

Future space explorations in the bio-nano millennium

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Some of the fundamental questions that NASA has outlined in its 2000 Strategic Plan include investigating how did the universe, galaxies, stars, and planets form and evolve, and what is their destiny; does life in any form exist (or has it existed) elsewhere in the universe; how can our exploration of the universe and our solar system revolutionize our understanding of physics, chemistry, and biology; and how can we enable revolutionary technological advances in space and air travel, and in other aspects of space exploration, and also benefit society on Earth [1-4].

Whereas answers to these existential questions may take us beyond the reaches of our solar system, recent technological advances (such as molecular imaging and others) offer a new perspective of the world at the atomistic and nanometer scale. In this author's opinion, researchers and technologists at NASA Centers, within the next 20 years, will become increasingly engaged in an exciting new intellectual challenge in which cosmic and atomistic physics meets biology, chemistry, and information sciences. Inter-disciplinary teams of scientists, technologists, mission engineers, and information scientists will be engaged in planning and launching networks of in-situ micro-spacecraft, probes, and robotic outposts for the exploration of our solar system, as scientific instruments and as precursors to the development of extra-terrestrial human habitats. Sophisticated robotic systems will be deployed at Europa and Mars in search of water and bio-molecular signatures of past or present signs of life based on pre-biotic chemistry, non-Brownian motion, or thermal disequilibrium. Molecular scale bio-nanotechnology will be used as front-end sensors and nanomechanical processors for the detection of early signatures of life in extreme environmental conditions. Radiation resilient nanodevices could be used for information sensing, storage, and processing. Similar technologies may be applied to the launching of autonomous nanoscale robotic vehicles, placed within the human body (within red or white blood cells) to navigate and search for bio-molecular signatures of cells that exhibit anomalous behavior. This author will outline some preliminary concepts currently under study that illustrate some of the visionary applications of bio-nanotechnology to space exploration and possibly human health care.

- [1] NASA Strategic Plan 2000, <http://www.nasa.gov>
- [2] NASA Space Science Strategic Plan NP-2000-08-258-HQ <http://spacescience.nasa.gov>
- [3] Astrobiology, Exploring the Living Universe, <http://astrobiology.arc.nasa.gov>
- [4] Center for Integrated Space Microsystems, <http://cism.jpl.nasa.gov>