THE PLANETARY SPECTRUM GENERATOR (PSG): AN ONLINE SIMULATOR OF EXOPLANETS.
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Abstract: We have developed an online radiative-transfer suite (https://psg.gsfc.nasa.gov) applicable to a broad range of exoplanets (e.g., terrestrial, super-Earths, Neptune-like and gas-giants). The Planetary Spectrum Generator (PSG) can synthesize planetary spectra (atmospheres and surfaces) for a broad range of wavelengths (0.1 µm to 100 m, UV/Vis/near-IR/far-IR/THz/sub-mm/Radio) from any observatory (e.g., JWST, HST, Keck, SOFIA, ARIEL, LUVOIR, OST). This is achieved by combining several state-of-the-art radiative transfer models, spectroscopic databases and planetary climatological models (e.g., Parmentier equilibrium P/T models and Kempton EOS chemistry).

Planetary generator: PSG has a 3D orbital calculator for all confirmed exoplanets, while the radiative-transfer models can ingest billions of spectral lines from hundreds of species from several spectroscopic repositories. It integrates the latest radiative-transfer and scattering methods and includes a realistic noise calculator that integrates several telescope / instrument configurations (e.g., interferometry, coronagraphs) and detector technologies (e.g., CCD, heterodyne detectors, bolometers). Such an integration of advanced spectroscopic methods into an online tool can greatly serve the planetary community, ultimately enabling to retrieve planetary parameters from remote sensing data, to efficiently plan mission strategies, to interpret current and future planetary data, to calibrate spectroscopic data and to develop new instrument/spacecraft concepts.

PSG capabilities – psg.gsfc.nasa.gov
A 3D (three-dimensional) orbital calculator for all solar system bodies and confirmed exoplanets, for Nadir, limb and occultation geometries.

The tool ingests billions of spectral lines and spectral constants from almost 1,000 chemical species from several spectroscopic repositories (e.g., HITRAN, CDMS, USGS, GSFC-Fluor).

Accurate atmospheric profiles and surface templates are available for the main bodies (e.g., Venus, Earth, Mars, Titan, Uranus, Pluto).

Radiative transfer performed with several modules: PUMAS, correlated-K, non-LTE fluorescence, and surface models.

The code synthesizes fluxes in any desired unit.

The tool allows applying terrestrial transmittances for a broad range of conditions (altitude and water, also from SOFIA and balloons).

For exoplanets, it includes the possibility to integrate realistic stellar templates (0.15-300 µm), and the high-resolution ACE Solar spectrum (2-14 µm) for G-type stars.

It includes a noise and signal-to-noise calculator for quantum and thermal detectors, at any observatory (e.g., Keck, ALMA, JWST).

The tool can synthesize a broad range of planetary spectra by combining a modern and versatile online radiative transfer suite that uses state-of-the-art spectroscopic databases. The modules are computationally optimized, with a typical runtime of one second.