Supernovae in Image Simulations

Kevin Wang

Duke
Motivation

• Lot of work done on catalog-level simulations

• Need pixel-level simulations to inform catalog-level simulations and to prepare for science pipeline

• This work combines two previous works: the catalog-level simulations of Roman SN group and the image-level simulations of the Roman Weak Lensing Team (w/ updates from Rose et al. and Macias et al.)
Troxel et al. 2019 simulates images over 5 square degrees using simulations of star and galaxy positions, and realistic accounting of camera artifacts

- Uses Buzzard simulations to create distribution of galaxies, then each galaxy is assigned to a CANDELS library (HST survey) galaxy for that redshift, from which we can derive galaxy properties
- Created using GalSim, open-source image simulation software with a Roman package with details of the telescope
- Model various detection effects such as reciprocity failure, dark current, and interpixel capacitance
Slewing Strategy

• For image simulations, we need to make choices that aren’t done in catalog sims, like exact slewing strategy
• Deep field strategy with exposure times 300, 300, 300, 900 seconds in YJHF respectively
• Go through snake pattern then change filter and reverse through pattern for 4 filters
• Cadence of 5 days
• Rotate telescope and pattern by 30 degrees every 30 days
Example Image
Example Image

Using Source Extractor (AstrOmatic program for detecting objects in images). Detections circled in red.
Inject Supernovae as Stellar Point Sources

Series of cutouts of a Y-band image showing a bright supernova
Generating Supernovae

• Give SNANA a catalogue with galaxy information
• Choose host galaxies with higher star formation rate and mass (proxies for SN rate)
• Effect is that host galaxies are brighter on average compared to galaxies overall
• On images, heatmap represents all galaxies. Contours represent host galaxies only.
Pipeline Preparation
Coadds

Can run AstroDrizzle (Python implementation of MultiDrizzle for HST) to combine images. Cyan circles show additional objects detected in coadd.
Difference Images

- Images created by subtracting a template
- Allows detection of transients
- Just an example – needs more development to be pipeline ready to run on full suite of images
Science Preparation
Supernova Detection

- Detection efficiency using isolated SNe
- Not done using difference images (ideally would be)
- Only SNe not next to large or bright galaxies
- Could feed efficiency back into catalog sims
Which is the right host galaxy?

• Simplest method – Just use distance between SN and galaxy center

• More complex method – Also take into account size and orientation of galaxies

• Additionally, can compare redshift of SN and galaxy
Host Galaxy Association

Using simplest method here

Correctly Identified Hosts

\[\text{z < 1: 96 correct, 2 not found} \]
\[\text{z > 1: 315 correct, 8 incorrect, 68 not found} \]

Good performance below \( z = 1 \)
Output

• Set of images representing a 1 square degree subset of the deep field slewing strategy (available soon)
• Truth files for objects included
• This work will be part of Wang et al. 22 which is currently in preparation

Illustration of the image simulation process. Red shapes are files that will be provided with the output
Conclusion

• Image simulations are necessary as part of the pipeline development for Roman telescope
• We created image simulations that include injected SNe
• We show several analyses with these simulated images to demonstrate their potential utility
• We will provide a set of these images for use