PhD Open Days

Shock-Impact Events and the Origin of life: a mechanochemical approach

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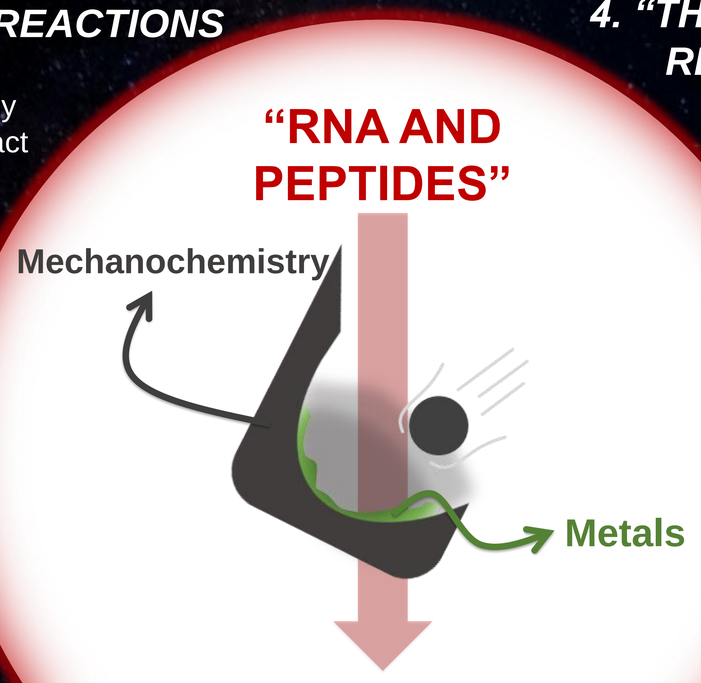
1.“THE PROBLEM”

The RNA World Hypothesis has been proposed to account for the evolution of life on Earth.[1] Nevertheless, the prebiotic synthesis of ribonucleotides, the building blocks of RNA, has not been fully accomplished.[2-4] With the detection of amino acids, ribose, and RNA nucleobases among meteorite extracts,[5-7] recent proposals focus on extraterrestrial bodies as the potential carriers of complex and essential molecules, crucial for the emergence of life on Earth.[8] However, no ribonucleosides nor peptides have been detected yet in meteorite samples. Therefore, either the current detection limits are unable to identify these molecules or induced degradation reactions modify the organic content within extraterrestrial bodies before their delivery to the Earth’s surface.[7]

2. “THE PROPOSAL”: DEGRADATION REACTIONS

Besides, thermal and radiative energy, which are mainly superficial, mechanochemical energy, from shock-impact events, were also present on the formation of proto-planets and in the meteoroid atmospheric entry.[9, 10]. Since shock-induced mechanochemical energy can be propagated throughout the entire extraterrestrial body, it is plausible that the organic content might be affected, and that extracted molecules from meteorite samples might have been deceiving our perception of exogenous delivery. To answer these questions, a new degradation model and novel detection and extraction methodologies for complex molecules will be developed.



3. “THE WORK PLAN”

A. DEVELOP THE DEGRADATION MODEL,
by studying the reactivity of complex organic molecules to mechanochemical energy, within meteorite and asteroid environments;

B. DEVELOP NOVEL EXTRACTION AND DETECTION METHODOLOGIES,
to search complex molecules (e.g. nucleosides, peptides, among others) in extraterrestrial environments;

