International Virtual Observatory Alliance

L'Organizzazione per gli Standard di Interoperabilita' per i dati di Astronomia

G. Fabbiano
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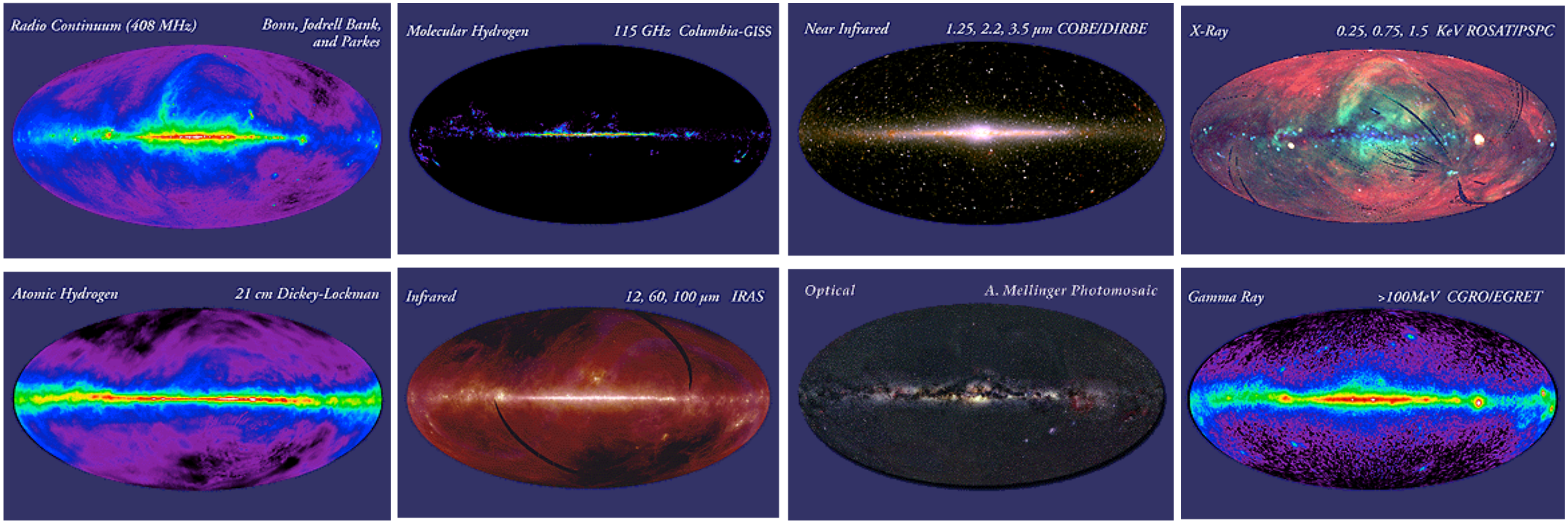
Head, Data Systems Division, Chandra X-ray Center
Chair of International Virtual Observatory Alliance Executive Committee

Cos’e’ il ‘Virtual Observatory’?

Il cielo digitale in tuttle le lunghezze d’onda che puo’ essere interrogato, visualizzato ed analizzato in modi nuovi ed innovativi


Radio Continuum (408 MHz)
Bonn, Jodrell Bank, and Parkes
Molecular Hydrogen
115 GHz Columbia-GISS
Near Infrared
1.25, 2.2, 3.5 µm COBE/DIRBE
X-Ray
0.25, 0.75, 1.5 KeV ROSAT/PSPC
Atomic Hydrogen
21 cm Dickey-Lockman
Infrared
12, 60, 100 µm IRAS
Optical
A. Mellinger Photomosaic
Gamma Ray
>100MeV CGRO/EGRET

Cos’e’ il ‘Virtual Observatory’?

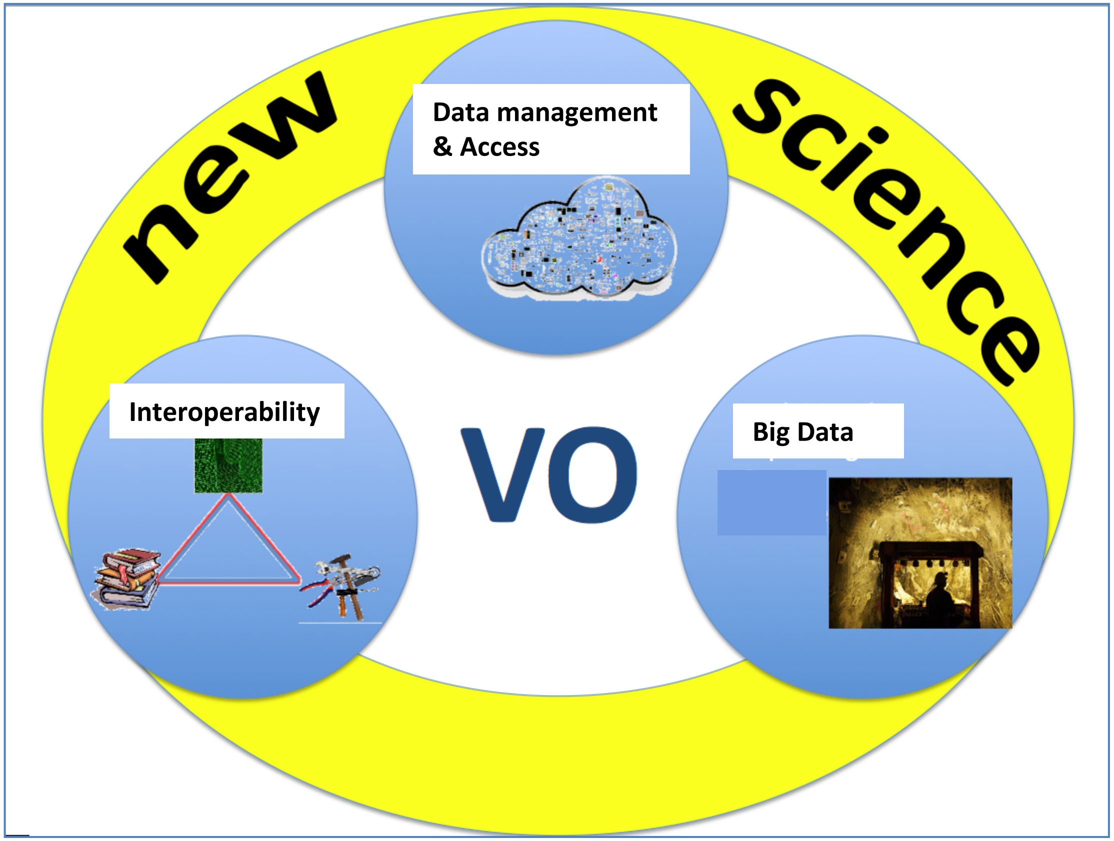
Il VO e’ l’ultima fase di una buona gestione di dati astronomici

- Ciascun centro dati / archivio ha strutture diverse per dati, metadati, e tabelle
- I dati ci sono, ma e’ difficile utilizzarli, in particolare se parecchi data sets sono usati insieme

- FITS defini’ una prima standardizzazione

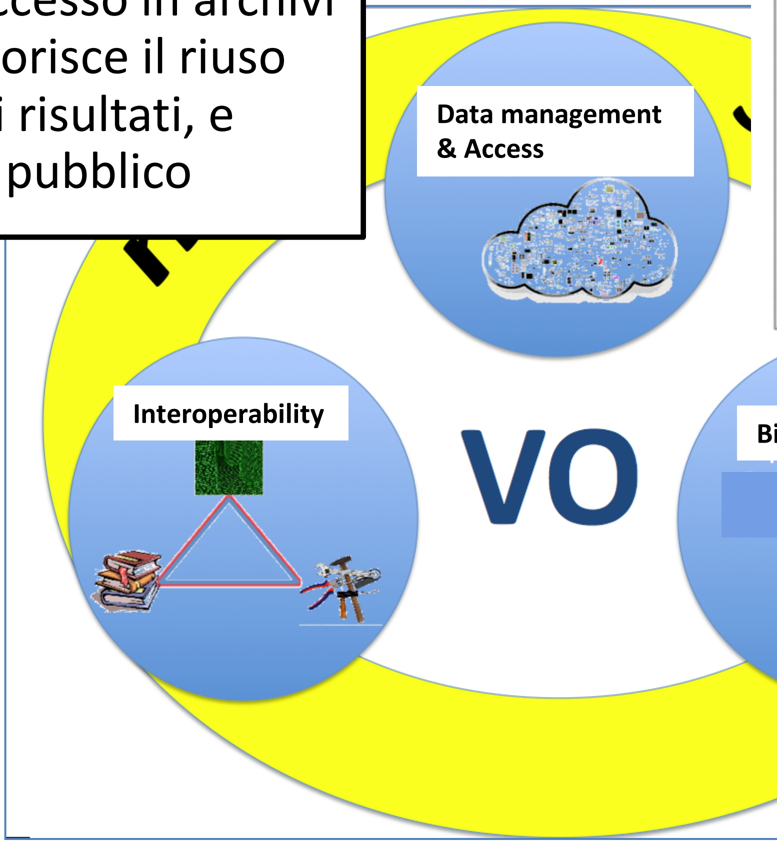
- Il VO rappresenta l’evoluzione naturale verso l’interoperabilita’ dei dati, servizi e strumenti

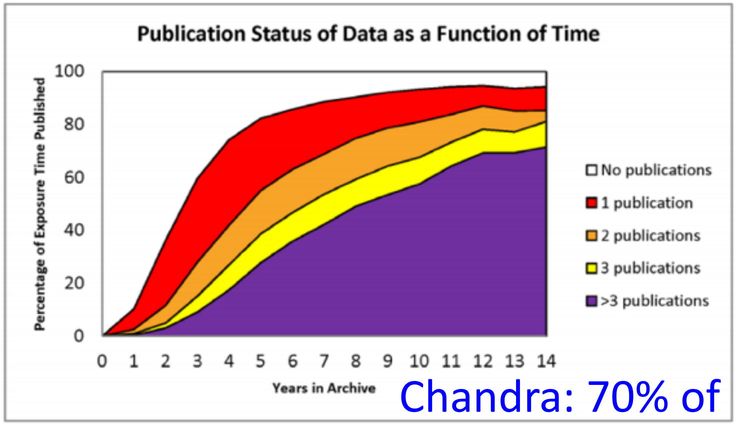
Cos’e’ il ‘Virtual Observatory’?


new
science
Data management & Access
Interoperability
VO
Big Data

Cos’e’ il ‘Virtual Observatory’?

Un comodo accesso in archivi ben gestiti favorisce il riuso dei dati, nuovi risultati, e diffusione nel pubblico


Data management & Access
Interoperability
VO
Big Data



Chandra: 70% of data published >3 times after 14 yrs

Cos'e' il 'Virtual Observatory'?

