CosmoPhi: A New Code for Hydrodynamic Cosmology Simulation by means Intel Xeon Phi Supercomputers

Dr. Igor Kulikov

ICM&MG SB RAS

7 July 2015

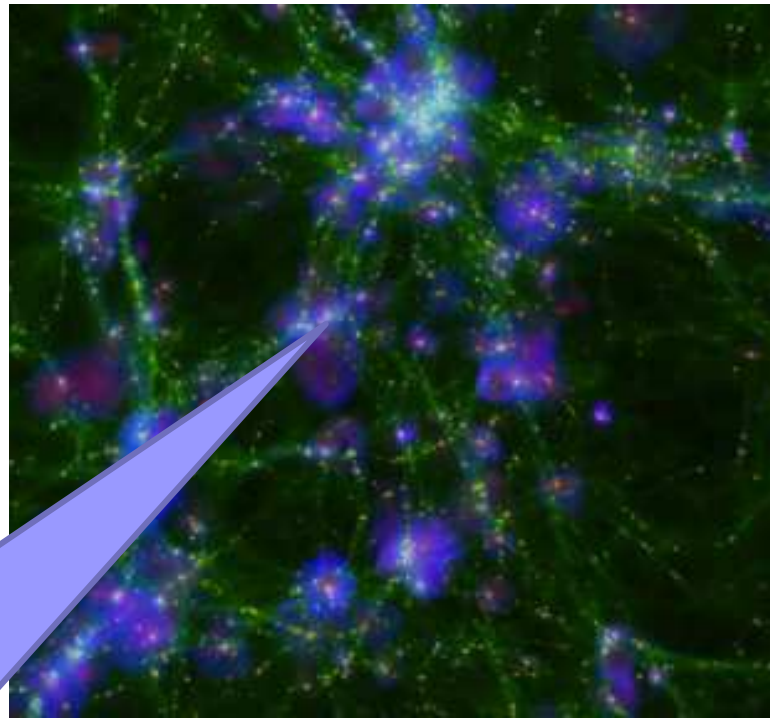
Aix-en-Provence, France

The motivation

«The movement of galaxies in dense clusters turns the collisions of galaxies into an important evolutionary factor»

Professor

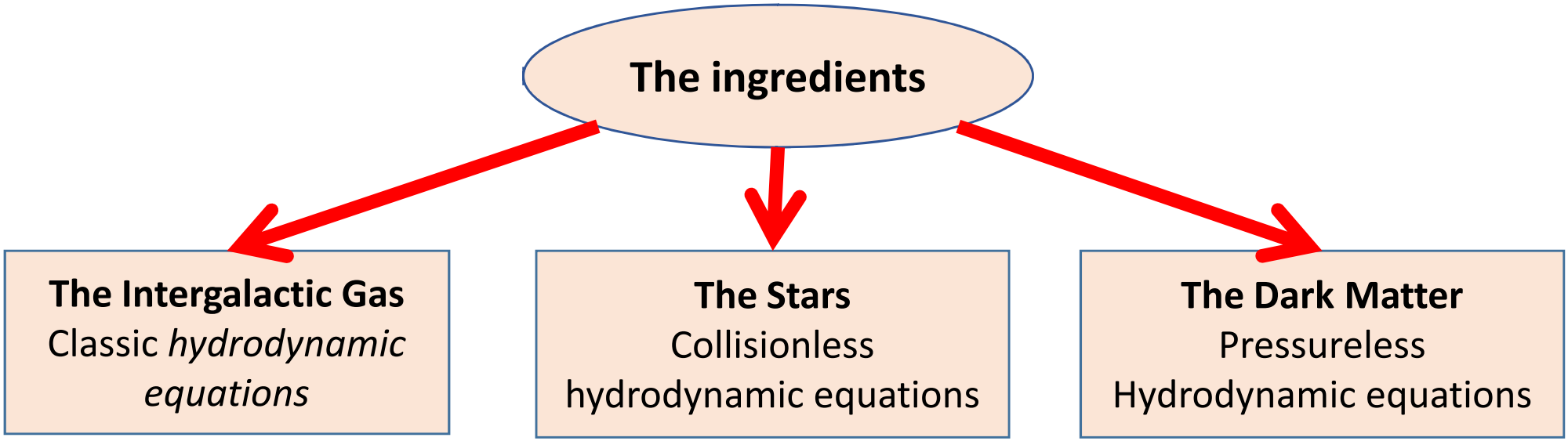
Dr. Alexander Tutukov



The challenges:

