GPU-accelerated Radiation Hydrodynamics Simulations

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Radiative Transfer

Radiative transfer (RT) is a key element to producing accurate cosmological hydrodynamics simulations but it is computationally expensive.

In current simulations it is usually treated by:

- Ignoring it
- Diffusion approximations
- Monte Carlo
- Solving higher-order moments of the RT equation
- Ray Tracing

Ray traced radiative transfer is the most accurate but also the most expensive method.

Taranis

Taranis is a ray-traced radiative transfer code which acts on SPH fields.

All of the calculations are performed on the GPU.

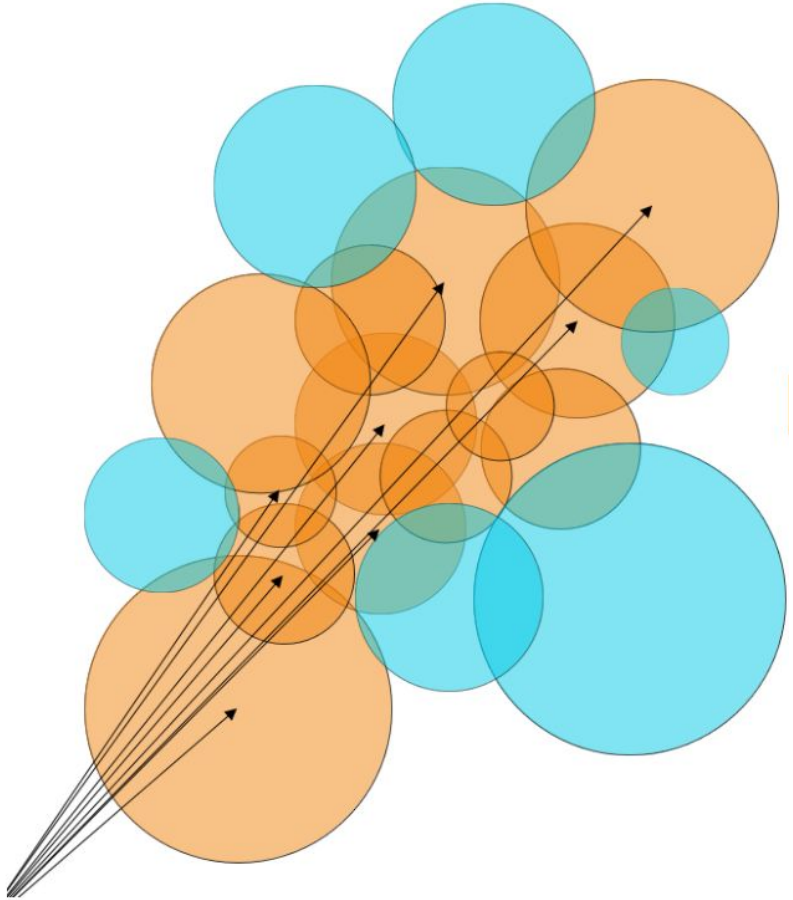
Ray tracing is handled by GRACE (Thomson, 2018).

Can be coupled to any SPH code.

We are currently working on coupling Taranis to GIZMO.

Taranis

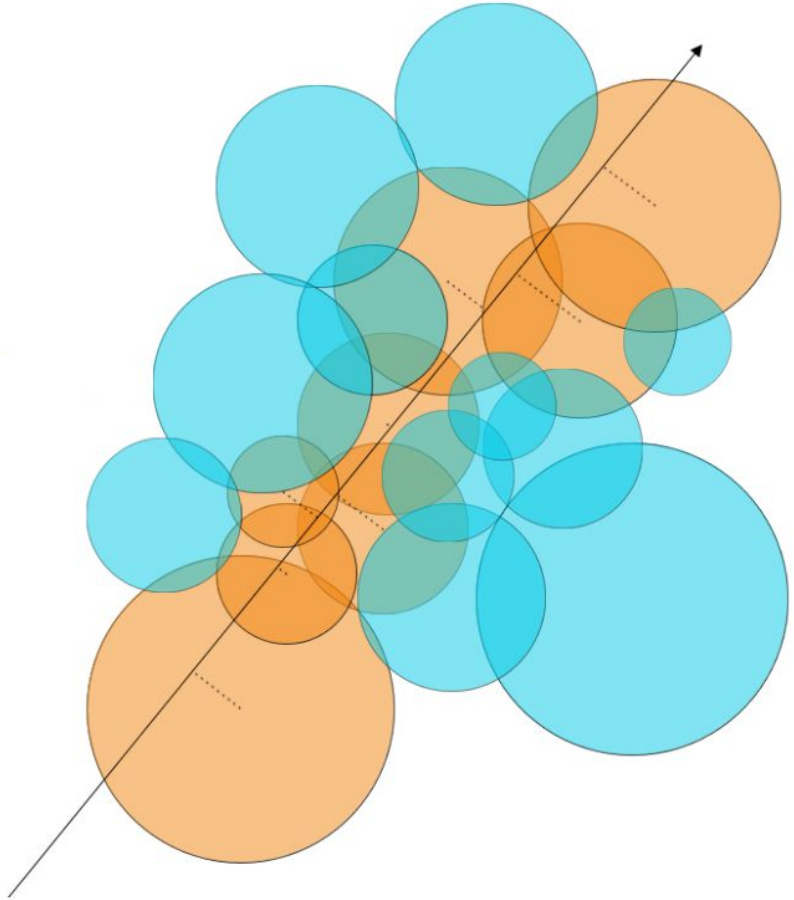
Naively we need ~$N_{Particle}$ rays per source.



