ROTATIONAL EVOLUTION OF LOW-MASS STARS IN BINARIES AND ITS ROLE ON THE ENVIRONMENT OF CIRCUMBINARY PLANETS. J. I. Zuluaga[1], P. A. Mason[2,3] and P. A. Cuartas[1], [1]FACom - Instituto de Fisica - FCEN, Universidad de Antioquia, Calle 70 No. 52-21, Medellin, Colombia, [2]Department of Physics, University of Texas at El Paso, El Paso, TX 79968, USA, [3]Department of Mathematics and Physical Sciences, New Mexico State University - DACC, Las Cruces, NM, 88003, USA.

Abstract: The history of stellar rotation and activity impacts the evolution of planetary atmospheres and life. Stellar rotation determines the strength of the intrinsic magnetic field and the resulting level of chromospheric activity. Stellar magnetic activity results in significant high energy radiation as well as mass-loss adversely affecting atmospheres and biospheres of planets in the habitable zone [1,2,3]. The evolution of rotation and activity in single stars and its potential impact on planets, has been extensively studied [4]. Less attention has been paid to the case of planets orbiting binaries. Binaries composed of low-mass stars are especially interesting, since gravitational and magnetic interactions introduce novel phenomena sometimes having a positive effect on habitability, even as compared to the potential habitability of single stars [5].

We describe here a comprehensive model to constrain the evolution of rotation and activity of low-mass stars in binaries. We have used this model to predict the radiation and plasma environment of known planets around circumbinary Kepler systems [6]. We apply the model to all known circumbinary systems. In addition we present results for a set of selected binaries where no planets have been discovered so-far but whose properties seem to be well suited for the operation of the mechanism described in [5]. Other hypothetical binary configurations, where several factors may converge to enhance habitable conditions with respect to the Solar System (binary habitable niches), have been also studied and are presented here.

We compare the prediction of our stellar rotational evolutionary models against measured rotational rates of stars in those systems and attempt to constrain the free parameters of the model.

The model presented here has been integrated in a computational tool, the BHM Calculator, BHMcalc, publicly available at http://bhmcalc.net. BHMcalc is intended to allow the stellar astrophysics, planetary science, and astrobiology communities to explore the vast landscape of binary configurations and the environment of planets in those systems. We briefly describe the tool and show examples of its application for the purpose of this and other similar efforts.

References: [1] Kasting, J. F. (1996), Ap&SS, 241, 3. [2] Lammer, H., Selsis, F., Chassefiere, E., et al. (2010), Astrobiology, 10, 45. [3] Tian, F., Kasting, J. F., Liu, H.-L., & Roble, R. G. (2008), Journal of Geophysical Research (Planets). [4] Bouvier, J. (2013), in EAS Publications Series, Vol. 62, EAS Publications Series, ed. P. Hennebelle & C. Charbonnel, 143–168. [5] Mason, P. A., Zuluaga, J. I., Clark, J. M., & Cuartas-Restrepo, P. A. (2013), ApJ, 774, L26. [6] Zuluaga, J. I., Mason, P. A., & Cuartas, P. A. (2015), ArXiv e-prints.

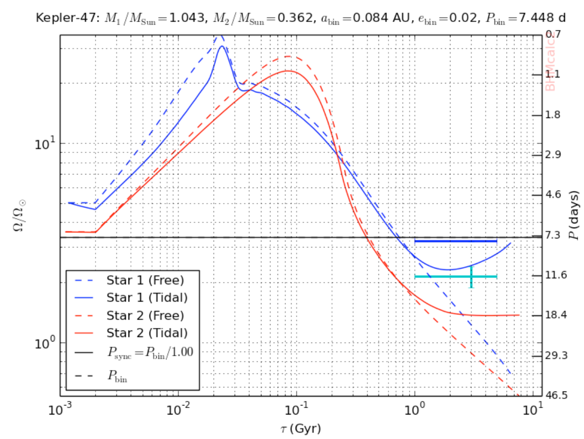

Figure caption: Evolution of rotation for Kepler-47A and B as calculated with our model. Dashed line shows the evolution of the rotational rate for the convective envelope of the stars disregarding the effect of tidal interaction. Solid line shows the evolution of rotation including tidal effects. Error bars correspond to measurements of the rotational periods using radial velocity (cyan) and photometry (blue).