Physics-Informed Deep-Learning Emulators for Type Ia Supernovae

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Background

Type Ia supernovae, the thermonuclear explosions of Carbon-Oxygen white dwarfs, **remain poorly understood** despite decades of investigation. A variety of sub-classes of Type Ia supernovae exist and the connection between these populations is an active area of research.

What is the cause of the observational differences between Type Ia sub-classes?

Do different Type Ia sub-classes share a common progenitor scenario?

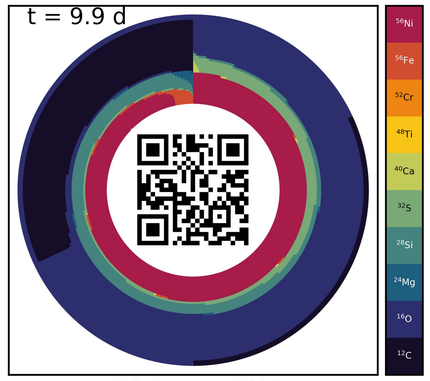
Massive computationally intensive hydrodynamic simulations have been developed to model an ever-growing number of theoretical explosion scenarios with increasing computational fidelity. However, **connecting individual supernovae observations to theoretical models** through physical simulations **remains computationally intractable.**

Solution

Radiative Transfer Emulators
+
Bayesian Inference

Probabilistically Inferring the **Abundance Distributions** of **Type Ia Supernovae** Ejecta from Spectral Observations

Parametric Supernova Model



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Step 1 **Emulator Training**

Ensemble of **Probabilistic** Neural Networks

Training Data Selection through **Active Learning**

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Radiative Transfer Spectral Synthesis

TARDIS!
Exploring supernovae made easy

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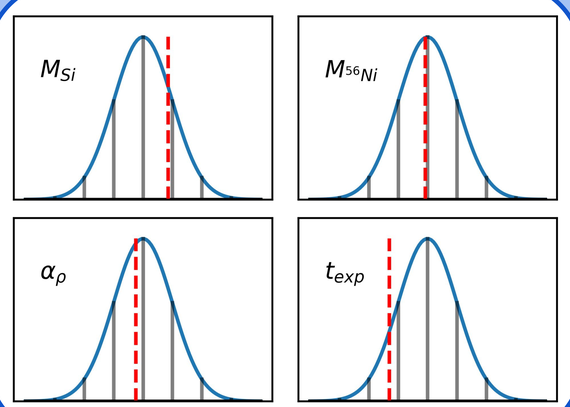
Sampling from Prior



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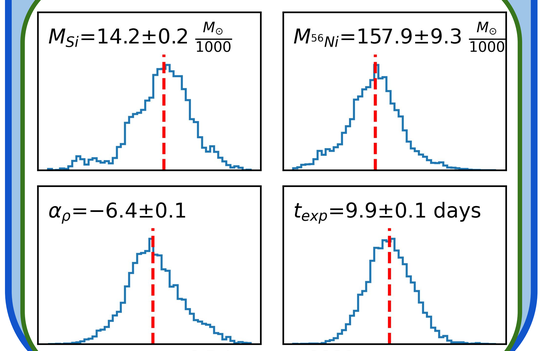
Step 2 **Posterior Estimation**



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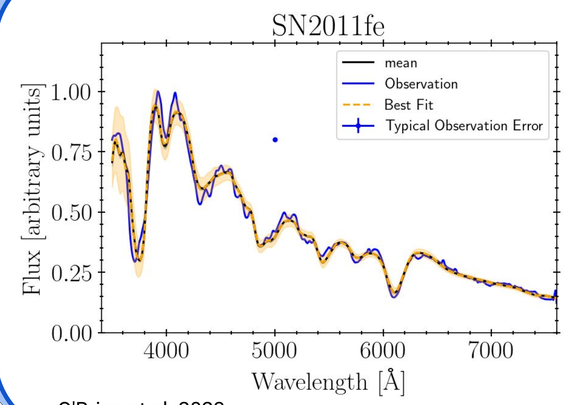
Likelihood Estimation



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