

HARNESSING ML FOR ATMOSPHERIC RETRIEVAL OF EXOPLANETS

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TARGETS ACHIEVED :

- Reading of Radiative Transfer equation. (POSEIDON Radiative transfer.)
- Training and testing the already existing Models (HELA (uses Random forest) , POSEIDON(Non ML-nested sampling method)).

LITERATURE REVIEW:

- Radiative Transfer Equation :

$$t_{\lambda,i} = \text{EXP} \left(- \sum_{i=1}^{N_{\text{lay}}} \alpha_{\lambda,j} \mathcal{P}_{i,j} \Delta h_j \right) = \text{EXP} \left(- \sum_{i=1}^{N_{\text{lay}}} \Delta \tau_{\lambda,j} \mathcal{P}_{i,j} \right),$$

$$\left(\frac{R_{p,\lambda}}{R_s} \right)^2 = \frac{1}{R_s^2} \left(R_p^2 + 2 \sum_{i=1}^{N_r} [1 - t_{\lambda,i}] b_i \Delta b_i \right),$$

Robinson, T. D. (2017, February 20). *A Theory of Exoplanet Transits with Light Scattering*. *The Astrophysical Journal*, 836(2), 236.

Márquez-Neila, P., Fisher, C., Sznitman, R., & Heng, K. (2018, June 25).

Supervised machine learning for analysing spectra of exoplanetary atmospheres *Nature Astronomy*, 2(9), 719–724.

- HELA : Random forest

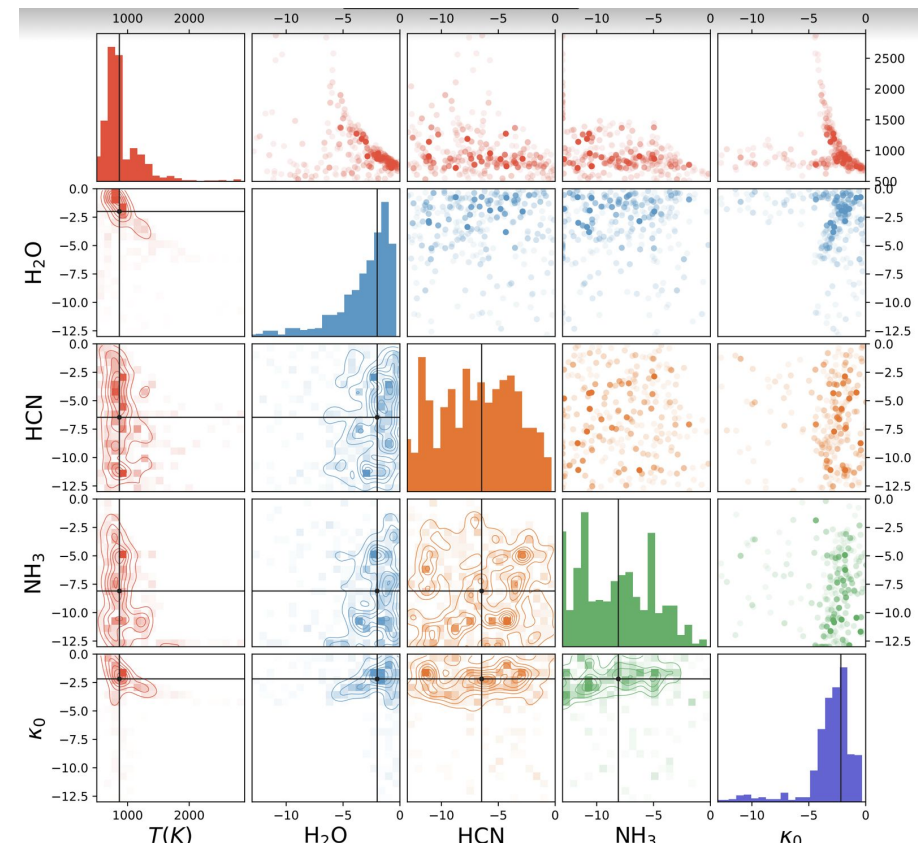
MacDonald, R. J. (2023, January 13). POSEIDON: A Multidimensional Atmospheric Retrieval Code for Exoplanet Spectra. *Journal of Open Source Software*, 8(81), 4873.

- POSEIDON

Hayes, J. J. C., Kerins, E., Awiphan, S., McDonald, I., Morgan, J. S., Chuanraksasat, P., Komonjinda, S., Sanguansak, N., & Kittara, P. (2020, April 14). Optimizing exoplanet atmosphere retrieval using unsupervised machine-learning classification. *Monthly Notices of the Royal Astronomical Society*, 494(3), 4492–4508. <https://doi.org/10.1093/mnras/staa978>

