Thesis outline

## Introduction

First papers on GSMD by Lilly (1996) and Madau ()

Development of this idea for over 20 years – new data (references in M&D 2014)

Applications of GSMD:

constraints on galaxy evolution models, boundary conditions for cosmological simulations

Problems that still exist: available data sets are either shallow or affected by cosmic variance.

Our approach – construct largest data set with consistent colors with limiting magnitudes up to XX

## Data

### optical

General way to get information about a large sample of galaxies is to perform SED fitting in optical. We’re using SDSS Stripe82 region – a 300 sq.deg field that was used for calibration purposes and thus is much deeper than single pass fields. To make it even deeper we shall use L.Jiang et al (2xxx) coadds that he produced in the following manner:

in total our field consists of 5556 images in bands u, g, r, i, z with limiting magnitudes xx, xx, xx, xx, xx and FWHM: xx, xx, xx, xx, xx respectively

### IR

IR data is essential for our purpose as it gives information about low-mass stars that contribute most to the stellar mass of the galaxy. WISE (Wright et al. 2010) obtained photometry of the full sky in 4 bands (w1, w2, w3 , w4).

Data that are publicly available (irsa.ipac….com) were convolved with the PSF of WISE. That helps to better detect isolated sources (like brown dwarfs) but leads to blending in the crowded fields. We shall use unWISE (Lang 2014) images with restored native pixel scale – 2.75 asec/pix

## Approach

Data in optics and IR have different resolution due to technical limitations, so it is a challenge to get a flux from the same object in different wavelength, especially in the crowded fields – blending can be severe. We are going to utilize “template fitting technique” using the code TPHOT (E.Merlin et al )

The idea of the code is the following: ………..

*I’d like to write 2 separate chapters, 1 about what I did to run tphot and another about doing SED.*

*my problem here is that it is hard to separate what I did for the catalog construction and what as a preparation step for the tphot. So I will explain it in chronological order.*

Catalog construction and preparatory work for SED fitting.

- Following recommendations of E.Merlin () we

changed reference pixels in all SDSS images so it has the same value as corresponding unWISE image (now sometimes the reference pixel is outside of SDSS image with maximum distance ~0.7 deg).

Changed unWISE pixel scale from 2.75 to 2.772 so that now the ratio of pixel scales of lores and hires images is now an integer (2.75/0.396=7)

- in order to have consistent fluxes in all 5 bands we decided to convolve g, r, I and z band to the PSF of the u-band – the one with the largest FWHM. That requires construction of a kernel for each pair of the SDSS image in u-band and a corresponding image in g, r, i and z-band.

- we first followed the standard approach of constructing Sf (*do not know if I need to write about it at all)* and used IRAF tasks daofind → phot → pstselect → psf for approximately 200 images and tested it with TPHOT. It is not applicable for the whole dataset as many things are done in a manual fasion.

- when this approach was proven to work we switched to semi-automatic way: we run SExtractor (Bertin&Arnouts 1996) and selected objects that contain all their flux in a relatively small aperture, are not saturated or extremely dim (criteria is given in a mathematical form). Then this set of objects (we remind that it is unique for each of 5556\*5 SDSS images) is supplied to the iraf/psf task and PSFs are constructed in non-interactive way. Than all PSFs are visually inspected and are fixed manually.

- next is to run iraf/lucy to construct 5556\*4 kernels and run iraf/psfmatch to convolve all bands to the u-band PSF (once again – unique for each u-band SDSS image).

- Now we run Sextractor with the same parameters for all bands - We ran SExtractor in a dual mode with r-band image for detection and r\_matched\_u image for photometry. SNR>5 rule was applied. Our parent sample of sources that consists of XX millions of sources (XXXX sources per image in average)

- convolution of the images to the PSF of the u-band did not changed magnitudes much but affected the magnitude error, so we corrected it by multiplying by a coefficient k=….. that we obtaiend independently for each SDSS image – this is the end of the part about construction of optical parent catalog

In order to use TPHOT we need to provide it a kernel – convolution of lores PSF and hires PSF. Next step was to construct hires PSF – we chose r\_matched\_u images as it has high detection limit as well as low initial FWHM. We used same set of PSF stars as when constructing SPF for the psfmatch.

Next was to create PSF for unWISE images. Because the size of the unWISE image is much larger than that of SDSS, each unWISE PSF will serve for construction of as many as 48 kernels and so this step is very important. Thus after selecting potential PSF objects in a manner that we described earlier, PSF stars were chosen in interactive mode for both bands.

All PSF images were scaled to have total flux of unity (iraf/imarith)

unWISE PSF were scaled up in size by factor of 7 to match the ration of the pixel scales in hires and lores (iraf/imlintran)

We used iraf/lucy to create kernels for r\_matched\_u-w1 and r\_matched\_u-w2

### TPHOT run

Following recommendations of E.Merlin each pair of lores and hires images was processed twice (pass 1 and pass2)

Each pass took approximately 2 hours. That leads to 2 hours \* 2 pass \* 2 bands in un WISE \* 5556 SDSS images = 44500 CPU hours. We used MU Lewis CPU cluster (credits).

Some of tphot results (catalogs and residuals)

### Masking bright stars

TPHOT does not perform well on bright or saturated objects and flux can be biased in a regions around bright stars, so we used BAO catalog () to mask regions around brightest stars. Area of masking depends on the class and brightness of the star.

### Star-galaxy separation

We run Sextractor on original set of images in 3 bands with the best FWHM – g, r and I. And used CLASS\_STAR parameter to separate stars and QSO from galaxies. We compared or results to the classification provided in a spectroscopic sample of SDSS DR13 and found the following criteria to be the most efficient:

…………………...

### SED fitting

we tried several SED fitting codes and compared z\_phot and z\_spec (SDSS DR13) and decided to stay with Hyperz (EAZY). Our current SD for the whole set is .0XX

Explanation of the choice of parameters: ….

### SMD construction

we tested our hyperz output for the largest z\_phot we can use. It is ~0.8. then we divided our sample by 3(4) bins of the same volume (...Gpc using standard cosmology)

### Correction for incompleteness

## Results

1. comparing our results with others

explain difference

plot our extrapolation of GSMD based on our results

maybe use SFR output from hyperz to hypothesize about CSFH

2. optical dropouts

## Conclusions.

It is a good thesis.