VIRUSES AT LARGE IN THE UNIVERSE. Tomohiro Mochizuki[1], Aaron J. Berliner[2], and Kenneth M. Stedman[3], [1]Earth Lfe Sciences Institute, Tokyo Institute of Technology, tomo.mochiviridae@elsi.jp, [2]BioNano Research Group, Autodesk, Inc. and University of California, Berkeley, aaron.berliner@autodesk.com, [3]Center for Life in Extreme Environments and Biology department, Portland State University, P.O. Box 751, Portland, Oregon, USA, kstedman@pdx.edu.

Introduction: Despite their ubiquity, diversity, roles in evolution, influences on terran biogeochemistry, and possible roles in the origin of life, there is very little focus on viruses in Astrobiology [1]. Viruses have arguably co-existed with cellular lifeforms since the origin of life and have profoundly influenced cellular evolution [2]. Virus genomes are the only ones on Earth to use either RNA or DNA in both single and double-stranded forms for their genetic material [3]. Virus genomes encode staggering numbers of novel genes, some of which profoundly influence not only their host's metabolism but also global biogeochemical cycles [4-5]. Extracellular virus structures, virions, particularly those of archaeal viruses, are unique and distinctive [6]. There are a number of pressing unanswered questions in Astrovirology, particularly regarding the detection of virus biosignatures and whether viruses could be spread extraterrestrially. These issues will be addressed in this presentation.

Viruses in Evolution: Viruses should be considered as symbionts rather than parasites, as there are a number of host-virus interactions that benefit hosts as well as clear parasitic examples. Evolutionary pressures due to parasitic relationships are relatively clear, however, horizontal gene-transfer due to viruses is probably at least as important for cellular evolution. Moreover, viruses could have been involved in the evolution of multicellularity, the division of the three cellular domains of life and the invention of DNA as the genetic material.

Viruses in Biogeochemisty: Some of the horizontally-transferred genes are critical for host metabolism. Not only are virus genes important for oxygenic photosynthesis [4] but also for carbon and other nutrient cycling [5]. Viruses also contain the vast majority of genetic diversity on Earth. However viruses have not been included in models of early oceans.

Virus Antiquity and Biomarkers: Viruses are clearly at least hundreds of millions of years old, probably much older, but there is no unequivocal evidence for viruses in the rock record. Since viruses have unique virion or capsid structures, these might provide morphological biomarkers, but resolution of current techniques is insufficient. Molecular biomarkers have been proposed but have not been validated to date. Possible differential isotopic fractionation from virus-encoded enzymes has not been addressed to date. It is critical to establish such biomarkers for any extra-terrrestrial virus detection experiments or deployments. Viruses are extremely abundant in terran oceans, with abundances estimated to be 10^{31}, development of biomarkers will be critical to determine if extra-terrestrial oceans are also virus-laden. Finally additional studies of virus stability in both simulated and actual space environments should be performed.

References:

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