Astrophysical Technology Group - OAT

Virtual Observatory: Observational and Theoretical data

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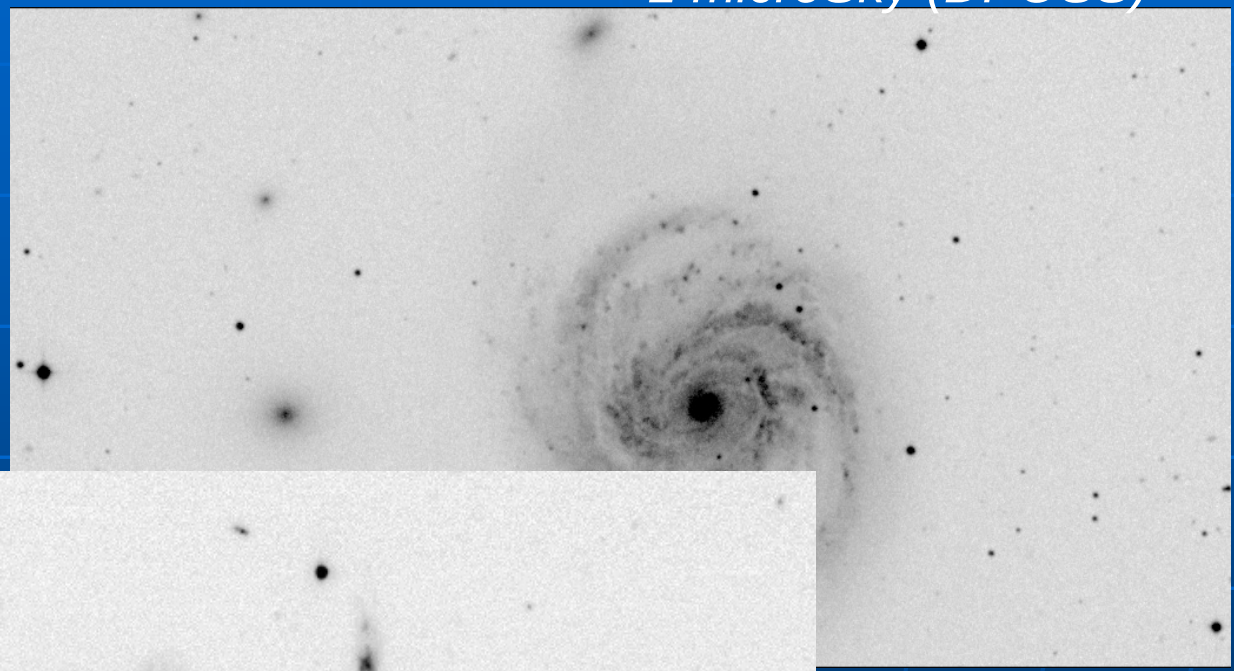
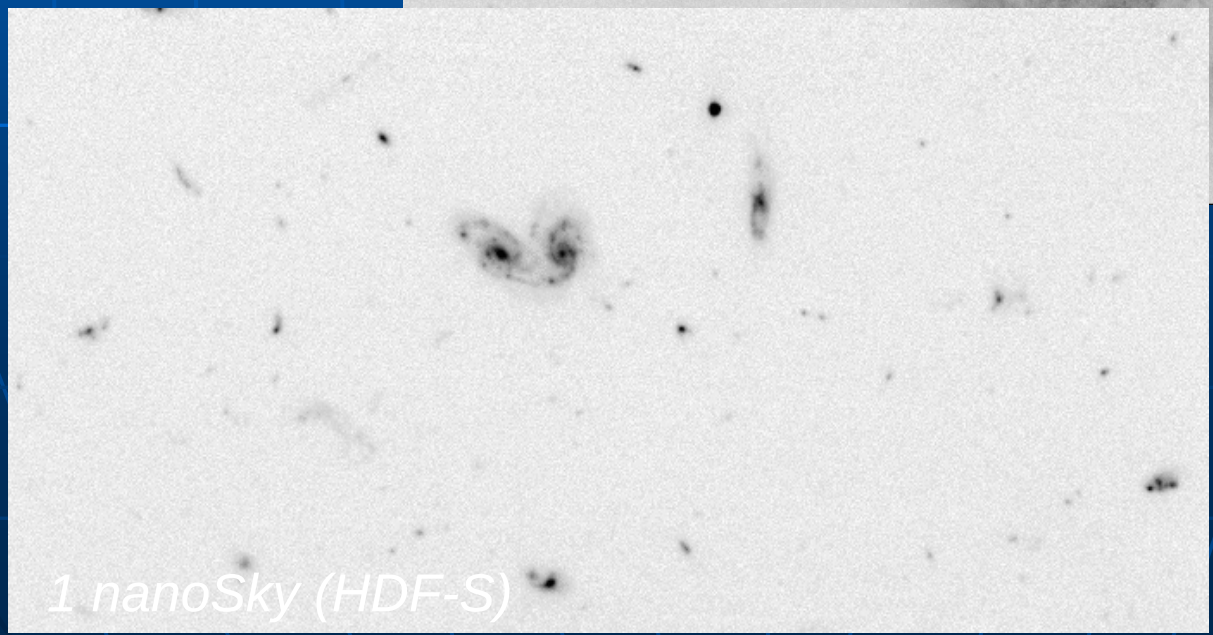
Astronomy is facing a data avalanche

