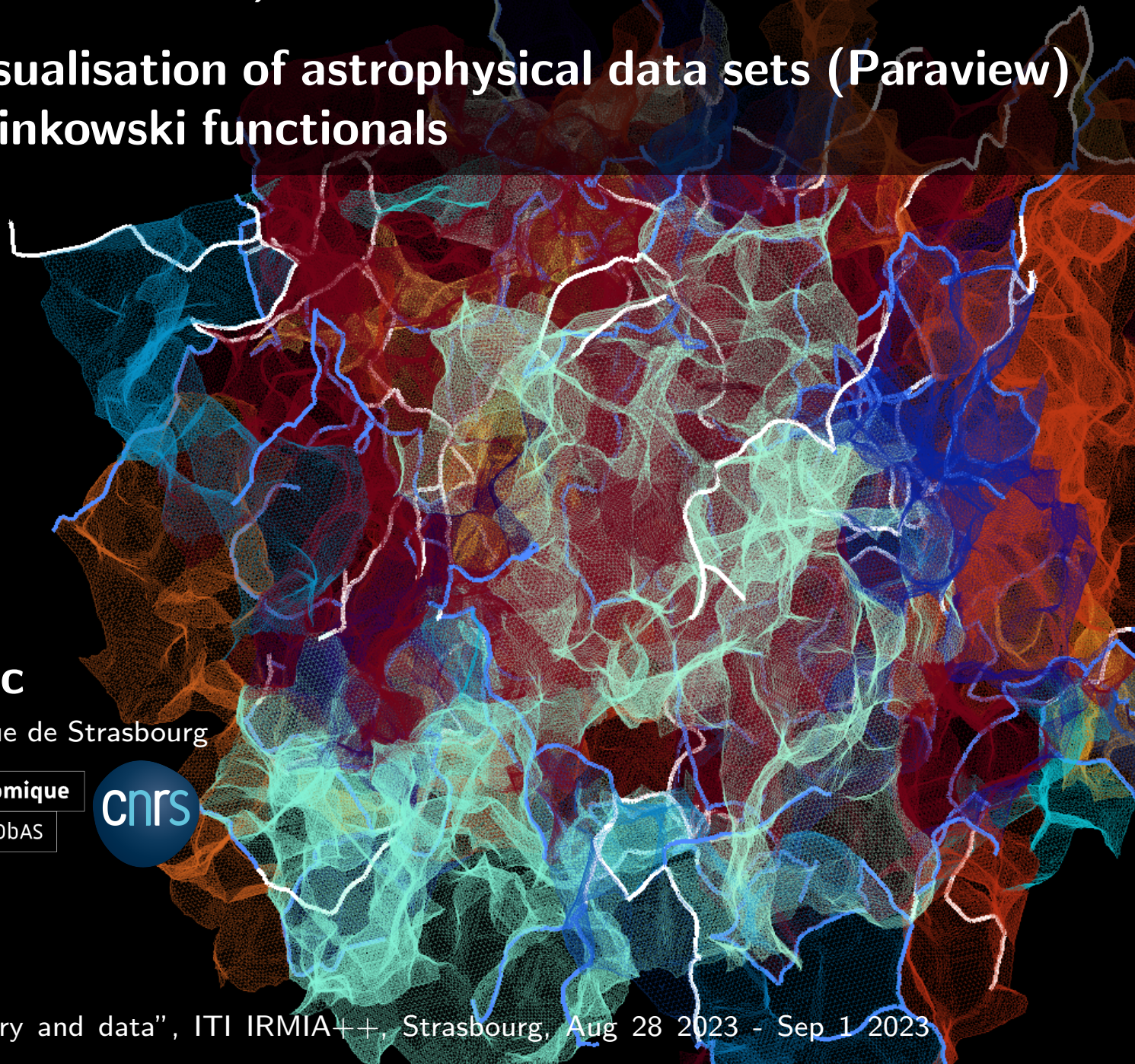
Topological (& geometrical) methods for astrophysical data

Practical: 1/ Visualisation of astrophysical data sets (Paraview)
2/ Minkowski functionals



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Software (minkowski2.1) by Martin Kerscher

→ minkowski2.1 (https://homepages.physik.uni-muenchen.de/∼Martin.Kerscher/software/)

→ computes Minkowski functionals of a Boolean grain model with boundary correction

→ open source post-processing visualization engine

→ uses the Visualization Toolkit (VTK) as the data processing and rendering engine