1. The mathematical model
2. The numerical solver
3. The efficiency implementation

The physics model



The subgrid physics model

- Gravity potential
- Cooling/Heating terms
- Magnetic field
- Nonequlibrium chemistry
- Star formation
- Supernovae feedback

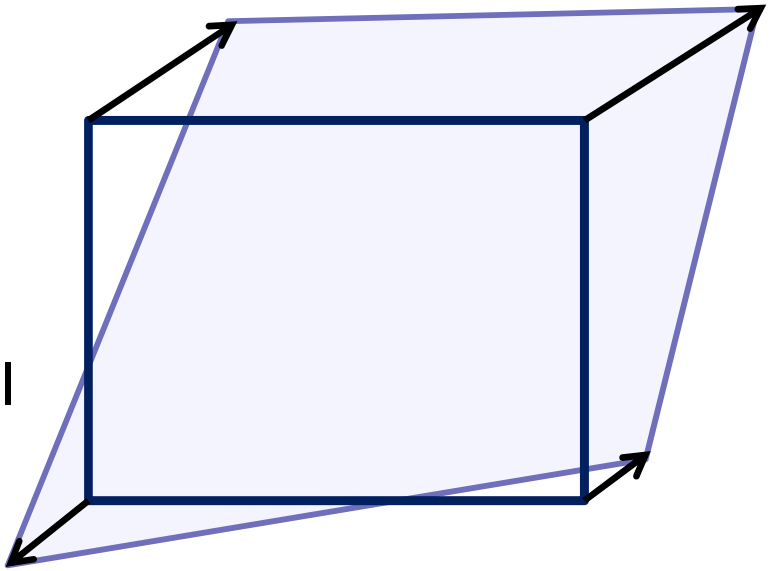
Main features:

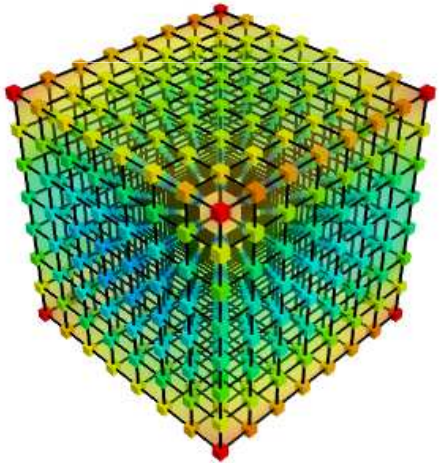
1. Unified numerical solver
2. Unified parallel algorithm
3. Potential infinity scalability

The numerical method

The numerical method

- Operator splitting approach
- Godunov method
- Roe solver adaptation for vacuum interface
- Piecewise-parabolic method on local stencil
- Fast Fourier Transform technique
- Dual energy formalism

