REMOTE DETECTION OF BIOSIGNATURES OF PRIMITIVE AND EVOLVED LIFE ON EXTRASOLAR PLANETS.

Julia DeMarines[1], Webster Cash [2], Shawn D. Domagal-Goldman[3], and Victoria S. Meadows[4] [1]Center for Astrophysics and Space Astronomy, University of Colorado (1255 38th st, Boulder, Colorado 80303 USA, julia.demarines@colorado.edu), [2]Center for Astrophysics and Space Astronomy, University of Colorado (1255 38th st, Boulder, Colorado 80303, USA webster.cash@colorado.edu), [3]Virtual Planetary Laboratory, UW Astronomy (Box 351580, University of Washington, Seattle, WA 98195, USA, sgoldman@astro.washington.edu), [4]Virtual Planetary Laboratory, UW Astronomy (Box 351580, University of Washington, Seattle, WA 98195, USA, vsm@astro.washington.edu)

Introduction: Extrasolar planetary detection is at an exciting stage, one in which we are detecting and imaging extrasolar planets as well as measuring their atmospheric constituents. New Worlds Observer developed the at University of Colorado by P.I .Webster Cash, is a new idea in imaging extrasolar planets currently being proposed to NASA's decadal review. New Worlds is just one of many proposed methods to image extrasolar planets but is unique in that it possesses the capabilities to observe their surfaces and atmospheres. The 4-meter visual New Worlds telescope will align itself in the shadow of the NWO starshade, which will block the light out of our target stars in order to image the faint reflected light off of its planets (*see figure 1*). NWO will also have the capabilities to analyze the atmosphere of these exoplanets with the use of a spectrograph.

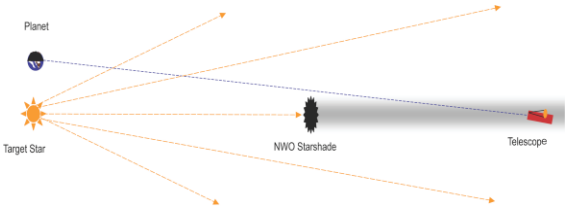

Figure 1: New Worlds Observer telescope aligns with the starshade to see faint reflected extrasolar planet light

Method: Computer models, which simulate our solar system at a distance of 10, 20 and 30 light years being viewed through the New World Observer telescope and starshade, suggest that the atmospheric biosignature of photosynthetic life (O_2) on Earth is detectable through New Worlds technology. O_2 is strong evidence for the presence of plant life, which is an evolved form of life. Biologically produced methane (CH_4) is evidence of primitive life existing before plant life [1,2]. What are the requirements for future missions, like New Worlds Observer, to be able to detect these small quantities of methane?

Results: Preliminary results indicate that New Worlds can accurately detect the levels of methane (~1000 ppm) that were present in the Archean atmosphere (*see figure 2*).

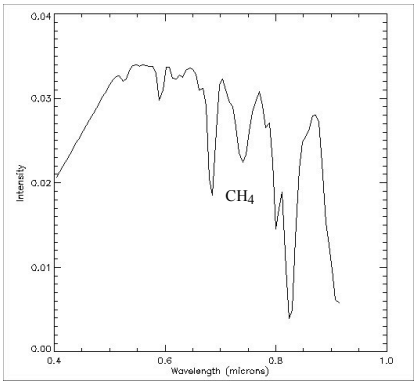

Figure 2: Methane detection at 0.725 microns

However, the results were obtained by using the spectrum of Jupiter, which possesses similar levels of methane as found in the Earth's Archean atmosphere. We reduced Jupiter's reflected spectrum to match the photon count of Earth at the stated distances and ran it through our computer models. Jupiter's spectrum contains many different constituents not present in the Archean atmosphere, and thus does not accurately represent the Archean spectrum.

Further Studies: Ongoing research is currently being conducted using simulated spectrum of the atmosphere of an early Earth produced by The Virtual Planetary Lab (VPL) at the University of Washington in Seattle. I will be running this simulated spectra though our New Worlds simulation codes to see if the atmospheric biosignatures of primitive methanogenic life could be detected through New Worlds technology. The answer to this question will yield a lower limit of methane detectable by future exoplanetary missions such as NWO and may help answer the question 'can primitive life be remotely detected on an extrasolar planet?'

References:[1] Kaltenegger, L. *et al.* (2007). Spectral Evolution of an Earth-like Planet. *The Astrophysical Journal*, 658:598–616. [2] American Geophysical Union, Fall Meeting 2003, abstract #PP21B-1168 [3] Domagal-Goldman, S. *et al.* (In prep). Simulated Spectrum of Early Earth