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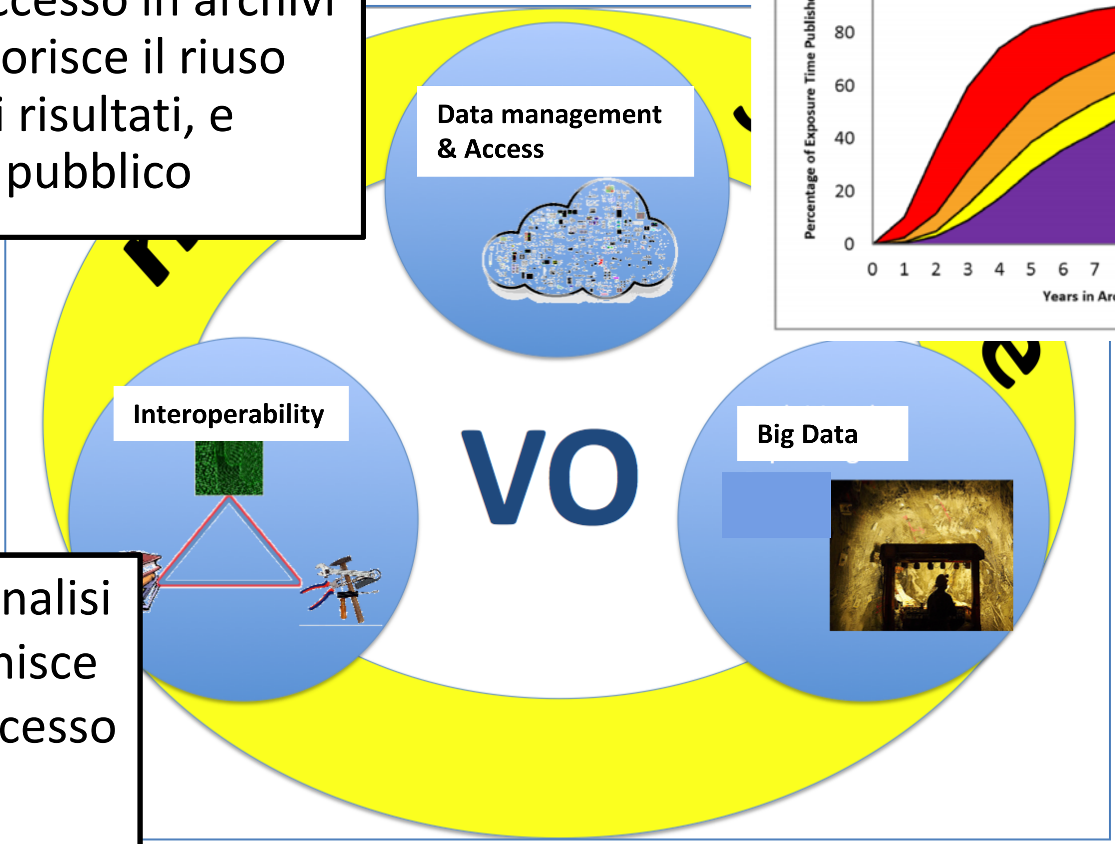
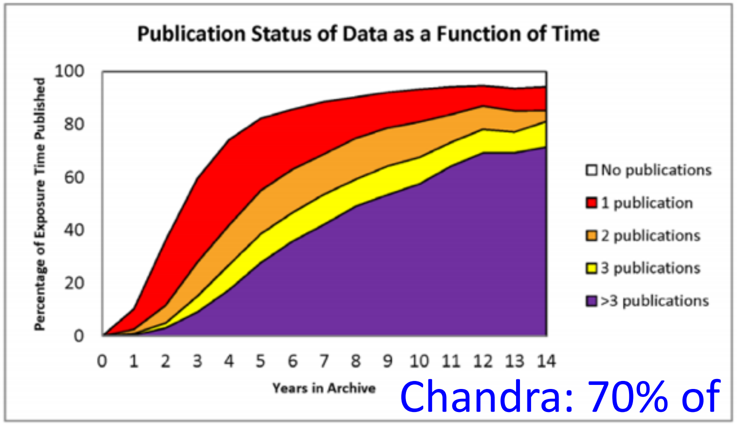

Data management & Access
Interoperability
VO
Big Data

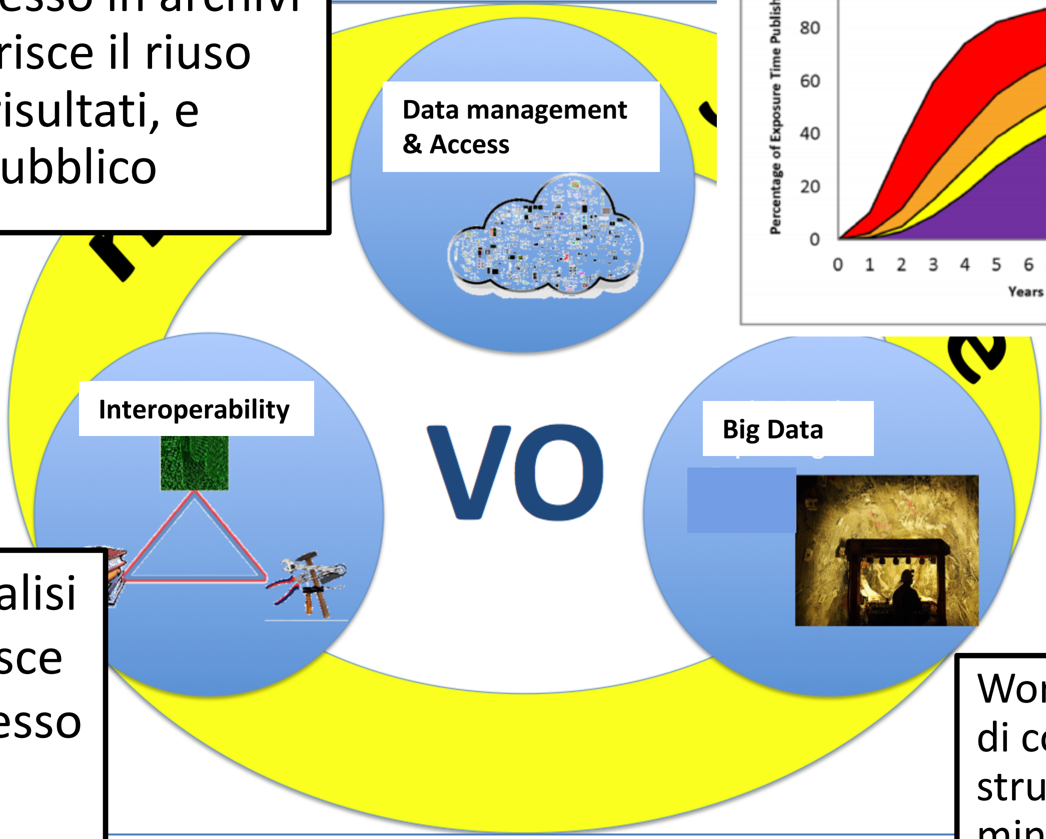


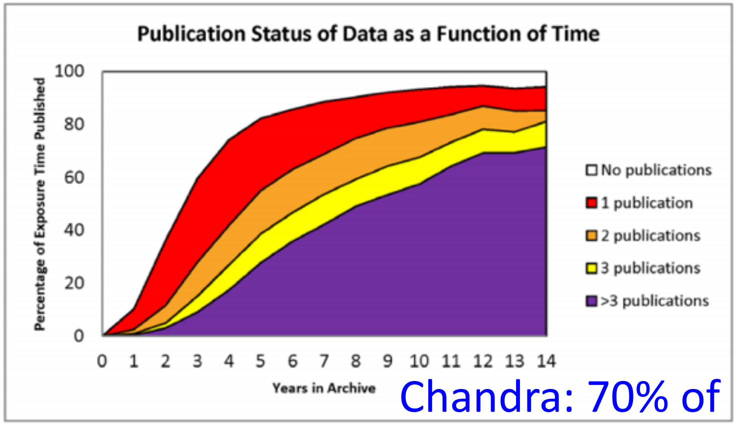
Chandra: 70% of data published >3 times after 14 yrs

Un ambiente di analisi versatile che fornisce agli astronomi accesso integrato ai dati, strumenti e letteratura.

Cos’e’ il ‘Virtual Observatory’?

Un comodo accesso in archivi ben gestiti favorisce il riuso dei dati, nuovi risultati, e diffusione nel pubblico

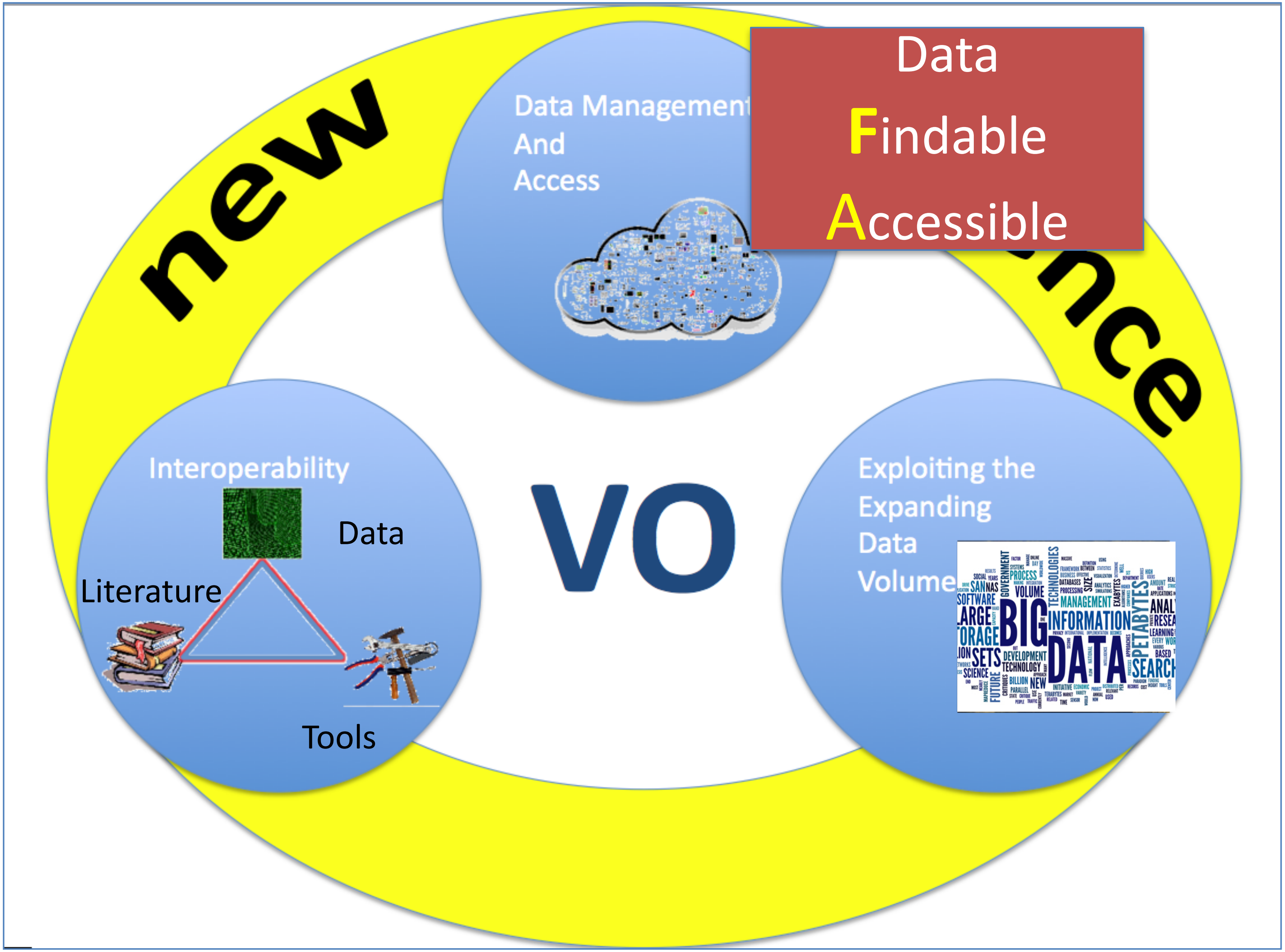

Data management & Access
Interoperability
VO
Big Data



Chandra: 70% of data published >3 times after 14 yrs

Un ambiente di analisi versatile che fornisce agli astronomi accesso integrato ai dati, strumenti e letteratura.

