Virtual Observatory & HORIZON project

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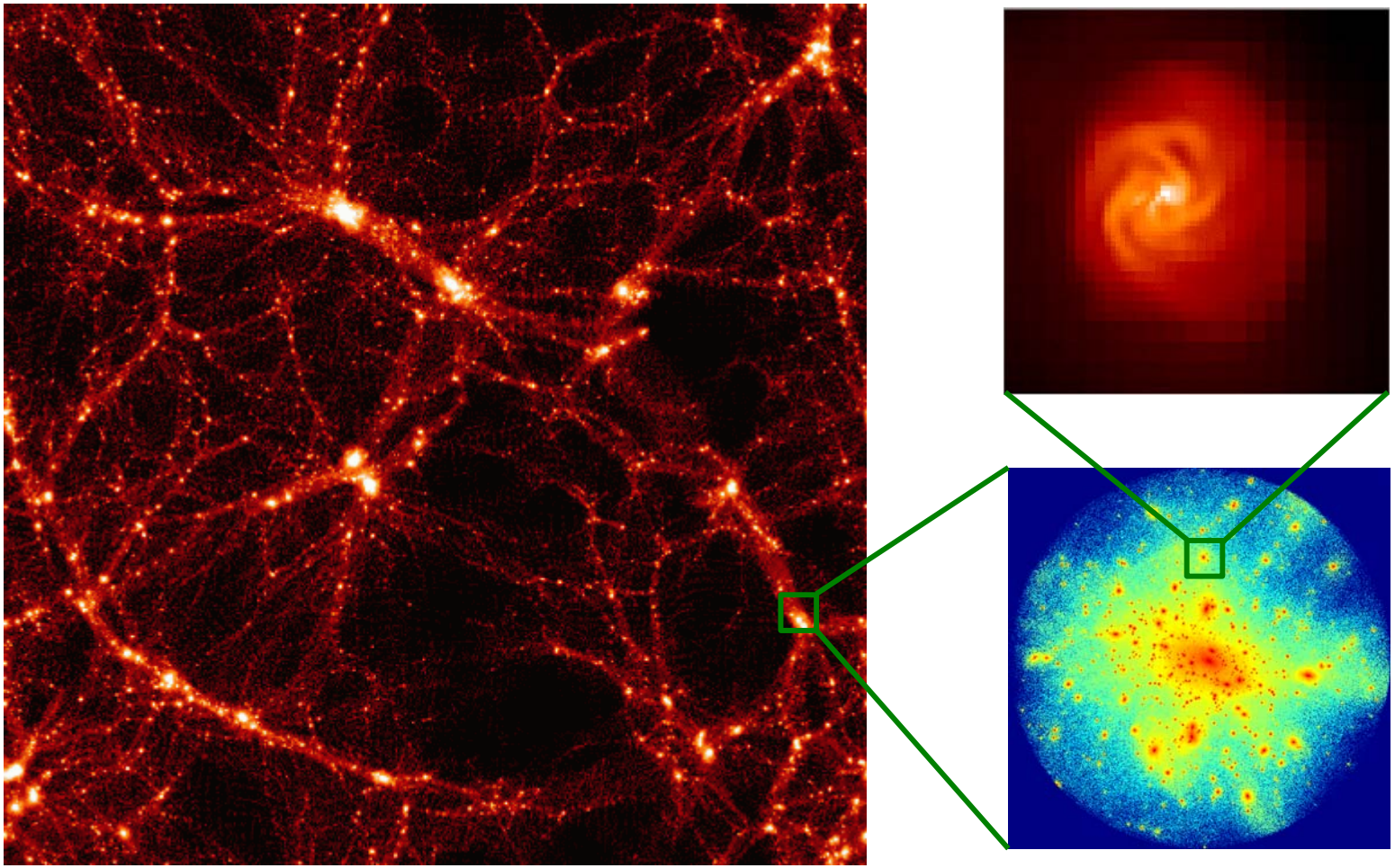
and HORIZON[2] consortium