Taranis

Naively we need ~$N_{Particle}$ rays per source.

If all points of intersection affect their corresponding particles the number of rays can be reduced to $N^{2/3}$. (Abel et al. 1999)

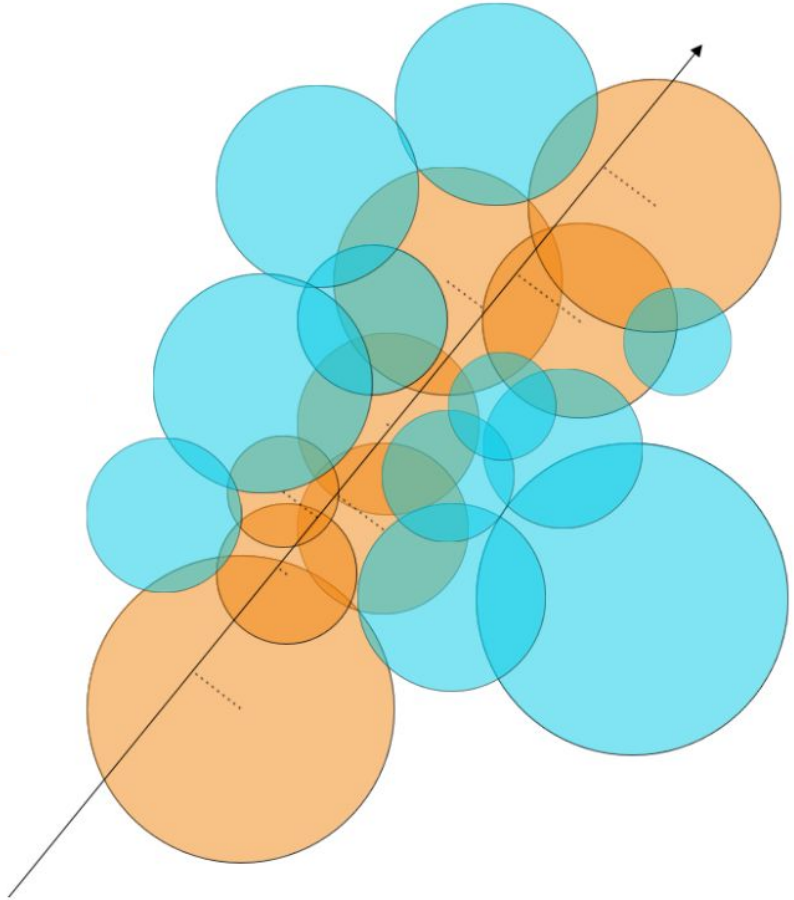


Taranis

Naively we need ~$N_{Particle}$ rays per source.

If all points of intersection affect their corresponding particles the number of rays can be reduced to $N^{2/3}$.