Multi-Terabyte (soon: multi-Petabyte) sky surveys and archives over a broad range of wavelengths

1 microSky (DPOSS)





1 nanoSky (HDF-S)

Billions of sources, hundreds of attributes per source

The changing face of observational astronomy

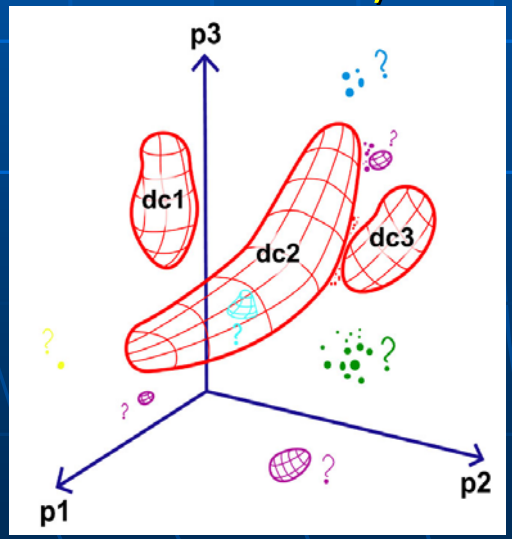
- Large digital sky surveys are becoming dominant source of data in astronomy: > 100 TB, growing rapidly:
  - SDSS, 2MASS, DPOSS, GSC, FIRST, NVSS, RASS, IRAS, QUEST, GALEX, SST; CMBR experiments; Microlensing experiments; NEAT, LONEOS, and other searches for Solar system objects;
  - Digital libraries: ADS, astro-ph, NED, CDS, NSSDC;
  - Observatory archives: HST, CXO, space and ground-based;
  - Future: PanSTARRS, LSST, and other synoptic surveys; astrometric missions, detectors;
- Data sets orders of magnitude larger, more complex, more homogeneous than in the past;
- Roughly 1 TB/Sky/band/epoch
  - Human Genome is < 1 GB, Library of Congress ~ 20 TB

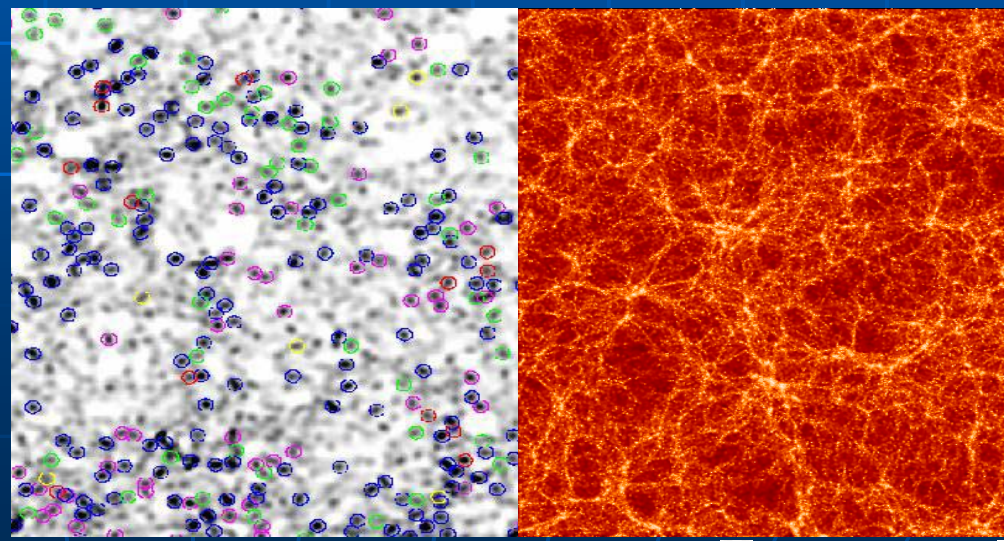
Toward a “new astronomy”