Workspaces, strumenti di collaborazione, strumenti di data mining & servizi



new

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Data
Findable
Accessible

Data Management
And
Access

VO

Interoperability

Data

Literature

Tools

Exploiting the
Expanding
Data
Volume

BIG
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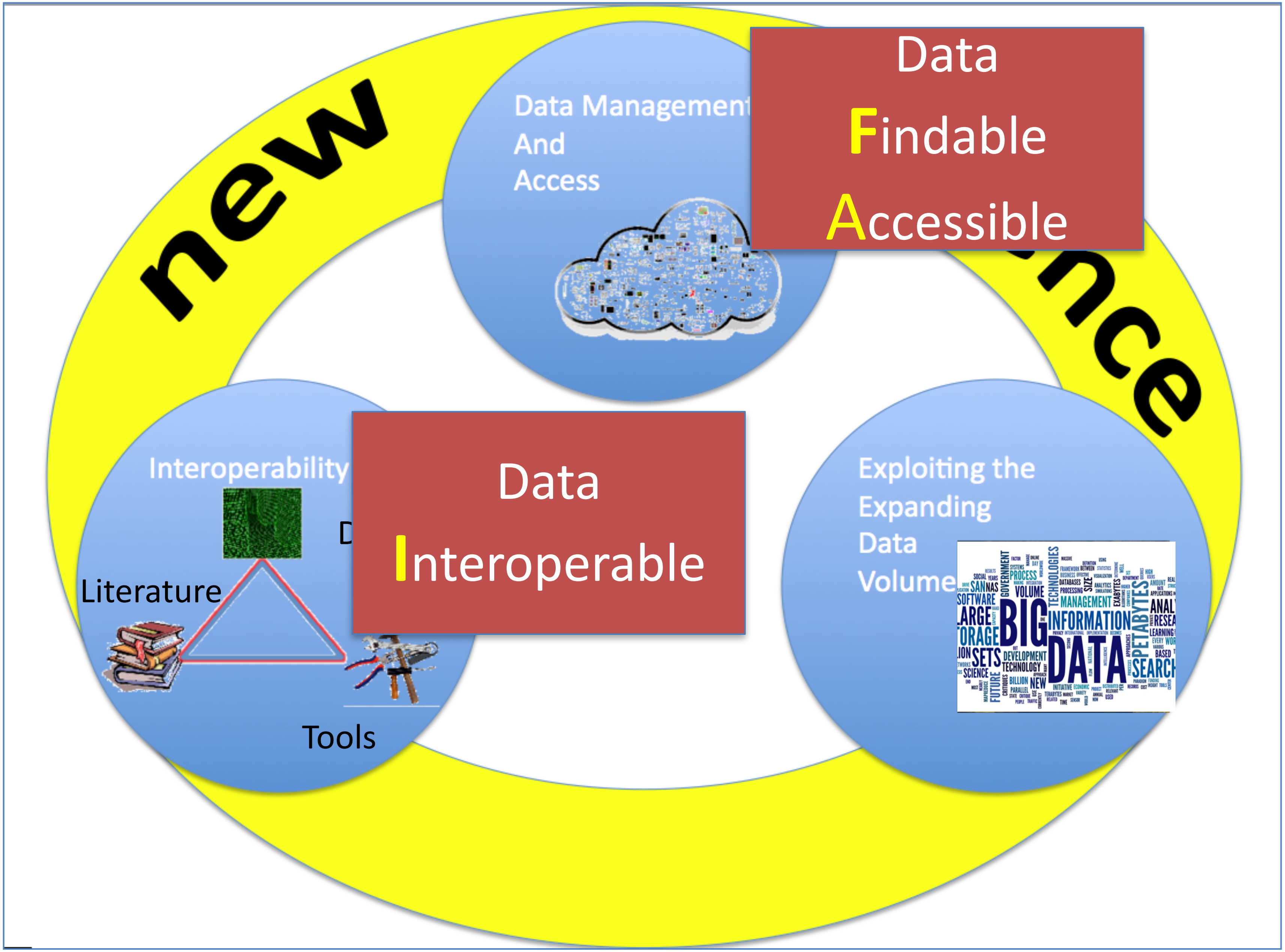
INFORMATION
MANAGEMENT
PETABYTES
SEARCH



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Tools

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Interoperable

Exploiting the
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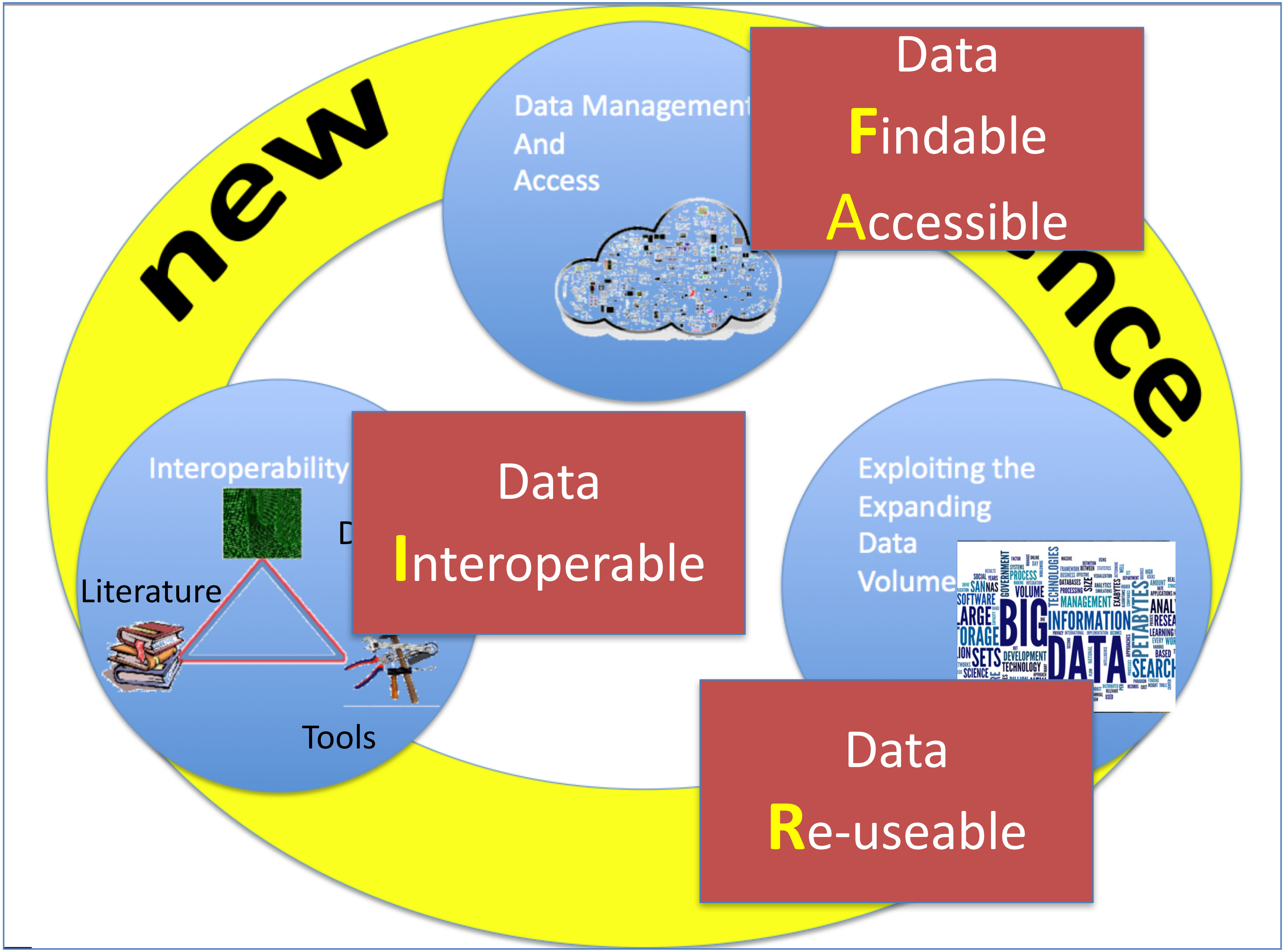
SETS
TECHNOLOGIES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SOFTWARE
DEVELOPMENT
TECHNOLOGY
SCIENCE

Data Management
And
Access

Data
Findable
Accessible

Interoperability

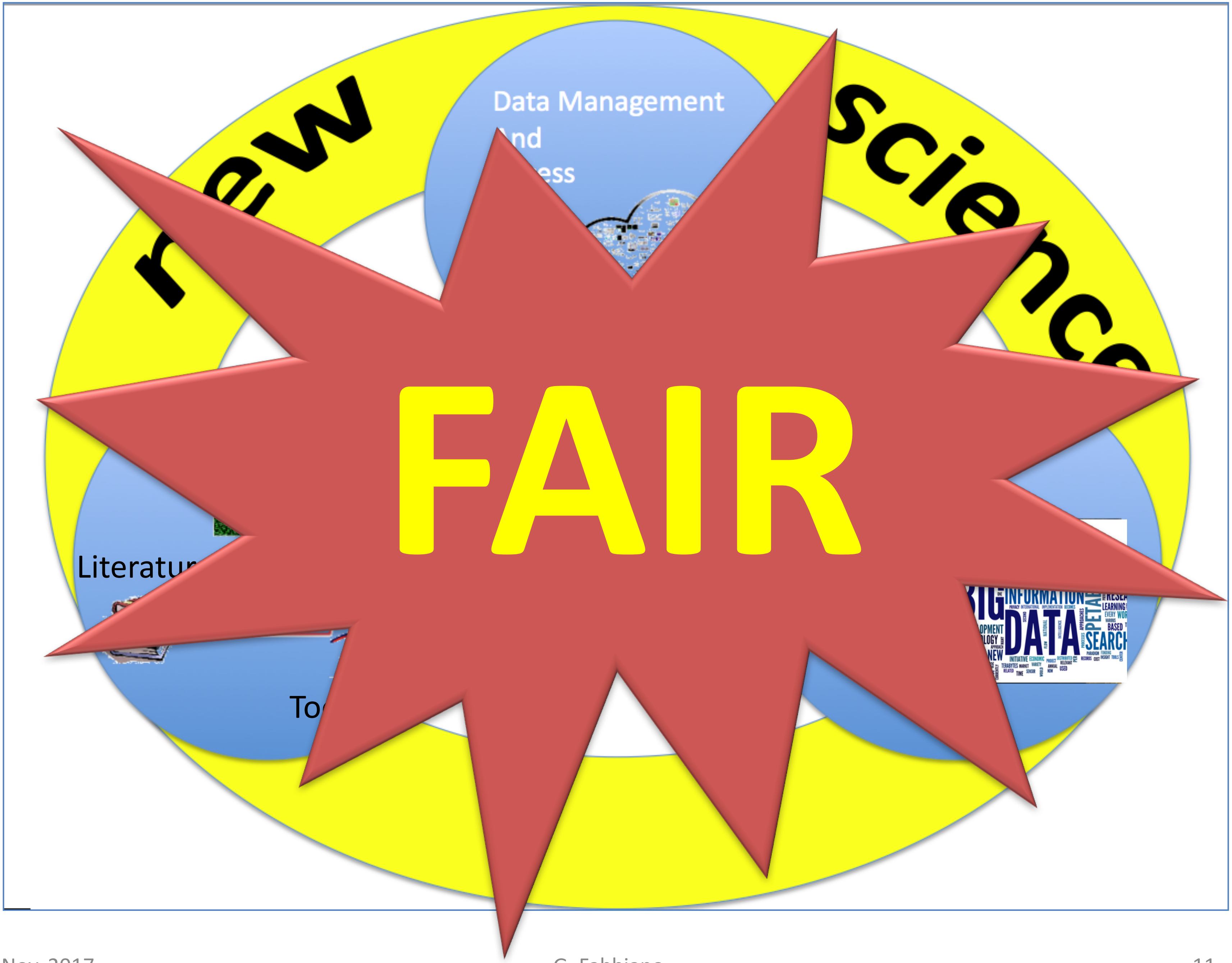
Literature

Tools

Data
Interoperable

Exploiting the
Expanding
Data
Volume

Data
Re-useable


new
science
Data Management
And
ess
Literatur
To
BIG INFORMATION DATA SEARCH
FAIR

Il VO e’ un modo di fare

- I centri dati forniscono servizi dati che parlano fra di loro
- Gli sviluppatori di software offrono una varieta’ di strumenti di analisi e visualizzazione e interfacce utenti compatibili fra di loro

Per

- Facilitare la ricerca interdisciplinaria (multi-wavelength) e collaborativa in astronomia
- Utilizzare a pieno nuovi e futuri data sets
- Offrire pieno accesso e potenti strumenti per l’educazione e la diffusione della scienza

The VO is a Framework

- For d ta centers to p vide co- rating data services
- For softv provid of ariety of compatible analysis and interfaces

Standards !

