Information Sciences

Thermal Management Tools for Propulsion System Trade Studies and Analysis

Applications include modeling and simulation in building and data center cooling analysis, and in ground-based vehicle studies.

John H. Glenn Research Center, Cleveland, Ohio

Energy-related subsystems in modern aircraft are more tightly coupled with less design margin. These subsystems include thermal management subsystems, vehicle electric power generation and distribution, aircraft engines, and flight control. Tighter coupling, lower design margins, and higher system complexity all make preliminary trade studies difficult. A suite of thermal management analysis tools has been developed to facilitate trade studies during preliminary design of air-vehicle propulsion systems.

Simulink blocksets (from MathWorks) for developing quasi-steady-state and transient system models of aircraft thermal management systems and related

energy systems have been developed. These blocksets extend the Simulink modeling environment in the thermal sciences and aircraft systems disciplines. The blocksets include blocks for modeling aircraft system heat loads, heat exchangers, pumps, reservoirs, fuel tanks, and other components at varying levels of model fidelity.

The blocksets have been applied in a first-principles, physics-based modeling and simulation architecture for rapid prototyping of aircraft thermal management and related systems. They have been applied in representative modern aircraft thermal management system studies. The modeling and simulation ar-

chitecture has also been used to conduct trade studies in a vehicle level model that incorporates coupling effects among the aircraft mission, engine cycle, fuel, and multi-phase heat-transfer materials.

This work was done by Kevin McCarthy of PC Krause & Associates and Ernie Hodge of Modelogics for Glenn Research Center. For further information contact Dr. Jeffrey Dalton, Avetec Chief Technology Officer, jdalton@avetec.org.

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18463-1/4-1.

Introduction to Physical Intelligence

NASA's Jet Propulsion Laboratory, Pasadena, California

A slight deviation from Newtonian dynamics can lead to new effects associated with the concept of physical intelligence. Non-Newtonian effects such as deviation from classical thermodynamic as well as quantum-like properties have been analyzed.

A self-supervised ("intelligent") particle that can escape from Brownian mo-

tion autonomously is introduced. Such a capability is due to a coupling of the particle governing equation with its own Liouville equation via an appropriate feedback. As a result, the governing equation is self-stabilized, and random oscillations are suppressed, while the Liouville equation takes the form of the Fokker-Planck equation with negative diffusion. Non-

Newtonian properties of such a dynamical system as well as thermodynamical implications have been evaluated.

This work was done by Michail Zak of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-47165

Technique for Solving Electrically Small to Large Structures for Broadband Applications

Methods are combined.

Lyndon B. Johnson Space Center, Houston, Texas

Fast iterative algorithms are often used for solving Method of Moments (MoM) systems, having a large number of unknowns, to determine current distribution and other parameters. The most commonly used fast methods in-

clude the fast multipole method (FMM), the precorrected fast Fourier transform (PFFT), and low-rank QR compression methods. These methods reduce the $O(N)$ memory and time requirements to $O(N \log N)$ by compressing the dense

MoM system so as to exploit the physics of Green's Function interactions.

FFT-based techniques for solving such problems are efficient for space-filling and uniform structures, but their performance substantially de-