THE HEAVY BOMBARDMENT EON OF THE EARTH-MOON SYSTEM
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Introduction: The impact cratering shaped Moon’s landscapes offer a fossil record of the Near Earth Object populations all the way back to the formation and cooling of the lunar crust [1-3]. Crater densities of highland and mare surfaces testify a substantially higher impact flux rate during the first ~1.5 Ga compared to the last 3 Ga of our Solar System. The temporal evolution of the impact flux (bombardment timeline) is the topic of intense scientific debate. End-member interpretations are the “Early Heavy Bombardment” (EHB) assuming an exponentially declining impact rate until it oscillated around a much lower value during the last 3 Ga, and the “Late Heavy Bombardment” (LHB) referring to a brief “terminal lunar cataclysm” with a sharply rising and falling peak centered around 3.9 Ga ago [1,2].

On current state of concepts: While the EHB may still be considered the least assumptions model consistent with our fuzzy sample-based knowledge of the bombardment timeline, it lacks a proper physical (orbital) explanation. In light of the recent knowledge from lunar, terrestrial and asteroid belt samples, the classical LHB scenario is no longer attractive [1,2]. In addition, it appears highly inconsistent with orbital models [4-5]. Intermediate views that consider a complex bombardment timeline with moments of heavy bombardment appear as a venue to consensus. Two events able to initiate moments of heavy bombardment are:

1) The giant Moon forming impact created an extremely massive heliocentric debris disk; meaning a new projectile population with high impact probability onto the Earth and the Moon for the following few hundred million years [6-7].

2) The reorganization of the planetary system architecture as proposed by the updated “Nice”-model basically explains the extended tail-end of the heavy bombardment as testified by the crater density on mare basalts and possibly the Archean spherule layers on Earth [4]. However the level of resolution in dynamical models is not yet equal to data from samples.

Other impactor populations (planetary left overs, comets, debris discs, asteroid belts) that resulted from single events or dynamical processes leading to additional spikes in the impact flux cannot be excluded. One should be aware that “you don’t know what you don’t know”. Therefore, additional work on current samples and/or new samples is required.

Discussion: The terms EHB and LHB are highly loaded with assumptions. Especially LHB is used for bombardment timelines of fundamentally different shapes. For example, one LHB version mimics the EHB bombardment timeline for the last 4.1 Ga. Therefore, we recommend the usage of a new term that is purely descriptive for the heavy bombardment during the roughly first 1.5 Ga of the inner Solar System. We suggest the term Heavy Bombardment Eon (HBE) that with increasing sample data confidence can be separated into smaller selenologic units, e.g. Eras that encompass the already defined lunar periods, epochs… [2].