anything 2D easily, 3D should possible

7. Francois: does AI constrain IA parameters or marginalise over them?

T: Can do both, constraining IA amplitudes or redshift evolution is doable

8. Francois: down to what scales?
    a. A: Tested down to nside=1024. Stored at 2048. But this is a lot of pixels.
9. Benjamin: Relation to infusion method?
    a. A: very similar to the infusion method (Harnois-Deraps+). Details may be slightly different.
    b. Francois: differs at the details of implementation, but basically the same, at least for NLA.
10. Mustapha: Timeline and schedules within collaborations may drive the methods that we use. Infusion methods are ready sooner, so will be useful for shorter timescales

Kai modelling IA in simulations:

1. Using sims (and semi-analytic) to translate lots of different observations into model predictions.

    Harry: TATT doesn't seem to add much
    Kai: it does - would see more effect if smaller scales shown
    Benjamin: use this method for homogenization. Leave the measurements as untouched as possible and then train SAM (or other) sim methods. Use that to extrapolate.
    Jonathan: suggest this as a discussion topic for later (simulation as an interpolation/extrapolation tool)

Nick IA with halo method:

1. Using halo information for IA predictions.
2. Use a gravity-only simulation to create IA
3. Currently using orientations. Want to also shape information.
4. Radially dependent alignment model - allow alignment strength to vary with halo radius. Adds model flexibility. Also can capture missing halo information (e.g. subhalos).
5. Compare with Illustris.
6. Extract halo orientation from a noisy set of particle data. How reliably can we get a halo orientation axis, even with low resolution.
7. Benjamin: halo model or sims?
    a. A: both
    b. Andrew: this method blurs the line. You can do inference using the SAM with a simulation. A mock catalog is a bi-product, but the inference can be done without this.
8. Kai: scatter in halo orientation can be absorbed by the SAM.
    a. JB: yes, but need to know what the scatter is to avoid double counting. **We should compare notes on this,** and discuss hybrid semi-analytic/simulation approaches.

Day 2

Modelling & methods focus pitches & discussion

1. Lamman: IA and RSD in DESI
    - Selection of LRGs will preferentially pick galaxies aligned to los
    - Looking at halos in abacus without misalignments. Maximizes signal.
    - Rachel: what are the prospects for looking at this with sims. A lot of DESI work is using low-res sims. How should we think about populating sims with galaxies, given the sims available? Do you have good halo shapes? Do you have all particles or a sub-sample?
        - A: Have HOD but no orientations. Abacus is a “reality check,” prob not the final answer.
    - Benjamin: if RSD is affected, what is the plan?
        - First: is this an issue? Then we will see what DESI wants to do. There are potential selection plans that could mitigate this.
        - Benjamin: use overlap with ELGs as a way to mitigate this.
        - Claire: ELGs have no significant density-shape correlation (as currently measured.
    - Jonathan: what is the selection impact?
        - Claire: working on this now. A geometry problem.
    - Andrew: only relevant at the selection edge?
        - Yes, only relevant in a narrow flux range.
    - Harry: pole-on objects might be more circular in shape; could help with selection for measurement of the effect
        - Yes, but tricky to separate orientation rounding from physical shapes, which is correlated with density
        - Andrew: Would need a way to jointly model other galaxy morphology.
2. Isaac: IA in Euclid.
    - Making forecasts and seeing strong degeneracy with the multiple power-law amplitude dependences (luminosity and redshift). Adding ggl helps to break this degeneracy.
    - Using a full MCMC analysis pipeline instead of Fisher. Currently cosmosis.Good constraints on A_IA with WL only. Nothing prior-dominated. Currently using NLA and TATT
    - Will look at other models
    - Elisa will you get bias if looking at wrong model?
        - Looking into this. May need to add more flexibility into model
    - Jonathan: surprised at overall gain from 3x2pt
        - Related to scale cuts - same for all probes. So not totally fair comparison.
    - Niall How are neutrinos treated? Any intuition about effect at small scales?
        - Fixed minimum mass for neutrinos.need to investigate more
    - Harry Are you modelling photo-z errors?