- Past: Observations of small, carefully selected samples (often with *a priori* prejudices) of objects in one or a few wavelength bands

Toward a “new astronomy”

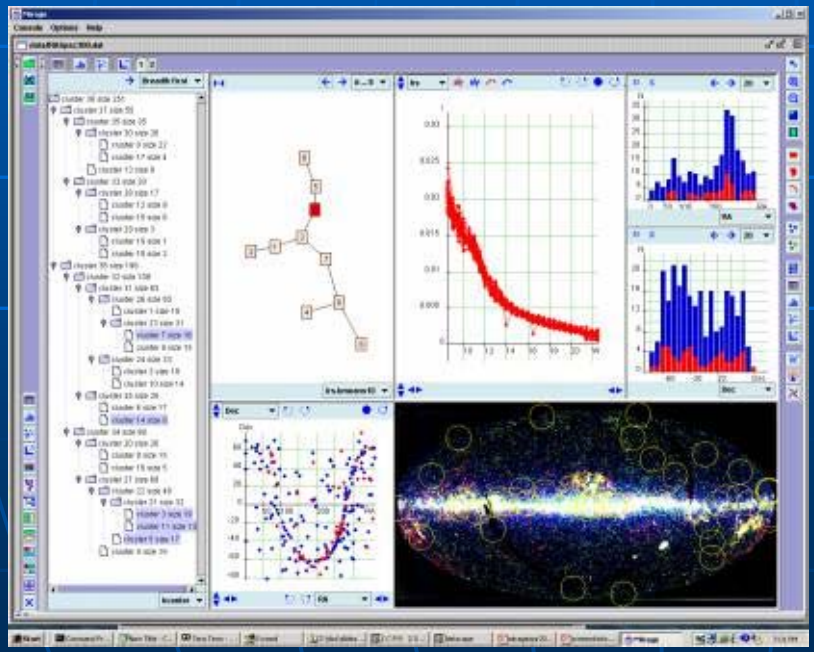
- Future: Multi-wavelength data for millions of objects, allowing us to:
  - Discover significant patterns from the analysis of statistically rich and unbiased image/catalog databases;
  - Understand complex astrophysical systems via confrontation between data and sophisticated numerical simulation;

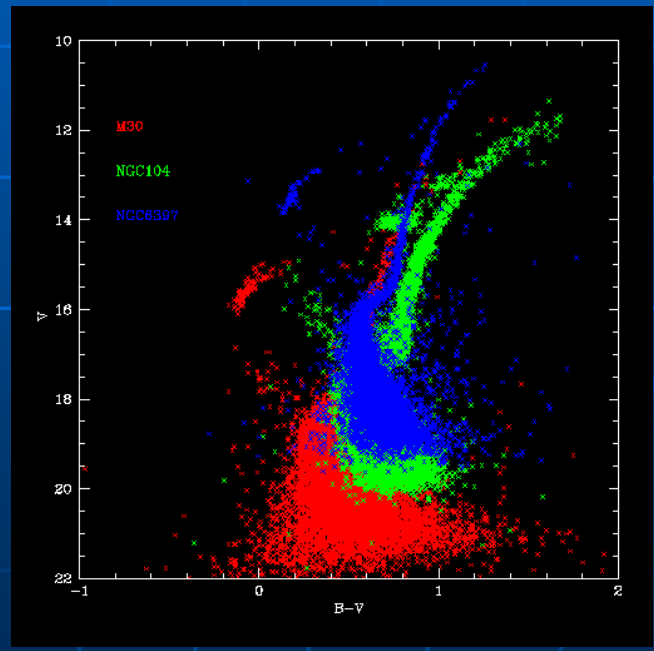




Toward a “new astronomy”

- Discovering new phenomena and patterns in these datasets will require simultaneous access to multi-wavelength archives, advanced visualization and statistical analysis tools





The Virtual Observatory is…

- A set of international standards to share complex data;
- A modular set of tools to work with distributed data;
- A simple environment to publish data to;
- An essential part of the research astronomer's toolkit;
- A catalyst for world-wide access to astronomical archives;
- A vehicle for education and public outreach;

R.J. Hanisch & P.J. Quinn, "International Virtual Observatory Alliance", http://www.ivoa.net/pub/info/

The Virtual Observatory is *NOT*...