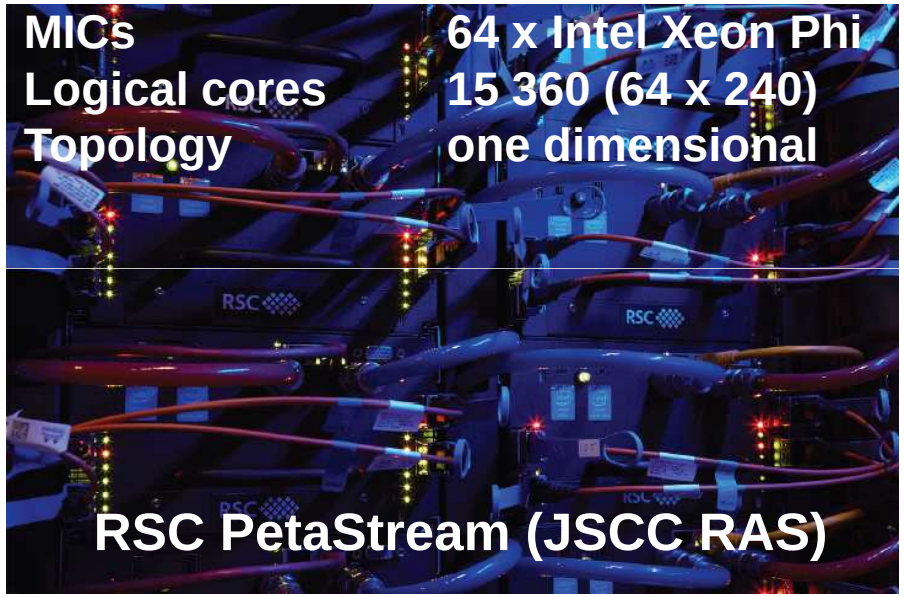


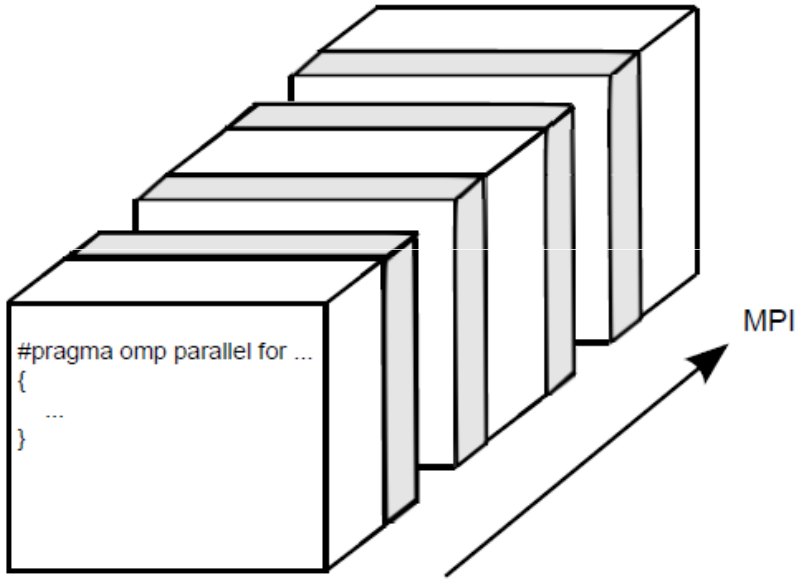


The features of numerical method

- High-order accurate method
- The limiter free solver
- Galilean invariant numerical solution
- Guarantee of non-decrease entropy
- Simplicity and Scalability of implementation
- Extensionability on more hyperbolic models