        - Gaussian Uncertainties. Tested if allow for shift in distributions - much less constraining power
    - Martin how did you motivate initial parameters for NLA and TATT?
        - Fiducial values are very important in NLA model
    - Alex Which parameter values?
        - Fiducials mostly at mid of priors. Need informed fiducials from sims.
3. Silvan Interplay between IA and redshift errors
        - Impact do systematics on cosmic shear constraints
        - ChaosHammer fast C_l emulator
        - Redshift bin errors - shift of bin mean, stretches of width
        - Very fast MCMC so can try many options eg IA amplitude not biased but s8 is biased depends on underlying IA parameter.
    - Ágnes - just marginalising over shift etc?
        - Marginalise over cosmo parameters, IA Paramus, photo-z
    - What about shear calibration bias?
        - Plot just illustrates sort of analysis possible
    - Alex Have looked at effect of on photo-z full distribution and found s8 constraints unchanged. Are your redshift shifts very large.
        - Varying widths 1 by 1 find linear change in s8.
    - Jonathan interesting to see if consistent story which explains this.
    - Elisa What if you vary z dependence in model?
        - Requirements specified for Euclid.
    - Benjamin. Expect crosstalk between redshift and IA so expect change in redshift assumptions to affect IA. So this is right way to investigate
4. Mustapha IA self-calibration in DESC pipeline
    - Used method before for KiDS - small IA detection, larger for DES
    - Additional correlations included
    - Self-calibration does not assume any IA model. From survey calculate usual CFs. Split within bin, selection function which distinguishes IA from lensing. C_IG proportional to C_Ig in single bin.
    - Projects: 1 calculate relevant correlations etc, 2 more sophisticated implementation in pipeline, code comparison.
    - Method very complementary with modelling.
    - Benjamin: Galaxy bias is critical - what do you do on small scales (where linear bias doesn't hold)?
        - Bias is calculated in nonlinear way. Biggest error in self-calibration comes from measuring C_ig, not from bias.
        - Jonathan: Will this still hold in Stage-IV?
        - Mustapha: working on combining non-linear bias and non-linear IA models for stage-IV
5. David NLA IA with PAUS data
    - PAUS 40 narrow bands, divide galaxies by color - see Johnston et al 2021
    - Goals to calibrate NLA for Stage III and IV
    - CFs in real space with angular separations
    - Check advantages of using NLA
    - Checked CFs from nbodykit and TreeCorr
    - Analytical covariance matrix using Cosmosis
    - Next steps: gglensing CF, blue galaxies,better cov matrix, design IA pipelines

- Harry - why switch to angular CFs?
  - Pragmatic - wanted to use Cosmosis
- Will you also measure CFs in narrow redshift bins?
  - At present 3 bins but will reconsider
  - Jonathan presumably PAUS allows finer binning?
- Ágnes Will you stop at gg lensing? Shear? Is gg lensing enough to pick up gI term?
  - Not at present. Haven't yet explored whether need more constraining power.
- Jonathan more tools should be made available so statistics/analysis not limited by tools - for discussion tomorrow. Avoid hacks.

6. Christos Halo model for IA in CCL
   - Open source halo model code in CC, so IA power spectra easy to produce. Not yet final.
   - Plan to add EFT model, and then compare models. Also firecrown likelihood and augur sampler.
   - Benjamin Very useful - the way to go
   - Martin How fast is it?
     - Power spectrum ~10 sec. Hope to speed up x10
   - How many parameters?
     - Can vary complexity of NLA eg luminosity,z etc