- Support i d colla ative r
- Exploit the full we gro and e rging data sets

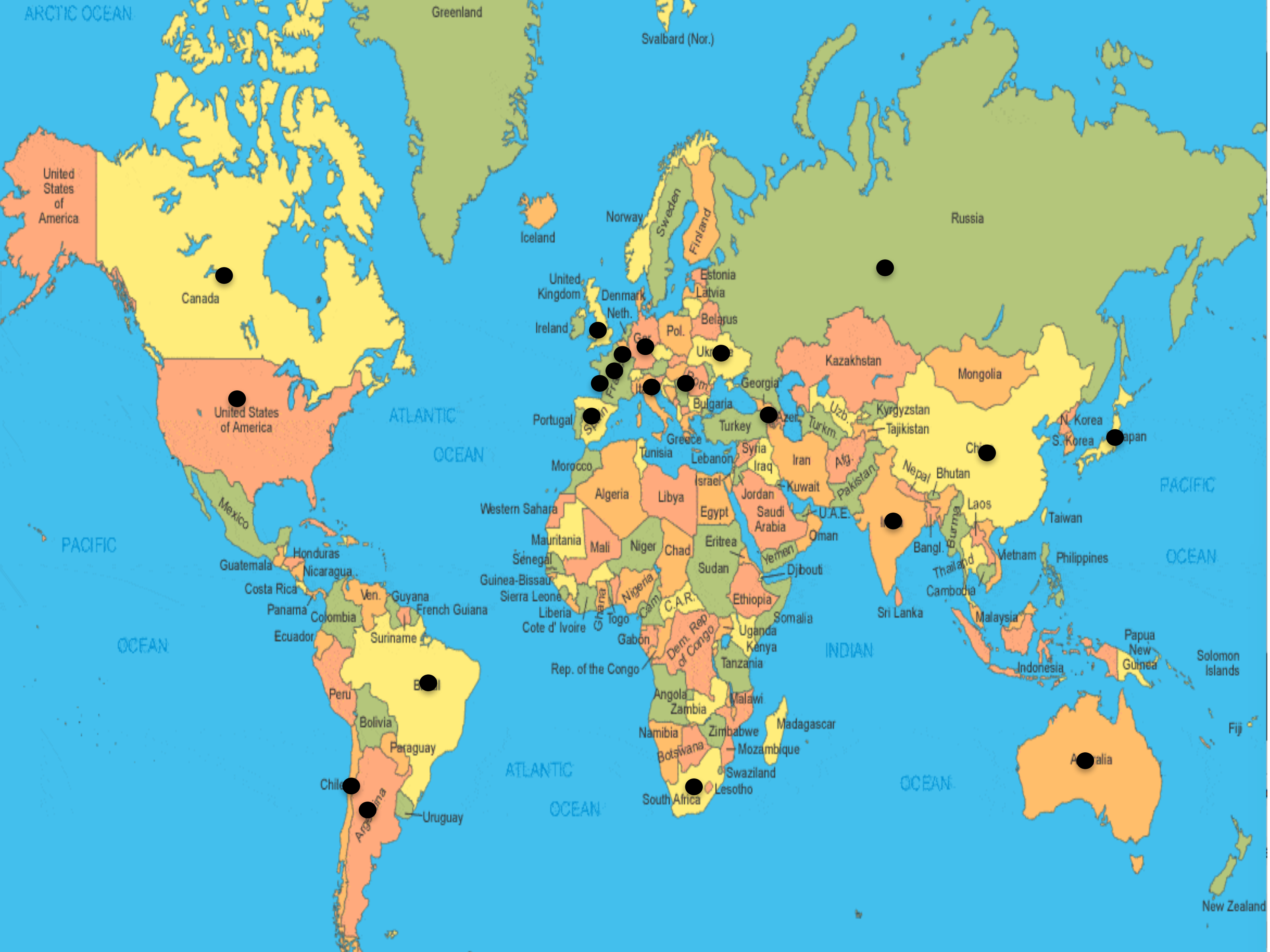
Gli Standard dell’IVOA

Il nucleo del VO e’ un insieme di standard sviluppati nel contesto dell’International Virtual Observatory Alliance (IVOA) per facilitare una buona gestione dei dati e l’interoperabilita’

- Standardizzazione di dati e metadati per dati da osservazioni e anche da simulazioni
  - Data Model; Uniform Content Descriptors
- Standardizzazione dei metodi di scambio dati
  - Data Access Layer; VO Query Language
- Standardizzazione delle liste e caratteristiche dei servizi del VO
  - IVOA registry
- Standardizzazione dell’ application messaging protocol
  - SAMP
  - VO-enabled tools and services can interface seamlessly with VO-enabled archives worldwide

IVOA www.ivoa.net

- Iniziata nel 2002, l' International Virtual Observatory Alliance (IVOA) oggi ha 21 membri
- **L' IVOA non riceve finanziamenti diretti**
  - I progetti affiliati ottengono finanziamenti dalle loro agenzie nazionali
- Ampia partecipazione a 2 interoperability working meetings per anno con un profilo altamente internazionale


ARCTIC OCEAN
Greenland
Svalbard (Nor.)
United States of America
Russia
Norway
Sweden
Finland
Iceland
Canada
Estonia
United Kingdom
Latvia
Denmark
Neth.
Belarus
Ireland
Ger
Pol.
Ukr
Kazakhstan
Mongolia
Georgia
Fr
It
Rom
Portugal
Sp
Bulgaria
Kyrgyzstan
United States of America
ATLANTIC
Uzb.
Azer.
Turkm.
Tajikistan
N. Korea
Turkey
S. Korea
apan
OCEAN
Greece
Syria
Chi
Tunisia
Lebanon
Iraq
Iran
Afg.
Morocco
PACIFIC
Nepal
Bhutan
Israel
Kuwait
Pakistan
Algeria
Libya
Jordan
Egypt
Saudi Arabia
Laos
Western Sahara
Mexico
U.A.E.
Taiwan
Burma
I
Oman
Mauritania
Eritrea
Bangl.
Mali
Niger
Chad
Yemen
PACIFIC
Vietnam
Philippines
OCEAN
Honduras
Senegal
Sudan
Thailand
Guatemala
Nicaragua
Djibouti
Guinea-Bissau
Cambodia
Costa Rica
Sierra Leone
Ven.
Guyana
Nigeria
C.A.R.
Ethiopia
Panama
French Guiana
Liberia
Ghana
Cam.
Sri Lanka
Somalia
Malaysia
Colombia
Togo
Cote d' Ivoire
Dem. Rep. of Congo
Uganda
Suriname
Ecuador
Gabon
Kenya
Papua New Guinea
OCEAN
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Solomon Islands
Indonesia
Tanzania
Rep. of the Congo
Peru
B l
Angola
Malawi
Zambia
Bolivia
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Fiji
Namibia
Zimbabwe
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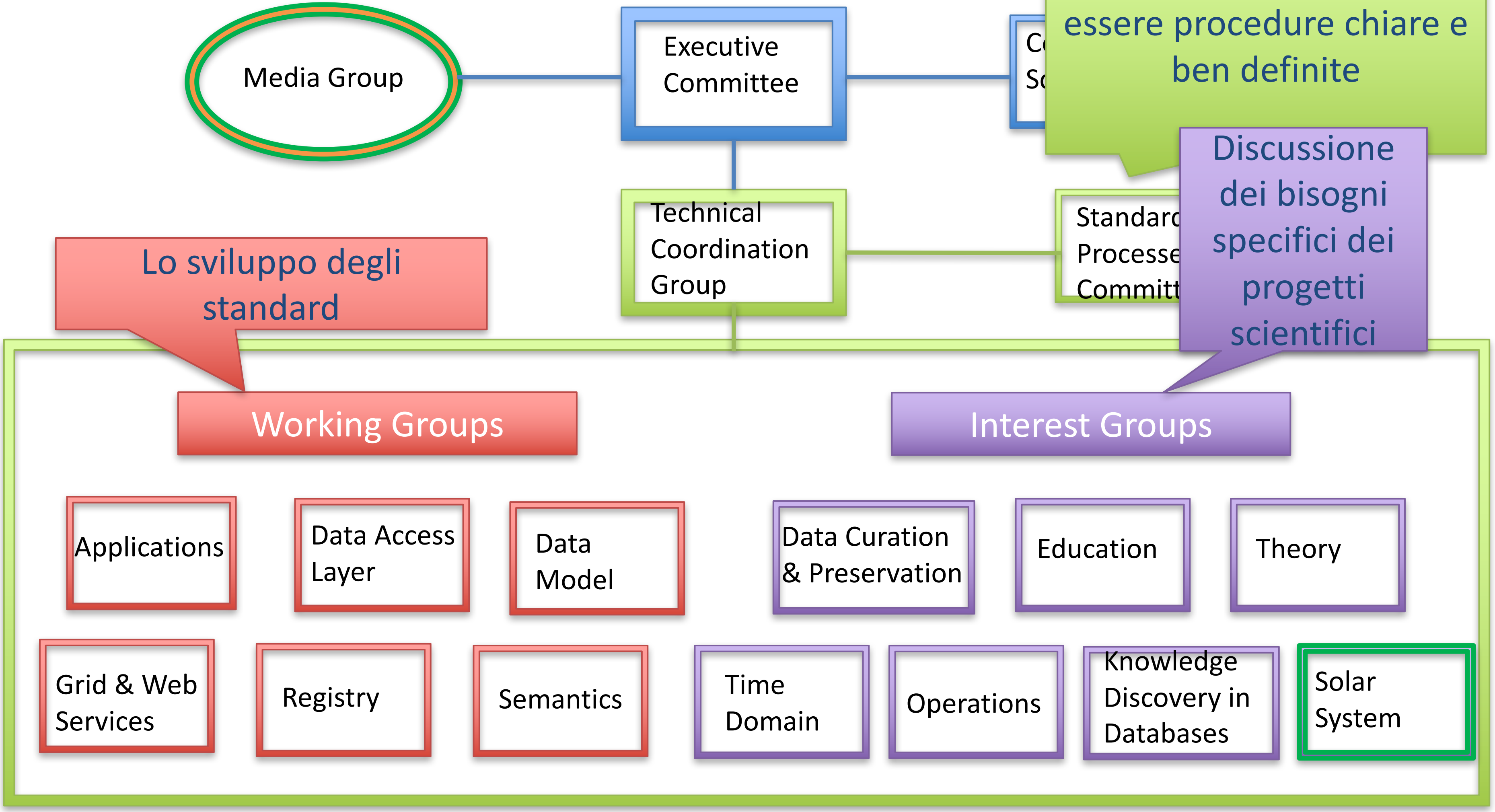
Uruguay
New Zealand

IVOA Organization C



Per fare funzionare bene questa collaborazione internazionale ci devono essere procedure chiare e ben definite

