Hypervelocity impacts and habitability.

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Impacts is a driving process in the Solar System, which breaks bodies, changes the morphology and alters the materials of their surfaces. However, impacts apart from catastrophic events are of extreme importance as they transfer and implant materials in different places of the Solar System.

Detailed spectroscopic observations on small bodies (asteroids) have shown variability, which could be explained by deposits of exogenous material via impacts. In particular more and more asteroids seem to have in their spectrum the 3-micron band in the near-infrared which is an indication of the presence of hydrations or even water-ice on their surface [1,2,3]. Hydration has been even detected on bodies that seem to be anhydrous [4] and such finding cannot be explained otherwise. Asteroid and cometary impacts are responsible also for the water delivery on Earth.

It has been proposed that the ingredients for the formation of life were generated during hypervelocity collisions where favourable conditions existed, or where even delivered directly with small body collisions. This idea is enhanced by the findings of lunar and martian meteorites and even by the exchange of material between Mars and its satellites [6].

They hypothesis of panspermia, that life exists in Universe and is transported by bodies at different areas, was introduced since ancient years at the 5th century BC from the Greek philosophers. Recent observations from the Dawn mission have reviled organic material on the surface of the dwarf planet Ceres [7] and there is a debate on whether the organics are endogenous or exogenous.

In this work it is going to present an overview of the laboratory experiments that have been done so far and focus mainly on these that involve organics [7] or the survivability of microorganisms [8,9,10]. Laboratory work will be coupled with the aforementioned findings on small body surfaces.

References

[1] A. Rivkin and J. Emery, Detection of ice and organics on an asteroidal surface, Nature, 2017
[2] A. Rivkin et al.: Hydrated Minerals on Asteroids: The Astronomical Record, Asteroids III book, 2002
[3] D. Takir and J. Emery: Outer Main Belt asteroids: Identification and distribution of four 3-μm spectral groups, Icarus, 2012
[4] D.Takir et al.: Detection of Water and/or Hydroxyl on Asteroid (16) Psyche, AJ, 2017
[5] Z. Martins et al.: Shock synthesis of amino acids from impacting cometary and icy planet surface analogues, Nature Geosciences, 2013
[6] L. Chappaz et al: Material transfer from the surface of Mars to Phobos and Deimos, 43rd LPSC, 2012
[7] De Sanctis et al.: Localized aliphatic organic material on the surface of Ceres, Science 2017
[8] D. L. S. Pasini et al.: Survival of the tardigrade hypsibius dujardini during hypervelocity impact events up to 5.49 km s^{-1}, EPSC, 2014.
[9] M.C. Price et al.: Survival of yeast spores in hypervelocity impact events up to velocities of 7.4 km/s, Icarus, 2013
[10] M. Burchell et al.: Survival of bacteria and spores under extreme shock pressures, MNRAS, 2004

Short Summary

In this work it is going to present an overview of the laboratory experiments that have been done so far and focus mainly on these that involve organics or the survivability of microorganisms. Laboratory work will be coupled with the aforementioned findings on small body surfaces.