

The Virtual Observatory and the IVOA



F. Genova, Interoperability meeting, Moscow,
September 2006



The Virtual Observatory

- Emergence of the Virtual Observatory concept by 2000
- Concerns about the data avalanche, with in mind in particular very large surveys such as the SDSS, statistical analysis, search for diamonds in haystacks, ...
- Based on solid grounds



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The context of astronomy (1)

- Long term observations of variable natural phenomena
- A large number of objects, complex interactions, many scales
- Study of variability, evolution, statistics
- Observations with different techniques, at different scales, have to be put together (ground- and space-based observatories, large surveys)
- Optimization of the scientific return of ‘big science’ (space/ground-based)

The context of astronomy (2)

- A small community
- Few commercial constraints
- Long term partnership for defining standards to describe data and for networking of on-line resources
- Most observatories and instruments installed on telescopes are international collaborations, some are national
- Property rights
 - Data is available after a proprietary period (1 year)
 - Academic journals
 - Table of contents and abstracts freely available
 - Full content in general available after 3 years
 - Some tables immediately available through data centres

Standards and tools in astronomy

- A long pre-VO history!
- FITS
Data from all telescopes
- SIMBAD and NED name resolvers
Translates object names into coordinates or list of references in which the object is cited
Used by most archive services and ADS
- Table description by the journals and VizieR: a homogeneous view of heterogeneous data – data curation, not only data collection

Catalogue description

Catalogues, tables
published in journals,
lists of observations

A single description
standard (physical
description + contents)


Shared by data centres and
journals

Information curation
(authors/journals/data
centres)

CDS: The Catalogue of Catalogues - Mozilla Firefox

http://vizier.u-strasbg.fr/cgi-bin/vizHelp?cats/cats.htx

Windows Mail :: Bienvenue sur ...

 **Catalogues and files available at CDS** 

[CDS](#) · [Simbad](#) · [VizieR](#) · [Aladin](#) · [Catalogues](#) · [Nomenclature](#) · [Biblio](#) · [Tutorial](#) · [Developer's corner](#)

Catalogues and files available at CDS
Version of 03-Jun-2006

- [B. Copies of external databases, regularly updated](#) (17 catalogues)
- [I. Astrometric Data](#) (255 catalogues)
- [II. Photometric Data](#) (240 catalogues)
- [III. Spectroscopic Data](#) (211 catalogues)
- [IV. Cross-Identifications](#) (24 catalogues)
- [V. Combined data](#) (113 catalogues)
- [VI. Miscellaneous](#) (101 catalogues)
- [VII. Non-stellar Objects](#) (210 catalogues)
- [VIII. Radio and Far-IR data](#) (77 catalogues)
- [IX. High-Energy data](#) (28 catalogues)
- Tables from [Astronomy and Astrophysics](#) (1690 catalogues)
- Tables from [Astronomy and Astrophysics Supplement Series](#) (1169 catalogues)
- Tables from [Astronomical Journal](#) (1012 catalogues)
- Tables from [Astronomicheskii Zhurnal \(Russian\)](#) (94 catalogues)
- Tables from [Astrophysical Journal](#) (552 catalogues)
- Tables from [Astrophysical Journal Supplement Series](#) (552 catalogues)
- Tables from [Monthly Notices of the Royal Astronomical Society](#) (464 catalogues)
- Tables from [Publications of the Astronomical Society of Japan](#) (31 catalogues)
- Tables from [Publications of the Astronomical Society of the Pacific](#) (120 catalogues)
- Tables from [Pis'ma v Astronomicheskii Zhurnal \(Astronomy Letters\)](#) (84 catalogues)
- (1 catalogues)
- Tables from [publications from other journals](#) (192 catalogues)