Media Group

Executive Committee

Co
Sc

Technical Coordination Group

Standard
Processe
Committ

Lo sviluppo degli standard

Discussione dei bisogni specifici dei progetti scientifici

Working Groups

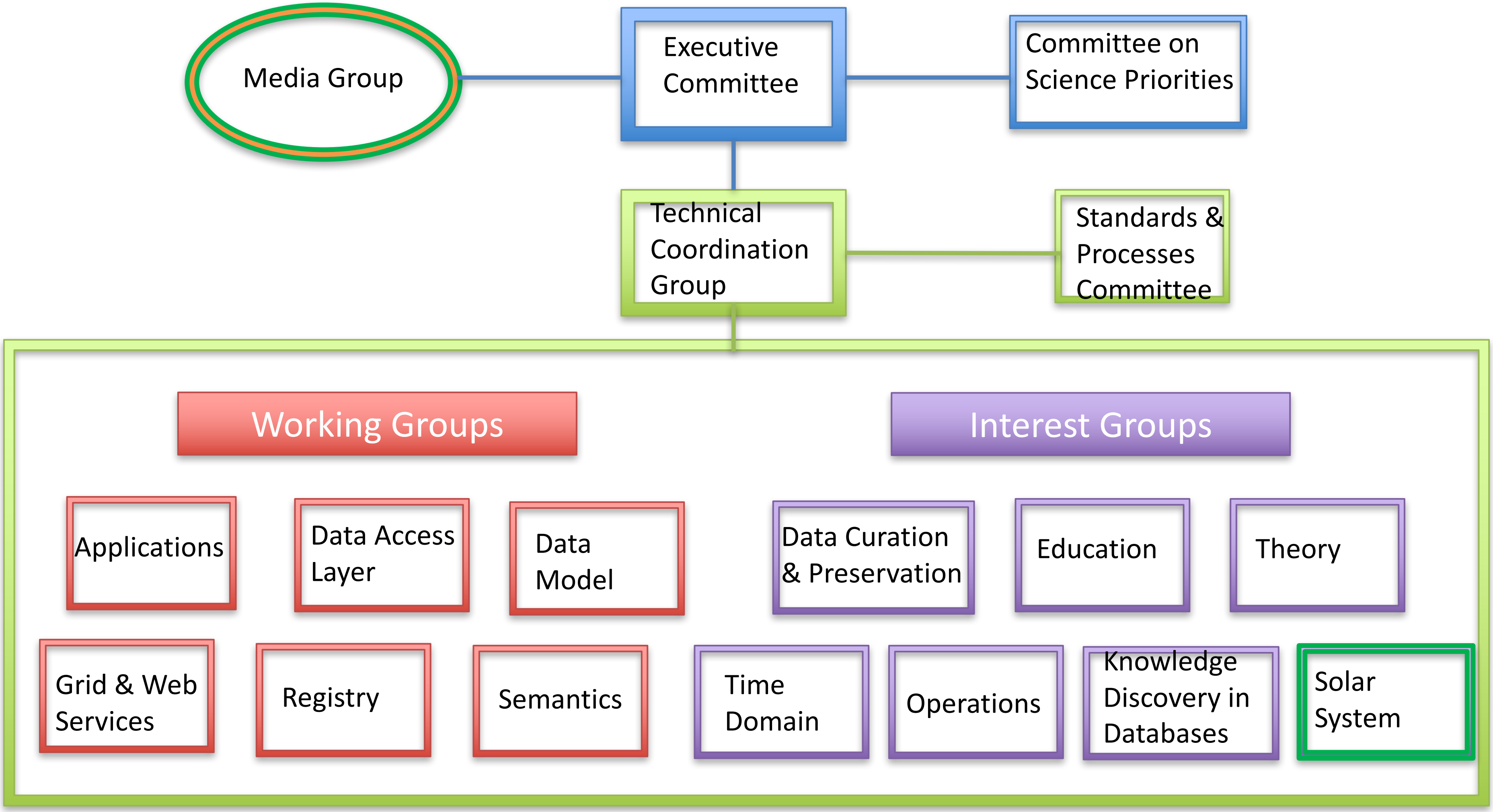
Interest Groups

- Applications
- Data Access Layer
- Data Model
- Grid & Web Services
- Registry
- Semantics

- Data Curation & Preservation
- Education
- Theory
- Time Domain
- Operations
- Knowledge Discovery in Databases
- Solar System

…after the Shanghai meeting

IVOA Organization Chart



Media Group

Executive Committee

Committee on Science Priorities

Technical Coordination Group

Standards & Processes Committee

Working Groups

Interest Groups

Applications

Data Access Layer

Data Model

Data Curation & Preservation

Education

Theory

Grid & Web Services

Registry

Semantics

Time Domain

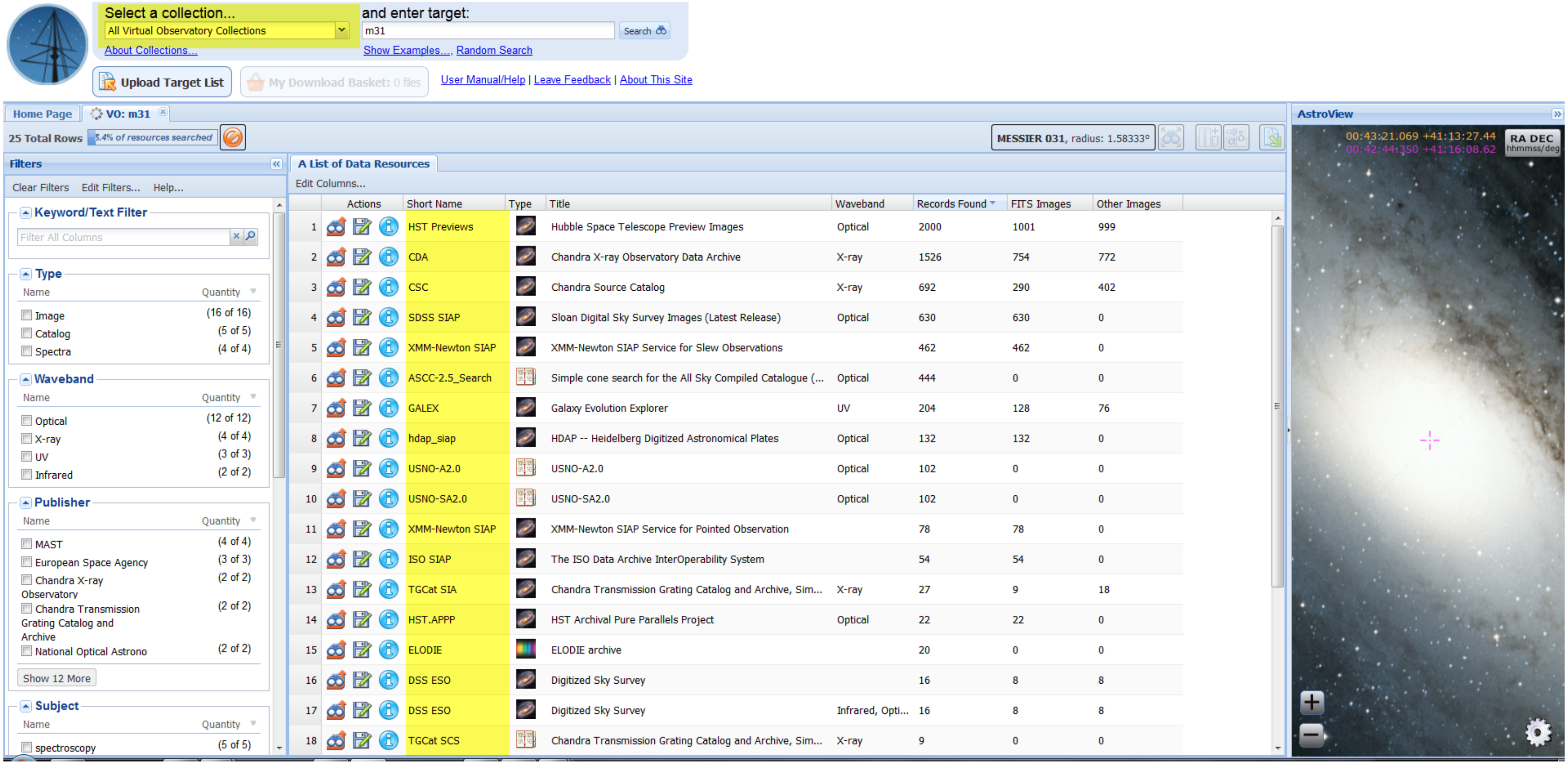
Operations

Knowledge Discovery in Databases

Solar System

Successi dell'IVOA – Gli Archivi nel VO

- Le principali collezioni di dati astronomici sone accessibili nel VO
  - CDS, CADC, MAST, IRSA, ESA, Chandra, …



Select a collection...
All Virtual Observatory Collections
About Collections...

and enter target:
m31
Search
Show Examples..., Random Search

Upload Target List | My Download Basket: 0 files | User Manual/Help | Leave Feedback | About This Site

Home Page | VO: m31

25 Total Rows | 5.4% of resources searched

MESSIER 031, radius: 1.58333°

Filters

Clear Filters Edit Filters... Help...

Keyword/Text Filter

Filter All Columns

Type

Name	Quantity
☐ Image	(16 of 16)
☐ Catalog	(5 of 5)
☐ Spectra	(4 of 4)

Waveband

Name	Quantity
☐ Optical	(12 of 12)
☐ X-ray	(4 of 4)
☐ UV	(3 of 3)
☐ Infrared	(2 of 2)

Publisher

Name	Quantity
☐ MAST	(4 of 4)
☐ European Space Agency	(3 of 3)
☐ Chandra X-ray Observatory	(2 of 2)
☐ Chandra Transmission Grating Catalog and Archive	(2 of 2)
☐ National Optical Astrono	(2 of 2)

Show 12 More

Subject

Name	Quantity
☐ spectroscopy	(5 of 5)

A List of Data Resources

Edit Columns...

	Actions	Short Name	Type	Title	Waveband	Records Found	FITS Images	Other Images
1		HST Previews		Hubble Space Telescope Preview Images	Optical	2000	1001	999
2		CDA		Chandra X-ray Observatory Data Archive	X-ray	1526	754	772
3		CSC		Chandra Source Catalog	X-ray	692	290	402
4		SDSS SIAP		Sloan Digital Sky Survey Images (Latest Release)	Optical	630	630	0
5		XMM-Newton SIAP		XMM-Newton SIAP Service for Slew Observations		462	462	0
6		ASCC-2.5_Search		Simple cone search for the All Sky Compiled Catalogue (...	Optical	444	0	0
7		GALEX		Galaxy Evolution Explorer	UV	204	128	76
8		hdap_siap		HDAP -- Heidelberg Digitized Astronomical Plates	Optical	132	132	0
9		USNO-A2.0		USNO-A2.0	Optical	102	0	0
10		USNO-SA2.0		USNO-SA2.0	Optical	102	0	0
11		XMM-Newton SIAP		XMM-Newton SIAP Service for Pointed Observation		78	78	0
12		ISO SIAP		The ISO Data Archive InterOperability System		54	54	0
13		TGCat SIA		Chandra Transmission Grating Catalog and Archive, Sim...	X-ray	27	9	18
14		HST.APPP		HST Archival Pure Parallels Project	Optical	22	22	0
15		ELODIE		ELODIE archive		20	0	0
16		DSS ESO		Digitized Sky Survey		16	8	8
17		DSS ESO		Digitized Sky Survey	Infrared, Opti...	16	8	8
18		TGCat SCS		Chandra Transmission Grating Catalog and Archive, Sim...	X-ray	9	0	0

AstroView

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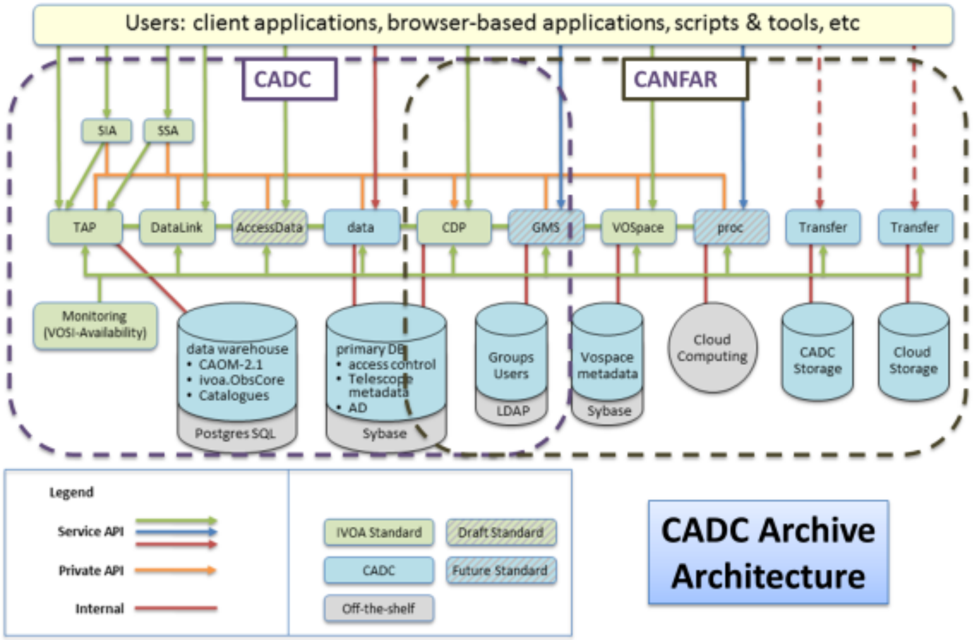
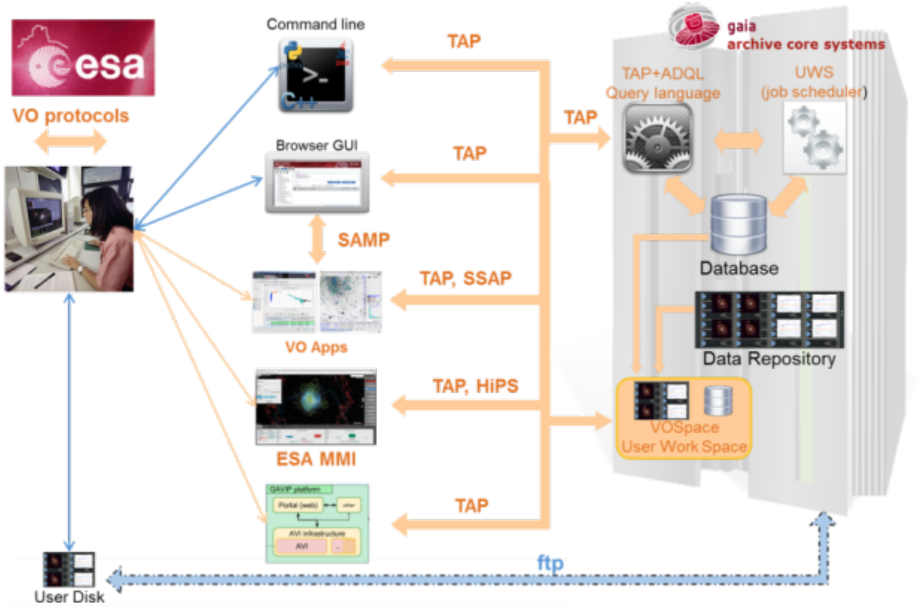
00:42:44.350 +41:16:08.62