Data focus pitches & discussion

1. David IA with PAUS data
   - PAU ideal for IA studies
   - Galaxy shapes from CFHTLS and KiDS
   - Start from Johnston et al 2021
   - Generate new photo-z catalogs using new calibration method - assume zero points are 1, recalibrate as if these are spectroscopic 3 times
   - PAU has very low photo-z scatter, high S/N
   - Use TreeCorr to compute position-shape correlations, split by Color and z and compare with sims. Hope for large improvement over Johnston results
   - Jonathan - is the plan to analyse using angular separation?
     - Will focus on projected angular CFs
   - Will correlations be made publicly available?
   - Elisa. Will shape catalogs be available?
   - Benjamin Shapes already available fromKiDS etc but will need revised catalogs
   - Harry Is redshift selection planned?
     - Not immediately
   - Kai Which redshift will catalogs go to?
   - 2 - currently 1.2
   - Benjamin This uses photo-z with all associated issues. Are we confident we can use them without more forward modelling?
     - Want to compare with sims also photo-z provides more data.
   - Mustapha Interesting to use PAU to compare method with self-calibration

- Christos A lot of effort already to measure alignments with photo-z. Do we need to do more?
- Benjamin. We know how to do this but complicated. Eg do we trust (old) Mega z results?
  - Harry - we briefly discussed weighting by a photo-z quality marker in PAUS ('Qz', not sure if this still survives?). Is there scope to revisit/homogenise photometric IA measurements with a prescription for weighting by confidence in photo-z point-estimates? Selection effects could be a hindrance
- Harry Also leakage of IA power into different scales due to photo-z
- Jonathan - discuss phot-z issues tomorrow

2. Sara. Separating WL and Galaxy IA in DES Y1
   - Method from Blazek et al 2012
   - Boundary between lens and source samples blurred
   - Took one source sample to have max overlap with lens sample. Other is separated from lens sample- less IA contamination
   - Robustness checks eg different cosmologies
   - Harry Explain green points?
     - Modelled samples as if not contaminated by IA and checked for robustness to width of z-bin.
   - Benjamin. Heard a few methods like this to measure clever data combinations. Which is most robust from IA perspective? What assumptions made? Which can be used for regimes where direct methods don't work?
   - Jonathan How does this method compare with self-calibration in particular on different scales?
3. Elisa L,Alex, Daniel Measuring and modelling IA as function of physical Galaxy properties
   - DES Y3 - decision tree to select properties
   - Explore how IA scales with properties - so far have only looked at stellar mass
   - Goal - description of galaxy properties to be used for forward modelling observable I. Photometric surveys including IA
   - What is the right ansatz for IA model?
   - Harry Synergy with halo model
   - Jonathan Which parts of data vector? If only shear- shear will have S/N issues after splitting data
     - Only shear-shear for now
   - Jonathan - explain decision tremors?
     - Train tree - minimise cost function (differences in redshift and physical parameters) at each stage - best split of data.
   - Benjamin Similar project on KiDS data, split on color and looked at difference vectors. Another indirect method with potential
   - Ágnes SOM? Have other ideas which can discuss
     - May not be best option in long term
4. Alex, Niall Direct detection of IA with DESI
   - Combination of DESI data with KiDS,DES, HSC. Compare different shape measurement techniques
   - DESI has a lot of useful data

- Use Johnston et al 2018 method
- Infer parameters of different models, NLA,TATT,halo
- DESI mock data from Buzzard
- Issues about what's available in Cosmosis,CCL
    - C_ell's and xi_+/- are straightforward, but the Hankel transforms for w_g+ and w_++ from IA P(k)'s are not explicitly implemented in many places. The hacks which have been mentioned are exploiting the similar form of angular C_ell → angular CF integrations. These are in CosmoSIS @ joezuntz / cosmosis / wiki / default modules / cl to xi nicaea 1.0 — Bitbucket and in CCL @ CCLX/CellsCorrelations.ipynb at master · LSSTDESC/CCLX · GitHub ("correlation functions", at the bottom)
- Jonathan - reiterate that outcome of meeting should be availability of tools
- Christos. Halo model should be available soon. What samples will you look at?
    - See first slide!
    - There are spectroscopic surveys coming up eg DESI which cover colour space better. Need to define ideal spectroscopic sample.
    - Discussion of areas available in forthcoming surveys and how to optimise samples for IAs.