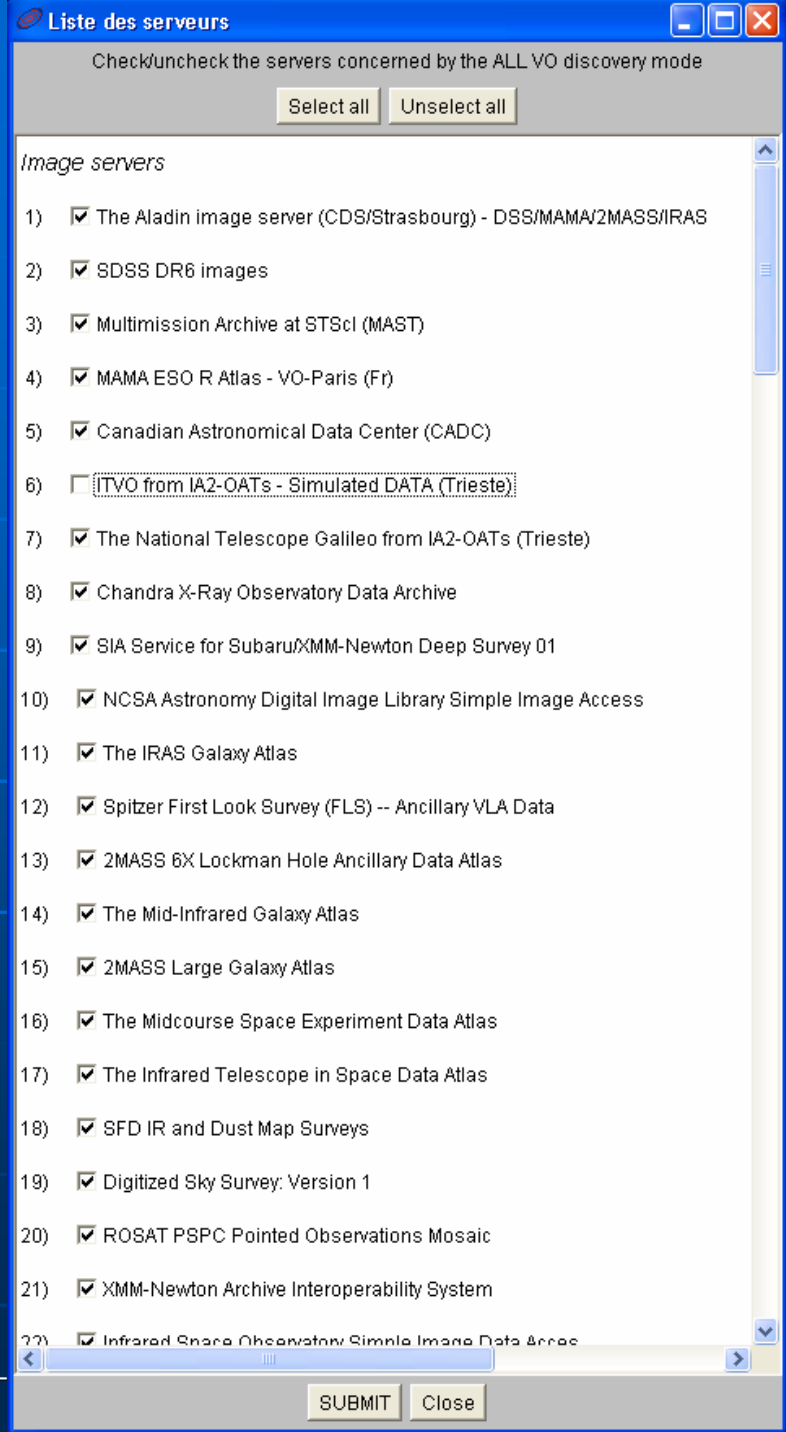
- A replacement for building new telescopes and instruments;
- A centralized repository for data;
- A data quality enforcement organization;

