A Framework For Rapid Parameter Inference of Kilonova Light Curves: Bayesian-Machine Learning Approach

Surojit Saha and Albert K.H Kong
Institute of Astronomy, National Tsing Hua University
surojitsaha@gapp.nthu.edu.tw

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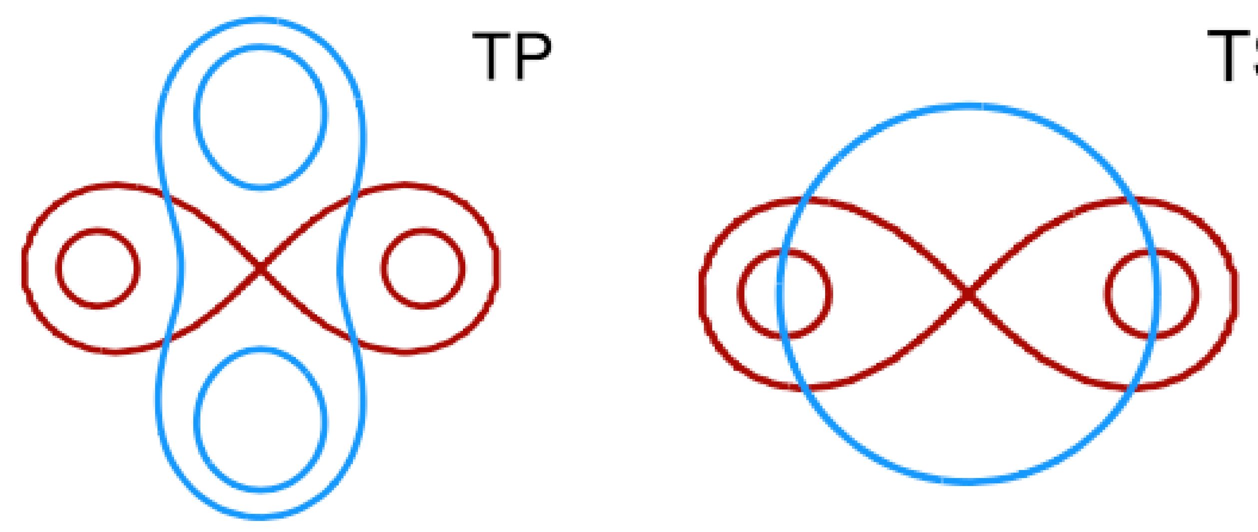
Parameter Inference Accelerated by 10^3 times

Saha et al. [in prep]

INTRODUCTION: **Parameter inference** of the astrophysical events is an important aspect in concluding the proposed model while comparing it with the existing observation. In the domain of **multi-messenger astronomy** (MMA) associated with **gravitational waves** (GW), low-latency analysis forms an integral part. Low-latency parameter inference of the observed EM signal is thus beneficial for further studies. Here, in this work, we provide a framework for **rapid parameter inference of KNe** using a machine learning tool popularly known as **conditional variational autoencoder** (CVAE).



