SUPERHABITABLE WORLDS. René Heller[1] and John Armstrong[2], [1]Origins Institute, McMaster University, 1280 Main St W, Hamilton (ON) L8S 4M1, Canada, rheller@physics.mcmaster.ca, [2]Department of Physics, Weber State University, Ogden (UT), USA, jcarmstrong@weber.edu. *March 2, 2015*

Context: Huge financial investments are made and a substantial amount of research is being conducted towards the detection and characterization of Earth-like, habitable planets. Yet, only an anthropocentric perspective seduces scientists to assume that Earth-like planets are the most likely type of a living extrasolar world [1].

We suggest that planets different from Earth tend to offer more benign environments to life than Earth does. We identify a range of geophysical and astrophysical processes that determine planetary habitability and we find that low-mass super-Earths two to three times the mass of Earth can be superhabitable. The most favorable conditions should occur on planets orbiting in the habitable zone around K dwarf stars that are several billion years older than the Sun [2].

Results: On these worlds, an internal electromagnetic dynamo and the resulting global magnetic dipole field can be active over billions of years. The latter aspect might be important to protect the planetary surface from high-energy stellar and cosmic radiation. Moreover, plate tectonics can be active over billions of years, which might be important for a long-lasting carbon-silicate cycle. These worlds also have a larger surface area than Earth, perhaps allowing for the buildup of a larger amount of biomass. Their larger surface gravity would make them have more shallow waters rather than a few global water reservoirs (oceans) and continents. This archipelago scenario prevents them from having vast deserts in the central continental regions and it might foster biodiversity, as observed in the shallow waters on Earth.

Conclusions: Eventually, just as the Solar System turned out to be everything but typical for planetary systems, Earth could turn out to be everything but typical for a habitable or, ultimately, an inhabited world. Our argumentation can be understood as a refutation of the Rare Earth hypothesis. Ward and Brownlee [3] claimed that the emergence of life required an extremely unlikely interplay of conditions on Earth, and they concluded that complex life would be a very unlikely phenomenon in the Universe. While we agree that the occurrence of another truly Earth-like planet is trivially impossible, we hold that this argument does not constrain the emergence of other inhabited planets. We argue in the opposite direction and claim that Earth could turn out to be marginally habitable. In our view, a variety of processes exist that can make environmental conditions on a planet or moon more benign to life than is the case on Earth.

References: [1] Heller R. and Armstrong J. (2014) *AsBio, 14,* 50–66, arXiv:1401.2392. [2] Heller R. (2015) *SciAm, 312,* 32-39, ADS:2015SciAm.312a..32H. [3] Ward P. D. and Brownlee D. (2000) *Rare Earth: Why Complex Life Is Uncommon in the Universe*, Copernicus Books, New York.

Figure caption: This artist's view of a superhabitable world shows an archipelago super-Earth both under a Sun-like illumination (left) and under the illumination of a K dwarf host star (right). Both the shallow waters and the relatively thin atmosphere are a result of the larger surface gravity compared to Earth.