

Grid Technology and Cosmological Simulations

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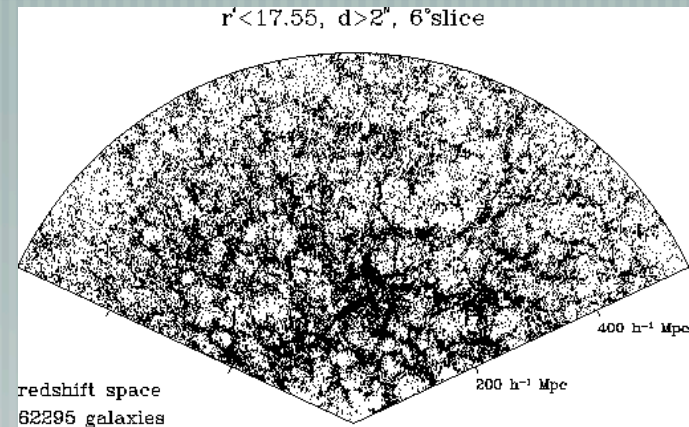
**Observatoire Astronomique de Strasbourg
Université Louis Pasteur
Horizon Project**

Understanding Galaxy Formation

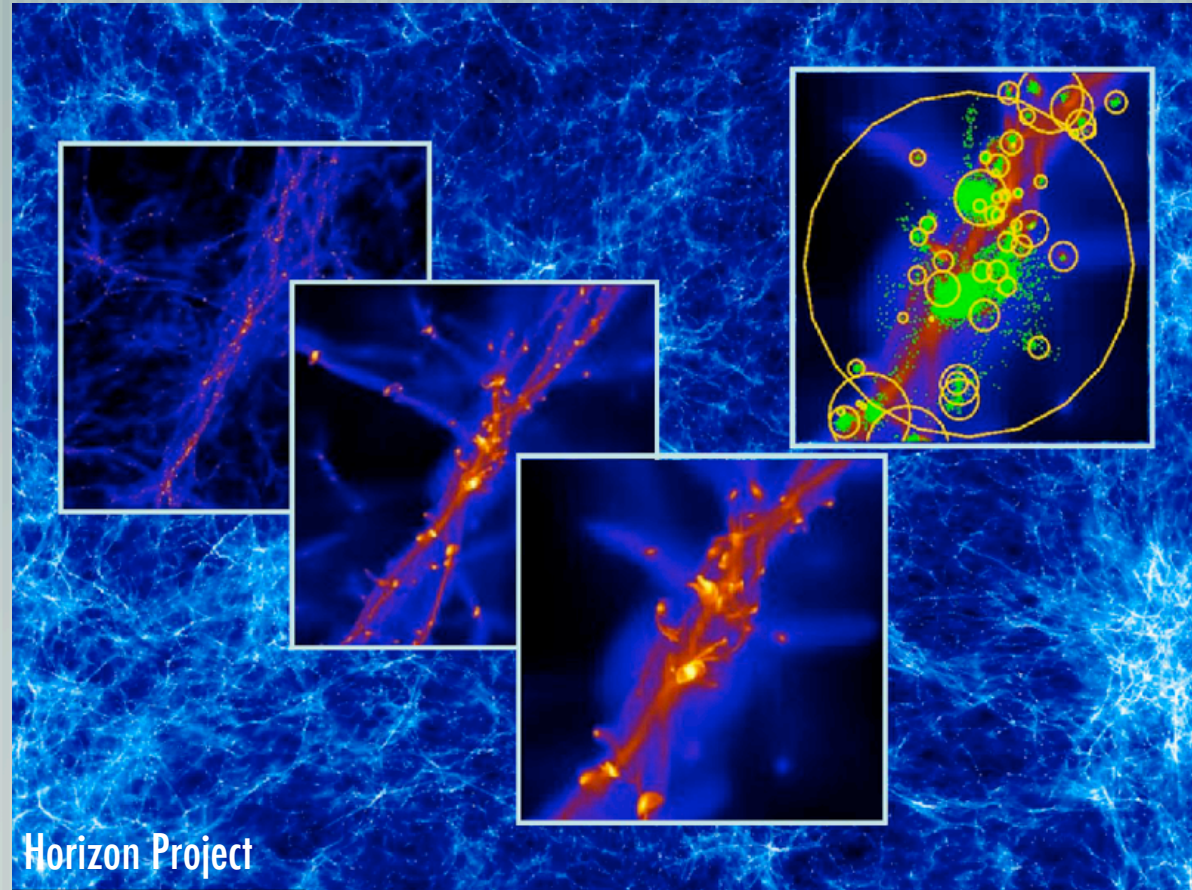
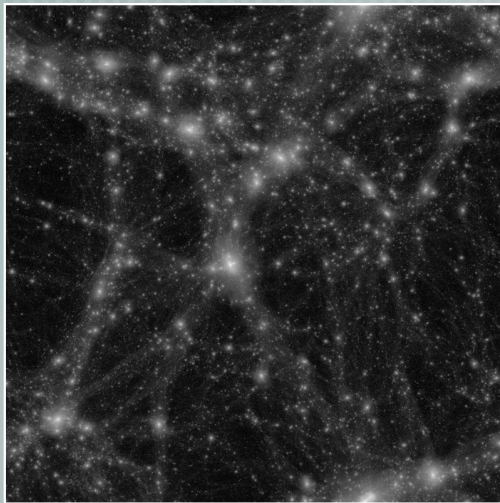
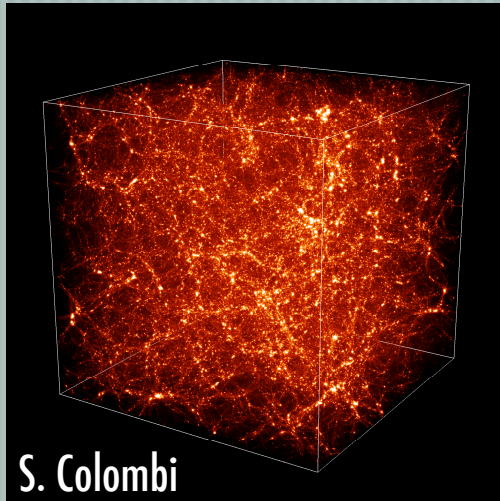
Galaxies are the hosts of numerous astrophysical phenomena (star formation, metal enrichment, winds, magnetic fields, dynamics, etc...) and tracks the formation of large scale structures.