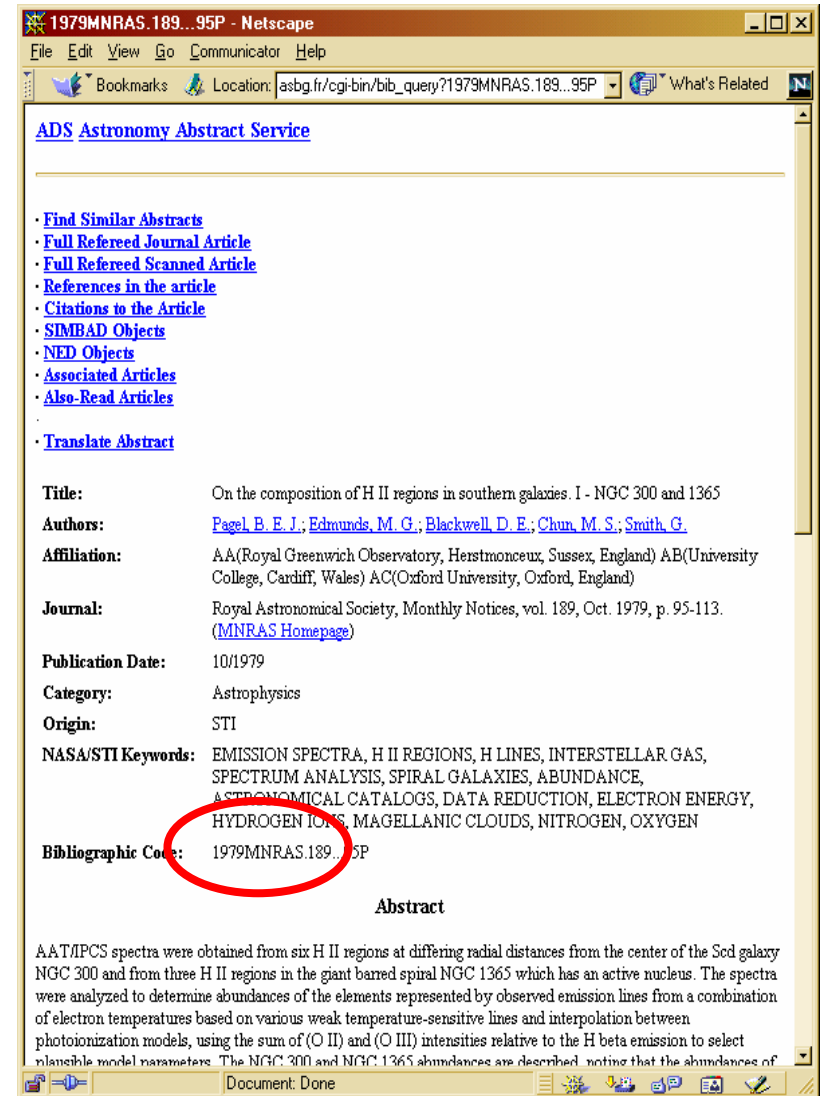
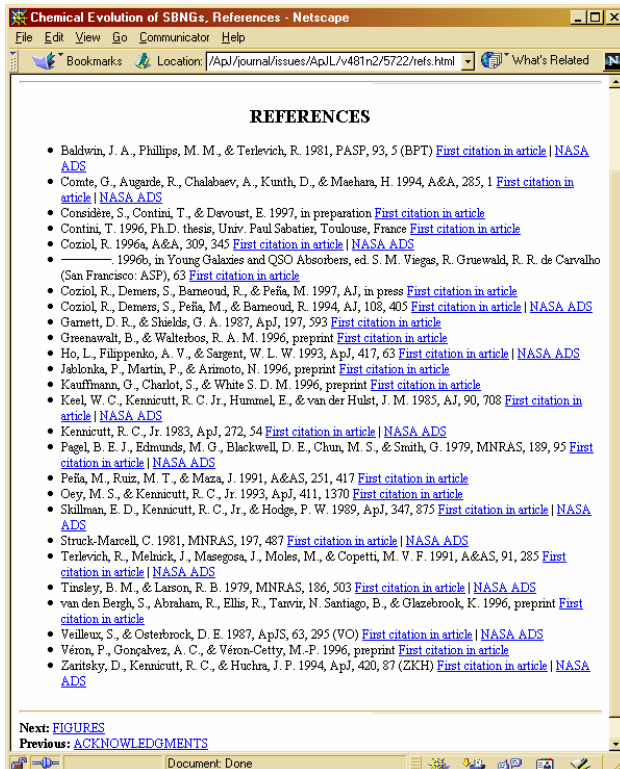
Terminé



