Alfnoor: assessing the information content of Ariel’s low resolution spectra with planetary population studies.

Lorenzo V. Mugnai¹, Enzo Pascale¹, Quentin Changeat², Ahmed Al-Refaie², and Giovanna Tinetti²

¹Dipartimento di Fisica, "Sapienza" University of Rome, Rome, Italy
²Department of Physics and Astronomy, University College London, Gower Street, London, WC1E 6BT, UK

In the next decade the Ariel Space Telescope will provide the first statistical dataset of exoplanet spectra, performing spectroscopic observation of about 1000 exoplanets in the wavelength range 0.5→7.8 μm thanks to its Reconnaissance Survey. About one half of these 1000 targets will be then selected for more accurate observations with higher spectral resolution.

We present a novel metric to assess the information content of the Ariel Reconnaissance Survey low resolution transmission spectra. The proposed strategy will not only allow us to select candidate planets to be re-observed in Ariel higher resolution Tiers, but also to classify exoplanets by their atmospheric composition and to put the basis for the statistical analysis of such a large exoplanetary sample.

To test our metric we use Alfnoor, a new package combining the TauRex spectral modelling with the ArielRad payload performance model, to produce populations of hundreds of exoplanets matching those presented in the Ariel Mission Reference Sample. For each of the planets in the Ariel candidate targets list we create an atmosphere with a randomised quantity of H₂O, CH₄, CO₂, NH₃ and clouds.

Our metric proves able to identify methane, carbon dioxide and water rich atmospheres in the cases of molecular abundances $> 10^{-4}$ in mixing ratio, but it shows its limits in separating water from ammonia.

We compare our metric with four different Deep Learning algorithms, they show only $\Delta 10\%$ better performance in identifying the molecular content.