IVOA
(International Virtual Observatory Alliance)

Australia
Canada
China
EU
Germany
India
Italy
Japan
Korea
Russia
UK
USA

VO data

- I step: VO started dealing with observational data, see "All VO" in Aladin tool;
- II step: now in the VO there is some prototypes for theoretical data, see VOTech project:
  - cosmological simulation;
  - stellar Spectra simulation;
  - Tracks and isochrones simulation BaSTI;
- You can provide your collection of data into the VO;

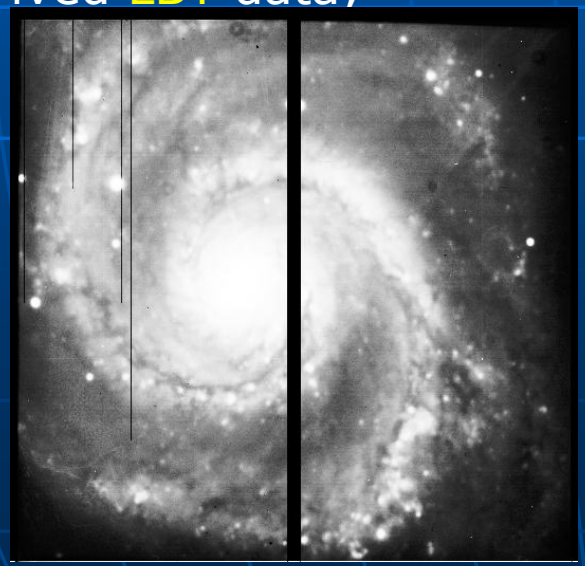


IA² - TNG / LBT

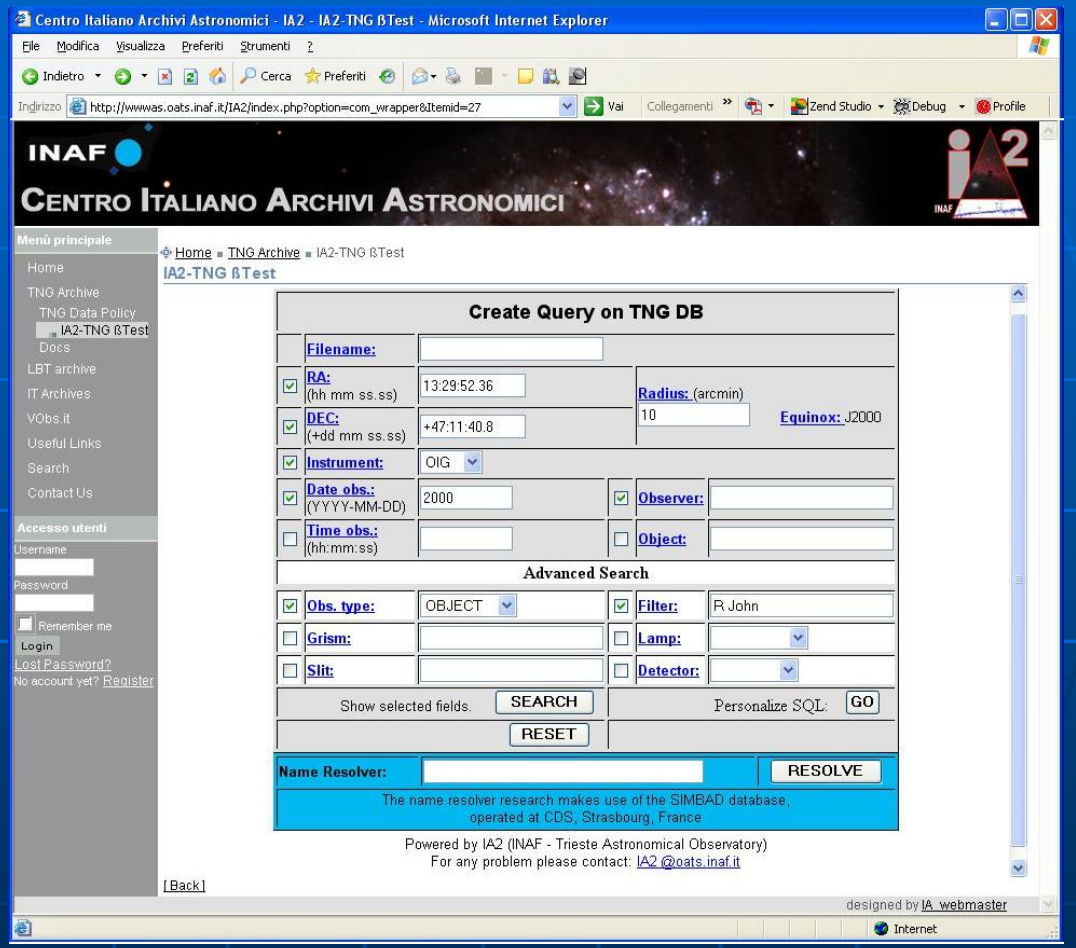
Italian Astronomical Archive center

http://wwwas.oats.inaf.it/IA2/