Schematics of the two combined morphologies of KNe model

Image Credits: Wollaeger et al, 2021

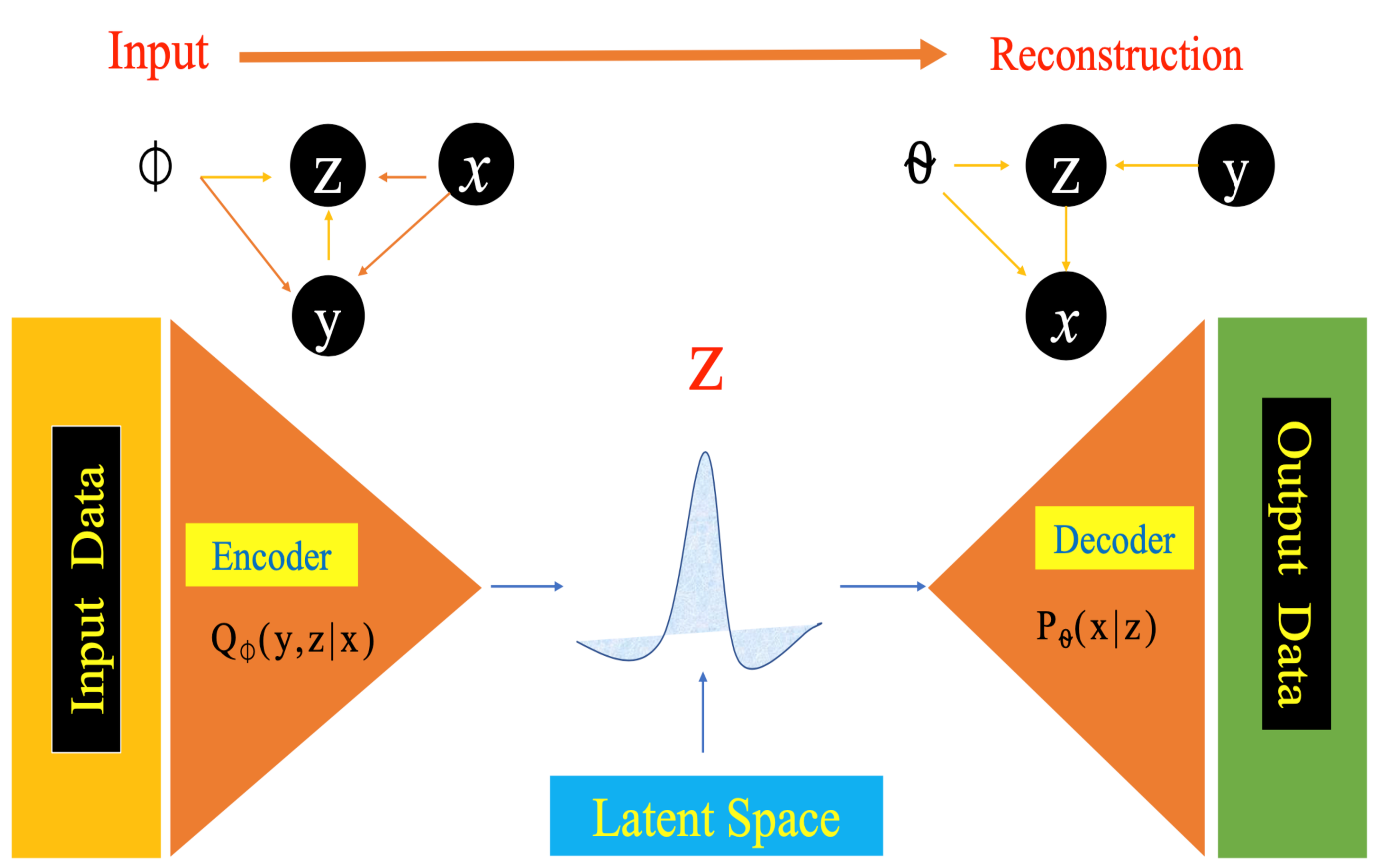
Objective

Perform Rapid Parameter Inference Utilizing Bayesian-Machine Learning Framework

DATA USED

KNe model	Morphology	Physical Parameters	No. of Physical Parameters	No. of Light Curves
Wind_1 (Y_e=0.37) *LSST: g,r,i,y and z bands*	Toroidal-Peanut	md, vd, mw and vw	225	11700 225 in 52 angular bins
	Toroidal-Spherical	md, vd, mw and vw	225	11700 225 in 52 angular bins
Wind_2 (Y_e=0.27) *LSST: g,r,i,y and z bands*	Toroidal-Peanut	md, vd, mw and vw	225	11700 225 in 52 angular bins
	Toroidal-Spherical	md, vd, mw and vw	225	11700 225 in 52 angular bins

md: mass of low Y_e component   vd: velocity of low Y_e component
mw: mass of high Y_e component   vw: velocity of high Y_e component



The schematic diagram of the conditional variational autoencoder. It consists of the encoder, the latent space, and the decoder. The encoder compresses the multi-dimensional input and provides a data distribution in the latent space. The decoder extracts the distribution from the latent space to reconstruct the results.