[1] CRAL

[2] CEA/SAp, CRAL, IAP, LERMA, LUTH

Centre de Recherche Astronomique de Lyon

Horizon project: computational astrophysics on massively parallel systems to understand formation and evolution of structure and galaxies in the universe



HORIZON project: high-level objectives up to 4 years

- **Computational modelling of cosmological structures formation. Prediction of observational signatures as a function of various physical scenarios.**
- **Promote state-of-the-art expertise in parallel programming and applied mathematics in computational cosmology.**
- **Put together several experts in the field to share knowledge and software, and optimize use of supercomputer centres.**
- **Provide to the scientific community an easy access to top quality simulations data, as well as educational and public outreach.**

HORIZON project: organization

- PI: **Romain TEYSSIER** (CEA, Saclay)
  - co-PI: **Jean-Michel ALIMI** (LUTH, Observatoire de Meudon)
  - co-PI: **Stéphane COLOMBI** (IAP, Paris)
  - co-PI: **Francoise COMBES** (LERMA, Observatoire de Paris)
  - co-PI: **Bruno GUIDERDONI** (CRAL, Lyon)
- **6 geographical nodes**

– SAp	R. Teyssier	Saclay
– IAP	S. Colombi	Paris
– Obs Paris	F. Combes	Paris
– Obs Paris	J.-M. Alimi	Meudon
– CRAL	B. Guiderdoni	Lyon
– LAM	L. Athanassoula	Marseille

- **Horizon scientists** are responsible of a work package (MoU) and have full access to the hardware and software infrastructure of Projet Horizon: **30 scientists**
- **Executive committee** validates day-to-day operations (5 co-Is among Horizon scientists)
- **Scientific committee** issues recommendations and scientific objectives to the project.

HORIZON project: main workpackages

- The HORIZON Project is organized in 4 large thematic actions
- Inside each theme, well identified task packages can be found, and for each task :
  - a task manager
  - a calendar
  - deliverable products.
- The 4 thematic actions are:
  - Mathematics applied to galaxy formation
  - Parallel programming and distributed computation
  - Virtual observations and data bases
  - Physical processes and initial conditions

HORIZON project: simulations

- 3 cosmological simulations (DM+hydro, RAMSES code, 1024^3 particles/cells):
  - 500 h^{-1} Mpc: grand structures, clusters
    - Will run on Mare Nostrum (as project of DEISA Extreme Computing Initiative (DECI))
  - 100 h^{-1} Mpc: focused on galaxy formation (to be compared to GalICS semi-analytical modelling)
  - 20 h^{-1} Mpc: re-ionization, primeval Universe
- Other kind of simulations
  - 'open-box' chemodynamical simulations of isolated galaxies (Wozniak et al.)
  - Interacting galaxies (Combes et al.)
  - Cluster of galaxies (Sauvageot et al.)
  - Etc.

HORIZON project: computer infrastructure

- “Extreme Computing Initiative” at European level (DEISA)
- 10^6 CPU hours per year on national supercomputer centers (IDRIS, CINES, CCRT)
- Shared resources on HPC1 (funded by INSU and CEA)
- **Mini-grid** : 1 quad AMD on each node (funded by IN2P3 and INSU “astroparticles”)
- 3D visualization servers (funded by Universities)
- 1 bi-opteron dual core at Lyon to provide access to data and services

Computer infrastructure

Supercomputer centers

HPC1

Post-processing on large data sets

Jobs submission

Visualization, Post-processing on Small data sets

Mini-grid Horizon

Paris **Meudon** **Saclay** **Lyon** **Marseille**

Partnership with HPC1

- ✔Hardware and Software support on working days
- ✔3 “master nodes” 64 Go each available full time
- ✔200 000 CPU hours for 3 years in 2 possible configurations
  - ✔Compact: 5 additional nodes for 95% of the time OR
  - ✔Distributed: 50 additional nodes for 5% of the time
  - ✔Annual planning with HPC1 team
- ✔5 To storage
- ✔Integration within Horizon Mini-grid (VPN, SSH) with RENATER + 100 Mbits

