7th KAGRA International Workshop

Generating Kilonova Light Curves Using Autoencoder to Investigate the Properties of a Compact Binary Merging System

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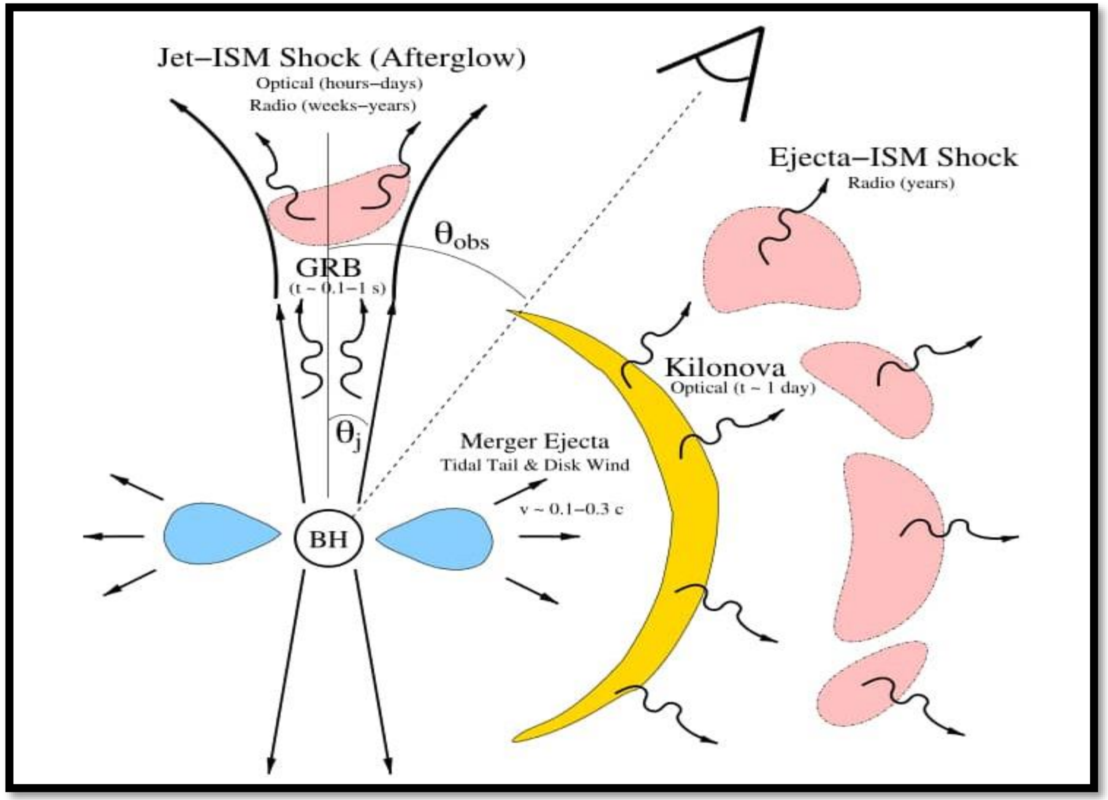
Outline

- Background and Motivation
- Planning
- Data Used
- Roadmap
- Results
- Discussion

