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Least Squares Estimates of Earthlike Exoplanet Temperatures from Infrared Emission Spectra

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Detailed characterization of exoplanets lies at the forefront of exoplanetary science.
Temperature is a key quantity to understand atmospheric physics and chemistry.
We retrieved temperatures of N_2-O_2 dominated atmospheres from thermal emission secondary eclipse spectroscopic observations of Earth-like exoplanets orbiting G-, K-, and M-stars.
A line-by-line (lbl) radiative transfer code (Py4CAtS) is used to generate synthetic thermal infrared (TIR) observations.
The atmospheric temperature is approximated by a function expansion with base vectors defined by a singular value decomposition of a matrix comprising representative profiles.
A standard nonlinear least squares solver coupled to the lbl code is used to estimate the unknown expansion coefficients.

Results suggest that even low signal-to-noise ratios (=5) and medium resolution fits of the shortwave and longwave CO_2 bands in the TIR spectra allow the inference of
reasonable temperature profiles. Deviations from the true temperature in the upper troposphere and lower-to-mid stratosphere are mostly in the range of a few Kelvin, with larger deviations in the upper atmosphere and, less often, in the lower troposphere.
Although the performance of the two bands is equivalent in most cases, the longwave TIR is more favorable than the shortwave due to increased star-planet contrast and higher intensities.