RA DEC
hhmmss/deg

Successi dell’IVOA –
VO nell’infrastruttura dei Centri Dati

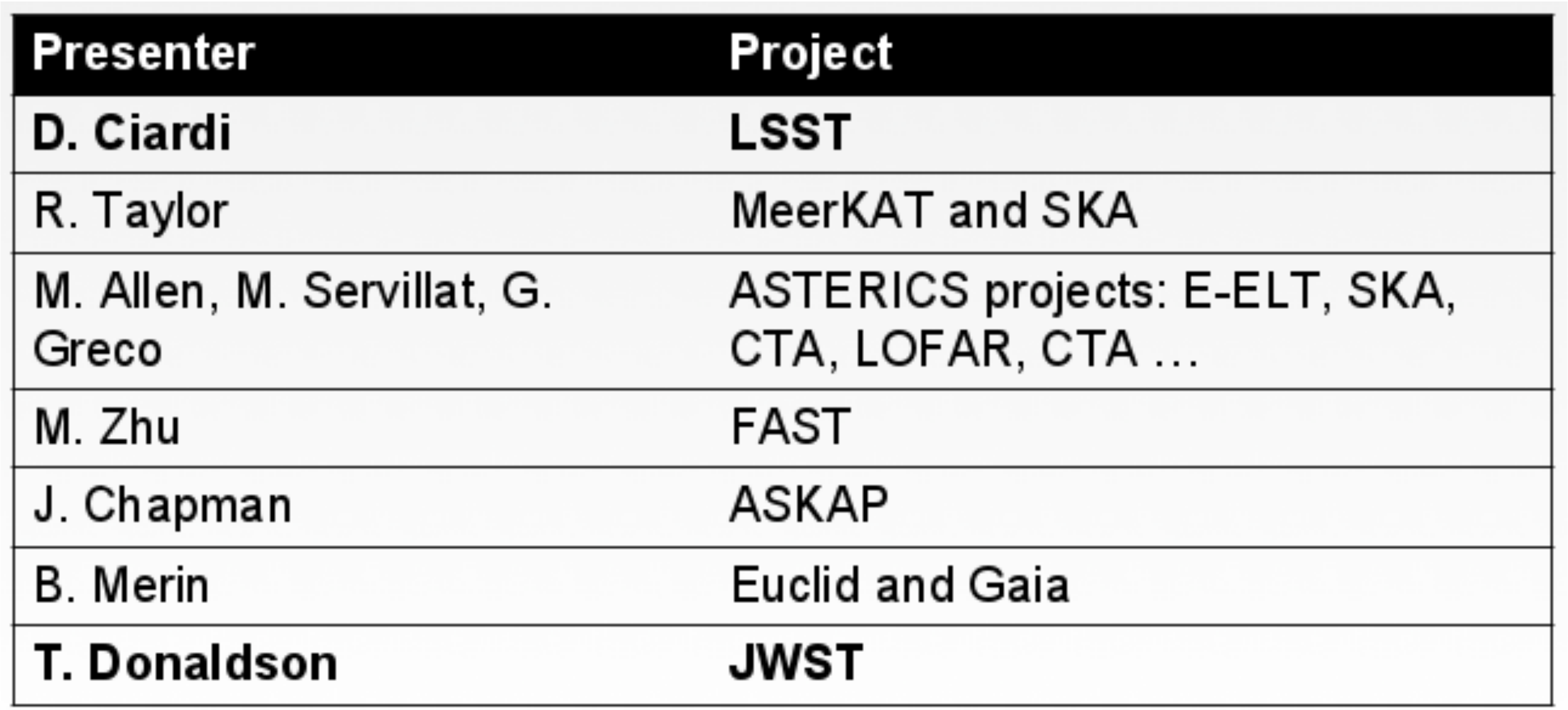
- VO-ready infrastructure built-in astronomical data centers
  - CADC, Gaia, Euclid, …
  - Data (file & database) access and User Work Space (VOSpace)


Users: client applications, browser-based applications, scripts & tools, etc
CADC
CANFAR
SIA
SSA
TAP
DataLink
AccessData
data
CDP
GMS
VOSpace
proc
Transfer
Transfer
Monitoring (VOSI-Availability)
data warehouse
• CAOM-2.1
• ivoa.ObsCore
• Catalogues
Postgres SQL
primary DB
• access control
• Telescope metadata
• AD
Sybase
Groups Users
LDAP
Vospace metadata
Sybase
Cloud Computing
CADC Storage
Cloud Storage
Legend
Service API
Private API
Internal
IVOA Standard
Draft Standard
CADC
Future Standard
Off-the-shelf
CADC Archive Architecture


esa
VO protocols
Command line
Browser GUI
SAMP
VO Apps
ESA MMI
User Disk
TAP
TAP
TAP
TAP, SSAP
TAP, HiPS
TAP
ftp
gaia archive core systems
TAP+ADQL Query language
UWS (job scheduler)
Database
Data Repository
VOSpace User Work Space

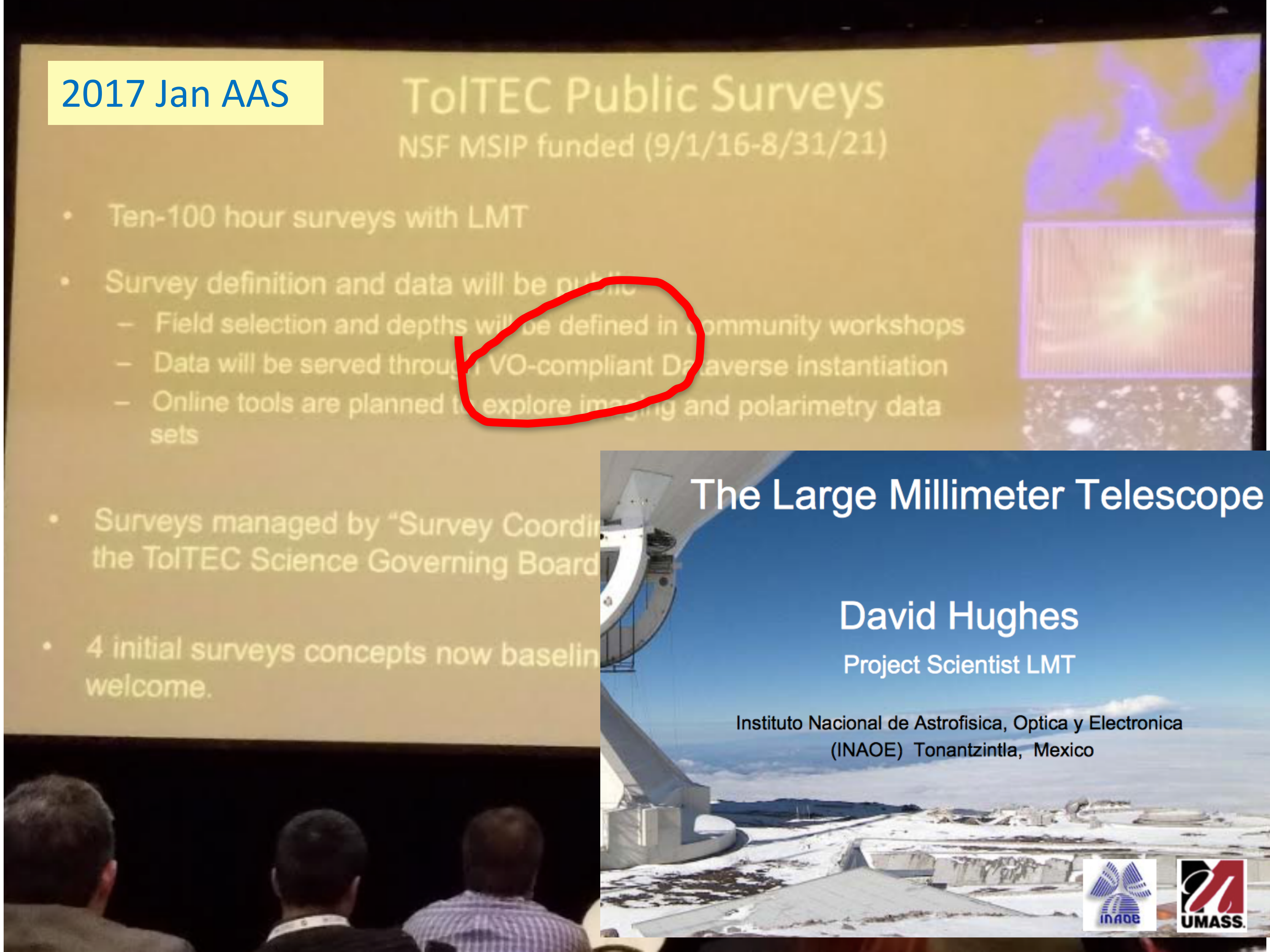
Coinvolgimento di progetti nuovi nell’ IVOA

- La commissione dell’ IVOA sulle Priorita’ Scientifiche investiga I nuovi sviluppi nel campo – identifica gli standard prioritari
- Organizza focus session con I progetti
  - e.g. Cape Town IVOA meeting, May 2016 **“Interoperability of data from major astronomical projects”**



Presenter	Project
D. Ciardi	**LSST**
R. Taylor	MeerKAT and SKA
M. Allen, M. Servillat, G. Greco	ASTERICS projects: E-ELT, SKA, CTA, LOFAR, CTA …
M. Zhu	FAST
J. Chapman	ASKAP
B. Merin	Euclid and Gaia
T. Donaldson	**JWST**

2017 Jan AAS



TolTEC Public Surveys

NSF MSIP funded (9/1/16-8/31/21)

- Ten-100 hour surveys with LMT
- Survey definition and data will be public
  - Field selection and depths will be defined in community workshops
  - Data will be served through VO-compliant Dataverse instantiation
  - Online tools are planned to explore imaging and polarimetry data sets
- Surveys managed by "Survey Coordi
  the TolTEC Science Governing Board
- 4 initial surveys concepts now baselin
  welcome.