- TNG ~ 3500 CD / 270000 (~10 MB one) images of the TNG (Galileo National Telescope)
- LBT –SDT (Large Binocular Telescope-Science Demonstration Time) blu camera, red camera: 100000(~80 MB)images;
- will arrived LBT data;



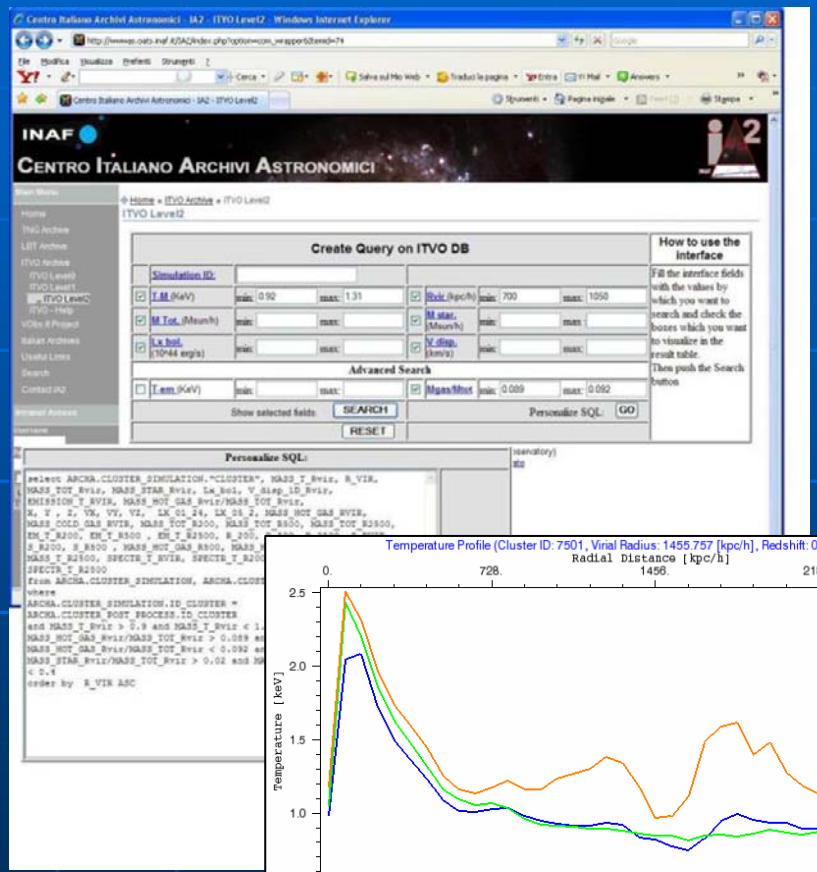
M51, TNG image



IA^2 – Theoretical VO

http://wwwas.oats.inaf.it/IA2/ITVO/ and http://itvo.oact.inaf.it/

- Gadget2 N-body+SPH, ~1.2 TByte, 40000 CPU hours on 64 processors of the IBM-SP4 machine, 102 snapshots;
- Enzo N-body+AMR;
- Fly N-body;
- Work in progress: a new web portal for the BaSTI stellar evolution simulation performed with FRANEC code.