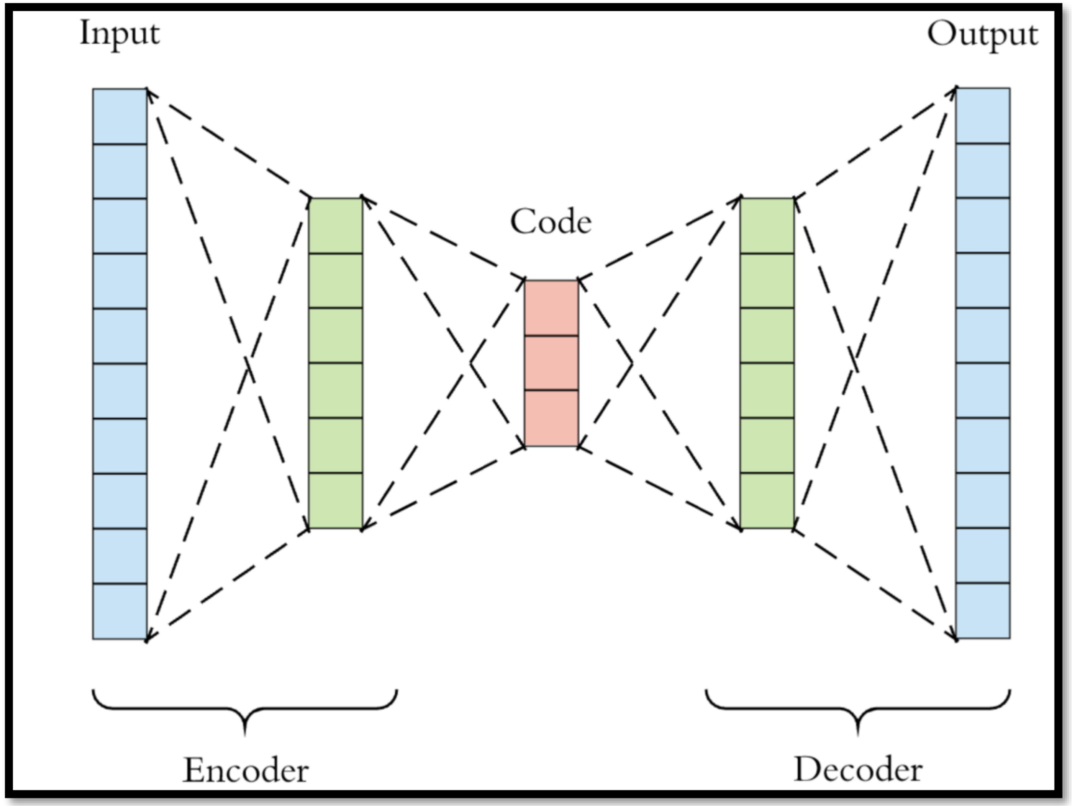
Background and Motivation

Kilonova: Transient electromagnetic counterpart resulting from merger of NS-NS or BH-NS, powered by the radioactive decay of ***r-process*** nuclei.



Metzger and Berger 2012

Autoencoder: Unsupervised learning technique where neural networks are used for representation learning.

