EFFECT OF UV RADIATION ON THE SPECTRAL FINGERPRINTS OF EARTH-LIKE PLANETS ORBITING M DWARFS. S. Rugheimer[1,2,3], L. Kaltenegger[1], A. Segura[4], J. Linsky[5] and S. Mohanty[6], [1]Institute for Pale Blue Dots, Astronomy, Cornell [2]Center for Radiophysics and Space Research [3]Harvard-Smithsonian Center for Astrophysics, [4]Instituto de Ciencias Nucleares, Universidad Nacional Autónoma de México, México, [5]JILA, University of Colorado and NIST, [6]Imperial College London, UK (srugheimer@cfa.harvard.edu, 304 Space Sciences Building, Cornell University, Ithaca, NY 14853).

Introduction: It is likely that the first habitable planet suitable for follow-up observations will be found orbiting a nearby M dwarf [1,2]. In our solar neighborhood, 75% of stars are M dwarfs, and the M spectral class is very diverse, spanning nearly three orders of magnitude in luminosity and an order of magnitude in mass. The abundance of M dwarfs as well as the contrast ratio and transit probability favor the detection of planets in the Habitable Zone of M dwarfs.

Methods: Using EXO-P [3], we generate planetary atmosphere models and high resolution spectra for remotely detectable features of habitable planets orbiting M stars. For our input stellar models, we generate a suite of models spanning the entire M dwarf spectral class (M0 to M9) to explore the boundaries of the UV environment of an exoplanet orbiting a main sequence M star.

We create two sets of models based on the extreme limits of stellar activity. H_α correlates with NUV/FUV fluxes from GALEX [4]. Therefore, we use H_α to estimate the FUV emission for our active stellar grid, by scaling from the known FUV and H_α emission in the active star, AD Leo. For the inactive stellar models we use the photosphere only lower limit of UV flux from PHOENIX models. We compare these limiting-case models to six well-observed M dwarfs which show significant chromospheric flux despite being traditionally classified as quiescent due to the presence of H_α in absorption [5].

Results: We present planetary atmosphere models for the full M dwarf main sequence, using a stellar temperature grid from 3800K to 2400K with recent observations by HST for 6 M dwarfs to explore the effect of different spectral energy distributions on terrestrial atmosphere models and on detectable atmospheric signatures [6].

We show spectra from the VIS to IR (0.4μm - 20μm) to compare detectability of features in different wavelength ranges with JWST and other future ground- and spaced-based missions to characterize exo-Earths. In our analysis we focus particularly on the effect of UV activity levels on the spectral biosignatures Earth: O_3, O_2, CH_4, N_2O and CH_3Cl and those that indicate habitability: H_2O and CO_2.

To observe signatures of life - O_2/O_3 in combination with reducing species like CH_4, we find early and active M dwarfs are the best targets of the M star grid for future telescopes. The O_2 spectral feature at 0.76μm is increasingly difficult to detect in reflected light of later M dwarfs in reflected light due to low stellar flux in that wavelength region. N_2O, another biosignature detectable in the IR, builds up to observable concentrations in our planetary models around M dwarfs with low UV flux. CH_3Cl could become detectable, depending on the depth of the overlapping N_2O feature.

In this work we present a spectral database of Earth-like planets around cool stars for directly imaged planets as framework to interpret future lightcurves, direct imaging and secondary eclipse measurements of atmospheres of terrestrial planets in the habitable zone (HZ) that can be used to design and assess future telescope capabilities.

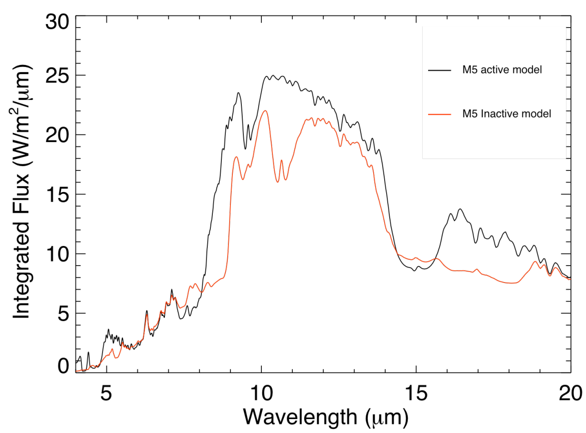

Fig. 1: IR remotely detectable spectra for an Earth-like planet orbiting an extremely active (black) versus no UV activity (red) M5 stellar model.

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