Mathematics in Space Science and Technology; Perspectives and Requirements

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The exploration of space extensively uses the tools and techniques of mathematics and mathematical physics. These methodologies play a key role in the analysis and simulation of nonlinear dynamical systems in celestial mechanics, aero and propulsion dynamics, atmospheric sciences, structural dynamics, image processing, design of guidance, navigation and control systems, interplanetary mission design and in many other important elements of space science and technology.

While briefly reviewing the current state of technology in space mission design, this lecture particularly emphasizes the modelling of atmospheric parameters for mission design using the methodologies of spectral analysis and optimization of Fourier coefficients perturbation bounds to generate any required number of atmospheric profiles for Monte Carlo mission studies, particularly to capture the aero, thermal, control, and propulsion interactions of the space vehicle. Also, the challenges and achievements of numerical simulation of partial differential equations representing the space vehicle fluid dynamical, structural and propulsion processes are highlighted. The domains of mathematical modeling, and multi-disciplinary optimization in this endeavor are emphasized. The future perspectives and directions of development are indicated.

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