MESHCHERYAKOV LABORATORY OF INFORMATION TECHNOLOGIES

Seminar on Computational and Applied Mathematics

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Room 310
Online seminar via Webex

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Efficient numerical integration methods for the Cauchy problem for ODE systems with contrast structures and singularities

A problem is called stiff if it has a large diversity of characteristic scales of processes. Examples are reaction kinetics, cumulation, nonlinear combustion, breakdown in plasma and semiconductors, etc. Such problems are extremely difficult to solve numerically. Firstly, the areas of abrupt change in the solution (contrast structures) require a very small integration step. Secondly, round-off errors can severely limit accuracy. Thirdly, the solutions of some problems have singularities, i.e., they turn to infinity in a finite time. In this work, a number of algorithms for the numerical solution of stiff Cauchy problems are developed and tested. A new method for the automatic selection of the integration step by the slope and curvature of the integral curve is proposed. It enables to solve even ultra-stiff problems with explicit schemes. The solution is calculated simultaneously with an asymptotically sharp error estimate, which considerably increases the robustness of the calculation. For problems with singularities, a new method for the numerical detection and investigation of the nearest singularity is presented. It allows one not only to determine the type of singularity, but also to calculate its order and time moment with posteriori accuracy control. For problems with sequences of poles of the integer order, a new method that provides the continuation of the solution through the pole, calculating the solution itself and the pole position with high accuracy up to computer round-off errors, is proposed.

More information on the seminar and the link to connect are available at Indico:
https://indico-hlit.jinr.ru/event/269/