Mechanisms for Generating False Positives for Extrasolar Life

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Fig. 1. Plot of LR data from first sample analysis on VL1. An active sequence was used on a fresh surface sample. Radioactivity was measured at 16-minute intervals throughout the cycle except for the first 2 hours after the first nutrient injection when readings were taken every 4 minutes. Radioactivity data include a background count of 490 cpm prior to the onset of the cycle. Detector and test cell temperatures were monitored every 16 minutes.
Take home point #1:
Searching for biosignatures is easy.
Eliminating false positives is hard.
Planets with high CO₂/low H₂ volcanoes, around F-type stars, could have O₃ buildup.

Chemically as Gas Giant Atmospheres

Water-rich Atmosphere: $H_2, CO, CH_4, CO_2, H_2O$ (depend on temperature)

Hydrocarbon-rich Atmosphere

Oxygen-rich Atmosphere: $CO, CO_2$

Hu and Seager, 2014
Kasting, 1993
Low-pressure atmospheres could lead to H-loss and be dominated by O2.
VERY high stellar activity could lead to H loss, and thick, O2-dominated atmospheres.
Review

Finding biosignatures is (relatively) EASY!
Confirming life as the source of these gases – and ruling out false positives is the HARD part.

CH4 is the best discriminator...

Stellar spectra are also critical for all false positives.

For identifying photochemical false positives, we want to measure/constrain CO2 and CO.

For identifying false positives from H-loss, we want to know the pressure of the atmosphere.