NEW MOLECULES AS POTENTIAL SIGNATURES FOR THE SEARCH FOR LIFE ON EXOPLANETS - AN EXHAUSTIVE APPROACH TO BIOSIGNATURE GASSES. J. J. Petkowski[1], S. Seager[2] and W. Bains[2], [1]Institute of Biochemistry (IBC), ETH Zürich, Otto-Stern-Weg 3, 8093, Zürich, Switzerland. janusz.petkowski@bc.biol.ethz.ch, [2]Department of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, 77 Massachusetts Ave., Cambridge, MA 02139, USA. seager@mit.edu, WB: bains@mit.edu

The search for biosignature gases in the atmospheres of exoEarths as a sign of life is a guiding goal for many in the exoplanet community. The observational evidence reveals a vast diversity both of exoplanet physical properties, a wide variety of the gases produced by living organisms on Earth and the fact that many of Earth's gaseous byproducts of life are not unique biosignatures and are also released to the atmosphere by geophysical processes. This diversity warrants a new approach in the study of biosignature gases.

The astrophysical search for biosignature gases on exoplanets, focuses on primary and secondary metabolism gaseous byproducts of microbial origin. Earth life produces a bewildering variety of volatile molecules, whose occurrence in an exoplanet atmosphere could signal the presence of life. In contrast to the few compounds that are produced as a result of energy or biomass capture, the majority of gases are made for reasons that are not dictated by the chemical environment of life.

Will life on an exoplanet chose the same biosignature gases to release? The goal of the presented work is to expand on the search of possible biosignature gases and go beyond gaseous products that have been studied so far, which include the canonical, unique Earth biosignature gases: O2, O3, and N2O, as well as secondary metabolites: methanethiol (CH3-SH), dimethyl sulfide (CH3-S-CH3), methyl chloride (CH3Cl) and carbonyl sulfide (CSO).

We present the initial results of a project to map the chemical space of life's metabolic products. We have constructed a systematic survey of all possible stable volatile molecules, and identified those made by life. Some (such as methyl chloride) are made by Earth life in sufficiently substantial quantities to be candidate biosignatures in Earth's atmosphere; some, such as stibine (SbH3), are produced only in trace amounts. Some entire categories of molecules are not made by terrestrial life (such as the silanes); these and other absences from the list of biogenic volatiles point to functional patterns in biochemical space. Such patterns may be different for different biochemistry, and so we cannot rule out any small, stable molecule as a candidate biosignature gas. We therefore suggest a new, exhaustive approach to biosignature gases by considering all small molecules that are stable, volatile, and may accumulate to high levels depending on different exoplanet atmosphere and surface environments. We present our approach to achieving this goal.