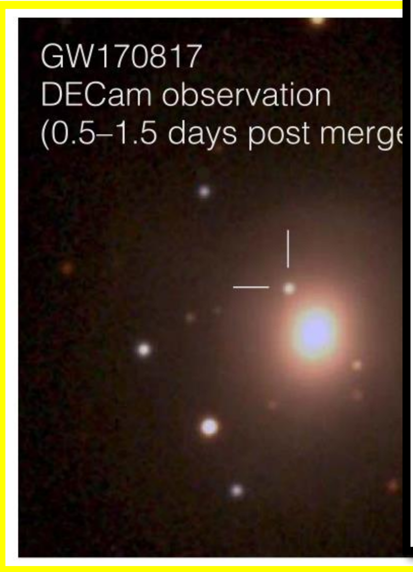


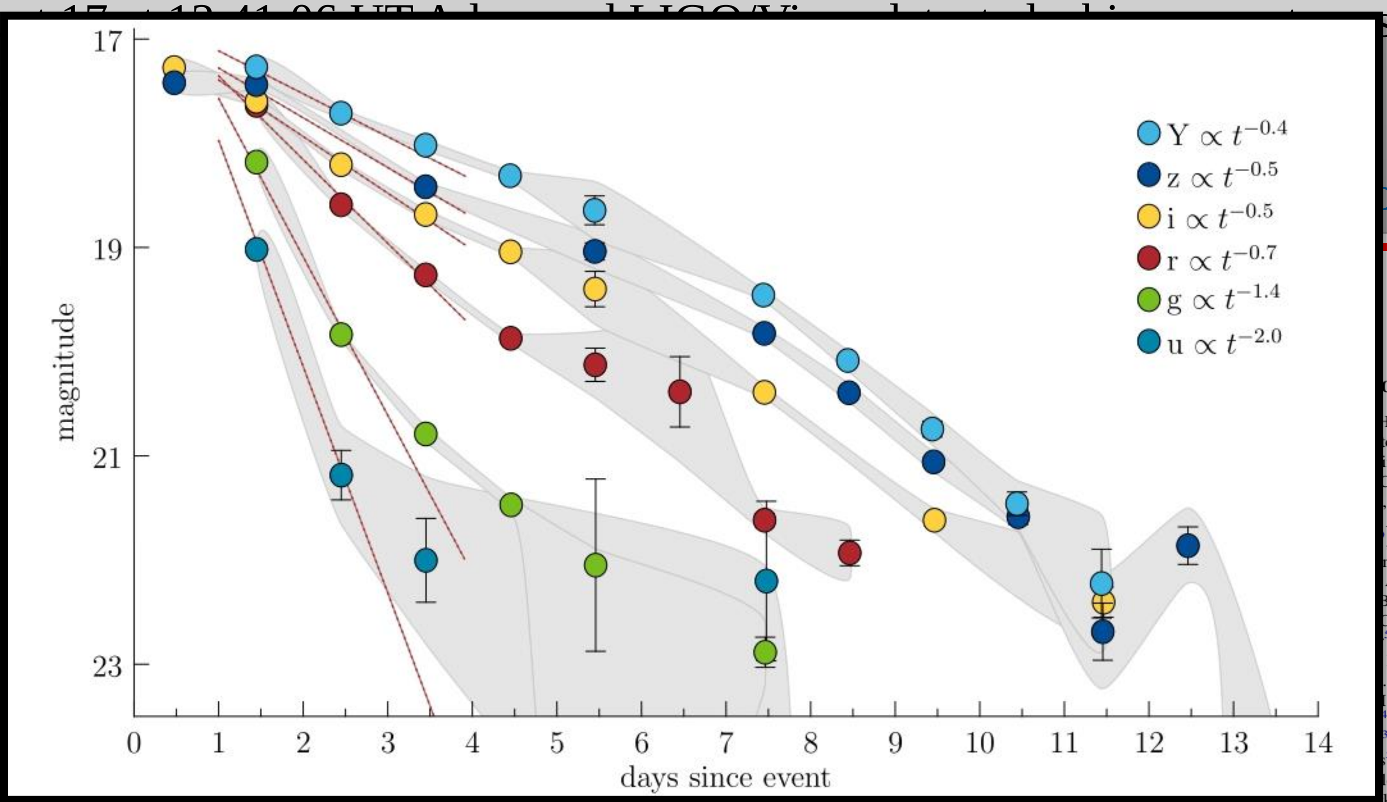
PaperspaceBlog

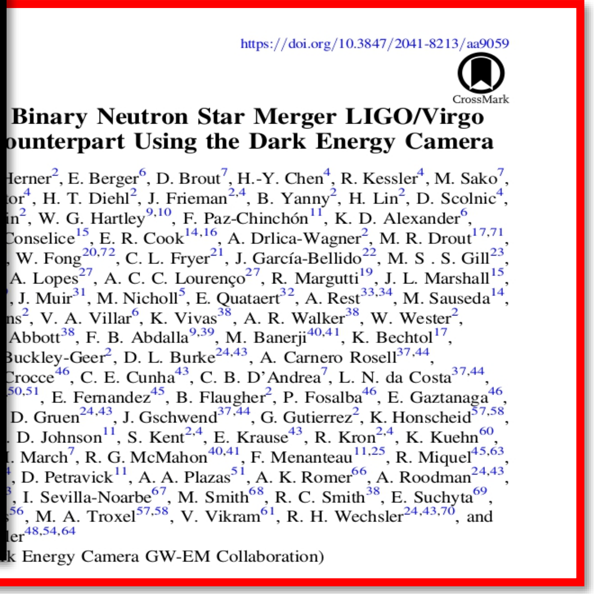
Background and Motivation

Birth of Multi-Messenger Astronomy

- On 2017, Augu… star merger (GW170817)
- Alert was issu…
- DECam follow… oulter et al.)