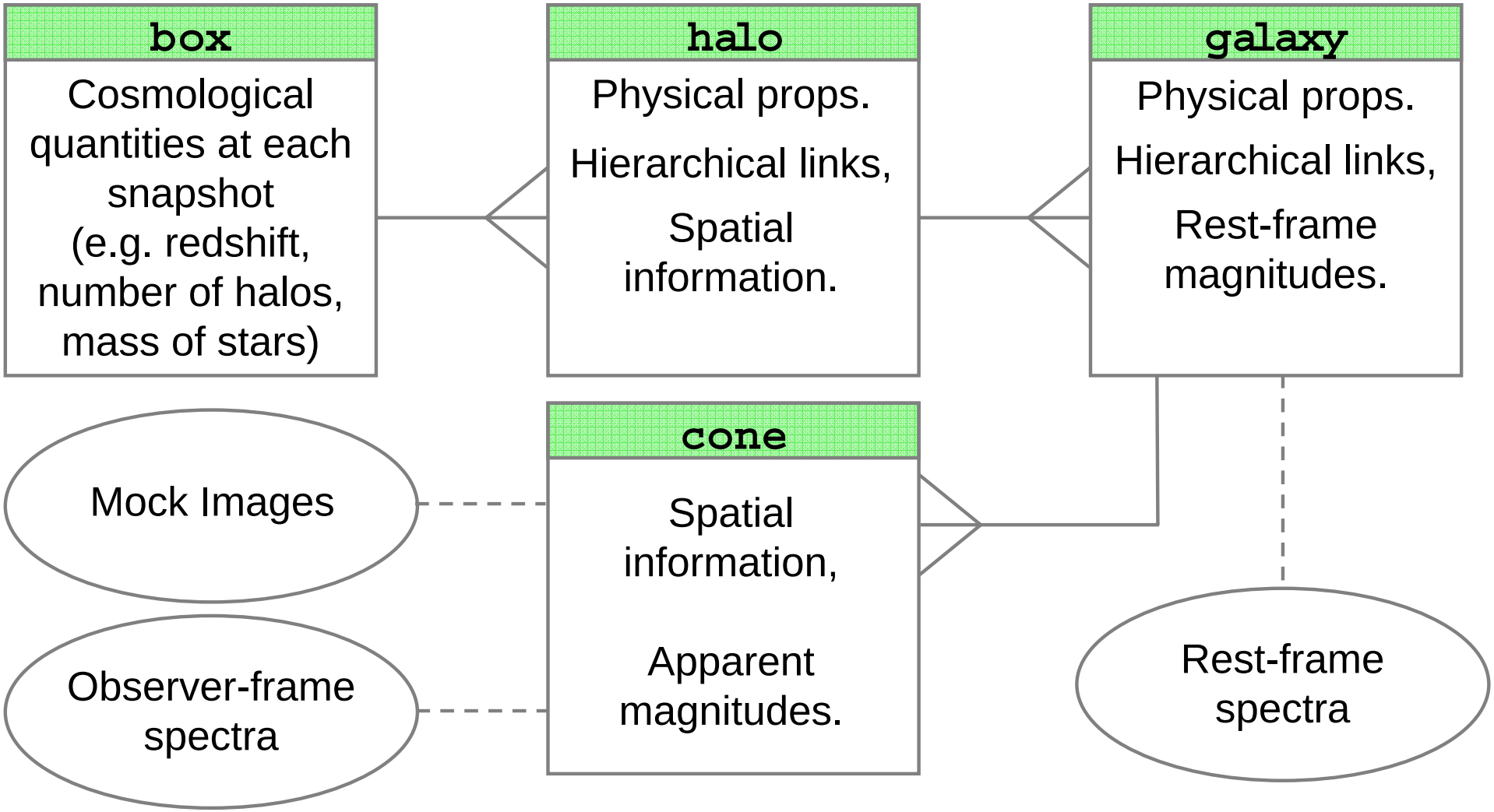
HORIZON project: databases and VO

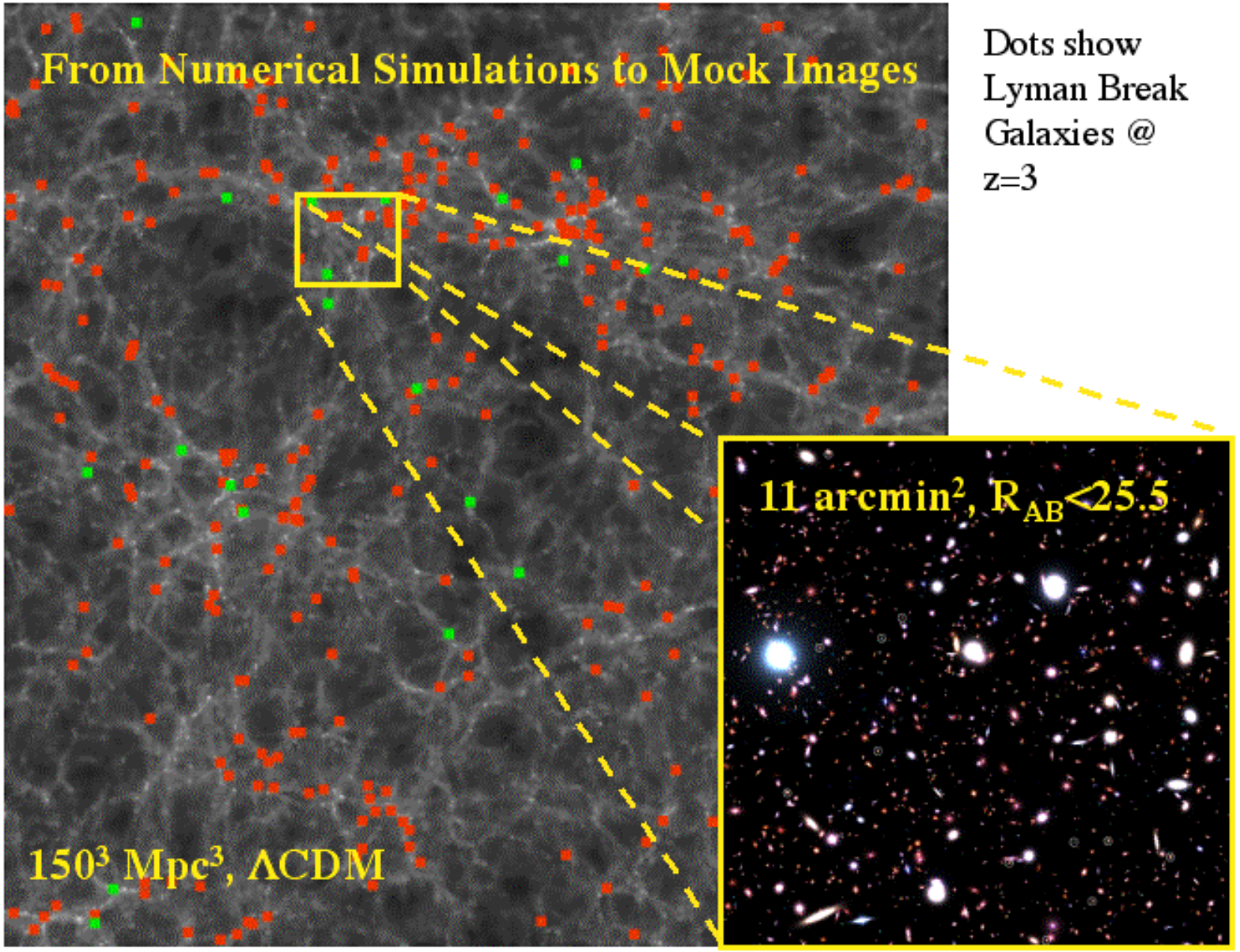
- Will use GalICS as a prototype (Guiderdoni et al.)
- http://galics.cosmologie.fr/ or http://vo.iucaa.ernet.in/galics/
- The GalICS/MoMaF Database of Galaxies includes information on:
  - the physical properties of galaxies,
  - their location in dark matter structures,
  - the merging history trees that link their progenitors and descendants,
  - the rest-frame spectral energy distributions in the ultraviolet, optical, infrared and submillimeter wavelength ranges;
  - and the absolute and apparent magnitudes in many photometric bands ranging from the ultraviolet to the submillimetre.