Temperature Graphic of simulated galaxy clusters

GRID and HPC

Two infrastructures for running expensive CPUs calculations:

- GRID (http://wwwas.oats.inaf.it/grid/)
  a computational Grid is a hardware and software infrastructure that provides dependable, consistent, pervasive, and inexpensive access to high-end computational capabilities. (*Carl Kesselman, Ian Foster "The Grid: Blueprint for a New Computing Infrastructure" 1998*)
  Contacts: vuerli@oats.inaf.it for the Grid workerNode in Trieste
  i.e.: Planck pipeline tests performed with Grid infrastructure.

- HPC=High Performance Computing, CPUs cluster.
  i.e.: CINECA (http://www.cineca.it/en/index.htm) is a Large Scale Facilities, supercomputer center.
  It was used for running Gadget2 simulation stored into IA2 web site.

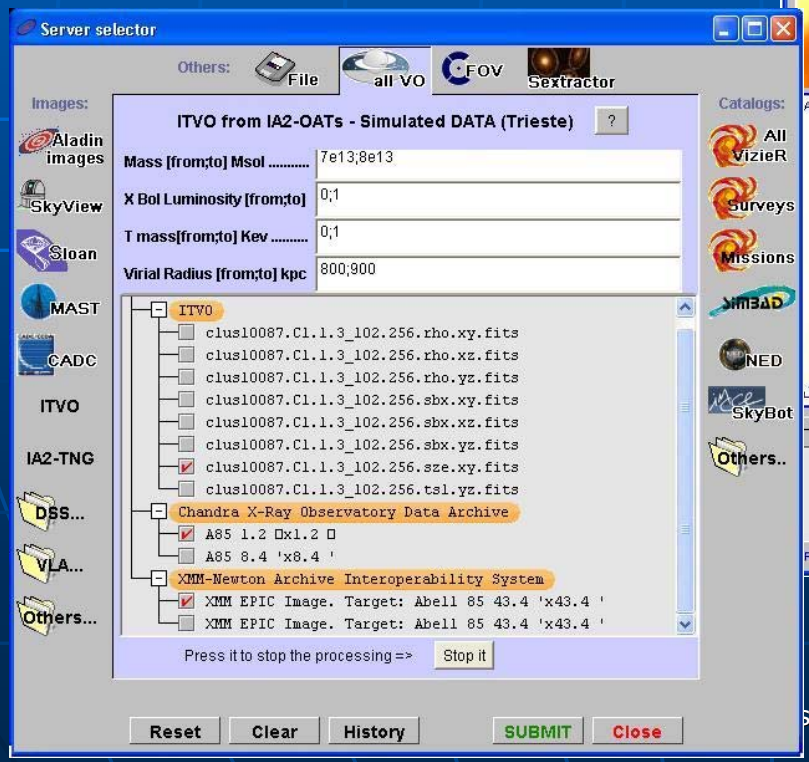
You can ask for tutorial.

Frequently used VO tools

- Aladin (CDS, Strasbourg) 2-D images visualizer http://aladin.u-strasbg.fr/aladin.gml;
- VisIVO (CINECA) N-D data (HDF5, Gadget, VOTable, fits table, ASCII table, raw binary) http://visivo.cineca.it/;
- TOPCAT (Starlink) to create plots http://www.star.bris.ac.uk/~mbt/topcat/;
  (can query the DB of the Millennium simulation, G. Lemson et al., "Halo and Galaxy Formation Histories from the Millenium Run: Public realise of a VO-oriented and SQL-queryable database for studying the evolution of galaxies in the ΛCDM cosmology" Astro-Ph/0608019, 2006)
- Specview (STScI) spectra http://www.stsci.edu/resources/software_hardware/specview ;
- VOSpec (ESAC) spectra http://esavo.esa.int/vospec/ ;
- Plastic Hub to connect all these tools (http://www.ivoa.net/Documents/latest/PlasticDesktopInterop.html)
- Etc.

