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Technology Needs for Future Missions, Systems, and Instruments (3)

Author: Dr. Kritsadi Thetpraphi
INSA de Lyon, France

Dr. Gil Moretto
CNRS, France
Dr. Jean-Fabien Capsal
INSA de Lyon, France
Prof. Jeff Kuhn
University of Hawaii, United States
Dr. David Audigier
INSA de Lyon, France
Dr. maud langlois
CNRS, France
Dr. Joe Ritter
University of Hawaii, United States
Mr. Kevin Lewis
Buble Studios, United States

AN EMERGING HYBRID TECHNOLOGY TOWARD ULTRA-LIGHT & SELF-CORRECTING "LIVE" MIRRORS, DEDICATED TO IMAGING EXO-PLANETS – THE ELF PROJECT

Abstract

The constantly increasing needs for astronomical imaging of ever fainter objects as well as for imaging the Earth from space require much higher angular resolution and dynamic range than current optical telescopes can deliver. Mirrors are the key elements of these systems; but they are technologically difficult to improve because they must maintain an exceedingly precise shape while resisting deformation from gravity and variable wind loads in the open environments in which they must operate. Our interdisciplinary novel technology team will establish a new paradigm: we will shape thin, very smooth, "fire-polished," lightweight glass to a predetermined curvature and generate dynamically controlled stiffness by using the addressable energy of electroactive polymers (EAPs) to resist environmental deformation – making what we call a "Live-Mirror." Because each m2 of optical mirror area will require about 200 force points, additive manufacturing and 4D printing technologies are crucial for enabling this degree of complexity and miniaturization. Enabling Live-Mirror technology will transform our ability to create large and very precise optical surfaces and deliver the new generation of extremely lightweight Earth-, space-, or Moon-based telescopes. In addition, this technology will serve all applications requesting precise and cheap remote detection such as: (i) Astronomical systems; (ii) Wireless optical communication systems (UV and free-space systems); (iii) Light-collection systems for the production of clean, solar energy plants; (iv) Space surveillance (of both Earth and near-Earth environments), for security and resources. It should be noted that, international space agencies (ESA, NASA, JAXA, CNSA) had declared the construction of giant telescopes in space to be one of their priorities for the next decade. Doing so, they want to bring astronomy into a new era as the discoveries made with current large telescopes have raised new questions that only such new instruments can help to answer. Our long-term vision is to leverage the

highly disruptive Live-Mirror technology terrestrially developments adapting them for operations in the space environment enabling telescope mirrors via 4D printing in-Space Manufacturing.