The parallel implementation on RSC PetaStream



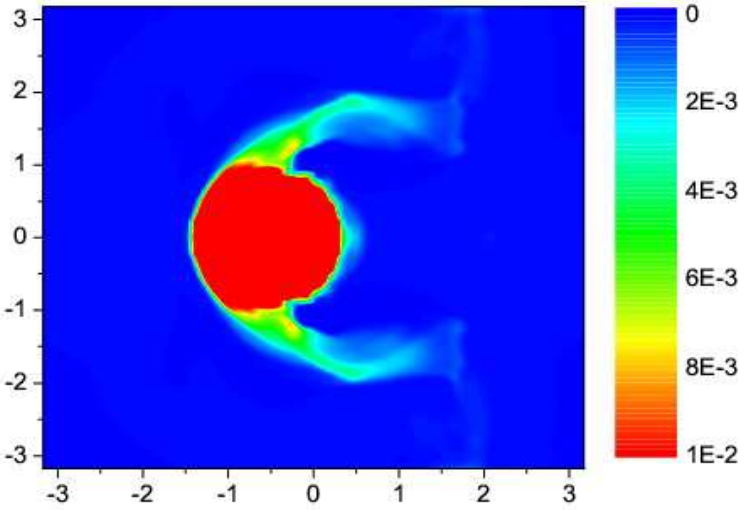


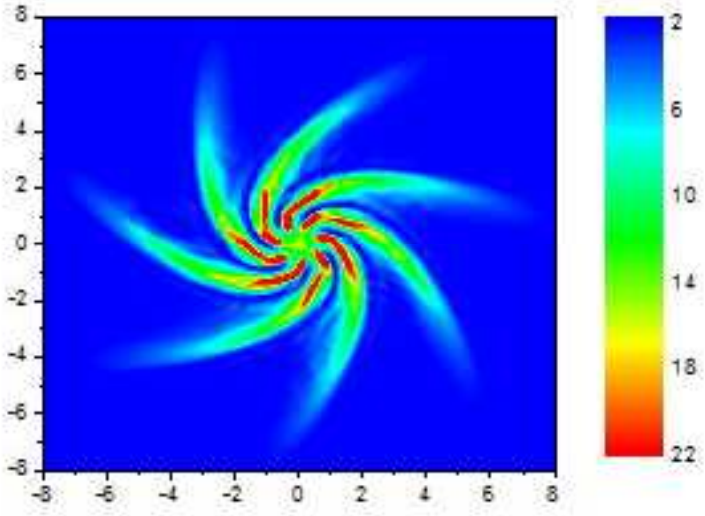
1. The speed-up factors of 134 on 260 logical cores
2. The efficiency of 92% on 64 MICs (or on 15 360 cores)
3. The 29 GFLOPS of scalar performance (or 40% from peak)

The simulation of behavior of parallel implementation on
983 040 cores
by means AGNES* system the
80% efficiency
was shown

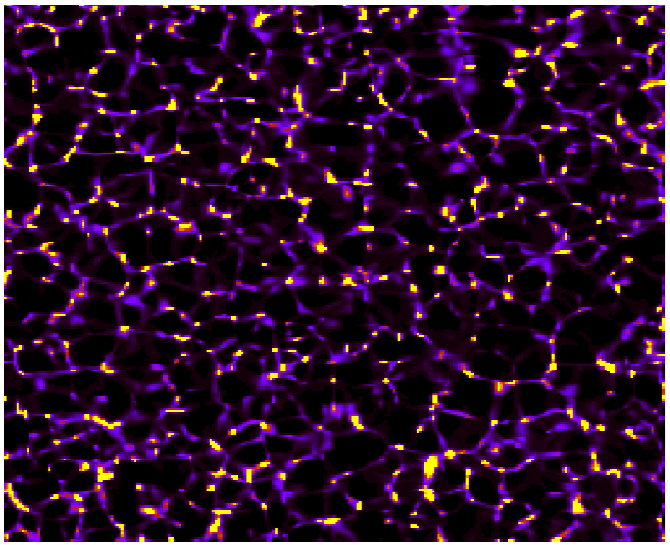
*Podkorytov et al., LNCS 2010

The interacting & evolution galaxy





Cosmology simulation



The collaborators

Acad. Sergey Godunov

Prof. Alexander Tutukov

Dr. Eduard Vorobyov

Dr. Alexey Snytnikov

Dr. Alexey Shmelev

Victor Protasov

Alexander Serenko

Prof. Vitaly Vshivkov

Prof. Boris Glinsky

Dr. Igor Chernykh

Prof. Alexey Rodionov

Dmitry Weins

Eugenya Katysheva

Vladislav Nenashev

The sponsors

Grant of the President of Russian Federation

MK – 6648.2015.9

Grants of Russian Foundation for Basic Research:

15-31-20150 and 15-01-00508

Thank you for attention!

Welcome to my poster