Networking on-line resources: the astronomy bibliographic network

- How to code a reference:
 - ***bibcode*** e.g. 1999A&A...351.1003G
 - Defined by NED and SIMBAD before the Internet age, because services shared data
 - Hugely used by ADS
 - Excellent partnership between journals, data centres and observatory archives
- Astronomers have been using the bibliographic network in their daily work for years now, long before agreement among publishers on DOI

Table of contents of an on-line paper To full information about the paper and links in ADS



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ADS/archives/AAS journals

From bibliography

To the original

observations

2000ApJ...544..895G - Netscape

File Edit View Go Communicator Help

Back Forward Reload Home Search Netscape Print Security Shop Stop

[ADS Astronomy Abstract Service](#)

- Find Similar Abstracts
- Full Referenced Journal Article
- On-line Data
- References in the article
- Citations to the Article (3)
- SIMBAD Objects
- Also-Read Articles
- Translate Abstract

Title: STIS Coronagraphic Imaging of the Herbig Ae Star: HD 163296

Authors: [Grady, C. A.](#); [Devine, David](#); [Woodgate, B.](#); [Kimble, R.](#); [Bruhweiler, F. C.](#); [Boggess, A.](#); [Linsky, J. L.](#); [Platt, Philip](#); [Clampin, M.](#); [Kalas, P.](#)

Affiliation: AA(NOA/O/STIS, Goddard Space Flight Center, Code 681, Greenbelt, MD 20771), AB(NOA/O/STIS, Goddard Space Flight Center, Code 681, Greenbelt, MD 20771), AC(Laboratory for Astronomy and Solar Physics, Code 681, NASA/GSFC, Greenbelt, MD 20771), AD(Laboratory for Astronomy and Solar Physics, Code 681, NASA/GSFC, Greenbelt, MD 20771), AE(Institute for Astrophysics and Computational Sciences, Catholic University of America, Washington, DC 20064), AF(Institute for Astrophysics and Computational Sciences, Catholic University of America, Washington, DC 20064), AG(JILA, University of Colorado and NIST, Boulder, CO 80309-0440), AH(Advanced Computer Concepts, Inc., Potomac, MD 20854), AI(Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218), AJ(Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218)

Journal: The Astrophysical Journal, Volume 544, Issue 2, pp. 895-902. ([ApJ Homepage](#))

Publication Date: 12/2000

Origin: UCP

ApJ Keywords: Stars: Circumstellar Matter, Stars: Planetary Systems, stars: individual (HD 163296), Stars: Pre-Main-Sequence

HST Proposal 7565 - Netscape

File Edit View Go Communicator Help

COMPARISON OF PROTOPLANETARY DISKS
HST Proposal 7565

Bruce Woodgate
NASA Goddard Space Flight Center

Cycle: 7
Category: YOUNG STARS AND CIRCUMSTELLAR MATERIAL
Proposal type: GTO/STIS
Status: completed

Information from [PRESTO](#):
[about this proposal](#)
[about other proposals by this PI](#)

Abstract

We will search for planets and disk structures around nearby bright stars, comparing an example of a solar type and a hotter star, each with a main sequence and a pre-main sequence star, using broad band coronagraphic imaging using the STIS CCD. Multiple roll angles will be used to minimize systematic errors and image artefacts. Parallel observations with NICMOS and WF/PC2 will be taken for distant galaxy studies.