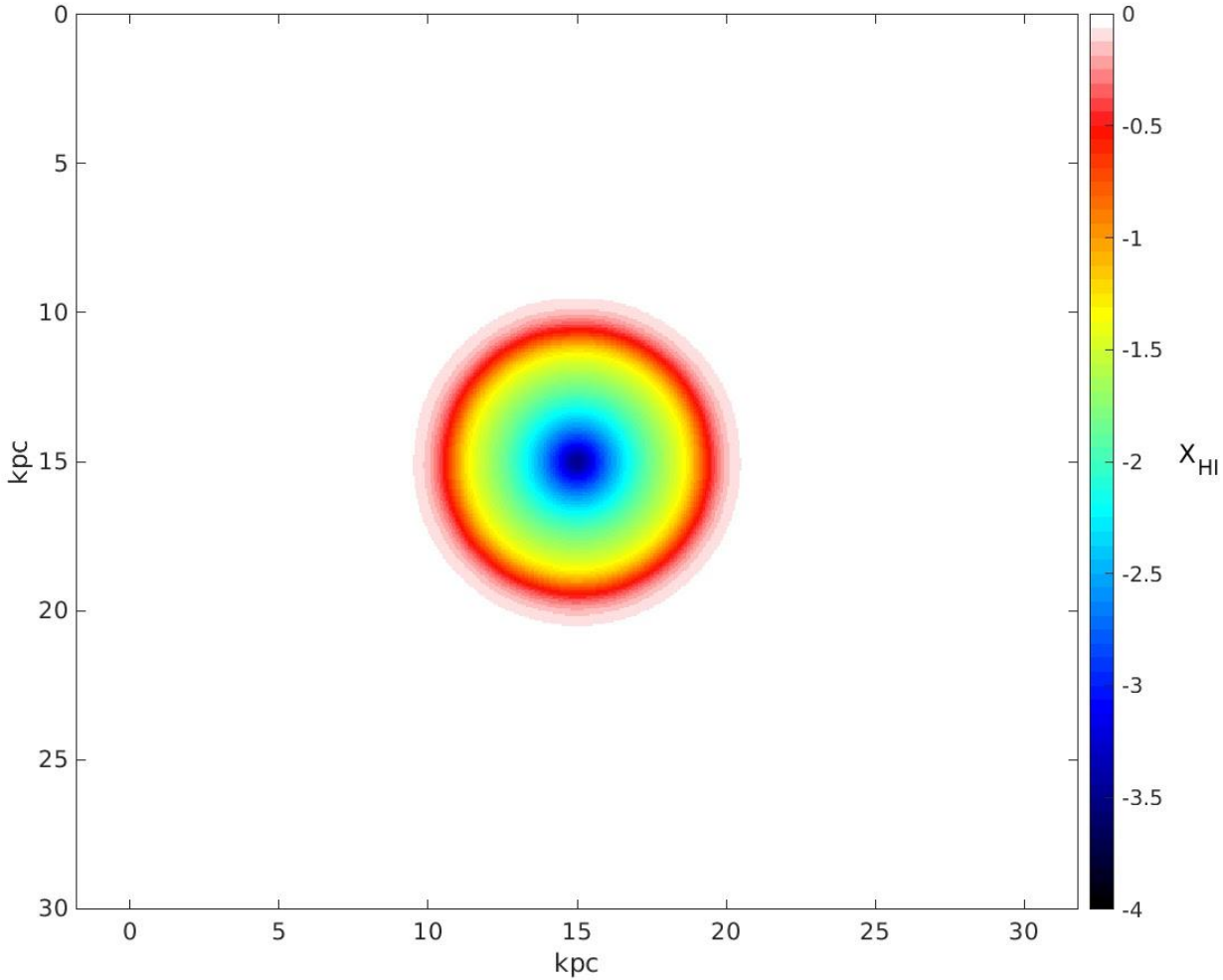
Create a set of uniformly distributed rays and rotate them by a random angle every timestep to fully sample the whole box.