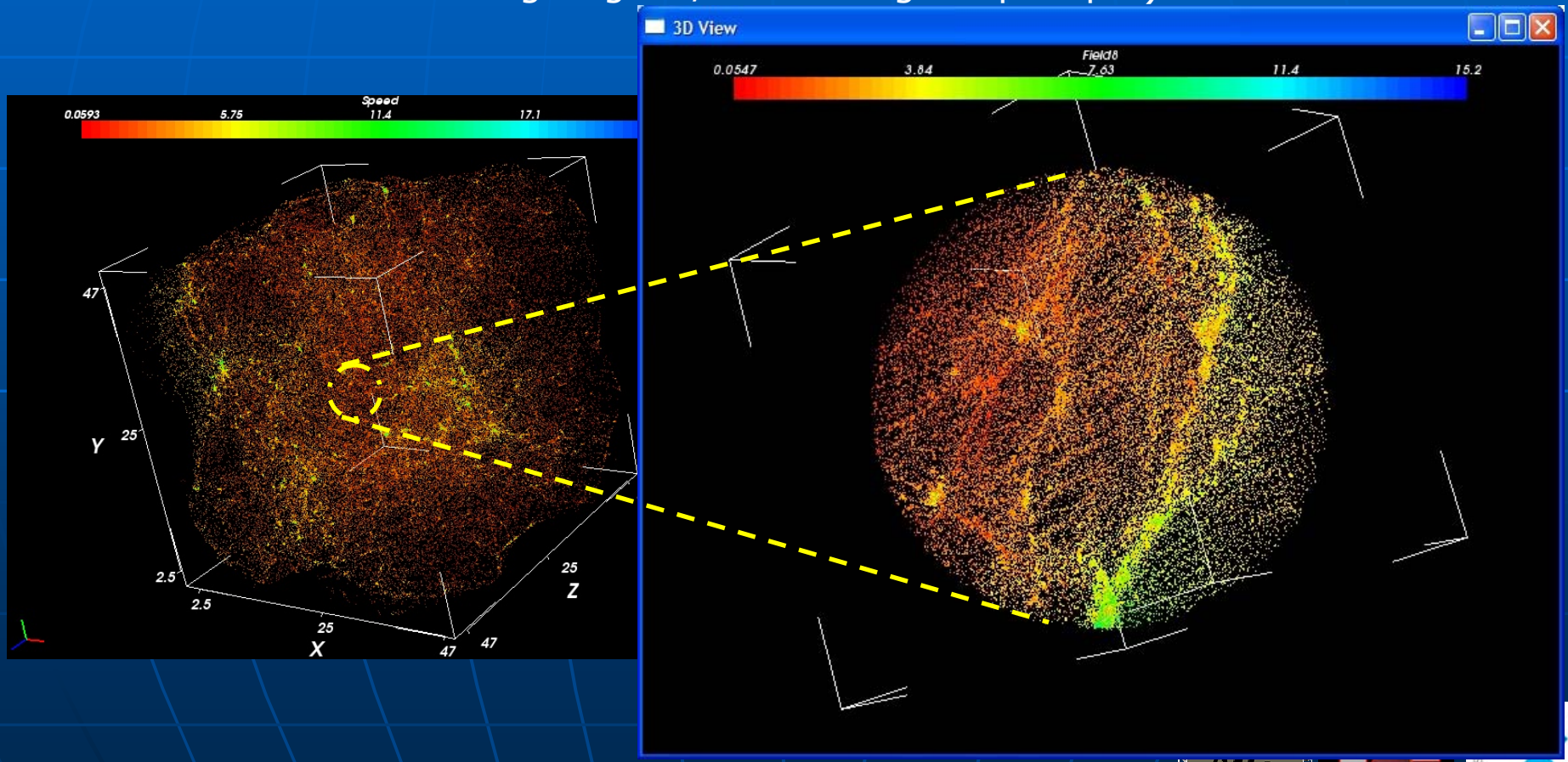
Aladin tool

Aladin is able to search and open observational and theoretical 2D images



Spherical Cutout

A cutout of a FLY output file performed by Catania@ITVO http://itvo.oact.inaf.it/ and visualized with VisIVO tool (new features: http://eurovotech.org/twiki/pub/VOTech/DS6PlanningStage06/VisIVOStage5report.pdf)



Conclusions

- the VO is the fundamental infrastructure that enable the astronomers of XXI century to use the totally investments of keeping for long time the astronomical data.
- so the VO becames a key element for every new astronomical facility:
  - guarantee the maximum scientific return of investments
  - distribute the knowledge to all scientific community.
- Merge technological and scientific group to collaborate inside the IVOA;
- I invite you to try to use the VO tools.

  We want a feedback or suggestions from scientists!!!

  e-mail to: IA2@oats.inaf.it or mailing lists of IVOA;
- Next "IVOA Interop. Meeting": 19-23 May 2008, Trieste, Italy (http://www.ivoa.net/twiki/bin/view/IVOA/InterOpMay2008)