5. Christos IA on bright sample
    - Bilicki et al 2021 for details of sample
    - Train photo-z data on GAMA spectroscopic sample
    - Large area and 1 million galaxies
    - Interesting sample to look at smaller scales and use halo model.Possible broken power law.
    - Harry. Low hanging fruit- data products available so can be done quickly. Luminosity, mass available
        - Discussion of broken power law
6. Martin UNIONS
    - Photometric data from various surveys. 800 sq deg in 5 bands
    - No IA measurements yet but potentially useful data
    - Not yet public but can recruit external collaborators
    - Benjamin what shape measurement methods?
        - Moments ??. r-bands only
    - Jonathan Synergy with DESI if politics can be overcome. Once DESI pipeline in place may be able to organise.
7. Simon Direct IA measurement with DES Y3 +eBOSS
    - Similar to some earlier projects. Five samples. Splitting into high- and low-z subsets. Measure projected CFs. Fit simultaneously.
    - Results broadly consistent with broken power law
    - Testing scales which models work on - see where TATT is preferred.
    - Jonathan magnification?
        - Magnification-lensing cross term is big enough to need modelling at low luminosity.
    - Benjamin CMASS extends into blue terrain. Do we need to correct points for where they fit ?
        - Discussion of low-z sample results

    - Rachel - enough information to revisit color. Would nice to have a good blue sample
    - Harry - PAU might be best for blue sample

Project planning & organisation

Slides Slide 12 onwards

General question: what if we are interested in a particular project but we are not part of the collaboration it is embedded in? Can we still help and participate? (for people who are not data right holders)

- Kai: two topics suggested. 3pt statistics, semi-analytic repo.
- Benjamin: echoIA is the vessel to achieve things that are of benefit to the community. How do we put in the extra effort.
    - In my dream: two or three large, cosmological sims, publicly available. We provide tools for 2-3 methods to create mock samples. Compare results to observations and hydro sims, and use this to make predictions.
    - The “grand re-analysis” is a very challenging task. Infrastructure to create mocks may be better for creating a consistent model. All of the various selection effects, etc can be included.
    - Do we have the sims we would need? MICE is available. Maybe that is a good place to start.
    - Galsim is an example of a community effort that has been very useful. Rachel: two things to keep in mind. 1) Initially focused on a simulated data challenge. There was a specific project that drove initial development. Once it hit critical mass, it was self-sustaining. 2) Connection between community effort and more survey-specific efforts. Can we put together survey-agnostic tools? E.g. IA model predictions are agnostic. But once we specify a specific survey set-up, it’s better to let individual surveys take it.
    - Christos: MICE exists. We need to identify the use cases. Libraries available to everyone is the highest importance.
    - What about a measurement repository?
        - Measurements are inhomogenous. We need to add value. For instance, re-measure and be clear on the selection? But this may be too much work.
    - Tomasz: working heavily on forward modeling. Creating sets of simulations (cosmogrid). Will be released to the community in the first half of this year. Create corresponding IA maps. Create a collaboration to have codes that can easily deploy IA models to create maps. First cosmogrid published soon. Then follow-ups. ~500TB of pixels on the sphere. (more useful for photo-z surveys)
    - Tassia: It is great if people are thinking about data format. But it’s probably not for us as echoIA to pick a format.
        - Data curation and documentation is feasible. But not uniformity.

- Martin: have a discussion between different surveys on how they are treating IA. Benjamin: this group should provide the infrastructure to make these comparisons. Martin: have an open discussion on what is currently being done.

