Revisiting the Mysterious Origin of FRB 20121102A with Machine-learning Classification

Leah Ya-Ling LIN[1] ,Tetsuya HASHIMOTO[2], Bjorn Jasper Raquel[2,3], Bo-Han CHEN[1], and Tomotsugu GOTO[1*]

[1]*Department of Physics and Institute of Astronomy, National Tsing Hua University, Hsinchu, Taiwan,* [2]*Department of Physics, National Chung Hsing University, Taichung, Taiwan*

[3]*Department of Earth and Space Sciences, Rizal Technological University, Boni Avenue, Mandaluyong, 1550 Metro Manila, Philippines*

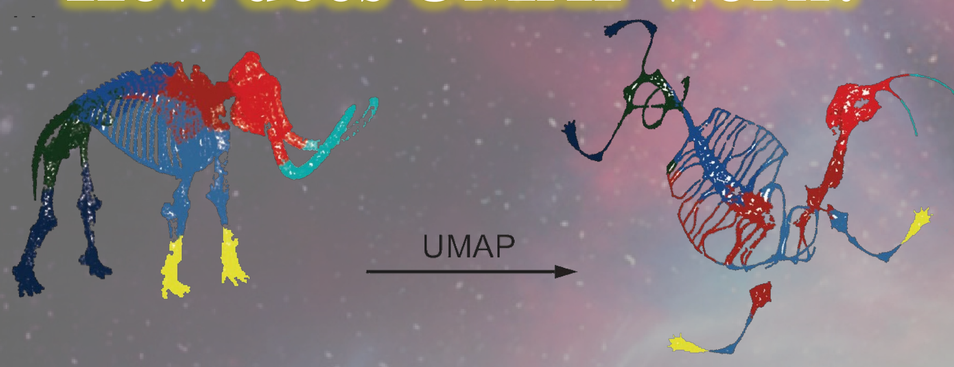
Introduction

Astrophysicists have detected numerous Fast Radio Bursts (FRBs) to date. However, despite the continuous proposal of various theoretical models, the origin of FRBs remains unknown. Therefore, unveiling the source of FRBs stands as a primary objective in astronomy. A fundamental approach towards understanding the origin of FRBs is through their classification, as different types of FRBs may stem from distinct progenitors or arise from different physical mechanisms.

What are FRBs?

Fast Radio Bursts (FRBs) are characterized by their extraordinary luminosity and rapidity, emitting radio waves at millisecond scales. These radio waves originate from extragalactic sources, yet their precise origins remain enigmatic.

How does UMAP work?

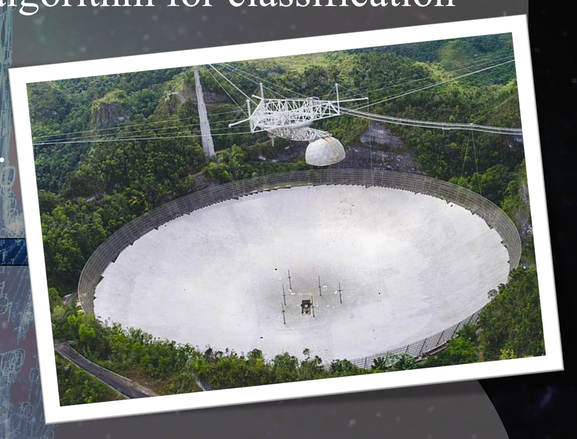


Method

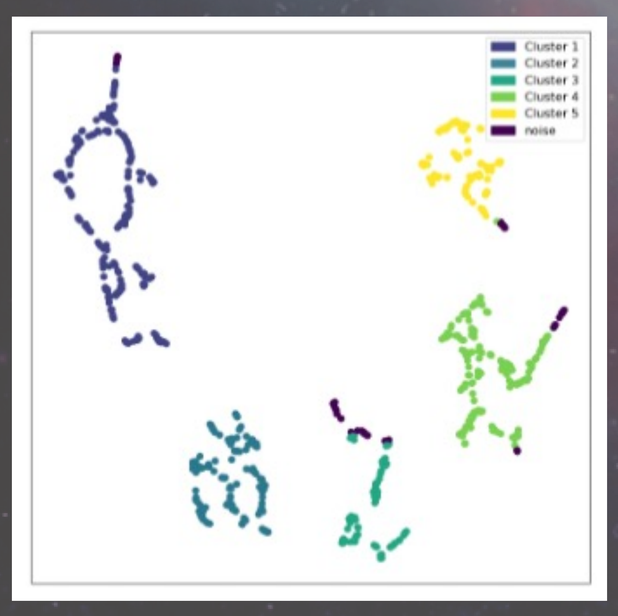
1. Obtain the publicly available FRB 20121102A data from the Arecibo catalogue, comprising a comprehensive collection of over 800 FRBs. This dataset stands out as one of the largest and most uniform samples of FRBs available. In this study, we aim to employ machine learning classification on this high-quality data, which was acquired from the world's largest radio telescope, marking the first application of this technique to such a dataset.