CURRENT RESULTS

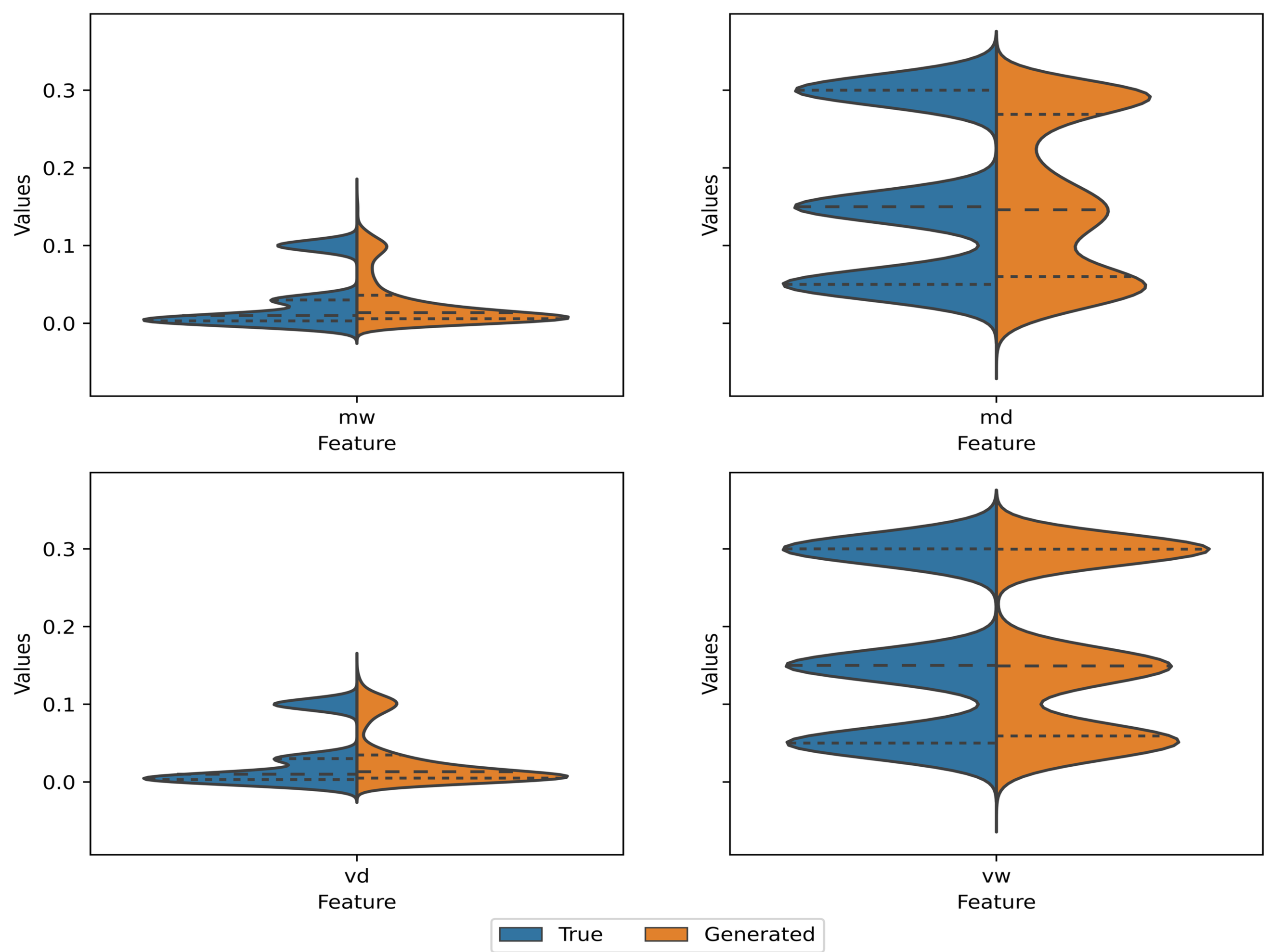


Fig 1: The violin plot shows the comparison between the true and generated data for a set of g-band light curves.

