Lawrence Livermore National Laboratory

Analytical Solutions to Test Computer Codes Simulating Gas Dynamics and Radiation Transport Problems in Different Approximations

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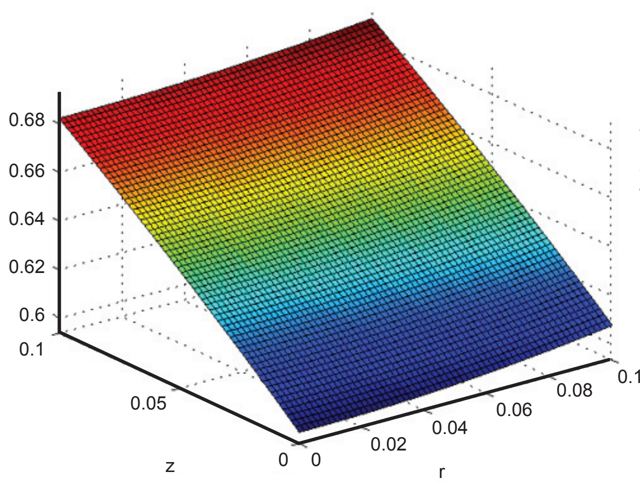
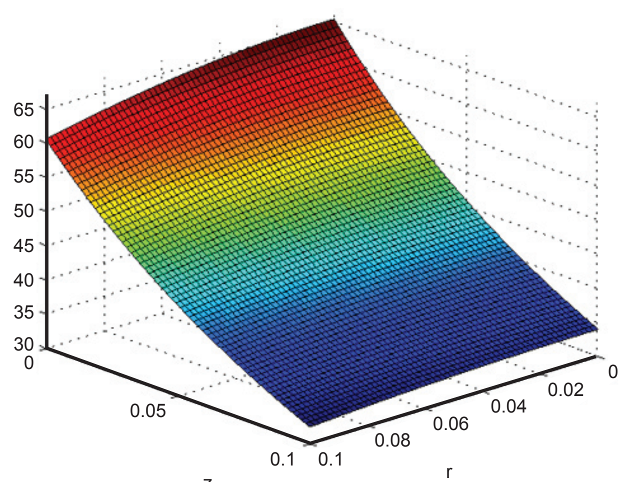
Project Description

The objective of the project is to obtain new analytical solutions for problems in gas dynamics and radiation transport, as well as to compile a collection of analytical solutions on the basis of these new and already existing solutions. These analytical solutions can be very useful for estimating the accuracy of numerical methods and to test numerical simulation codes.

For radiation transport, these problems include the solution to the energy and radiation transport equations in the gray approximation for the one-dimensional, two-material configuration; the solution to the energy and radiation transport equations including the radiation spectrum in two-dimensional cylindrical geometry (motionless); the solution to the energy and radiation transport equations including the radiation spectrum in two-dimensional spherical coordinates (motionless); the solution to the spectral equations for energy and radiation transport in three-dimensional Cartesian coordinates (motionless); and the solution to the spectral equations for energy and radiation transport in three-dimensional Cartesian coordinates (with motion). For gas dynamics, these include solutions for problems with shock waves, pressure-driven gas motion at low initial surface curvature, strong discontinuities in the flows of plane and spatial double wave type, and an angle-shaped piston in a heterogeneous mixture of isothermal gases.



Temperature profile at *ct* = 0.8 for an analytical multi-frequency radiation transport problem.



Opacity profile at *ct* = 0.8 for an analytical multi-frequency radiation transport problem.

Technical Purpose and Benefits

Physical processes in space and time are described by systems of multidimensional partial differential equations. These systems are usually nonlinear and difficult to solve. To simulate different physical processes, numerical methods are used to enable computer codes to generate discrete solutions depending on spatial variables and time. There are a large number of techniques and codes for solving problems in gas dynamics and radiation transfer. To estimate the actual accuracy of a numerical method and computer code, problems with analytical solutions are very useful. This project collects a large set of different analytical solutions to problems in both gas dynamics and radiation transport that can be used in Validation and Verification assessments.

Collaboration between Lawrence Livermore National Laboratory (LLNL), Livermore, CA, USA, and the Russian Federal Nuclear Center - All Russian Research Institute of Technical Physics (RFNC-VNIITF), Snezhinsk, Russia

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