NGC4993 *grz* color composites

Kilonova from follow up observation of GW170817

Follow up observations: HST, GS/F2, Swift/UVOT

Motivation and Planning

Looking For Some Answers

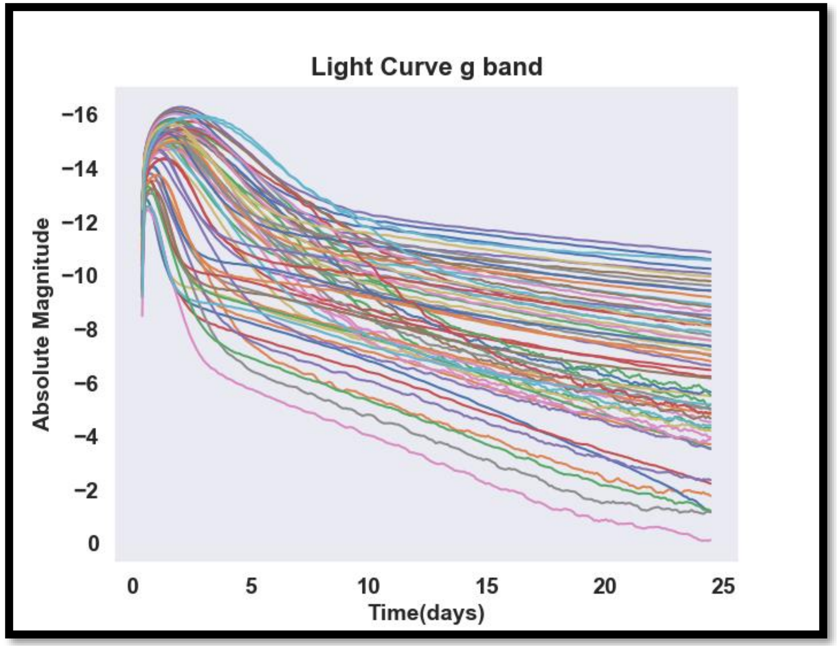
- How to relate the ejecta parameters with the kilonova (KN) light curves (LC) from the follow-up observations using autoencoder?
- Is it possible to generate KN LC based on certain ejecta parameters, hence helping in better parameter estimation?

Build an autoencoder (AE) model of KN using some simulated data and reconstruct the LC, learn the physical parameters, use the model to extract KN LC from other data (if present).

Data Used

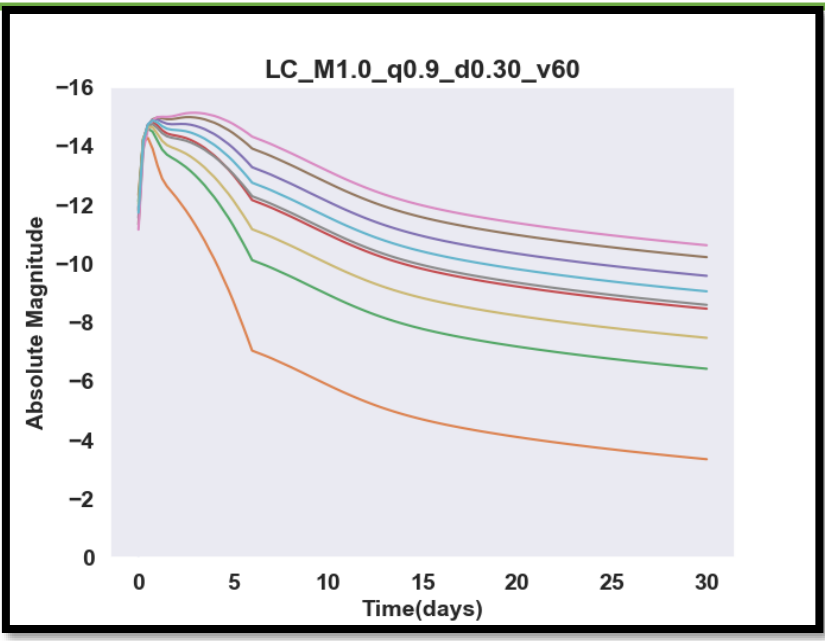
Data 1

- Simulated LC using Kasen Model
- Each LC has its own dynamical ejecta properties
- Time, Absolute magnitude, ejecta mass, ejecta velocity, lanthanide fraction.
- LC curves are available in *g,i,r,y and z bands* of DECam.