Problems: a large range of scales and physics are convoluted and galaxies are difficult to understand (theoretically) with simple models

➔ Numerical Simulations



Cosmological Simulations

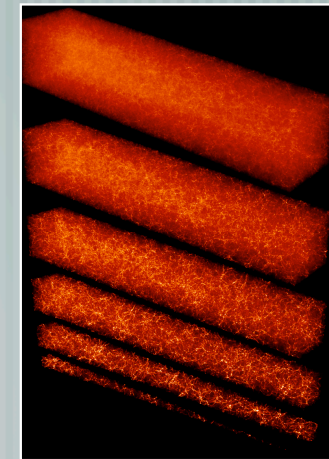
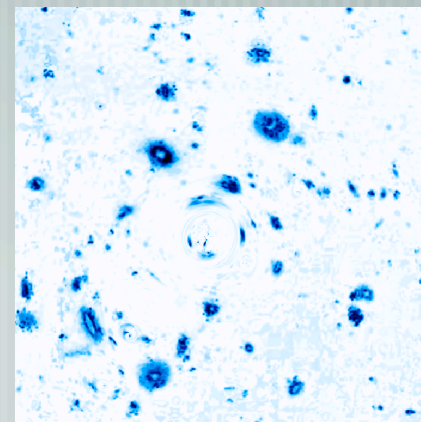
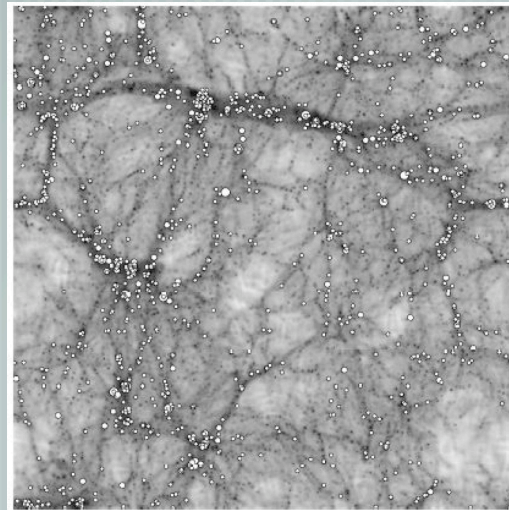
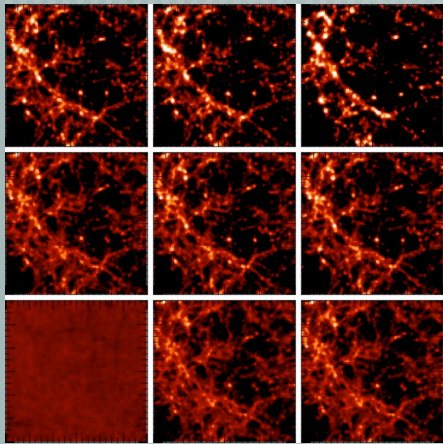