Results

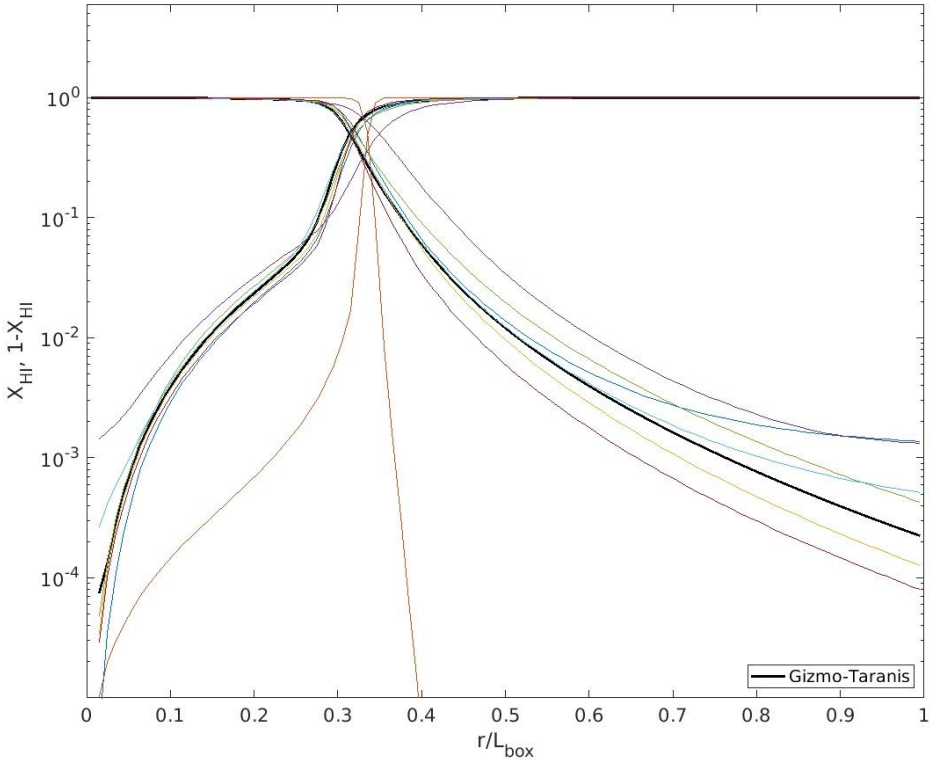
Radiative Transfer Comparison Project attempts to set a series of standardised test cases which can be used to compare RT codes.

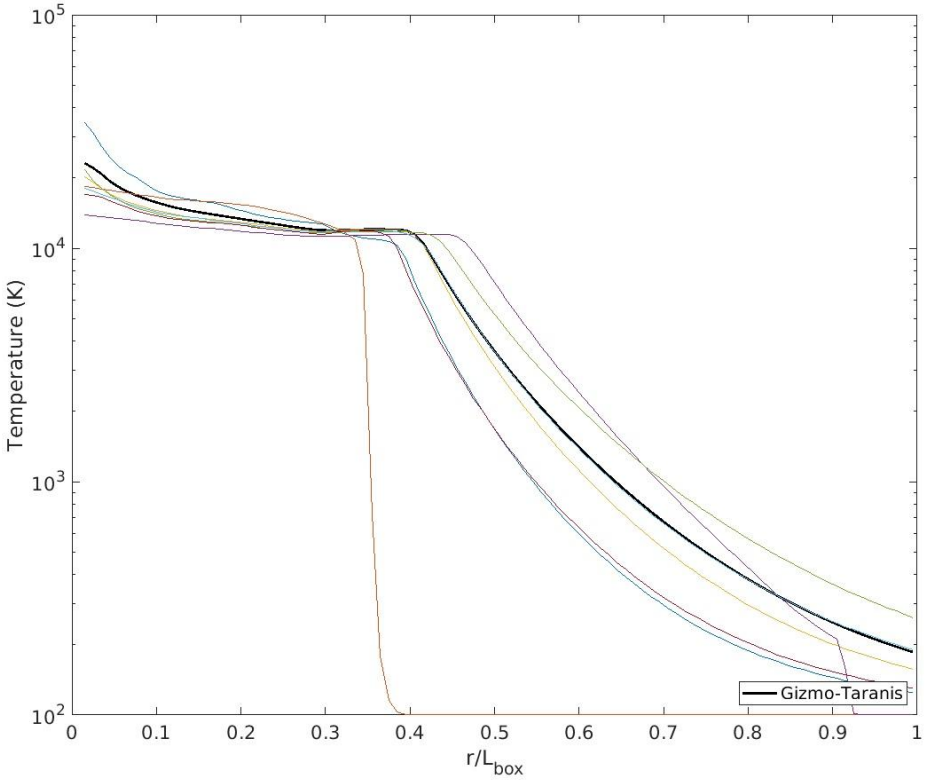
Test 5: Dynamical expansion of an HII region into a constant density medium.



Results

Radial profiles of the HI fraction and temperature at 100Ma compared to RTCP codes





Summary

Taranis is a GPU-accelerated cosmological radiative transfer code.

It can be used to perform fully coupled 3D radiation hydrodynamics simulations.

Preliminary results show good agreement with other radiative transfer codes.

Will be used to study a range of topics including the impact of helium reionisation on the structure of the IGM.

GPUs are an amazing resource that should be used more widely.