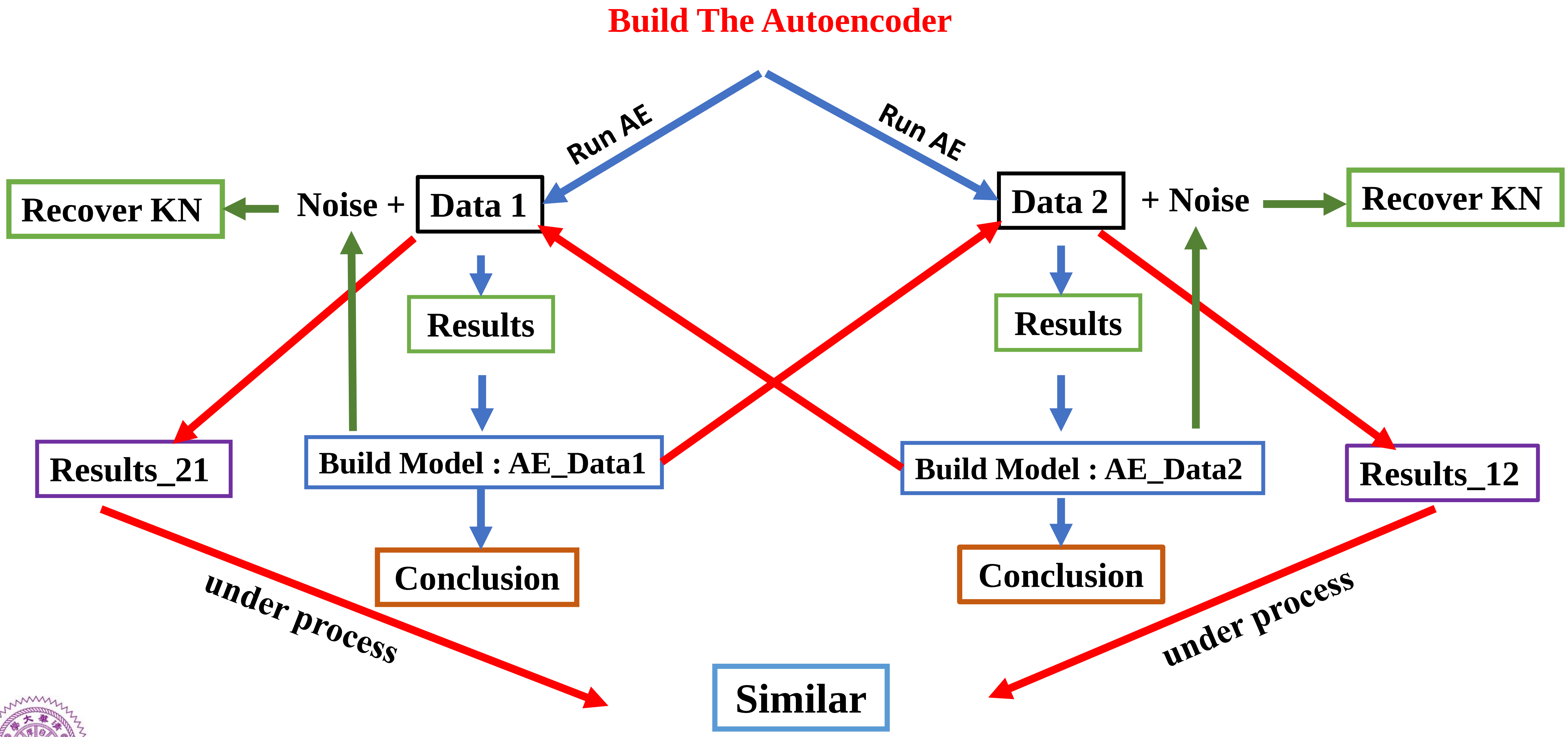


Data 2

- Simulated from his own KN model.
- LC are generated based on chirp mass, mass ratio, viewing angle fraction of the ejected remnant disk.
- Each data set has a particular value for the above parameters and has values for *LSST (u,g,r,i,z,y), PanSTARRS (w) and ATLAS (c,o) bands.*



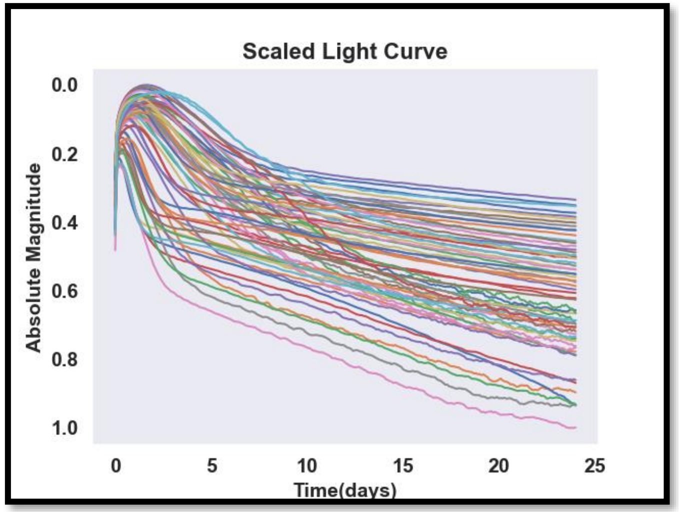
Roadmap


Build The Autoencoder
Run AE
Run AE
Recover KN
Noise +
Data 1
Data 2
+ Noise
Recover KN
Results
Results
Results_21
Build Model : AE_Data1
Build Model : AE_Data2
Results_12
Conclusion
Conclusion
under process
under process
Similar