2. Feed the data (including amplitude, linear temporal drift, time duration, central frequency, bandwidth, scale energy, fluence) into a Machine learning algorithm for classification

3. Find new groups in the FRB data. Results are presented in Fig.1.

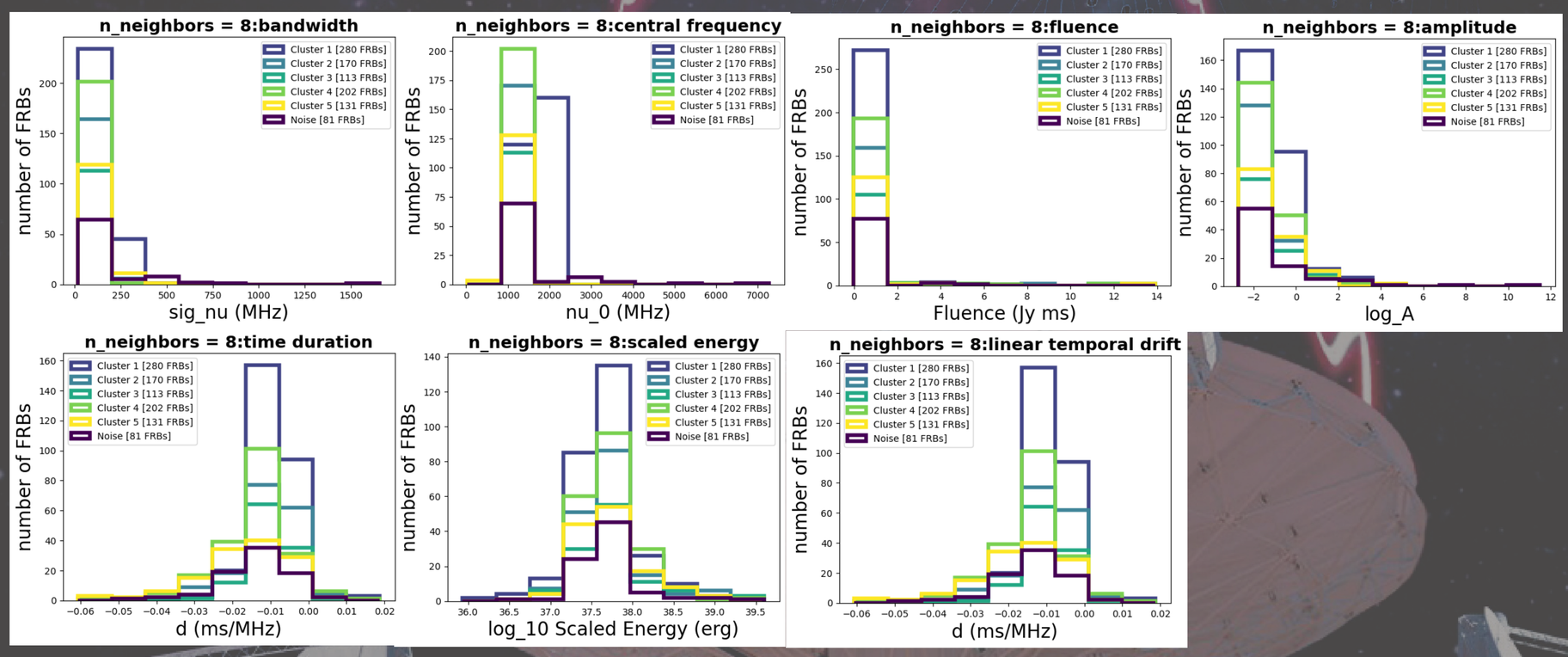


Result



◀Fig. 1. FRBs have been classified into four clusters.

The machine learning algorithm successfully classified over 800 FRBs into four distinct groups, suggesting that these FRBs may have originated from different physical mechanisms. To explore the unique characteristics of each cluster, we calculated the mean values and determined the parameter ranges for each group.



◀ Fig. 2. In order to know what is the classification basis, we made these histograms of the parameters to each cluster of FRBs . (amplitude took log values, linear temporal drift, time duration, scaled energy; bandwidth to, fluence, central frequency)

Conclusion

With classifying each of the parameters ,defining each clusters with different range and different mean values ,we may have found different physical mechanisms of this FRBs source.