ADS links

Papers related to proposal id:

- STIS Coronagraphic Imaging of the herbig Ae Star: HD 163296 -- GRADY,C.A. et al, [2000ApJ...544..895G](#)

Search for relevant abstracts using the [ADS Abstract Service](#)

Author's name

Search on proposal abstract Return

Begin abstract search Reset form



The Virtual Observatory (1)

- From networking to the astronomical Virtual Observatory (integration)

Seamless and transparent query of data centres

New analysis and visualisation tools

A standard structure for data centres to publish their data and services



The Virtual Observatory (2)

- Two colloquia (Pasadena, Garching) in 2000
- The first projects (AstroGrid, AVO, NVO) began in 2001 (also IDHA > Characterisation DM)
- The first Interoperability Working Group was created in 2001, in the frame of the European OPTICON Network, with international participation beyond Europe from the beginning



IVOA pre-history

VOTable

F. Ochsenbein/R.
Williams

(Hot) discussion in
Strasbourg

Agreement in April
2002



2002 January 28th



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IVOA (1)

- Created in June 2002 by an agreement between AstroGrid, AVO, NVO
- Colloquium in Garching
- An alliance of the VO projects to define a common framework
 - High level goals
 - Roadmap and Milestones
 - Interoperability standards

IVOA (2)

- IVOA mission

To facilitate the international coordination and collaboration necessary for the development and deployment of the tools, systems and organizational structures necessary to enable the international utilization of astronomical archives as an integrated and interoperating Virtual Observatory



An International Alliance

- Rotating chair
- Each project has its own goals
- Interoperability standards are the key
 - Working groups
 - Bi-yearly international meetings
- Links with general IT standards: Astronomy group at GGF
- Science demos: relevance and applicability of the standards



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The International Virtual Observatory Alliance - Microsoft Internet Explorer

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Adresse <http://www.ivoa.net/> OK





International Virtual Observatory Alliance

About IVOA	Members	Events	Contacts
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IVOA Events