Relational database

(http://galics.iap.fr/)

-> data structure




From Numerical Simulations to Mock Images
Dots show
Lyman Break
Galaxies @
z=3
11 arcmin², R_{AB}<25.5
150^3 Mpc^3, ΛCDM

HORIZON project: databases and VO

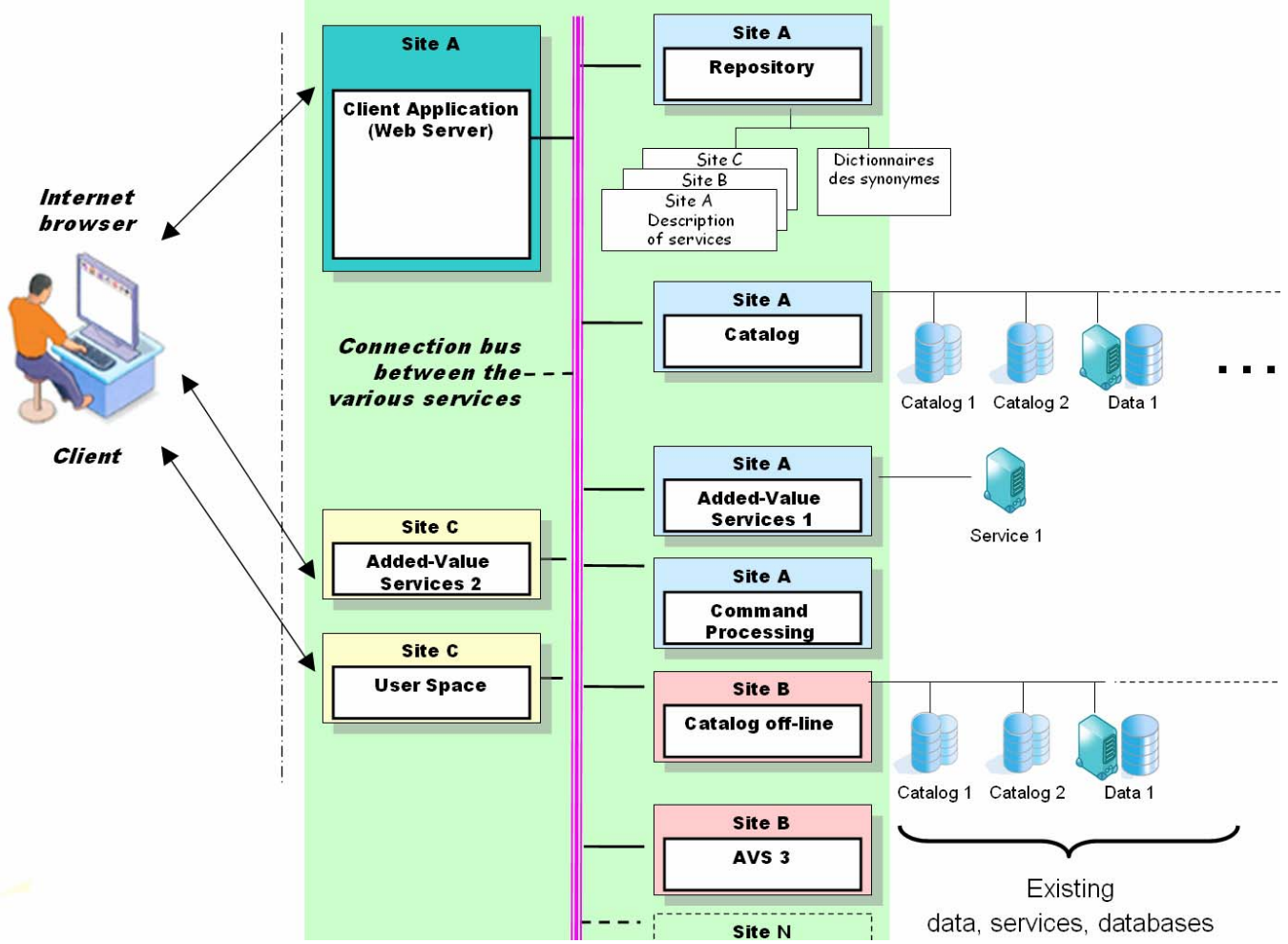
- Databases hosted by Nuclear Physics Computing Centre in Lyon (CC IN2P3)
- Databases install in progress
- Future WEB services: **horizon-VO.univ-lyon1.fr** (not yet opened)
- VO framework: **SITOOLS** developed by CNES (French Space Agency) and Cap Gemini.
  - open-source interface to provide access to data and services
  - Already used in Space Labs: DB COROT, CASSINI, VVDS (IAS, CESR and LAM)

