SUPERHABITABLE CIRCUMBINARY PLANETS, P. A. Mason[1], J. I. Zuluaga[2], P. A. Cuartas[2], and R. Heller[3], [1]Department of Mathematics and Physical Sciences, New Mexico State University - DACC, Las Cruces, NM, 88003, USA, [2]FACom - Instituto de Fisica - FCEN, Universidad de Antioquia, Calle 70 No. 52-21, Medellin, Colombia, [3]Origins Institute, Physics and Astronomy Department, McMaster University, 1280 Main St W, Hamilton (ON) L8S 4M1, Canada

Introduction: It is difficult to estimate the limits of planetary habitability even in the most easily accessible cases in the Solar System. So how are we to assess the potential for life within an environment as complex as that experienced by a circumbinary planet? The lack of surface habitability on Venus and Mars as well as the global presence of surface life on Earth provide strong constraints on the allowed range of stellar illumination. Application of recent Venus and early Mars insolation limits, as well as more conservative limits based on atmospheric response to the presence of greenhouses gasses have been provided [1,2], both for the sun and other main sequence stars. These radiative habitable zone limits have been extrapolated to circumbinary planets [3][4]; see Figure 1.

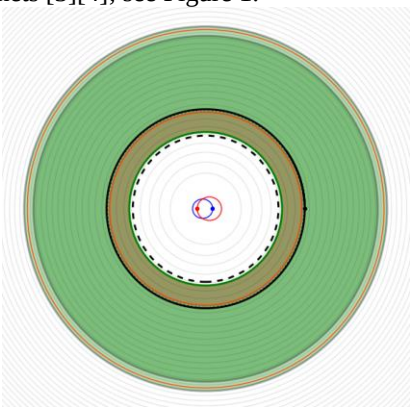

Figure 1: The circumbinary habitable zone of a binary with 0.85 solar mass (blue) and 0.75 solar mass (red) stars. A hypothetical planet is shown just outside the runaway greenhouse limit as a solid black line.

In addition to consideration of radiative limits, it is well known that planetary atmospheres, especially in the habitable zones of low mass stars, are adversely affected by non-thermal high-energy emission from stellar corona and the associated stellar wind, see e.g. [5]. In binaries, tidal interaction may be beneficial to planetary habitability. For 10-60 day binary periods, mutual tidal interaction results in early deceleration of stellar rotation, reducing the magnetic dynamo and coronal activity of one or both stars [4].

Here we explore the parameter space of habitability in binary star systems using the BHM Calculator, BHMcalc, available at http://bhmcalc.net [6].

Do some binaries provide superhabitable conditions?

Tidal deceleration results in reduced water loss from the planet illustrated here. In Figure 2, we see that the planet receives the same insolation as Earth, but more of that light is red, so the photoelectric photon flux density is higher than received by Earth. Beyond that, all locations on the planet receive some light for more than 50% of the time, due to one star rising and one star setting before the center-of-mass rises or sets. This results in less downtime for photosynthesis. The variation in the received spectrum over the course of the binary cycle would also likely aid in the diversity of life. Such a case should be considered to be a super-habitable world [7]. Searches for life should include potentially superhabitable circumbinary planets.

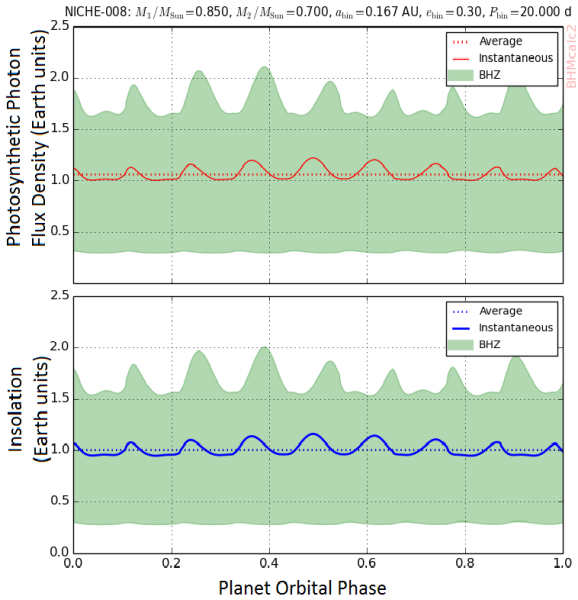

Figure 2: Insolation and photosynthetic photon flux density incident on the hypothetical planet of Figure 1.

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