The Large Millimeter Telescope

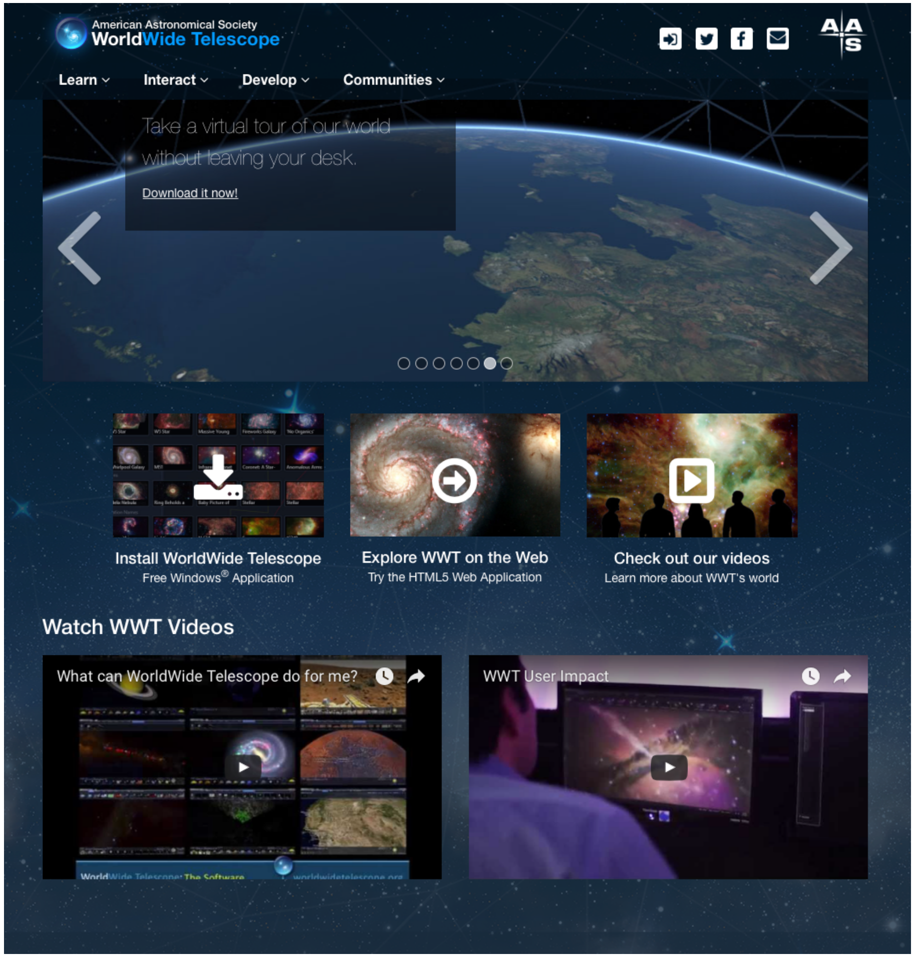
David Hughes

Project Scientist LMT

Instituto Nacional de Astrofisica, Optica y Electronica
(INAOE) Tonantzintla, Mexico

IVOA Successes - 3rd-party applications

- VO-inspired and VO-compliant
  - WorldWide Telescope (Microsoft)
  - Now under American Astronomical Society management
  - Used for education and outreach in the USA and other countries (e.g., China)


American Astronomical Society
WorldWide Telescope
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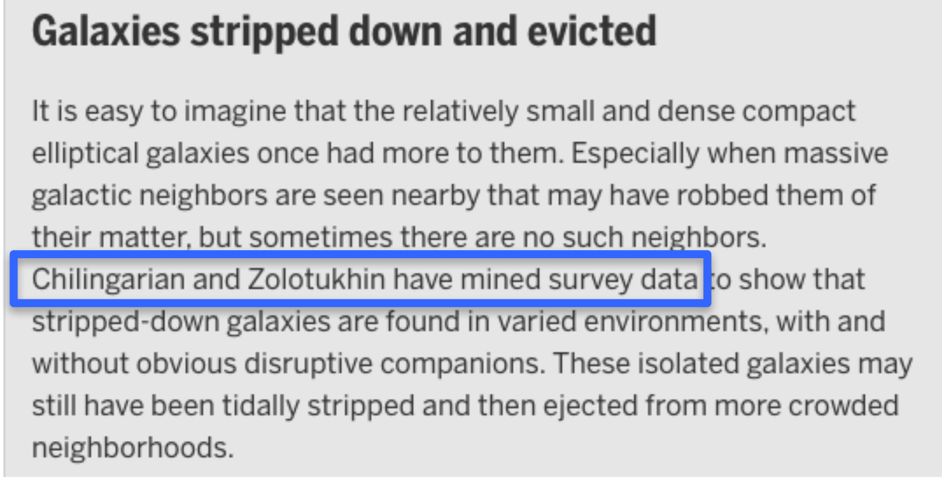
Interact
Develop
Communities
Download it now!
Install WorldWide Telescope
Free Windows® Application
Explore WWT on the Web
Try the HTML5 Web Application
Check out our videos
Learn more about WWT's world
Watch WWT Videos
What can WorldWide Telescope do for me?
WWT User Impact

Take a virtual tour of our world without leaving your desk.

IVOA Successes – ***Archival*** Science

- Un approccio efficiente e standardizzato alla ricerca
- L’accesso agli archivi tramite interfacce VO e l’uso di strumenti compatibili con il VO facilita la ricerca basata su molteplici e grandi cataloghi di dati astronomici

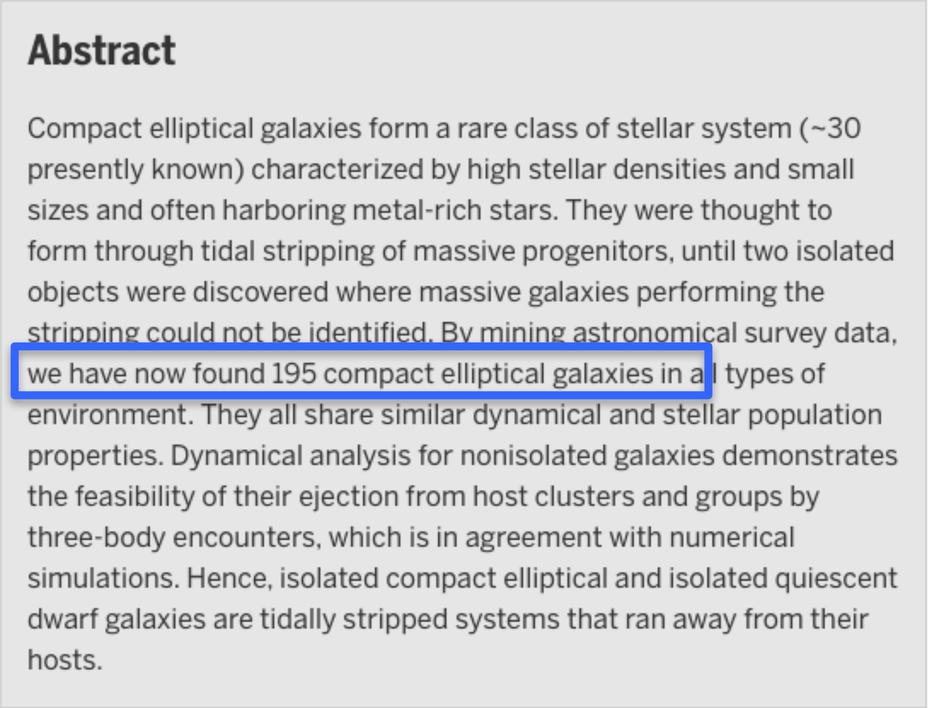
VO data extraction and VO tools are used for most data mining work
…..and are often transparent to the user



Galaxies stripped down and evicted

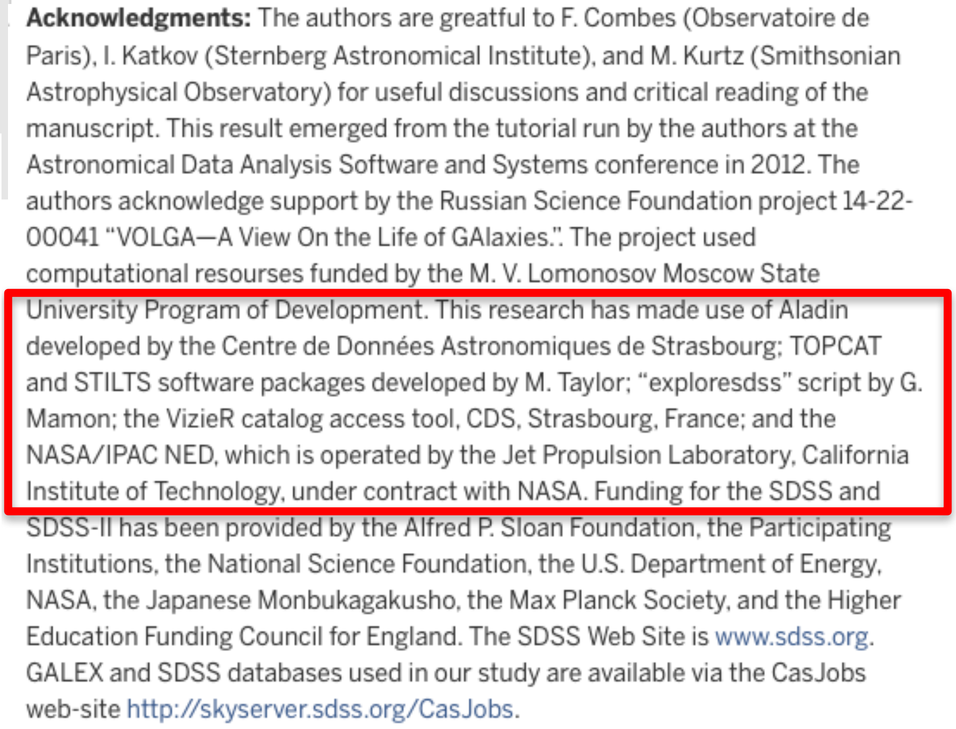
It is easy to imagine that the relatively small and dense compact elliptical galaxies once had more to them. Especially when massive galactic neighbors are seen nearby that may have robbed them of their matter, but sometimes there are no such neighbors. Chilingarian and Zolotukhin have mined survey data to show that stripped-down galaxies are found in varied environments, with and without obvious disruptive companions. These isolated galaxies may still have been tidally stripped and then ejected from more crowded neighborhoods.

Chilingharian, I. & Zolotukhin, I.
Science, 2015



Abstract

Compact elliptical galaxies form a rare class of stellar system (~30 presently known) characterized by high stellar densities and small sizes and often harboring metal-rich stars. They were thought to form through tidal stripping of massive progenitors, until two isolated objects were discovered where massive galaxies performing the stripping could not be identified. By mining astronomical survey data, we have now found 195 compact elliptical galaxies in all types of environment. They all share similar dynamical and stellar population properties. Dynamical analysis for nonisolated galaxies demonstrates the feasibility of their ejection from host clusters and groups by three-body encounters, which is in agreement with numerical simulations. Hence, isolated compact elliptical and isolated quiescent dwarf galaxies are tidally stripped systems that ran away from their hosts.



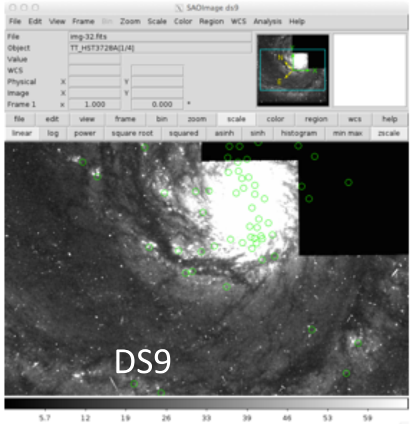
Acknowledgments: The authors are greatful to F. Combes (Observatoire de Paris), I. Katkov (Sternberg Astronomical Institute), and M. Kurtz (Smithsonian Astrophysical Observatory) for useful discussions and critical reading of the manuscript. This result emerged from the tutorial run by the authors at the Astronomical Data Analysis Software and Systems conference in 2012. The authors acknowledge support by the Russian Science Foundation project 14-22-00041 "VOLGA—A View On the Life of GAlaxies.". The project used computational resourses funded by the M. V. Lomonosov Moscow State University Program of Development. This research has made use of Aladin developed by the Centre de Données Astronomiques de Strasbourg; TOPCAT and STILTS software packages developed by M. Taylor; "exploresdss" script by G. Mamon; the VizieR catalog access tool, CDS, Strasbourg, France; and the NASA/IPAC NED, which is operated by the Jet Propulsion Laboratory, California Institute of Technology, under contract with NASA. Funding for the SDSS and SDSS-II has been provided by the Alfred P. Sloan Foundation, the Participating Institutions, the National Science Foundation, the U.S. Department of Energy, NASA, the Japanese Monbukagakusho, the Max Planck Society, and the Higher Education Funding Council for England. The SDSS Web Site is www.sdss.org. GALEX and SDSS databases used in our study are available via the CasJobs web-site http://skyserver.sdss.org/CasJobs.