Day 3

Block 1 now - 15:25 UTC

Room 1 CCL/Cosmosis modelling
Room 2 Simulation census
Room 3 free
Room 4 free

Block 2 15:35 UTC - 16:30 UTC

Room 1 Self-Calibration/Indirect/alternative measurements
Room 2 Samples for measurements
Room 3 3pt stats
Room 4 free

Breakout discussion notes

CCL/cosmosis modeling notes

JB: working on SPT modelling in CCL and cosmosis, form NLA to TATT (quadratic). CCL ones public. Cosmosis is public but not part of main release. Relies on FAST-PT for PT calculations, both call that library. Cosmosis release expected in a few weeks.
EC: in CCL we have LA, NLA, TATT, halo model (open branch) and we expect EFT in a few months. We don't have capability for w_{g+}. I don't suggest having it inside CCL (not an LSST observable).
HJ: there is a way to wrap CCL to get w_{g+}. Could also use nicaea. Fast because it uses FFTLog.
JB: This should be pretty straightforward for CCL. Use the existing FFTLog tools, just get the bookkeeping right. Would be a good student project. **Should make this a high priority!**
DSC: Using cosmosis but modelling w(r).
CG: Halo model implemented in CCL. Not yet optimized (~10s per power spectrum). Planning to release an example notebook in CCLX repo:

https://github.com/LSSTDESC/CCLX EFT predictions currently w/FFTLog w/Mathematica. Needs porting.
NJ: **Documentation in CCL needs to be updated!** Difficulties finding NLA/TATT in readthedocs.
CG: Put CCLX link on top at readthedocs?
DG: would be great to have IA amplitude based on galaxy properties
JB: This could be done internal to CCL using the existing model parameter rescaling function as a model
EC: Right now, the L-scaling is in the likelihood code, sitting outside of CCL.
MI: make the CCL note PDF visible to users
MI: There is one more correlation that needs to be calculated for the TATT model
JB: yes, there are in fact 2 correlations that need to be added to CCL, I have a student who is is working on it but if other are welcome to work on it if they want to.
EC: Higher order stats?
SCH: Need some model for the bispectrum. Can someone do this? It would be very helpful for us. (EC: SPT/EFT/halo model can be used, but they aren't coded up)
EC:
MI: we'll need it eventually. Higher order stats topical team in DESC could be a point of contact.
EC: Model choices? We have more than one. How can we advise the community as to which one to use and when.
IT: Euclid just started looking into different models, but it is tricky at this point. Halo model implementations are too slow. We haven't decided which types of models to consider with the data. It would be great to get access to more models, so we can figure out what to do with real data.
RR: We don't know how nature implements IA. Sims suggest that blue galaxies don't align, for e.g.
EC: Self-calibration works very nicely in this case. Can complement and help assess robustness of model choice.
RR: Do sample splits to check.
EC: Yes, as long as you can calibrate.
IT: There is also the problem of choosing the fiducials.
EC: Coupling of the model with other aspects should also be considered.

Summary -> Christos

- CCL-> LA/NLA/TATT, halo model ongoing, soon EFT (requests to improve docs)
- Cosmosis -> LA/NLA/TATT, halo model ongoing
- Discussed having a wrapper for common statistics like wg+
- Model choice often driven by implementation: what is available/simple to use
- Complementing model choice with self-calibration method (publicly available pipeline TXPipe)
- Possibility to forecast higher order stats

Census of sims and infusion models

https://arxiv.org/pdf/1909.07976.pdf page 21

Kai's list:
https://docs.google.com/spreadsheets/d/13rWIlHkDIPphjopQMNwRz2aLxdK7or98GIXUJkcdaSg/edit?usp=sharing

N-body: list of info needed, some available in the above paper ^

- Name of simulation suite / paper / website / other identifying information
- Volume;
- resolution;
- Redshift range for snapshots available or for light cone
- availability of particle data, halo shapes in 2D/light cone or 3D (not just orientation / major axis direction), subhalo information, tidal fields in 2D or 3D
- Lensing data available? (e.g., convergence maps)
- Which halo finder?
- existence of galaxy catalogs from a SAM or halo model? (with link to list of properties available, as that can affect the IA modeling)
- public or not? If yes -> link
- Number of available cosmological models
- Name of IA model infused, if any

Can envision a "simulation ladder" to go from higher res to lower res sims.