→ **webpage:** https://www.paraview.org

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ParaView

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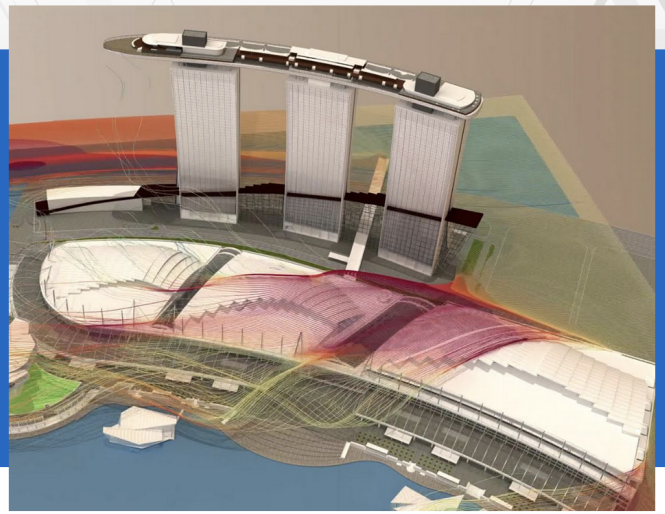
About ParaView

Large Data Visualization Made Easier with ParaView

ParaView is the world's leading open source post-processing visualization engine. It integrates with your existing tools and workflows, allowing you to build visualizations to analyze data quickly. With its open, flexible, and intuitive user interface, you can analyze extremely large datasets interactively in 3D or programmatically using ParaView's batch processing.



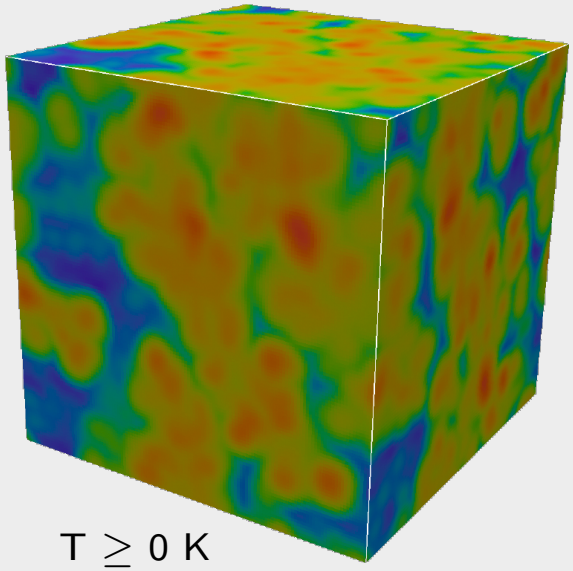
From Laptops to Supercomputers

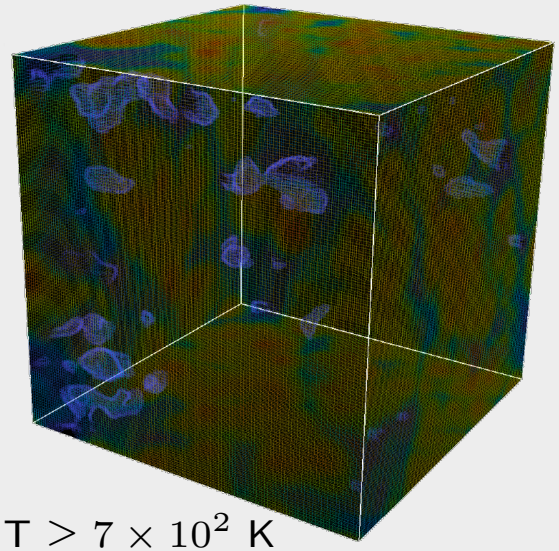
ParaView was designed to run on anything from laptops to supercomputers, so you can analyze small datasets all the way up to exascale datasets. ParaView runs on:

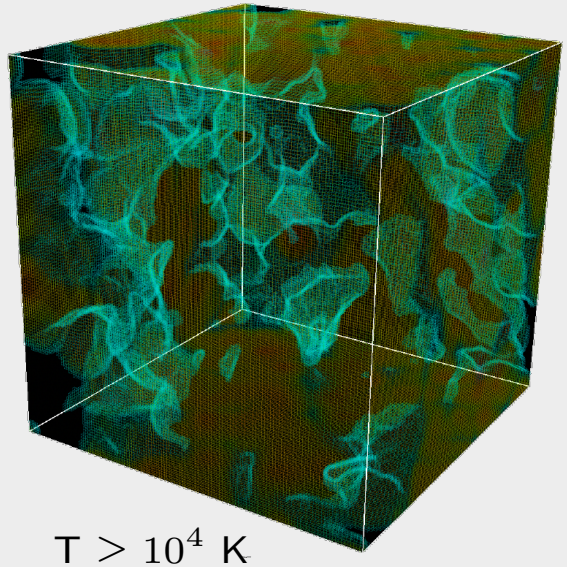
Hydrodynamic simulation: baryonic physics