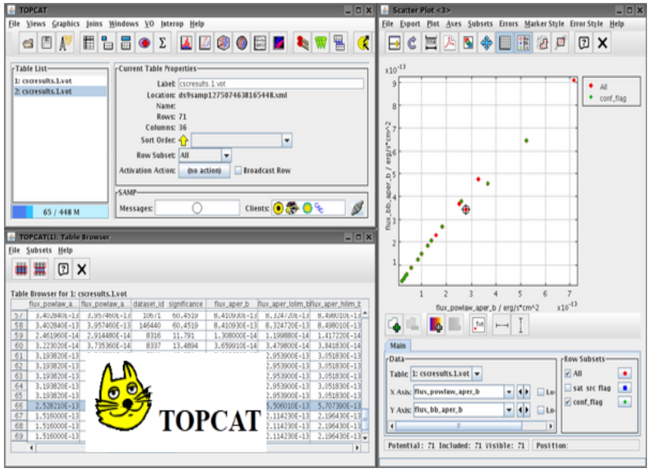
IVOA Successes – ***Seamless*** Science

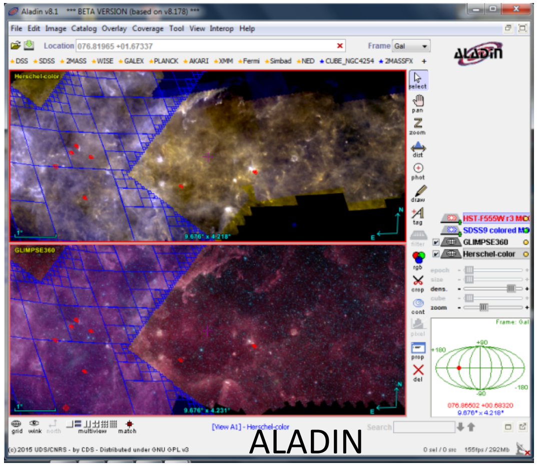
- Un nuovo modello per la ricerca
- Integrated archive – literature - analysis sessions, through
  - IVOA-compliant user interfaces
  - Query protocols
  - SAMP – VO interoperable applications
  - ADS-archive two–way links (e.g. Chandra)

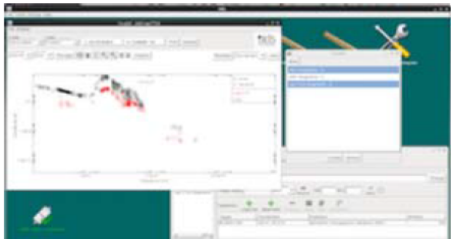
VO interoperable applications

- Topcat, Aladin, VOSpec, SPLAT-VO, Iris, DS9 …

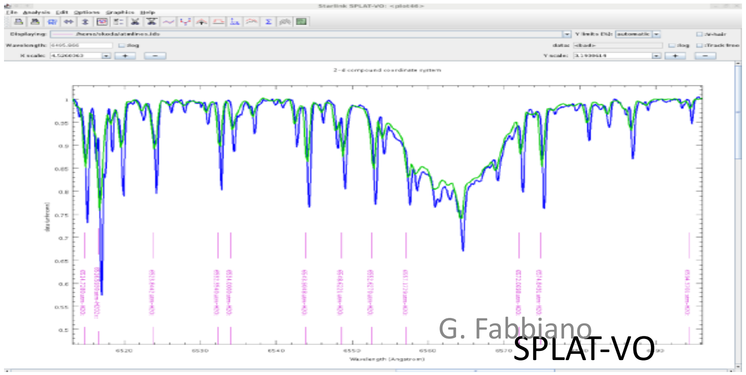


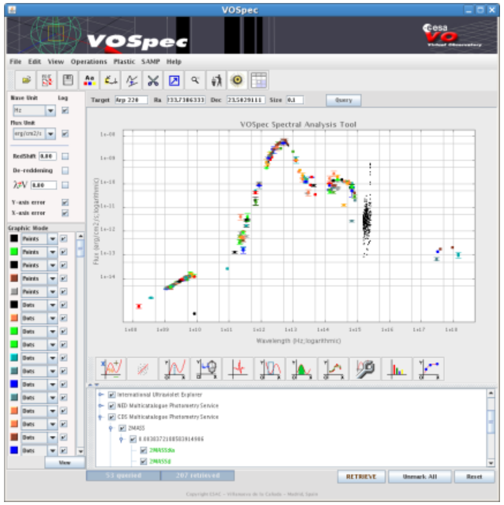




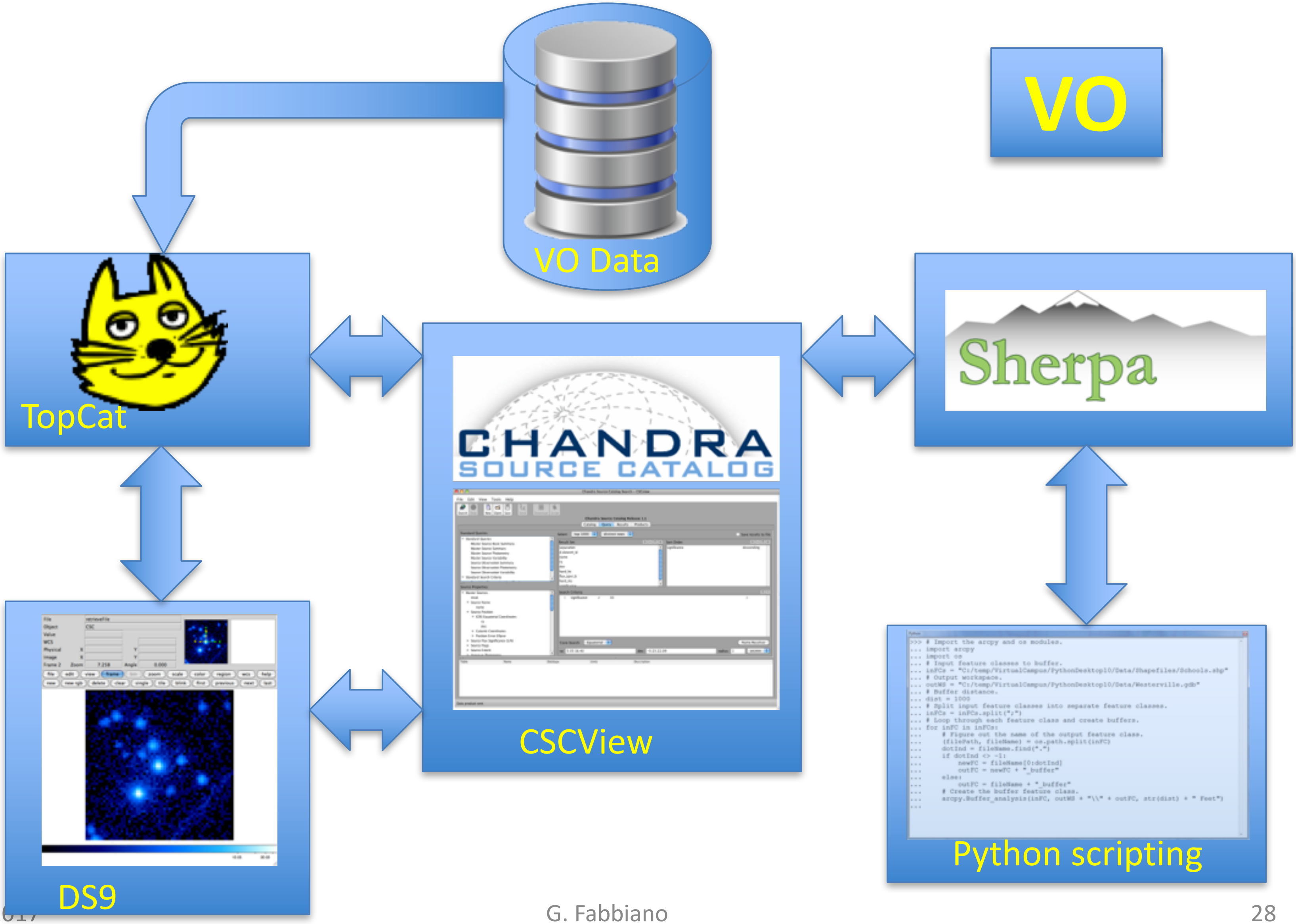


USVOA-IRIS: import, build, display, edit SEDs, fit to models with Sherpa





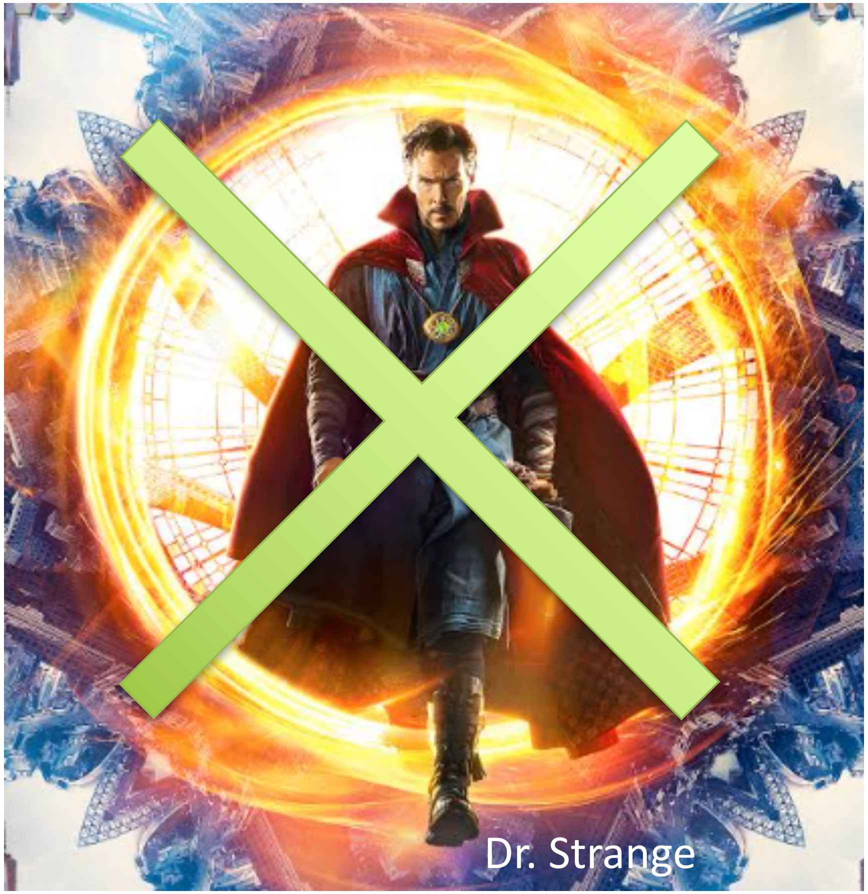
Chandra Source Catalog Thread



```
>>> # Import the arcpy and os modules.
... import arcpy
... import os
... # Input feature classes to buffer.
... inFCs = "C:/temp/VirtualCampus/PythonDesktop10/Data/Shapefiles/Schools.shp"
... # Output workspace.
... outWS = "C:/temp/VirtualCampus/PythonDesktop10/Data/Westerville.gdb"
... # Buffer distance.
... dist = 1000
... # Split input feature classes into separate feature classes.
... inFCs = inFCs.split(";")
... # Loop through each feature class and create buffers.
... for inFC in inFCs:
...     # Figure out the name of the output feature class.
...     (filePath, fileName) = os.path.split(inFC)
...     dotInd = fileName.find(".")
...     if dotInd <> -1:
...         newFC = fileName[0:dotInd]
...         outFC = newFC + "_buffer"
...     else:
...         outFC = fileName + "_buffer"
...     # Create the buffer feature class.
...     arcpy.Buffer_analysis(inFC, outWS + "\\" + outFC, str(dist) + " Feet")
...
```

Chandra Source Catalog Thread

The VO **is not** a Killer Application



Il VO e' un Ecosistema in Evoluzione

- L' IVOA definisce l'ecosistema del VO e gli standard di interoperabilita'
- I telescopi e gli archive in Astronomia costruiscono I servizi e gli strumenti del VO
- Gli elenchi delle risorse del VO, le interfacce degli archivi, e gli strumenti software compatibili col VO rendono accessibili agli astronomi I dati del VO e gli strumenti di visualizzazione ed analisi
- Il miglioramento delle conoscenze medie in ambito technologico ed informatico aiuta la diffusione del VO nella comunita'