<i>previous</i>	<i>upcoming</i>
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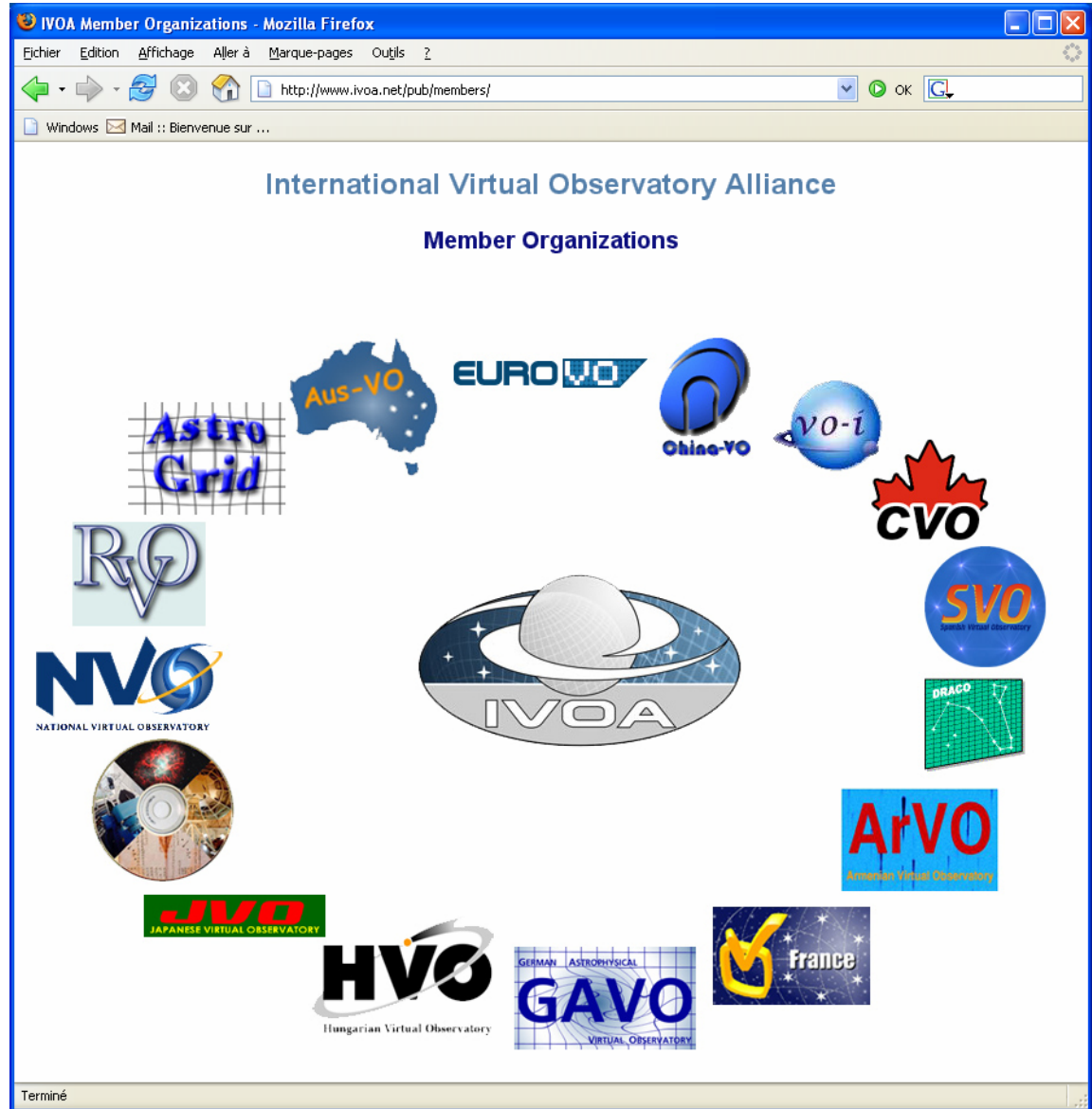
 <p>207th meeting of the american astronomical society 8-12 January 2006 Washington DC final program</p>			
<p>AAS 207th Meeting 8-12 January 2006, Washington, DC, USA</p>	<p>IVOA Interoperability 14-19 May, 2006 Victoria, Canada</p>	<p>IAU XXVI General Assembly, Special Session 3 14-25 August, 2006 Prague, Czech Republic</p>	<p>IVOA Interoperability 18-21 September, 2006 Moscow, Russia</p>



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 India
 Canada
 Spain
 Italy
 Armenia
 France
 Germany
 Hungary
 Japan
 Korea
 USA
 Russia
 UK (AstroGrid)
 Australia



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International
Virtual
Observatory
Alliance

Guidelines for Participation

Version 1.00

IVOA Note 2006 August 17

This version:

<http://www.ivoa.net/Documents/Notes/IVOA/IVOAParticipation-20060817.html>

Latest version:

<http://www.ivoa.net/Documents/latest/IVOAParticipation.html>

Previous version(s):

Based on an Informal document dated 2003-07-01.

Author(s):

R. J. Hanisch and P. J. Guinn

Abstract

This document gives an overview of the goals of the International Virtual Observatory Alliance and describes guidelines for participation

Status of This Document

This is an IVOA Note expressing suggestions from and opinions of the authors. It is intended to share best practices, possible approaches, or other perspectives on interoperability with the Virtual Observatory. It should not be referenced or

National projects

- Each project has its own goals
 - Local data
 - Local expertise
 - Funding agencies' demands
- Very diverse in size and organization, from one single large organization to a network with 'triggering' funds
- Science Reference Missions/Science WG/AC
- New projects are emerging

WebHome - IVOA - i v o a . n e t - Microsoft Internet Explorer

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W/I GROUPS

[Data Access](#)
[Data Model](#)
[GWS](#)
[Query Language](#)

Welcome to the IVOA TWiki!