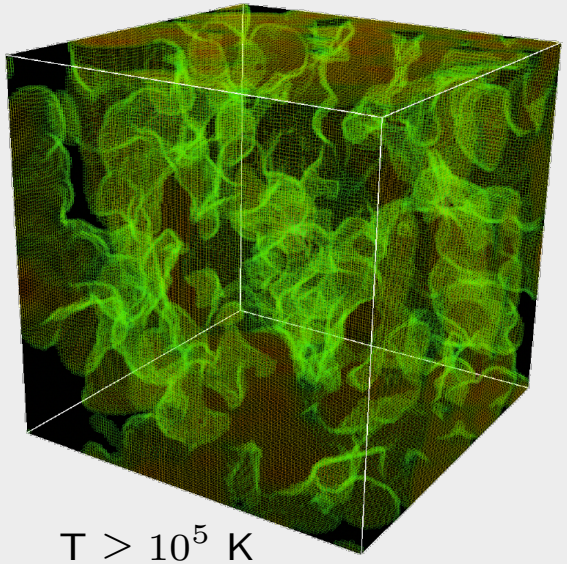
Simba: cosmological simulation (Davé et al. 2021 arXiv:astro-ph/1901.10203)

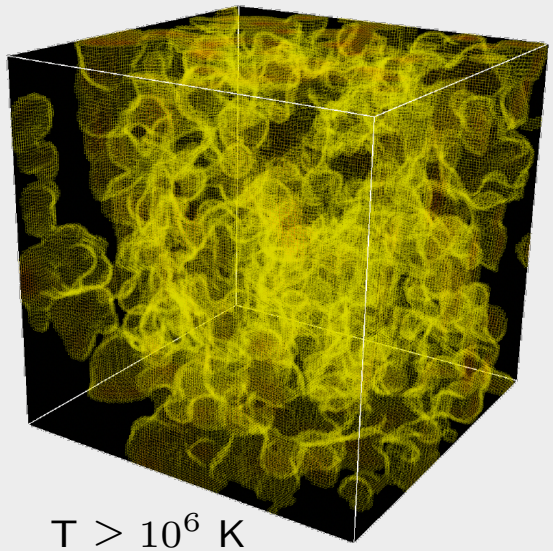
Excursion sets

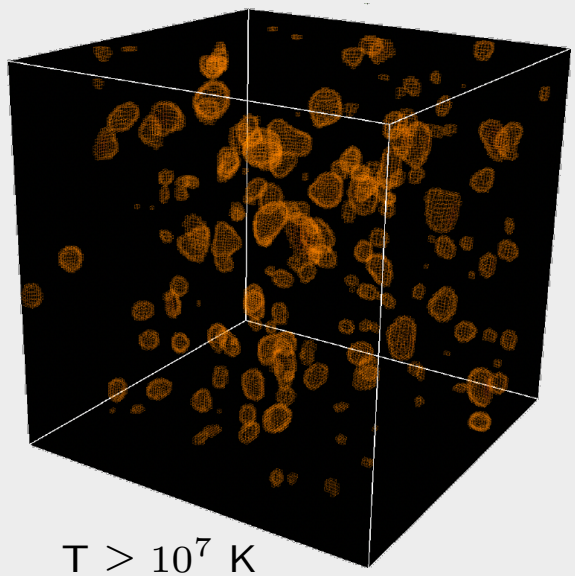

$T \geq 0$ K


$T \geq 7 \times 10^2$ K


$T \geq 10^4$ K


$T \geq 10^5$ K


$T \geq 10^6$ K


$T \geq 10^7$ K

Hydrodynamic simulation: baryonic physics

File preparation:

→ temperature field: **T_m50n512_s50j7k_151_128.asc**

→ convert numpy array into .vtk file using pyevtk package

→ pip instal pyevtk
or

conda install -c conda-forge pyevtk

→ from pyevtk.hl import gridToVTK
...

gridToVTK(file, x, y, z, cellData = "temperature" : field_smth)