Results

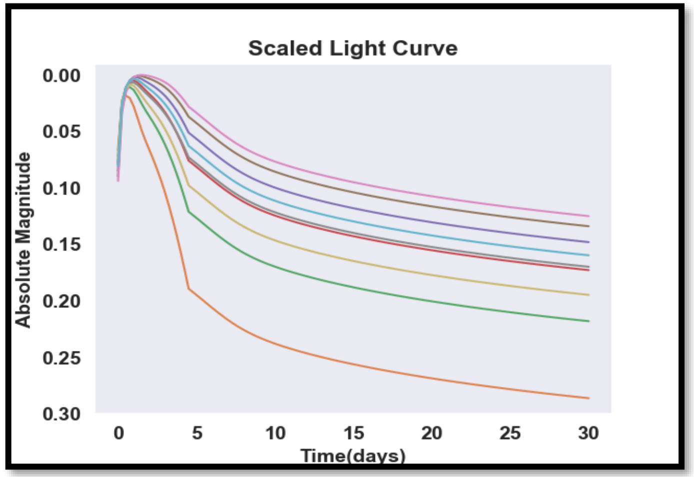
From Data 1

Input to AE



From Data 2

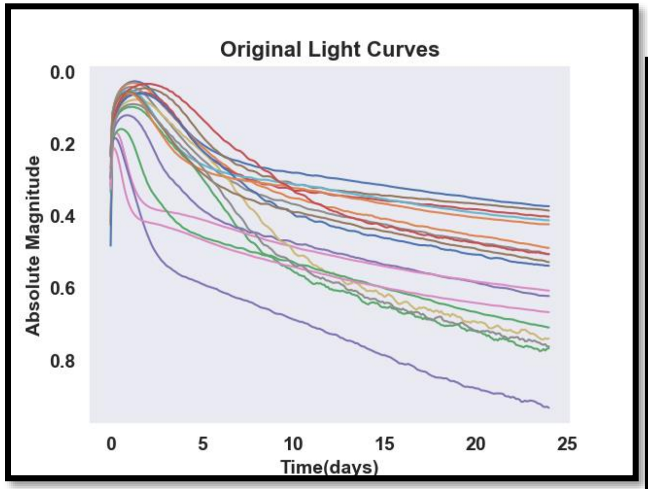
Input to AE



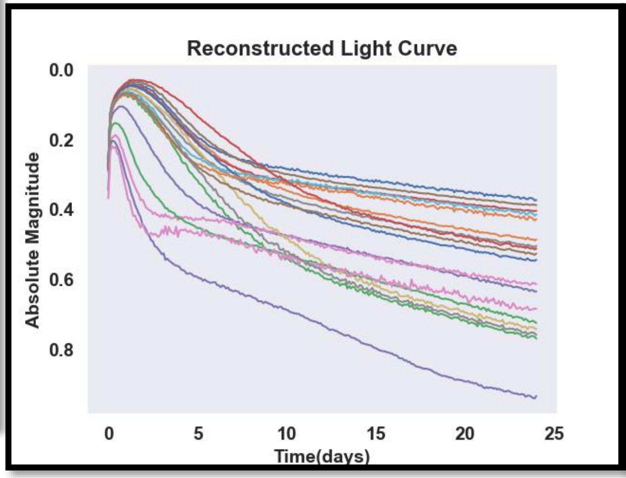
For Data 1: Each LC has different ejecta parameters

