The Opportunities and Challenges of Using Near-Infrared High-Resolution Spectroscopy to Detect Atmospheric Technosignature Gases in Exoplanets

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The search for atmospheric technosignature gases using high-resolution spectroscopy in the near-infrared is a valuable extension of the search for general biosignatures and low-abundance gases in exoplanet atmospheres. High-resolution cross-correlation spectroscopy (HRCCS) is the best technique currently available for this, since it can disentangle faint potential technosignatures from features of more significant atmospheric constituents, such as H_2O, and use the light-collecting power of the Extremely Large Telescopes. My research explores the viability of searching for technosignature gases with next-generation, high-resolution spectrographs, such as ANDES/HARMONI/METIS on the ELT, setting realistic expectations on the likelihood of being able to detect these gases on nearby exoplanets, as a function of their concentration. One of the current limitation in this search is the availability of accurate line lists for important technosignature gases. In this talk, I will present a simulated search for sulphur hexafluoride (SF_6) on rocky exoplanets, which has potential to exist as an industrial pollutant, and as an intentionally released artificial greenhouse gas on planets with insufficient natural CO_2 production. SF6 is nontoxic, relatively chemically inert, and has an atmospheric lifetime of ~ 1000 years, making it a prime technosignature target. However, there are no sufficiently accurate line lists for SF_6 in the wavelength ranges and spectral resolutions of existing and upcoming high-res spectroscopes, only absorption cross-section data. During this talk, I will demonstrate the challenges in HRCCS that need to be addressed for this technosignature search, including the required spectral resolution and light-collecting power, and the availability of detailed and accurate line lists, when considering observations from ground and space with e.g. JWST, the ELTs, and the Habitable Worlds Observatory.