Simulations: AbacusSummit
(contact Claire Lamman claire.lamman@cfa.harvard.edu)
https://abacussummit.readthedocs.io/en/latest/
https://ui.adsabs.harvard.edu/abs/2021MNRAS.508.4017M/abstract
Suite of >140 N-body simulations. Size / resolution varies but the most common parameters are listed here.

- Volume; 2 Gph / h
- resolution; 6912^3 particles
- Redshift range for snapshots available or for light cone: 12 snapshots from z=0.1-3.0
- availability of particle data, halo shapes in 2D/light cone or 3D (not just orientation / major axis direction), tidal fields in 2D or 3D: Triaxial halo shapes and orientations, 3% and 7% subsamples. Particle positions, velocities
- Which halo finder? CompaSO
  https://abacussummit.readthedocs.io/en/latest/compaso.html
- existence of galaxy catalogs from a SAM or halo model? (with link to list of properties available, as that can affect the IA modeling): Yes, for ELGs, and package to do more. Contains positions, velocities, no shapes: https://doi.ccs.ornl.gov/ui/doi/362
- public or not? If yes -> link: Yes
  https://abacussummit.readthedocs.io/en/latest/data-access.html#public
- Number of available cosmological models: 97
- Name of IA model infused, if any: N/A

Models:

- Model name / paper / GitHub repo / other identifying information
- Map-based or object-based?
- Model outputs? (galaxy shapes in 2D or 3D, kappa/shear on a grid, …?)

- What simulated data products are needed to apply the model? (halo shapes, tidal fields, certain galaxy properties, …)
- Model limitations / rigidity
- What tunable parameters are in the model? Priors?
- Public implementation available?
- Any simulated catalogs available?

People to start filling this in: Joachim, Tomek, Kai, Yesukhei
To fill in later: Nick van Alfen's halo model implementation;

Model:***IA-infusion from projected flat-sky tidal field***
(contact Joachim Harnois-Deraps, joachim.harnois-deraps@ncl.ac.uk)

- Paper: https://ui.adsabs.harvard.edu/abs/2022MNRAS.509.3868H/abstract

- Based on projected tidal fields computed from projected mass sheets. The output are mock galaxy catalogues with controllable N(z) including shear, convergence and the tidal field s_11, s_22 and s_12 components. These can be transformed into intrinsic ellipticities following a linear coupling and redshift evolution, which is fully consistent with the NLA-IA(z) model. Moreover, the method puts in galaxies following the matter distribution, so we recover in fact the density-weighted NLA-IA model
- To apply the model, one needs the light-cone mass sheet/shells.
- At the moment, I have made such mocks with KiDS1000, DES-Y1 and Stage-IV like surveys. If one needs another n(z), new mocks likely need to be created.
- From existing mock products, one can tune the A_IA and b_TA parameters.
- Possible split into double model for red/blue with red/blue fraction parameter if n(z) for each is known
- Tunable internal parameters in the model includes the smoothing scale of the tidal field
- The tidal torque has been added too but is currently not validated
- Model limitation: use only 2d information, 3d not possible
- The projection thickness seems to put a limitation in the accuracy of the method, finer sheets would be preferable
- Tested on 26 wCDM cosmological models.
- Catalogues available, contact me (email above)!
- Public implementation not available yet, but soon.

Model: NLA-IA model on map level
Used by: Tomasz Kacprzak (tomaszk@phys.ethz.ch), Janis Fluri, Dominik Zuercher
Description: creating IA convergence map with IA kernel in the same way as the NLA model, then adding kappaIA to kappaG, scaled by the A_IA parameter. Possible to have redshift dependent A_IA(z) factor for different redshift bins

- Map-based or object-based?
- Model outputs: 2d KappaIA maps
- Data needed: lightcone particle counts in map shells

- Model limitation: use only 2d information, 3d not possible
- Tunable parameters: A_IA(z), either directly or via eta (power law), possible split into double model for red/blue with red/blue fraction parameter
- Public implementation available? Yes, see DES Y3 repositories
- Any simulated catalogs available? No, the IA maps are created “on the fly” from shells

Papers:

