PREBIOTIC SYNTHESIS IN HABITABLE PLANETS AROUND M DWARFS. J. M. Nava-Sedeño[1], A.Segura[2,3], A. Ortiz[4], S.Domagal-Goldman[5,3], [1]Dept. for Innovative Methods of Computing, ZIH, Technische Universität Dresden, Nöthnitzer Strasse 46, D-01062 Dresden, Germany, nava@mail.zih.tu-dresden.de, [2]Instituto de Ciencias Nucleares, Universidad Nacional Autónoma de México Circuito Exterior C.U. A.Postal 70-543 04510 México D.F. antigona@nucleares.unam.mx, [3]NASA Astrobiology Institute—Virtual Planetary Laboratory, USA, [4]Structural Bioinformatics and Computational Biology, BIOTEC, Technische Universität Dresden, Tatzberg 47/49 D-01307 Dresden, Germany, adrian.ortiz@biotec.tu-dresden.de, [5]Planetary Environments Laboratory, NASA Goddard Space Flight Center, 8800 Greenbelt Road, Greenbelt, MD 20771, USA; shawn.goldman@nasa.gov

Introduction: There is an active debate about the habitability of planets around M main sequence stars (red dwarfs or M dwarfs) These stars are abundant, being 75% of the stars in the solar neighborhood, and they spend about 10^{10} years on the main sequence, giving their planets enough time for the origin and evolution of life. On the other hand, many M dwarfs have active chromospheres that produce high energy radiation and particles that may be harmful for life (for a review see [1,2]).

Here we explore the production of compounds relevant for prebiotic chemistry by high energy particles in potentially habitable planets around M dwarfs. For habitable planet we refer to rocky (iron/silicate) planets with CO_2-N_2 atmospheres located in the habitable zone of their parent star.

Methodology: Photochemical simulations were performed using the computer model described in [3] for atmospheres with a 1 bar surface pressure composed by N_2 and CO_2 (3×10^{-4} to 0.5 bars). The stars used for this work where AD Leonis (M3.5V), GJ876 (M4V) and the Sun, for comparison.

We use the surface mixing ratios of CO and CO_2 from the models to calculate the chemical yields of important prebiotic compounds: uracil, hydrogen cyanide, formaldehyde and amino acids. For the yields of uracil, we considered two energy sources: cosmic rays and stellar protons, which we used to calculate uracil production rates as reported on [4]. For cosmic rays we used the value reported by [5] to calculate the production rates of uracil in each of our simulated atmospheres. Given that proton fluxes from M dwarf stars have not been experimentally measured, we calculated them from X ray fluxes using the relation reported by [6]. For the X ray fluxes, we used the values for M and K stars within 7 pc in [7]. Using these data we obtained the proton fluxes in proton flux units (pfu=protons cm^{-2} sr^{-1} s^{-1}) for each of the reported stars. Using the Weibull distribution for proton fluxes reported in [8] we found the necessary energetic fluxes to calculate the uracil production rates. Finally, we calculated hydrogen cyanide, formaldehyde and amino acid chemical yields due to electric discharge using the mixing ratios found from our simulations and the trends found by [9,10]. In this case, we considered the yields of the compounds due to carbon dioxide and carbon monoxide separately.

Results: Our results show that superficial CO mixing ratio in the atmospheres of planets around M dwarf stars is up to one order of magnitude higher than that in planets around the Sun. This phenomenon occurs due to the great chromospheric activity of these stars, and translate into higher production rates of biomolecules such as uracil. Furthermore, such production rates were found to be up to five orders of magnitude higher when considering stellar high energy protons as the main energy source, thought to be typical of active stars such as M dwarf stars, when compared to production rates where the main energy source is cosmic radiation. Chemical yields of biomolecules produced by electric discharge that considered only CO presented significant values only in the cases of planets around M dwarf stars with a very high CO_2 mixing ratio. Yields that considered only CO_2 presented negligible values for planets around M dwarfs, and values commeasurable with those of planets around the Sun in the best cases.

Acknowledgment: We acknowledge support from the Universidad Nacional Autónoma de México grant DGAPA PAPIIT IN109015. This work was also performed as part of the NASA Astrobiology Institute's Virtual Planetary Laboratory Lead Team, supported by the NASA Astrobiology Institute under Cooperative Agreement Notice NNH05ZDA001C.

References: [1] Scalo et al. (2007) *Astrobiology 7*, 85-166. [2] Tarter et al. (2007 *Astrobiology 7*, 30-65. [3] Domagal-Goldman et al. *Astrophys. J. 792*, 90 (15pp). [4] Miyakawa, S. et al. (2002) *PNAS 99*. 14628-14631. [5] Kobayashi, K. et al. (1998) *Origins Life Evol Biosphere. 28*, 155-165. [6] Belov, A. et al. (2007) *Solar Phys 246*, 457-470. [7] Schmitt, J. H. M. M. and Fleming, T. A. (1995) *Astrophysical J. 450*, 392-400. [8] Xapsos, M. A. et al. (2000*) IEEE Transactions on Nuclear Sciences 47*, 2218-2223. [9] Schlesinger, G., and Miller, S. L. (1983) *J. Mol. Evol. 19*, 105-115. [10] Schlesinger, G., and Miller, S. L. (1983) *J. Mol. Evol. 19*, 376-382.