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Detecting Biosignatures in the Atmospheres of Gas Dwarfs with JWST

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No planet in the Solar System exists that is analogous to super-Earths and mini-Neptunes, a class of exoplanets with radii between those of Earth and Neptune. Because of stronger gravity than Earth, the new class of exoplanet can retain a sizable hydrogen-dominated atmosphere. We call these planets gas dwarf planets, in contrast to gas giant planets. The James Webb Space Telescope (JWST) will offer unprecedented insight into the atmospheric composition of potentially habitable gas dwarf planets through transmission and emission spectroscopy, whose reducing atmospheres have entirely different chemistry from an inhabited Earth-like planet with an oxidizing atmosphere. We investigate the detectability of NH3 (ammonia, a potential biosignature) in the atmospheres of seven potentially habitable gas dwarf planets using various JWST instruments (NIRISS, NIRSpec, and MIRI). We use open-source package petitRADTRANS and PandExo to model planet atmospheres and simulate JWST observations. We consider different scenarios by varying cloud conditions, mean molecular weights (MMWs), and NH3 mixing ratios, and define a metric to quantify detection significance and provide a ranked list for JWST observations in search of biosignature in gas dwarf planets. Generally, it is challenging to search for the 10um NH3 with MIRI given a noise floor of 100 ppm for emission spectroscopy. NIRISS and NIRSpec are feasible under optimal conditions such as a clear sky and low MMWs for a number of gas dwarf planets. The study shows that searching for biosignature is now feasible with a reasonable investment of JWST time (10 orbits) if we consider gas dwarf planets as potential places to harbor life.