SITools is based on a concept of services:
- interconnected by a virtual Web Services bus,
- offering a global service which includes
  - basic services
  - added-value services (AVS),
- accessed by one or more client applications.

The system may run locally, on a single machine, or be distributed over several machines or even several laboratories.

SITools defines 5 types of basic service which can be "plugged in" to the SITools virtual bus :
On-line catalog : provides access to metadata and data accessible on-line.
Off-line catalog : identical to the On-Line Catalog Service with batch access to data.
Repository : links all accessible services to form a global system;
Command Processing : end-to-end management of user commands,
User Space : manages the command and processing result space, where the user will find command results.

A SITools instance has one repository, one user space, one command processing, and may has many catalogs.



SITools & Virtual Observatory

As SITools design was done in VO logical concepts (from the interoperability point of view), it's not a big challenge to integrate VO capabilities.

All the services are Web-services, catalogs are linked through synonyms, which could be UCDs, SITools has also the capability to use an added value service to handle VO protocol queries (SIAP, SSAP, VOQL, …) and to transform results in VOtable format.

A study is undergoing for, initially, developing an AVS which can reply to a SIAP request.

HORIZON project: science cases for Horizon-VO

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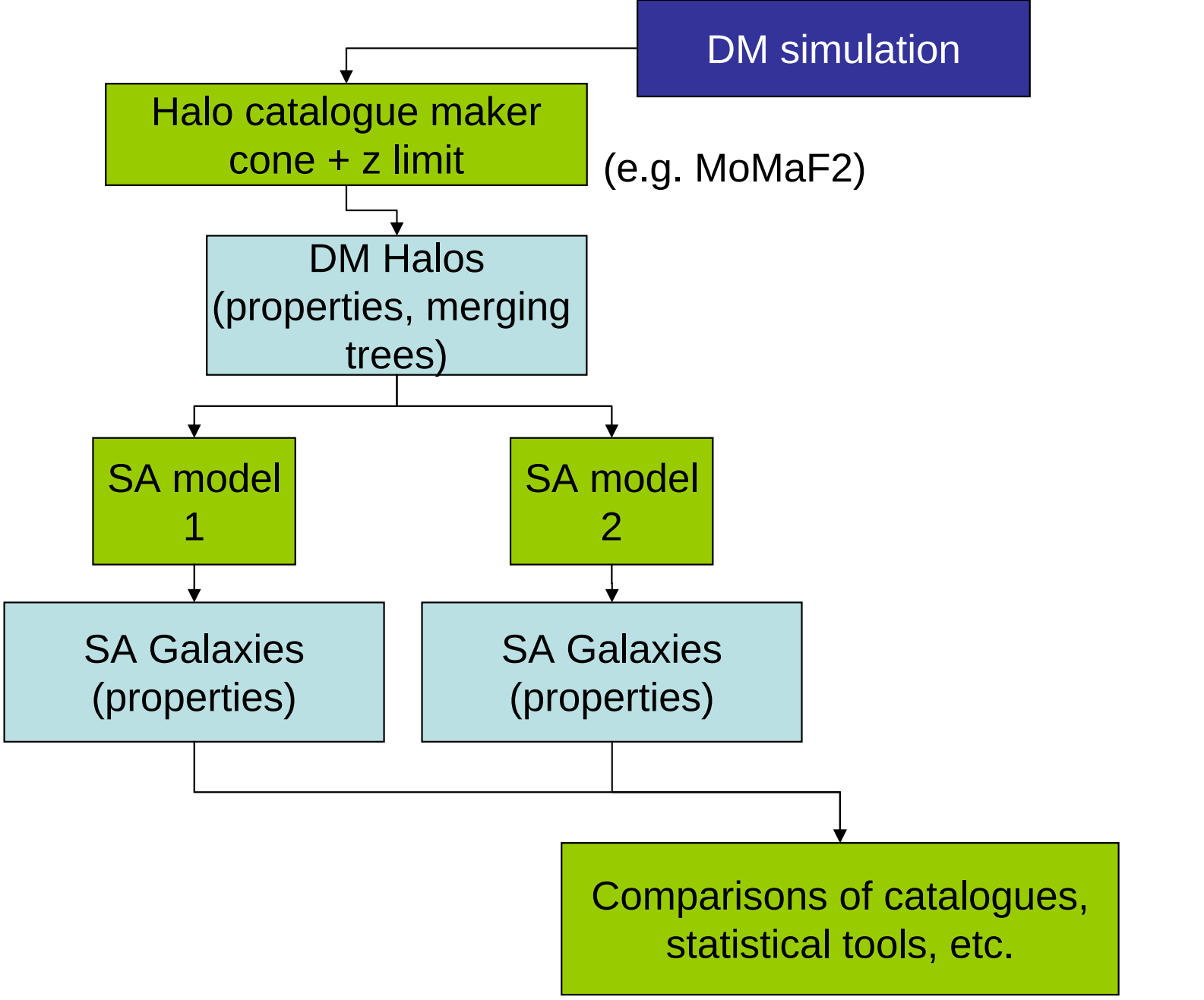
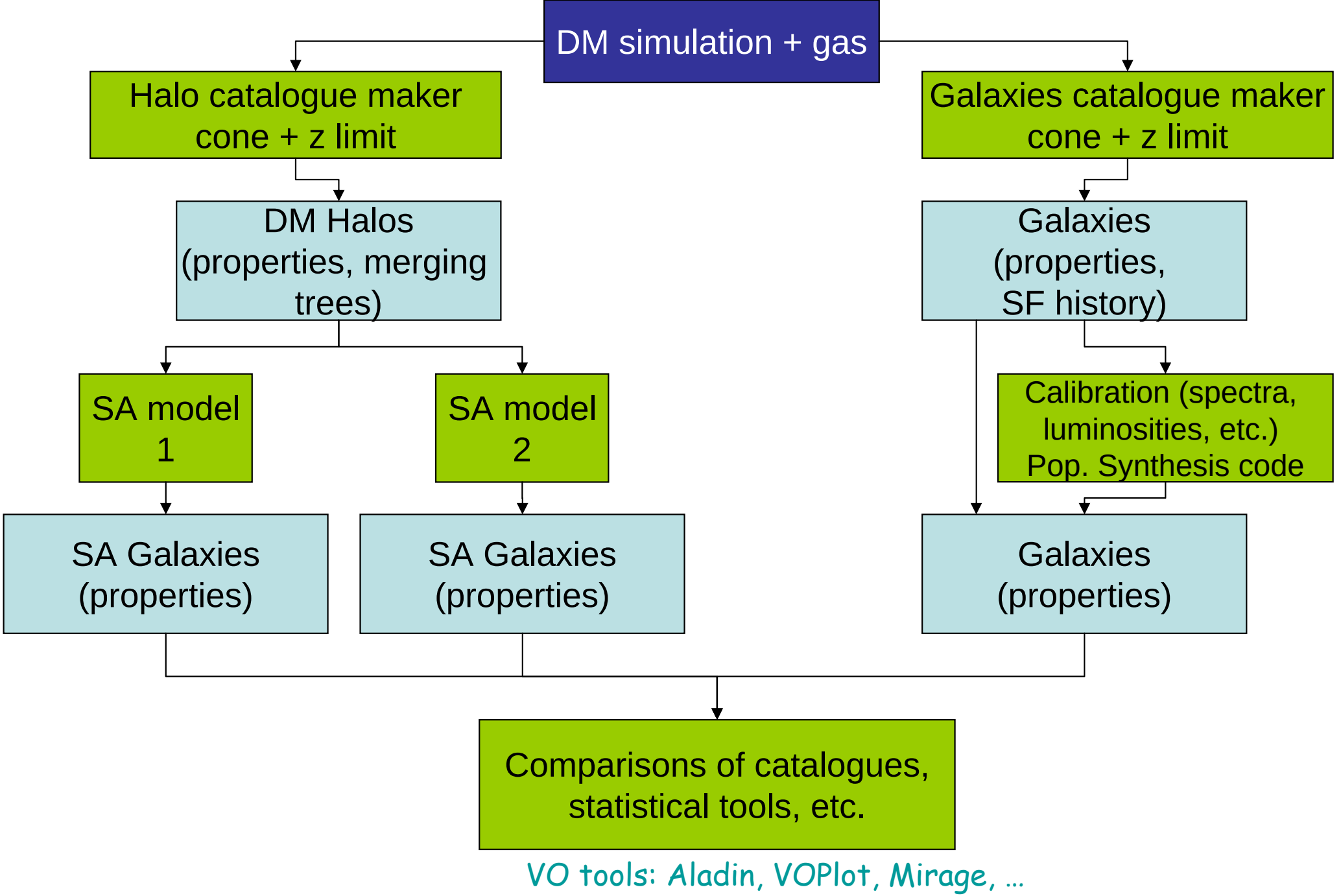


