Contribution ID: **10** Type: **not specified**

Clustering of FLUX and EW Maps Across Energy Bands in Supernovae Using Deep Learning Methodologies

Thursday 29 May 2025 12:30 (15 minutes)

Analyzing spectral and spatial information across di.erent energy bands in supernova remnants is crucial for understanding their physical and chemical evolution. In this work, we proposed a novel deep learning methodology aimed at clustering FLUX and Equivalent Width (EW) maps corresponding to di.erent energy bands of individual supernovae. Our approach consists of three main phases: (1) synthetic image generation, (2) embedding computation, and (3) hierarchical clustering. Given the limited number of real images available, we employed Variational Autoencoders (VAEs) [1] to generate synthetic FLUX and EW maps, training dedicated models for each energy band. Subsequently, we computed image embeddings using a Siamese Neural Network [2] with a ResNet18 backbone, optimized to bring embeddings of similar spectral characteristics closer together in the latent space. Embeddings provide a compact and informative representation of the spectral maps, significantly reducing dimensionality and accelerating the clustering process without losing relevant morphological or spectral information. Finally, we performed hierarchical clustering using the cosine distance between embeddings. Comparative experiments against classical clustering approaches based on image linearization with cosine distance and statistically validated clustering [3] with inner product showed that our method achieves clustering results consistent with these traditional techniques. Furthermore, we validated the robustness of the clustering results by applying the same methodology to synthetic data generated from magnetohydrodynamic simulations of supernova remnants [4], confirming the approach's reliability and physical interpretability. This study demonstrates the potential of combining generative and metric learning models to automatically group energy bands according to spectral and morphological similarities. It o.ers a powerful and e.icient tool for the astrophysical analysis of supernova remnants even in low-data regimes. We will also exploit the capability of this approach in discriminating signal from noise in images relative to cosmic background emissions.

Presenter: Prof. MICCICHE, Salvatore (Università degli Studi di Palermo, Dipartimento di Fisica e Chimica Emilio Segrè)

Session Classification: Bandi a Cascata