This is the web-based collaboration area of the **International Virtual Observatory Alliance**



Main topics:

- [Who is Who?](#) • [Events](#) • [Reports & Minutes](#) • [Forums](#) • [Technical Milestones](#)

Working Groups:

- [Resource Registry](#) • [Data Modeling](#) • [VO Event](#) • [Grid & Web Services](#) • [VOTable](#)
- [Semantics](#) • [Data Access Layer](#) • [VO Query Language](#) • [Standards & Processes](#)

Interest Groups:

- [Applications](#) • [Theory](#) • [GGF Astro-RG](#) • [Data Curation & Preservation](#)

List of Initial working Draft documents (version < 1.0): [InitialWorkingDrafts](#)



IVOA Document Standards Version 1.0

IVOA Recommendation 2003 October 24

This version:

<http://www.ivoa.net/Documents/REC/DocStandards/DocumentStandards-20031024.html>

Latest version:

<http://www.ivoa.net/Documents/latest/DocStd.html>

Previous versions:

<http://www.ivoa.net/Documents/REC/DocStandards/DocumentStandards-20030311.html>

<http://www.ivoa.net/Documents/WP/DocStandards/DocumentStandards-20030208.html>

Editors:

R. J. Hanisch, A. E. Linde

Authors:

IVOA Executive Committee

Abstract

This document describes the types of official IVOA documents and the process by which documents are advanced from Working Drafts to formal Recommendations.

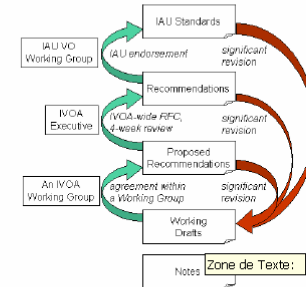
Status of this document

This is a Recommendation.

This document has been produced by the [IVOA Standards & Process Working Group](#). It has been reviewed by IVOA Members and other interested parties, and has been endorsed by the IVOA Executive Committee as an IVOA Recommendation. It is a stable document and may be used as reference material or cited as a normative reference from another document. IVOA's role in making the Recommendation is to draw attention to

1

IVOA Document Standards Process



3 Changes from previous versions


None.

VO standard bearer is
IAU VO WG
being constituted
Chair: Bob Hanisch

IVOA Documents - Microsoft Internet Explorer

http://www.ivoa.net/Documents/

Alliance Documents



[Documents](#) [XML Schema](#) [Templates](#) [Docs Submission](#)

On this page:

[Technical Specifications](#) [Notes](#) [Promotion process](#) [Submission Log](#)

Technical Specifications

Title	Group	Most stable	In progress	Version history						
IVOA Astronomical Data Query Language	VQL	1.01	RFC	1.01	1.00					
IVOA Document Standards	SDP	1.00		1.00	1.00	1.00				
IVOA Identifiers	ReR	1.11	RFC	1.11	1.10	1.10	1.10	1.00		
Maintenance of the list of UCD words	semantics	1.20		1.20	1.20	1.10	1.00			
Resource Metadata for the Virtual Observatory	ReR	1.01	1.10 RFC	1.10	1.10	1.01	1.01	1.00	1.00	
Simple Image Access	DAL	1.00		1.00						
IVOA Single-Sign-On Profile: Authentication Mechanisms	GWS	1.00		1.00						
IVOA SkyNode Interface	VQL	1.01	RFC	1.01	1.00					
Space-Time Coordinate for the Virtual Observatory	DaM	1.21	RFC	1.21	1.20	1.10	1.00			
An IVOA standard for Unified Content Descriptors	semantics	1.10		1.10	1.10	1.06	1.05	1.03		
UCD1+ Controlled Vocabulary	semantics	1.11	1.20	1.20	1.11	1.11	1.10	1.02	1.00	
Sky Event Reporting Metadata (VOEvent)	VOE	1.11	RFC	1.11	1.10	1.01				
VOResource: an XML Encoding Schema for Resource Metadata	ReR	1.01		1.01	1.00					
VOTable Format Specification	VOT	1.10		1.10	1.00					