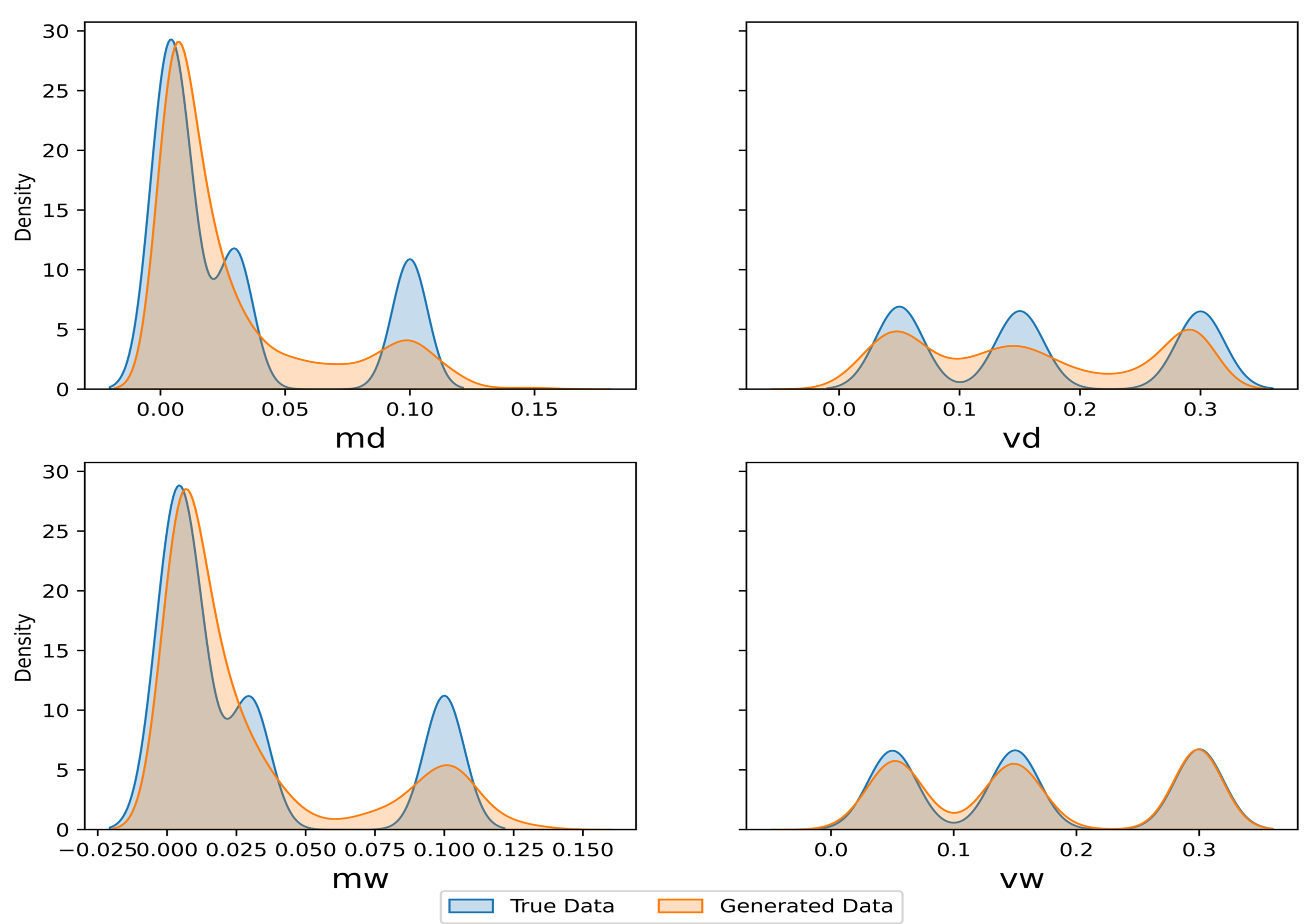


Fig 2: The KDE plot shows the distribution of the true and generated data for a set of g-band light curves.