Exemples of data produced by simulations

- [Snaphots: evolution of matter distribution in simulated universes
- [Catalogs: galaxies (i.e. discrete objects) properties
- [Observables: skymaps at different wavelengths, lightcones, lensing, instrument simulations



Post-processing



Technology and Sociology

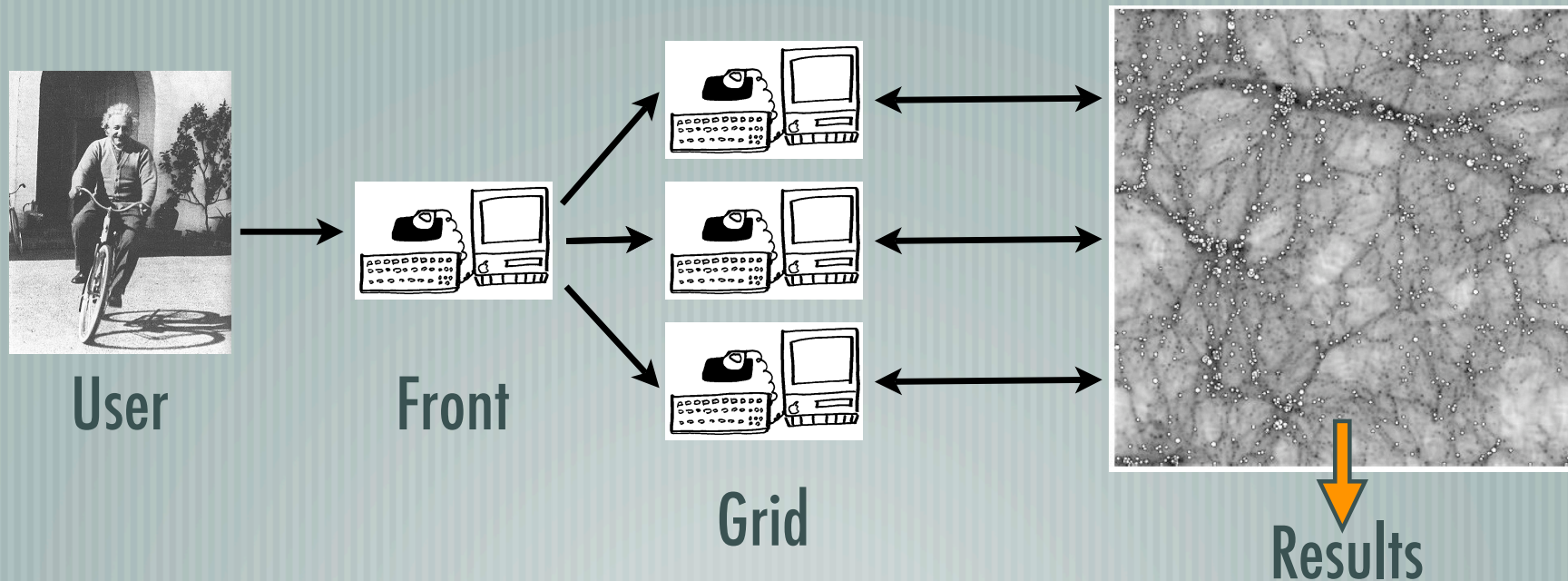
- [State-of-the-Art cosmological simulations requires important numerical resources with high-level communication abilities.
 - [Ex : Horizon Simulation : 2048 processors @ BSC, 1 Tb Memory, 10 Tb of data produced, selected in DEISA Extreme computing Initiative in 2005.
 - [“Universe” produced by supercomputers must be analysed : post-processing is as important (maybe more) than producing the simulation.
 - [Until recently, only experts were concerned
- BUT**
- [The public is now larger : observers, instruments designers, non-experts theoreticians. State of the art simulations are not necessary.
 - [Several simulation codes are public, automatized post-processing tools, more experience

Grid Technology

- [Not necessarily suited for big simulations : intensive I/Os, and high rate of communication between nodes.
- [Post-processing of existing simulations (like 'normal' VO).
- [On-the-fly small simulations and post-processing.

Existing simulations and post-processing

Assuming the state-of-the-art simulation exists and has already been post-processed at a basic level