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Notes

Title	Latest Version
Guidelines for Participation	1.00
Software Licensing Guidelines	1.00
Document Standards Management: Guidelines and Procedures	1.00
The IVOA in 2006: Assessment and Future Roadmap	1.00
The IVOA in 2005: Assessment and Future Roadmap	1.00
Report to the 24th CODATA General Assembly on data activities in the IAU	1.00
Management, Storage, and Utilization of Astronomical Data in the 21st Century	1.00
Virtual Observatory Architecture Overview	1.00
Ranking Query Result Sets	1.00
Design and Implementation of the AstroGrid Workflow system	1.00
Data Model for Astronomical DataSet Characterisation	1.00
Single-Sign-On Authentication for the IVO: introduction and description of principles	1.00
A Proposal for a Common Execution Architecture	1.20
Data Model for Observation	1.00
DAL query Response with Extensions: Use cases and implementation rules. Example of SIAP	1.00
STC-X	1.00
STC-S	1.10
Linear STC	1.00
Data Model serialisation in VOTable	1.00
Proposal for an evolution of the SIA protocol	1.00
Simple Spectral Access for ISO data	1.00
Lessons Learned Using the VOResource XML Schemas in the NVO	1.00

Document promotion process summary

Here is a summary of the document promotion process as described in IVOA Document Standards recommendation.

IVOA Document Standards Process



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Relations with IT

- The VO is science driven and must remain so
- It has to take the best advantage from IT developments
- Lots of interdisciplinary work with the IT community (e.g., ontologies, mediation tools, image processing), but this requires time and effort and we have to build win-win collaborations (good research and test beds for the IT community, aiming at developing operational, sustainable solutions for the VO)
- R&D is required (in particular to make sure that our specific needs are taken into account in IT developments), but when it comes to implementation, we can only use stable operational solutions – adoption of new technologies not too early, not too late – a proper balance between risk and sustainability

Relations with the GRID (1)

- The GRID context has been favourable to the emergence of the VO projects but also an obstacle to discipline-specific, VO-oriented actions in some cases
- VO is a grid of data and services and many aspects do not require usage of the GRID techniques but some do
- VO is well suited with the agencies (at least, Brussels’) trends to develop “Knowledge infrastructure”

Relations with the GRID (2)

- Use of the computational GRID is relevant in particular for massive data analysis, creation and storage of “Virtual Data” – simulated data, theoretical data ...
- A growing community of Grid astronomers (including operational service)
- Bridge between the VO and the GRID

Single Sign-on

Interoperability between GRID implementations (Globus, EGEE, Naregi,...)



VO at IAU in Prague


- IVOA Exec
- Constitution of the IAU Commission 5 WG VO
- Demo booth
- VO Special Session 3
- Also discussions during Special Session 6 on data management

The Virtual Observatory in action - Microsoft Internet Explorer

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Adresse <http://www.ivoa.net/pub/VOScienceIAUPrague/> OK



The Virtual Observatory in action: New science, new technology, and next generation facilities

IAU XXVI General Assembly Special Session 3

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Home

The Virtual Observatory in action: new science, new technology, and next generation facilities

IAU XXVI General Assembly, Special Session 3

Prague, August 17-18 2006

This conference will highlight scientific achievement enabled by the world-wide Virtual Observatory initiatives, review technical progress towards the VO vision, and examine the importance of the VO for future astronomical facilities.

Location and Date

The location for the conference is Prague, The Czech Republic. Our conference is a "Special Session" during the IAU General Assembly which runs through the period August 14-15 2006. Together with a related session on Astronomical Data Management, the VO special session covers 3.5 days in the period Aug 17-22 :

Thursday	Aug 17 pm	SPS3 - VO Science
Friday	Aug 18 all day	SPS3 - VO Science
Monday	Aug 21 all day	SPS3 - VO Science
Tuesday	Aug 22 am	SPS3 - VO Science
Tuesday	Aug 22 pm	SPS6 - Astronomical Data Management

News

The travel grant application deadline has now passed.