VO tools: Aladin, VOPlot, Mirage, …


DM simulation + gas
Halo catalogue maker
cone + z limit
Galaxies catalogue maker
cone + z limit
DM Halos
(properties, merging
trees)
Galaxies
(properties,
SF history)
SA model
1
SA model
2
Calibration (spectra,
luminosities, etc.)
Pop. Synthesis code
SA Galaxies
(properties)
SA Galaxies
(properties)
Galaxies
(properties)
Comparisons of catalogues,
statistical tools, etc.
VO tools: Aladin, VOPlot, Mirage, …

DM simulation + gaz

Halo catalogue maker
cone + z limit

Catalogue Particles maker
cone + z limit

DM Halos
(properties, merging trees)

Particles
(properties,
SF history)

SA model 1

SA model 2

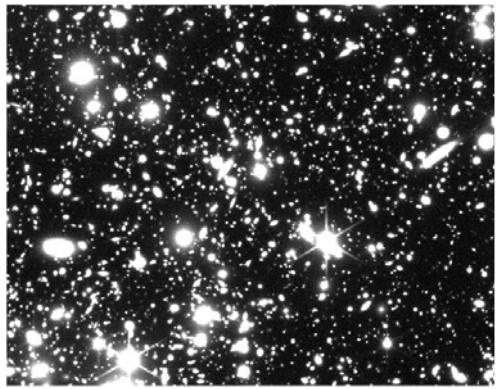
Calibration (spectra, luminosities, etc.)
Spectral synthesis code

SA Galaxies
(properties)

SA Galaxies
(properties)

(Wild)-field images

(Michel-Dansac & Wozniak 2004)



SkyMaker
(instrument/telescope)

Comparisons of images,
Statistical tools, etc.

VO tools: Aladin, VOplot, Mirage, VOSpec,
WESIX (SExtractor), GALMORPH (GIM2D), etc.

Produits et codes HORIZON..