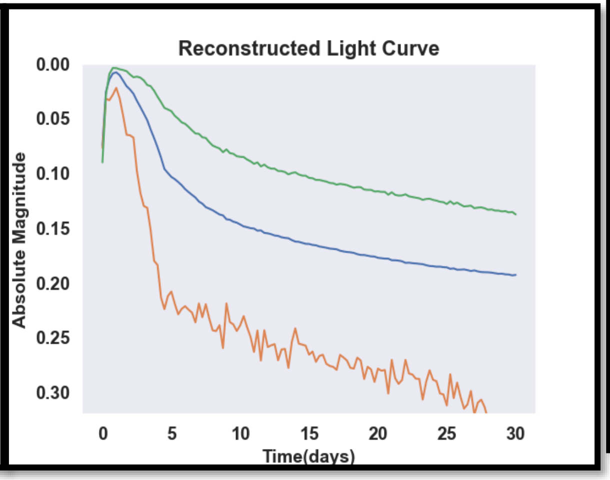
For Data 2: Each LC corresponds to different band

Test Set of LC

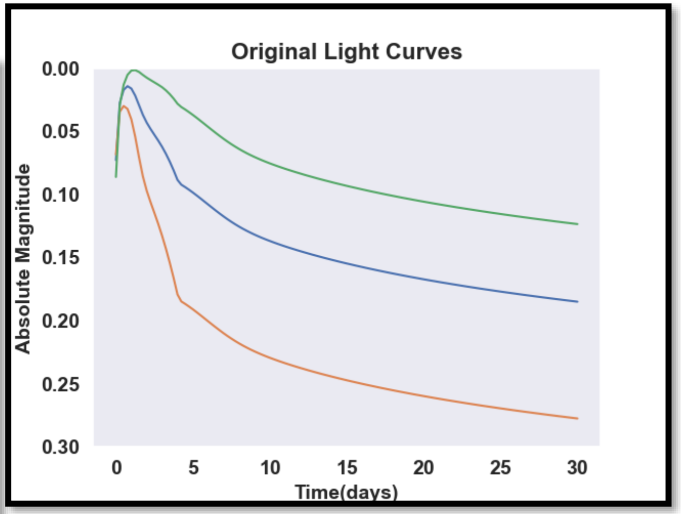


Reconstructed Light Curve



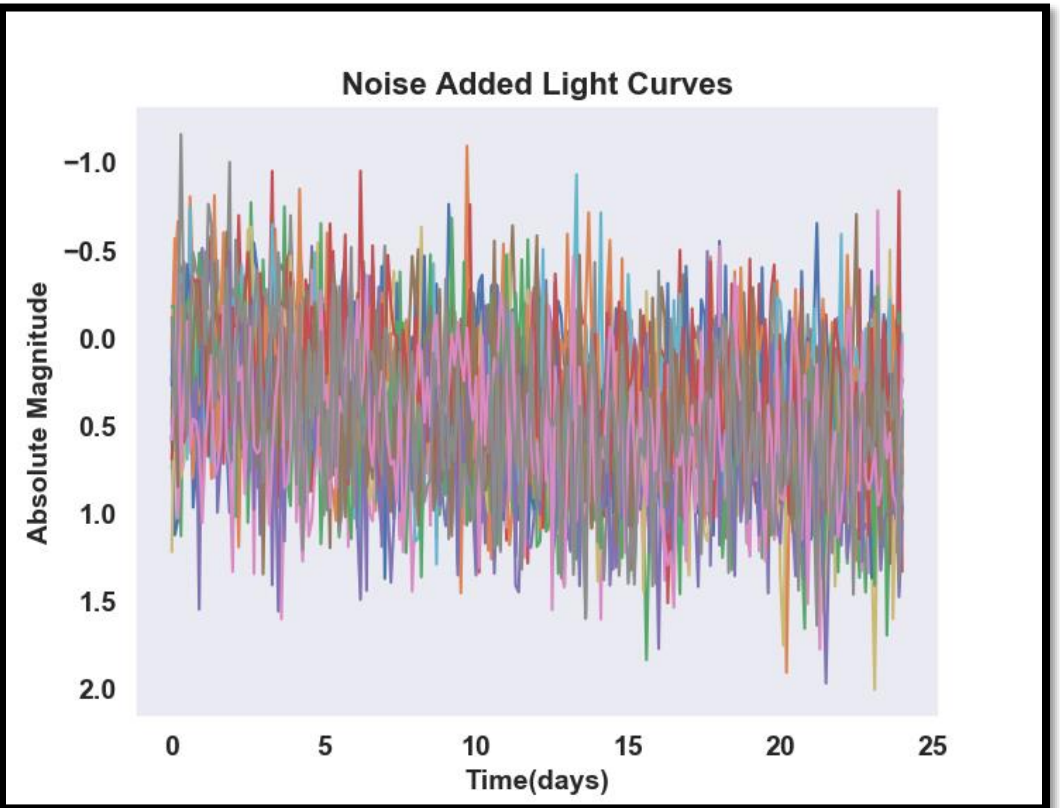


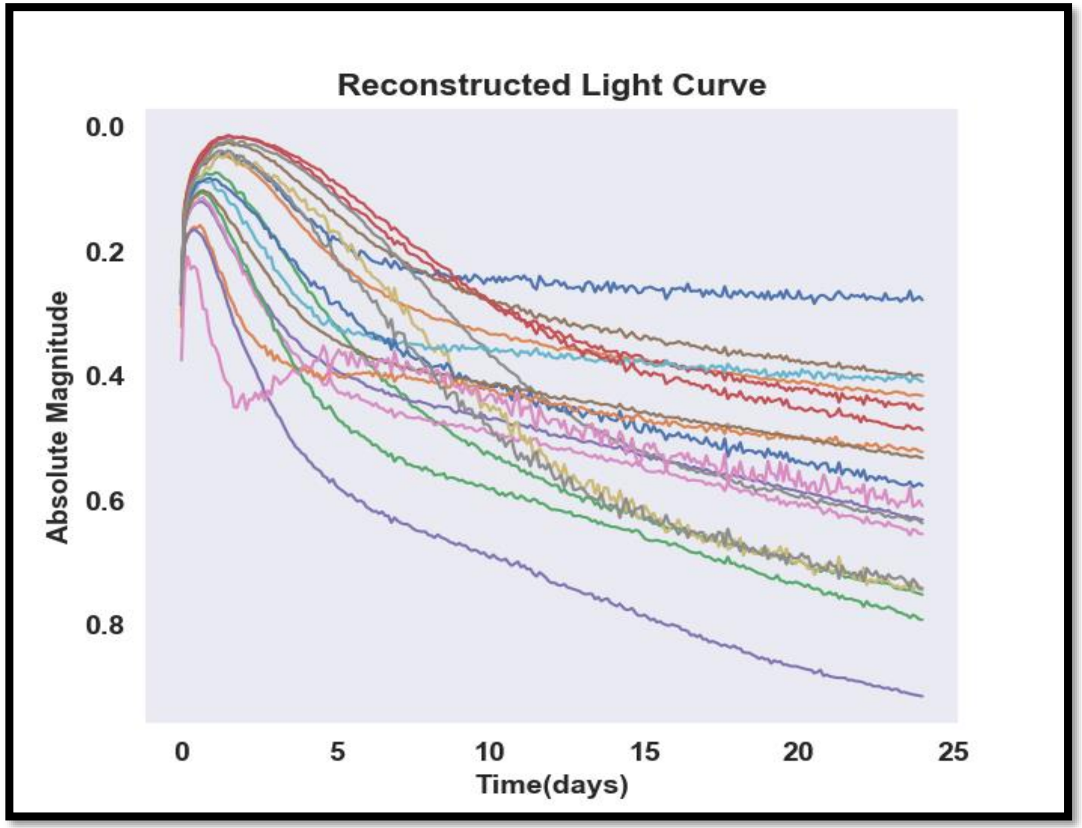
Test Set of LC



Model Test With Denoising Autoencoder

- To test the validity and accuracy of the model, denoising autoencoder has been used
- Random noise has been added to the data
- Model is run on it to extract the LC.





Discussion

- Currently the autoencoder provides quite satisfactory results in reconstructing the LC
- In some cases there are still some issues in reconstructing LC
- Even though the noise added to the is not physical, but the recovery shows good results with the model-test run.
- The model built – AE_data1 and AE_data2 depends on the shape of the input.
- More realistic noise need to be added for achieving better physical significance.
- It is possible to recover hidden KN from a noisy data set.

Future Works

- Make the autoencoder model more general.
- Add GRB afterglow data (generated with suitable time steps) to the autoencoder to perform the same analysis.
- Generate KN LC based on physical parameters (long term!!!)

That's Great **I am Useless**

Thank you for your Attention