June has gone, July has come. Let's set some goals for July:

- [ ] Finish UDG paper (high priority)
- [ ] Get started on the IMF project
- [ ] FIgure out a way to wrap up the `popsed`.

UDG

1. I finished the methodology part of the paper (still primitive, need polish). For measurement uncertainty estimation, I replace the neural net with an interpolation. This has minor impact on the science plots. However, the R_e uncertainty still need to be tweaked.
2. Still working on deciphering Johnny's completeness.
3. Will have science plots by next week.

SBF

Jenny and I talked about SBF. I think there are two ways to go about the proposal:

1. SBF for distance. We need to figure out what's the best way of calibrating the abs SBF mag. This could be an optimization problem, basically finding a combination of colors which gives you the least scatter. After having this, we can do image simulations to help us understand to what distance and stellar mass can we both detect the galaxy in LSST and measure its SBF using LSST+Roman. This will need to incorporate ArtPop into the Roman `STIPS`. We need Rachael's knowledge on which isochrone shall we use for ArtPop.
2. SBF for stellar population. In Johnny's paper, different isochrones produce different SBF magnitudes. This is equivalent to the fact that we know very little about AGB stars. Therefore, SBF not only tells you the normal stellar pop (age, metallicity, etc.), but also tells you which isochrone is better (given that we know their distances). I think this is more challenging...

We should schedule a meeting with Rachel and talk more.

popsed

I changed the meeting frequency to every two weeks. I just think that, each time I meet with Peter & Chang, we just get stuck at some weird and detailed things.

The biggest problem is where are we going about this project. Two ideas:

1. Use `popsed` as a photo-z code, but galaxy-physics motivated. Then we have to show that `popsed` is way faster than any other code, but still gives you good results. At least for now, it doesn't give you good results.

   We just cannot start the NDE from a tophat. We have to tell it where to start, or we have to give up stellar mass (not including it in the NDE, but sample it based on external $P(M_*|z,\theta)$). I think I'll try both.

   The possible datasets are 1) NSA, 2)COSMOS, 3)GAMA.

2. Use `popsed` as a stellar pop code. In this case, spec-z must be given, otherwise it will just be a piece of junk. The way of feeding spec-z is then tricky. There are several experiments I can play:

   1. directly fit an NF $g_\phi(M_*|z,\theta)$ to the `sedflow` posterior. We still initialize NDE with flat prior. The NDE contains parameters except for stellar mass. For each sample drawn from NDE, we plug it into g_ϕ and get a sample of stellar mass. Let's see what happens.
   2. we learn $g_\phi(M_*|z,\theta)$ based on mock spectra + selection function. Chang has a feeling that this will work. I doubt.

Anyways, the selling point of this paper is: it is way cheaper to transfer to other datasets. It is also cheaper to test different model (different SFH, or SPS model). A pop-level posterior is hard to compute in the sedflow case, but it's cheap here.

Anyways, I feel like we are stuck. What's the way out?

Chat with Yuan-Sen

This guy has so many ideas.

1. Spec emulator. He has several trick to improve the accuracy of training emulator, from 1% (which I have now) to less than 0.1%. Also interesting on how to solve the spikes of error at deep absorption lines. A high accuracy emulator is more needed for stellar science (since they have S/N of several hundreds). Not that important for galaxy science.

This could be a good pathway to try to emulate `alf`.

2. My `popsed`. He mentioned that we can study the MW halo star mass profiles in the population-level manner. The forward model is just stellar physics (which I don't understand at all). But the philosophy is there.

   A PKU undergrad student, 刘行健, contacted Yuan-Sen about potential project. I was trying to convince her to do the Gaia project.

   Also Alexa's idea on population level inference for GCs.

3. The metallicity [Fe/H] is not a constant for an SSP, and the spread σ of P(Z) is a function of SSP age, etc. Therefore, $P_{\rm SSP}(Z|c)$ (where c is other parameters) can be parameterized by a normalizing flow. Maybe just use `sbi` ANPE?

   The stellar spectra library is generated using some theoretical model.

   Oh... you want to infer $P(Z|c)$ from observed spectra absorption features?

   Okay, had a nice lunch with Yuan-Sen and Meng. We want to learn $P(Z, age, mass, etc)$ from the observed Wing-Ford band spectra.

   Sounds like doable. Meng & Yuan-Sen think this is a 'low hanging fruit', could be finished within 1 semester. I kinda agree.

4. The graph net + NF work. This reminds me of Yingjie's words on predicting the gas dynamics