→ structured grid: **T_m50n512_s50j7k_151_128.vts**

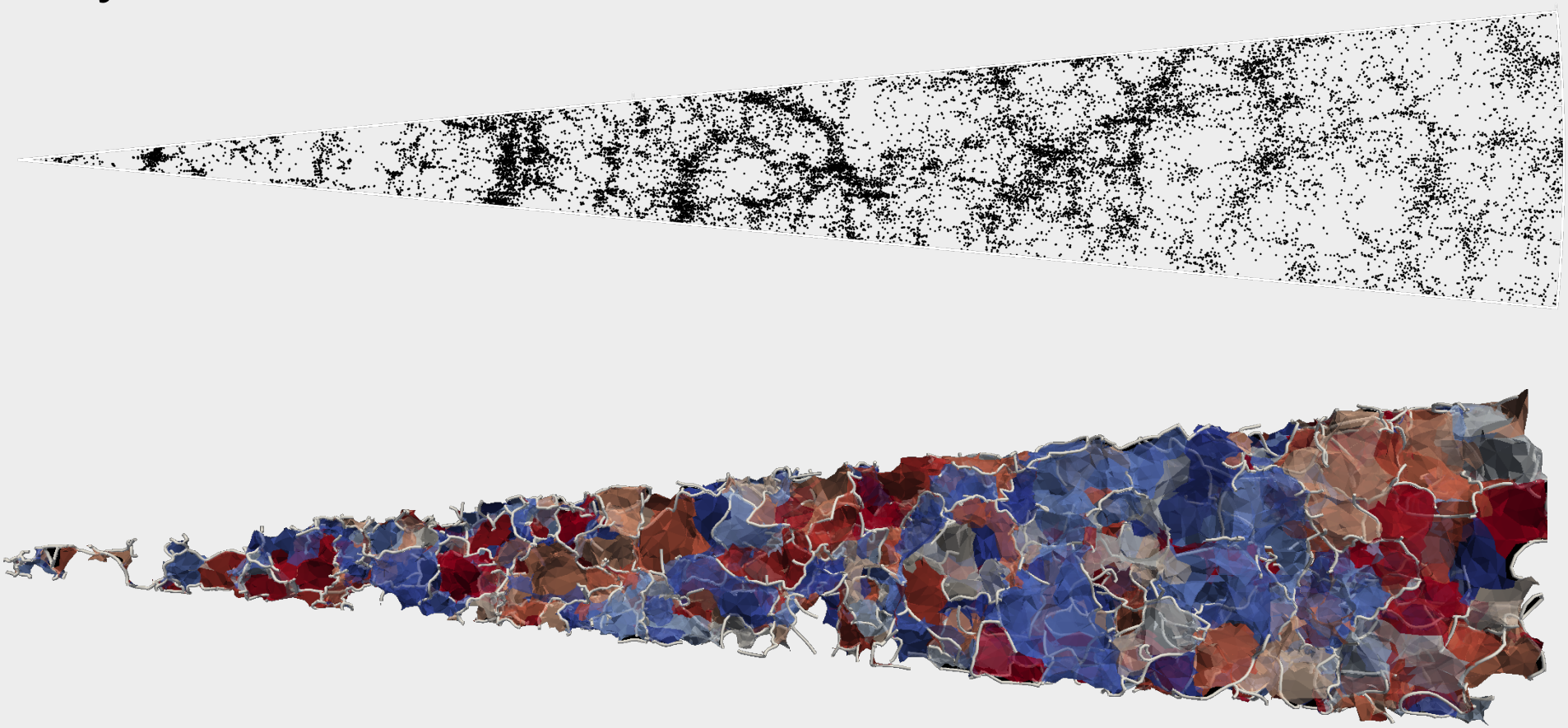
Paraview:

→ load file: **T_m50n512_s50j7k_151_128.vts**

→ thresholding the data: apply *Threshold*

→ creating 2d maps: apply → *Slice*
→ *CellDatatoPointData*
→ *Contour*

Galaxy distribution



→ **G12_19p8_fofgt6_s3Mpc_dtfe_SD0_S5_K1.vtu** → DTFE information
→ **G12_19p8_fofgt6_s3Mpc_dtfe_SD0_S5_K1.vtp** → filaments
→ **G12_19p8_fofgt6_s3Mpc_dtfe_SD0_S5_K1_manifolds_J1a.vtu** → walls
→ **G12_19p8_fofgt6_s3Mpc_dtfe_SD0_S5_K1_manifolds_J0a.vtu** → voids