- Nested Sampling

RESULTS of RETRIEVAL From HELA



Corner plot : HELA after training and testing

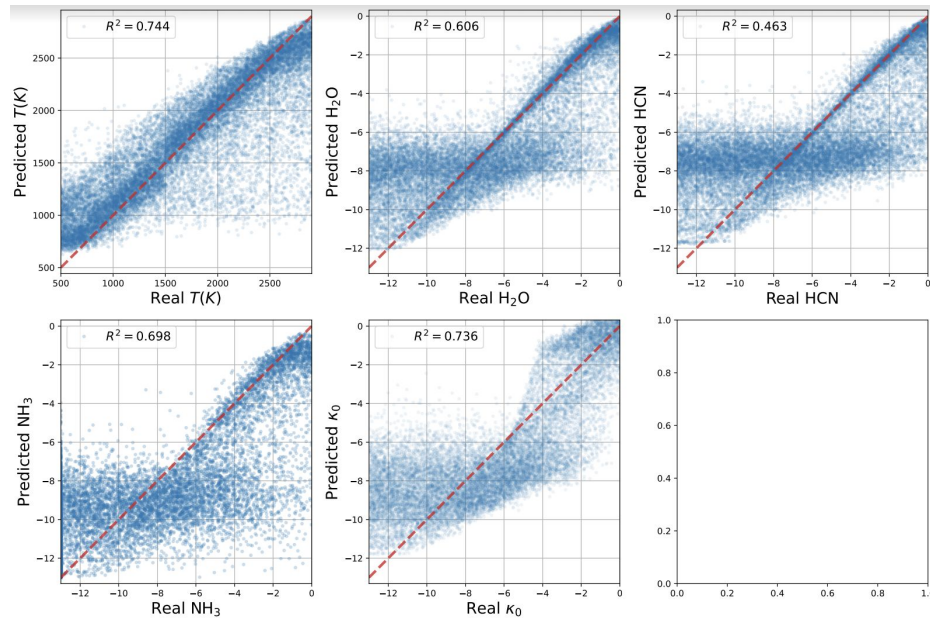


Fig : Tested R^2 Score

RESULTS of RETRIEVAL From POSEIDON

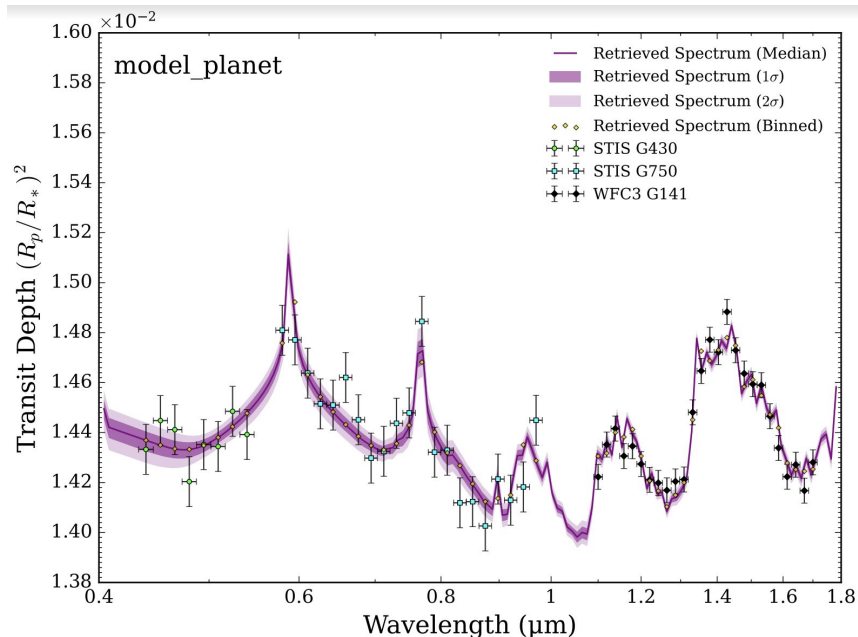
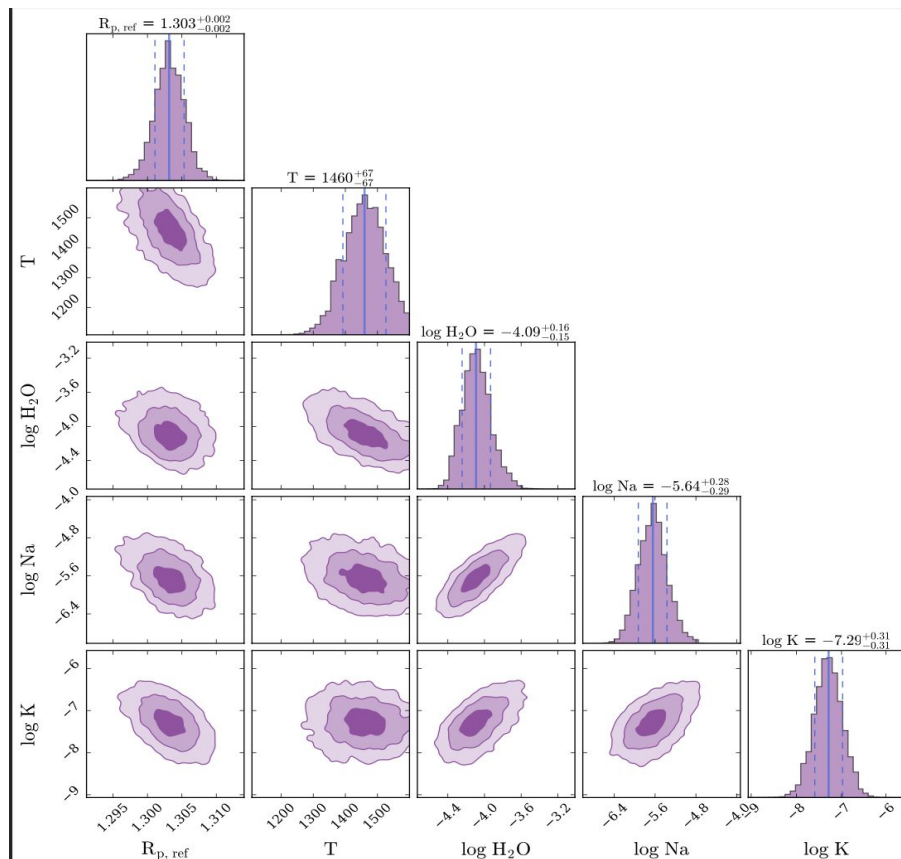


Fig :Forward model



Corner plot : POSEIDON

FUTURE PLANS

- Data Set would be taken from HELA DATA SET (80,000 2. WFC3 transmission spectra for training and 20,000 dataset for testing.).
- Implementation of Neural networks and Ensemble neural networks with the data set.