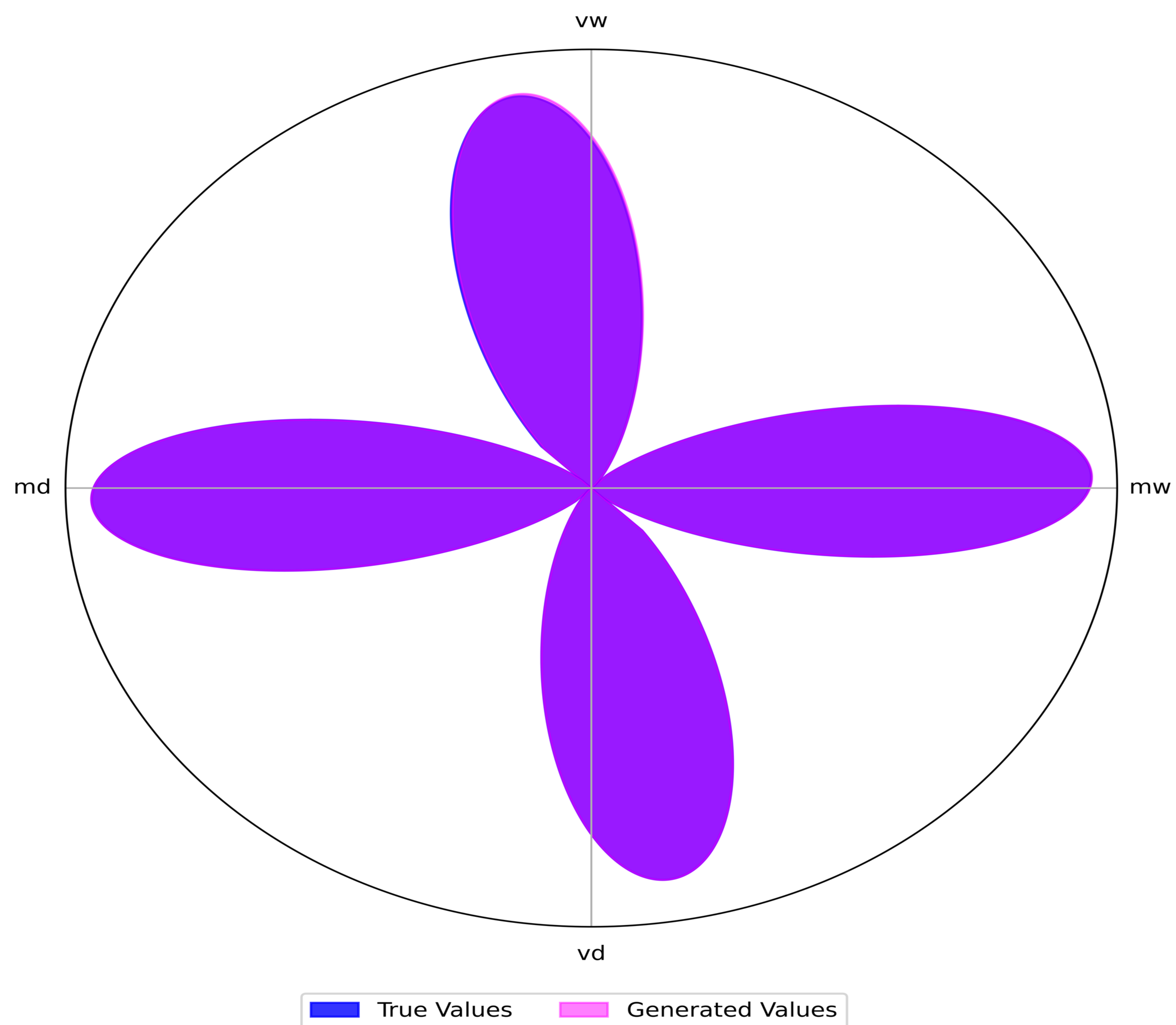


Fig 3: This polar plot shows the overlapping KDEs of all the physical parameters across all the filter bands. There is quite a good agreement between the true and the generated physical parameters.

Future Works: To include more KNe models to provide the most generalized PE.

References: 1. Wollaeger et al., The Astrophysical Journal, 918:10, 2021 September
2. Kawaguchi et al., The Astrophysical Journal, 825:52, 2016 July 1.
3. Saha et al, The Astrophysical Journal, Vol 961, Number 2