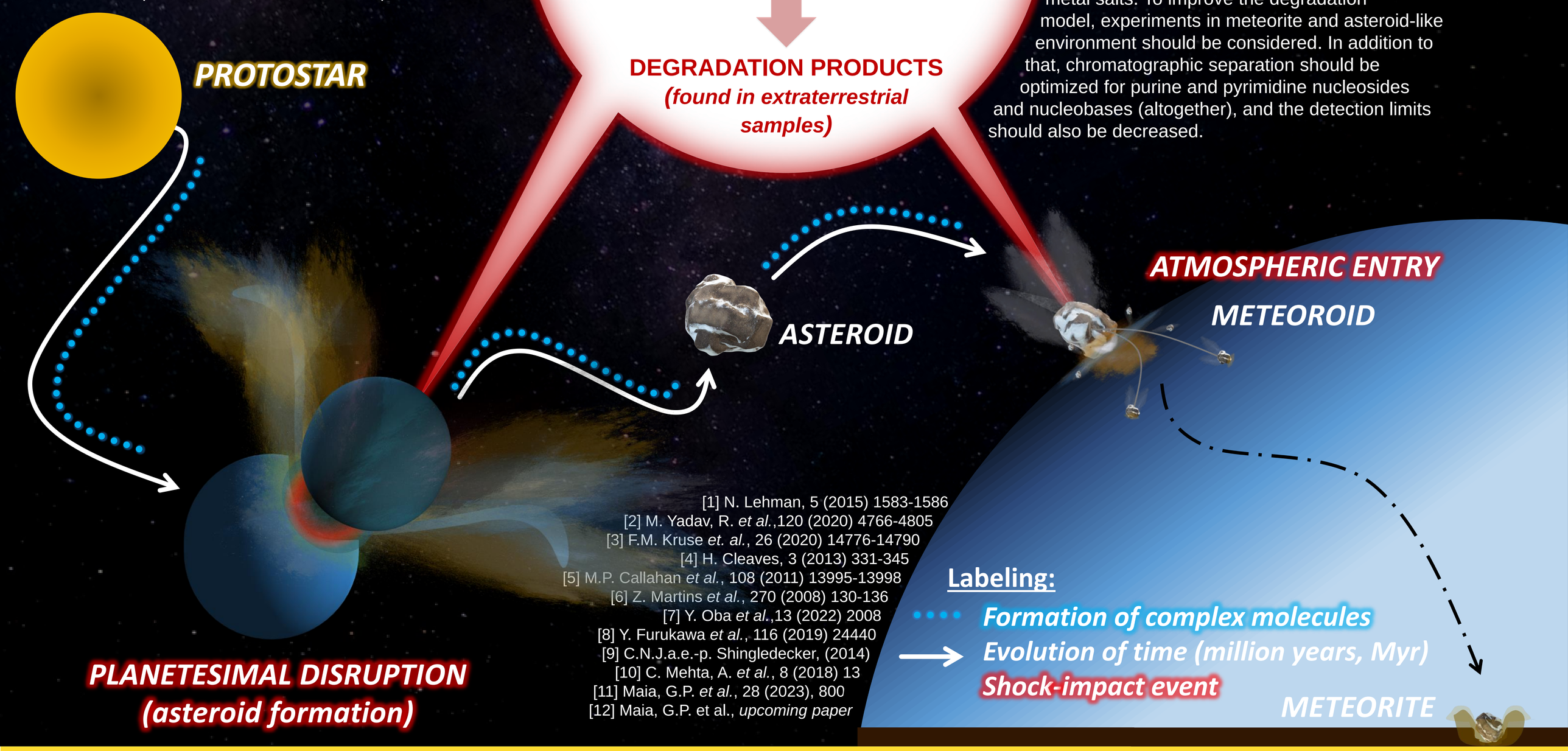
C. INTEGRATE THIS HYPOTHESIS,
into planetary sciences and space missions;

4. “THE EXPERIMENTAL OUTCOME”: FIRST RESULTS

Until now, the mechanochemical degradation of canonical ribonucleosides (adenosine, guanosine, cytidine, and uridine), induced by metals with high Lewis’s acidity, as Al(III), Fe(II)/Fe(III) and Ni(II) was accomplished and verified through HPLC-UV.[11, 12] In addition to that, purine and pyrimidine HPLC-UV/MS separation individually was accomplished.

5. “NEXT STEPS"

Ribonucleoside degradation is possible with metal salts. To improve the degradation model, experiments in meteorite and asteroid-like environment should be considered. In addition to that, chromatographic separation should be optimized for purine and pyrimidine nucleosides and nucleobases (altogether), and the detection limits should also be decreased.



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