CLOSE ENCOUNTERS WITHIN THE SUN´S STELLAR CLUSTER AS TRIGGER FOR THE LHB AND OTHER EPISODIC BOMBARDMENTS OF TERRESTRIAL PLANETS

M. Trieloff[1,2]. [1]Klaus-Tschira-Labor für Kosmochemie, Universität Heidelberg, Im Neuenheimer Feld 234-236, 69120 Heidelberg, Germany [2]Institut für Geowissenschaften, Universität Heidelberg, Im Neuenheimer Feld 234-236, 69120 Heidelberg, Germany. (e-mail: Mario.Trieloff@geow.uni-heidelberg.de).

The concept of the Lunar (or Late) Heavy Bombardment (LHB) is a major outcome of geochronological studies of lunar rocks demonstrating that the large multi ring basins originated by giant impacts in an extremely confined time interval between 4.0 and 3.8 Ga ago [1-3]. It requires that long after final formation of the terrestrial planets, there was an increased flux of small bodies (up to about 100 km size) in the inner solar system 3.8 Ga ago, which was also recorded by other solar system bodies like Vesta or Mars [4-6]. Two major scenarios appear plausible: i) The LHB was the final phase of terrestrial planet accretion - this requires that the small body flux must have been considerably higher before (implying somewhat unrealistic total mass estimations of initial small body populations), and that the record of earlier impacts must have been erased by the late impact phase 3.8 Ga ago. ii) The LHB was an episodic spike of the influx of asteroidal or cometary bodies, caused by dynamical excitation of small body populations in the asteroid or Kuiper belts. As explanation for the dynamical excitation, planetary migration processes are promising candidates, particular resonance crossing of Jupiter and Saturn, i.e. in more general terms, the giant planet instability [7,8], with advanced models considering a more prolonged bombardment history [9].

However, there is increasing evidence that before the time of the LHB 3.8 Ga ago, there were other episodic times of increased impact rates, e.g. both Ar–Ar and zircon chronology [10,11] evidence increased impact cratering 4.2 Ga ago, which was also experienced by the LL chondrite parent body [12,13]. I suggest to consider close stellar encounters as possible reason for repeated episodic dynamical excitation of small body populations and accompanying increased cratering rates to explain the isotope chronology of lunar, terrestrial and meteoritic rocks. The early solar system Fe-60 abundance implies a massive supernova-progenitor within the sun´s stellar cluster, so that it is likely that the sun belonged to a larger stellar cluster with about 1000 solar masses. Such large clusters can have considerable lifetimes (up to 1 Ga or more) until final dispersion, and a few close stellar encounters are likely within this time [14].

References: [1] Tera F. et al. (1974) *Earth Planet. Sci. Lett*. 22, 1. [2] Jessberger E. K. et al. (1974) *Proc. LPSC* 5,1419–1449. [3] Turner G (1977) *Phys. Chem. Earth* 10, 145. [4] Bogard D.D. (1995) *Meteoritics* 30, 244-268. [5] Kunz J. et al. (1995) *Planet. Space Sci*. 43, 527. [6] Turner G. et al. (1997) *Geochim. Cosmochim. Acta* 61, 3835. [7] Tsiganis K et al. (2005) *Nature* 435, 459. [8] Morbidelli A. et al. (2007) *Astron. J.* 134, 1790. [9] Morbidelli A. et al. (2012) *Earth Planet. Sci. Lett.* 355, 144. [10] Nemchin A A. et al. (2008) *Geochim. Cosmochim. Acta* 72, 668. [11] Fernandes V A. et al. (2013) *Meteorit. Planet. Sci.* 48, 241. [12] Trieloff M. et al. 1994. *Meteoritics* 29,541. [13] Trieloff M. et al. (1989) *Meteoritics* 24, 332. [14] Malmberg D. et al. (2011) *Mon. Not. R. Astron. Soc*. 411, 859.