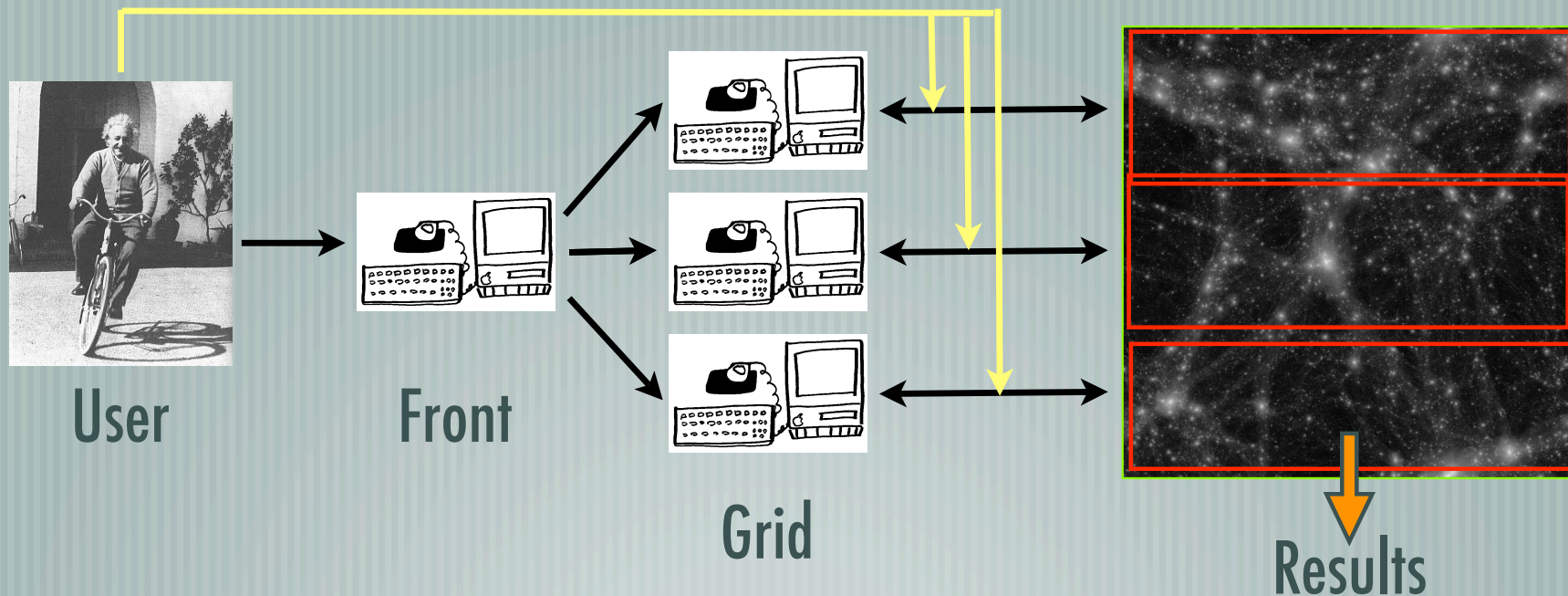
Catalogs exist and the Grid organizes the Tasks and the requests on these catalogs

E.g: catalogs of mass evolution for galaxies with a given luminosity today.

Similar to regular VO.

Existing simulations and post-processing II

Assuming the state-of-the-art simulation exists and requires non-standard post-processing



Grid deals directly with the snapshots

Eventually, non-standard post-processing can be provided by the user

BUT: simulations are large (e.g. 500 Gb per snapshot).

May require subdivision by using the Grid ? => Limits the relevance of the simulation

On-the-fly Simulations

— [The interest of non-experts is growing.

AND

— [Only post-processed results are required, with simple physics

— [Existing simulations may not be adequate (e.g. cosmological parameters).

— [For local effects, a bunch of small, easy to produce, simulations are equivalent to large simulations. Statistics and parameters exploration.

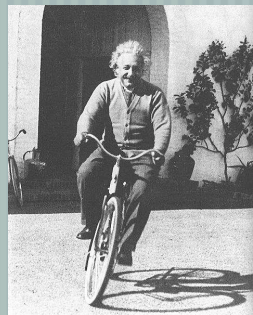
— [Searching for special configurations.

— [Automated parallelisation tasks.

— [Requires some numerical experience, experts may not be available, etc...

On-the-fly Simulations

Simulations are produced,
analysed... and trashed away

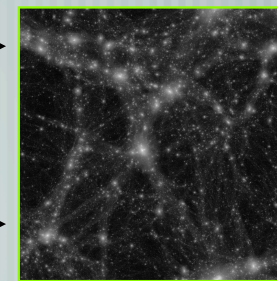
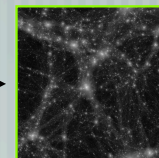
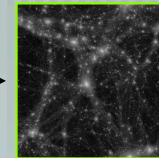
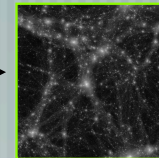


User



Front

Grid



→ analysis

→ analysis

→ analysis

→ analysis

A simulation can be produced in a
few hours on a single Desktop PC

Conclusions

- [Democratisation of Cosmological simulations
- [Like 'regular' VO, Grid can be used to post-process existing data
- [Grid technology can also be used to produce data
- [Particularly suited for cosmological simulations because few parameters are involved.