- Cosmological constraints with deep learning from KiDS-450 weak lensing maps https://arxiv.org/abs/1906.03156
- Dark Energy Survey Year 3 results: Cosmology with peaks using an emulator approach https://arxiv.org/abs/2110.10135
- A Full wCDM Analysis of KiDS-1000 Weak Lensing Maps using Deep Learning https://arxiv.org/abs/2201.07771

Repositories:

- https://cosmo-gitlab.phys.ethz.ch/cosmo_public/NGSF - DES Y3 peak statistics analysis, possible to use on any lightcone kappa maps

Graph Neural Network based Deep Generative model (paper and repo soon to be published, contact Yesukhei Jagvaral yjagvara@andrew.cmu.edu)
Pitch:
https://docs.google.com/presentation/d/1CoUeg7-Vu9xClOUSekFZegR_xCrugGOLNU6WDL7l61A/edit#slide=id.g111c688a9fc_0_25

- object-based
- Model outputs: Major axis orientation in 3D, complex ellipticites in 2D, various scalars: shapes 3D, stellar mass
- Simulated data products that are needed to apply the model: tidal field in 3D, mass oh parent halo, mass of subhalo
- Based on GAN architecture which could be quite unstable.
- Non-parametric
- Public implementation soon to be available
- Soon to be available
  09 Feb. 2022 by Yesukhei Jagvaral

Semi-analytic IA model:
Pitch:
https://docs.google.com/presentation/d/1CoUeg7-Vu9xClOUSekFZegR_xCrugGOLNU6WDL7l61A/edit#slide=id.g111ccea14e2_0_0
(Contact: Kai Hoffmann, kai.d.hoffmann@gmail.com)

- Object based
- Output: 3D axis ratio, 3D orientations of major and minor axis, 2D ellipticities
- Data products needed to apply the model: 3D halo orientations, galaxy type (central satellite), galaxy magnitude, galaxy color
- (3 parameters for defining galaxy shapes, 4 parameter for defining orientations) for centrals and satellites => 14 parameters in total. Parameters for orientations need to be adjusted for each simulation. Shape parameters are universal
- Catalogs available for MICE (z<1.4) and Flagship (z<2.0) on Cosmohub Database

- Simulation are public within corresponding collaboration, usage outside of collaboration needs to be discussed
- Model is integrated at mock production pipeline at pic, plan to make it public over the next months
- Model limitations: model requires halo shape measurements and galaxy properties, parameters need to be recalibrated for each input simulation, calibration is computationally expensive

Hydro: TBD!

Summary:

- We've outlined a set of information that it would be useful to have in a census of simulations and of models that can be used to infuse IA into sims.
- We've collected links to a few lists of simulations that subsets of that information.
- Several people have provided the requested information about their IA model implementations (info for 4 models, so this is a good start but likely incomplete)
- Census of sims, and putting the model census into a more useful form, can be follow-up work.

Self-calibration and alternative measurements

People intro:
Mustapha: working on IA mitigation methods, sel-calibration and IA infusion
Tomasz: Neural Networks
Silvan: interplay between photo-z errors and IA, fast C_ell emulator to run MCMC very fast
Leonel: Self-calibration

Discussed the possibility of using Neural Networks into self-calibration
Redshift error into the self-calibration, how does it impact cosmological constraints? possible source for fsigma8 tension?

IA 3pt stats

People introductions:
Susan Pyne: Measuring IA bispectrum in N-body simulations (IllustrisTNG) - hydro sims later, IA dependence on galaxy properties
Laila Linke: Modelling 3rd order shear statistics, experience with treecorr, estimator for 3rd order aperture mass statistics, convergence bispectrum
Sven Heydenreich: Same as Laila
Joachim Harnois-Deraps: SLICS with NLA, delta-NLA and soon TATT available for DES, KiDS and Stage-IV-like surveys (paper), happy to share
Laurence Gong: experience in HOS, integrated shear 3pcf, experience with treecorr

