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Artificial Intelligence in planetary spectroscopy

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Abstract

The field of exoplanetary spectroscopy is as fast moving as it is new. Analysing currently available observations of exoplanetary atmospheres often invoke large and correlated parameter spaces that can be difficult to map or constrain. This is true for both: the data analysis of observations as well as the theoretical modelling of their atmospheres.

Issues of low signal-to-noise data and large, non-linear parameter spaces are nothing new and commonly found in many fields of engineering and the physical sciences. Recent years have seen vast improvements in statistical data analysis and machine learning that have revolutionised fields as diverse as telecommunication, pattern recognition, medical physics and cosmology.

In many aspects, data mining and non-linearity challenges encountered in other data intensive fields are directly transferable to the field of extrasolar planets. In this talk, I will discuss how deep neural networks can be designed to facilitate solving said issues both in exoplanet atmospheres as well as for atmospheres in our own solar system. I will present a deep belief network, RobERt (Robotic Exoplanet Recognition) [1], able to learn to recognise exoplanetary spectra and provide artificial intelligences to state-of-the-art atmospheric retrieval algorithms. Furthermore, I will present a new deep convolutional network [2] that is able to map planetary surface compositions using hyper-spectral imaging and demonstrate its uses on Cassini-VIMS data.

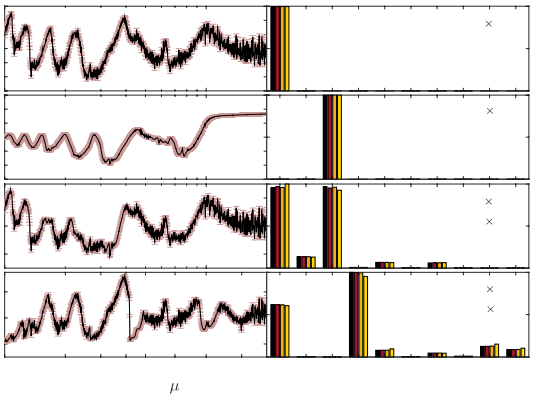

Figure 1: Left: simulated emission spectra of exoplanet atmosphere (normalised by the planetary black body). Right: RobERt estimated probability of molecules being present in the spectrum. In all cases molecules were detected accurately.

References

[1] Waldmann 2016, ApJ, 820, 107

[2] Waldmann & Griffith, in prep.