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SPECTRO-ICE: On-chip Spectrometers for Submillimetre-wave Atmospheric Sensing

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Advanced quantum devices known as Kinetic Inductance Detectors (KIDs) have been developed over the past decade for astronomical applications in the millimetre and submillimetre wavelength range. They are set to revolutionise astronomy across a very wide range of wavelengths. KIDs are essentially superconducting resonators with high quality factors that can be multiplexed into large arrays of thousands of devices, which can be read out used fast digital electronics through a single transmission line. When submillimetre-wave radiation is absorbed, the resonant frequency shifts and an extremely sensitive detector results. By combining the resonators with an array of high-performance superconducting RF filters, it is possible to manufacture single-chip spectrometers customised for observing a large number of spectral lines simultaneously. The SPECTRO-ICE project is assessing the potential applications of this new technology in atmospheric science. Atmospheric sensing of the submillimetre and far infrared wavelength range has been limited by the gap in instrumentation between the heterodyne receivers developed for microwave sensing and the photoelectric detectors used in the infrared regime. KIDs provide the technological basis for compact on-chip spectrometers with the highest sensitivity available in this frequency range to make ultra-precise measurements of atmospheric species. In this pilot study ground based atmospheric spectra are simulated using the Atmospheric Radiative Transfer Simulator (ARTS) for selected locations including Summit, Greenland and Halley station, Antarctica. The spectral requirements needed to resolve signals from gases of interest to climate studies are determined in order to feed into the prototype design of future on-chip devices.