Anik Halder: Like Laurence, mainly focused on integrated shear 3pcf (probes predominantly squeezed bispectrum), experience with Takahashi, MICE, … simulations, very interested in IA modeling for 3rd order statistics
Robert Reischke: modelling, mitigation of IA, IA in cosmoSLICS
Tomasz Karcprzak: Constraining IA using deep learning, more realistic IA models in simulations, IA for HOS
Silvan Fischbacher: correlation between redshift errors and IA

Most people seem to prefer **real-space statistics**; pro: easier to measure on real surveys, con: mixing of scales, tend to be harder to model

MICE: really detailed alignment model, IA signal depends on galaxy properties, we could measure IA signal on different galaxy sample sets

Kai: **Modeling of IA in both MICE and Euclid Flagship**, HOD model gives realistic galaxy catalogues. IA model is a toy model constructed from hydrosims: Each galaxy is 3d ellipsoid, separated into central/satellite and blue/red, disks aligned perpendicular to halo angular momentum, ellipsoids align with halo ellipticity, satellites align with host halo, observational properties are set to match COSMOS survey, orientations randomized to follow 2pt statistics from different surveys

Modeling side: NLA, EFT (not yet really implemented, at lowest order they fall back to NLA/TATT models)

Modeling NLA would be relatively straightforward, but it needs to be validated

Interested in measurements:
Sven Heydenreich & Laila Linke (3pt-correlation functions (GGG, etc..))
Laurence and Anik (integrated 3PCF)
Susan Pyne (bispectrum)

interested in modelling:
Robert Reischke
Anik Halder (NLA for real space 3PCF)
Laurence Gong (same as Anik)

interested in comparing model vs. measurements:
Kai: How to access MICE simulations. Arrange telecon in march to plan next steps

Summary:

- multiple people interested measuring and modelling 3rd order IA stats
- Sims based on semi-analytic and infusion models are available for measuring 3rd oder IA stats
- Plan to have follow up meeting to plan specific steps (email kai.d.hoffmann@gmail.com with subject “IA 3pt stats” if you want to join)

Samples for IA measurements

What do we have?

- SDSS Main – Mandelbaum+ 2006, Hirata+ 2007, Johnston+ 2019
- GAMA(+KiDS) – Georgiou+ 2019, Johnston+ 2019
- KiDS LRGs - Fortuna+ 2021
- PAUS (early) – Johnston+ 2021
- WiggleZ – Mandelbaum+ 2011
- BOSS LOWZ – Singh+ 2015
- BOSS CMASS (coming soon) – Samuroff+
- DES redmagic (coming soon) – Samuroff+
- MegaZ - Joachimi+ 2011
- eBOSS ELG and LRG (coming soon) - Samuroff+
- DESI - various upcoming…
- PFS galaxy evolution survey (starting in a few years)
- WAVES (4MOST) + other programmes - https://wavesurvey.org/ - includes Wide and Deep

What is missing? (e.g. a good blue sample)

- Is it feasible to hope for a good blue sample?
- Maybe if we use a different estimator.
- COSMOS-30: small area, photo-z scatter, but very deep
- WAVES will have nice blue galaxies.
- CANDELS? FastSound? Both small area, deep, with spectroscopy
- Kinematic lensing measurements give orientations for galaxies -> get IA from this?

Can we make measurements public?

Yes! Co-host them

What formats are most useful?

Something like json

Collect IA and clustering CFs, covariances, redshift distributions, galaxy property distributions

What metadata do we need to provide?

- Type of shape measurement method, passband, calibration
- Spectroscopic vs photometric; if the latter, photo-z characteristics
- Shared volume between different measurements - we have to think about correlations and such.
- Type of IA/clustering estimator, Pi_max, integral constraint, binning details
- Fiducial cosmology, H_0 convention, comoving vs. physical coordinates
- Galaxy sample selection: colour cuts, magnitude cuts, S/N, etc.
- Systematics corrections applied + data to apply corrections: magnification bias (luminosity function slope), GGL, etc.

- How covariances were estimated, number of samples
- Information on randoms/masks used
- Catalogues/measurement software available if required?