As of May 18th, 280 people have registered their intention to attend our conference (out of 1290 in total for the GA), and 25 people have already submitted abstracts (the deadline is June 22nd)



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Adresse http://www.ivoa.net/pub/VOScienceIAUPrague/programme/index.html



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Scientific Programme

- Session I. Introductory Review
- Session II. AGN and galaxies
- Session III. Large Facilities and Data Archives
- Session IV. Stars and galaxies
- Session V. VO Technology and Projects
- Session VI. Large surveys
- Session VII. Solar System science
- Session VIII. VO Applications
- Session IX. Closing Review

VO Science in Prague: Scientific Programme

Thursday August 17, 14:00 through Tuesday August 22, 12:30
Small Theatre

Thursday August 17

Session I. Introductory Review

14:00	The Virtual Observatory : what it is and where it came from	(Invited) A. Lawrence	[ppt]
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Session II. AGN and galaxies

14:30	Large Surveys and the VO	(Invited) K. Kuijken	[ppt]
15:00	A VO study of SDSS AGN with X-ray emission from ROSAT pointed observations	R. Hanisch	[ppt]
15:15	The Hungarian VO	L. Dobos	[ppt]
15:30	Coffee		
16:00	A VO-based solution to the origin of soft X-ray emission in obscured AGN	M. Guinazzi	[ppt]
16:15	Determination of radio spectra from catalogues and identification of GHz peaked sources using the VO	B. Vollmer	[ppt]
16:45	Study on the environment around QSOs with redshift of 1.3 using the IVO system	Y. Shirasaki	[ppt]
18:15	Invited Discourse, Congres Hall The Magnetic Field and its Effects on the Solar Atmosphere as Observed at High Resolution	Alan Title	

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VO Science in Prague : Astronomical Data Management

A closely related "special session" (SPS6) on **Astronomical Data Management** follows on immediately after ours.

Information about SPS6 can found [here](#)

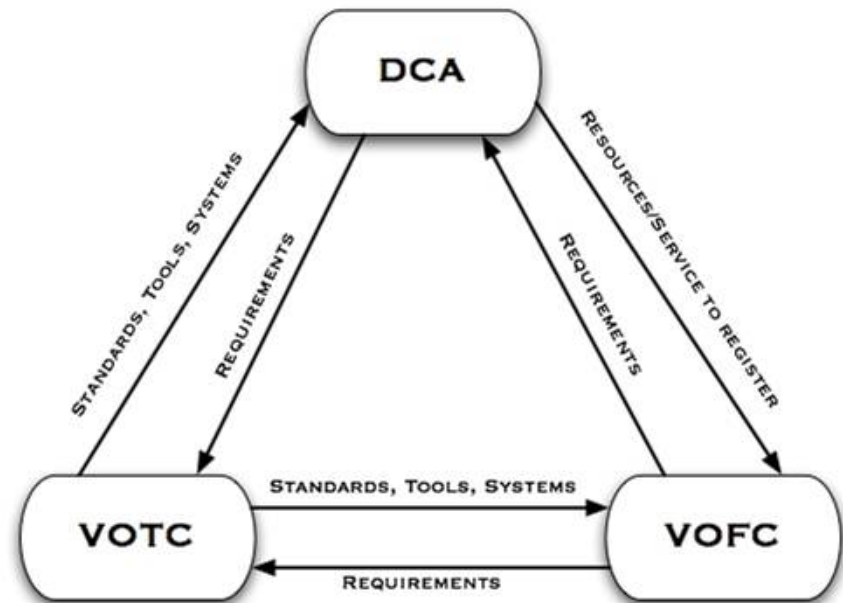
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VO Special Session in Prague

- An excellent overview of the present status of the VO
- In Sydney (2003): expectations and projects
- A very rapid evolution
 - Framework by IVOA, national projects
 - Implementation by data centres has begun
 - Already influences astronomers' work environment: 'science ready' data, services and tools

DCA: Data Centre Alliance
VOTC: Technology Centre
VOFC: Facility Centre



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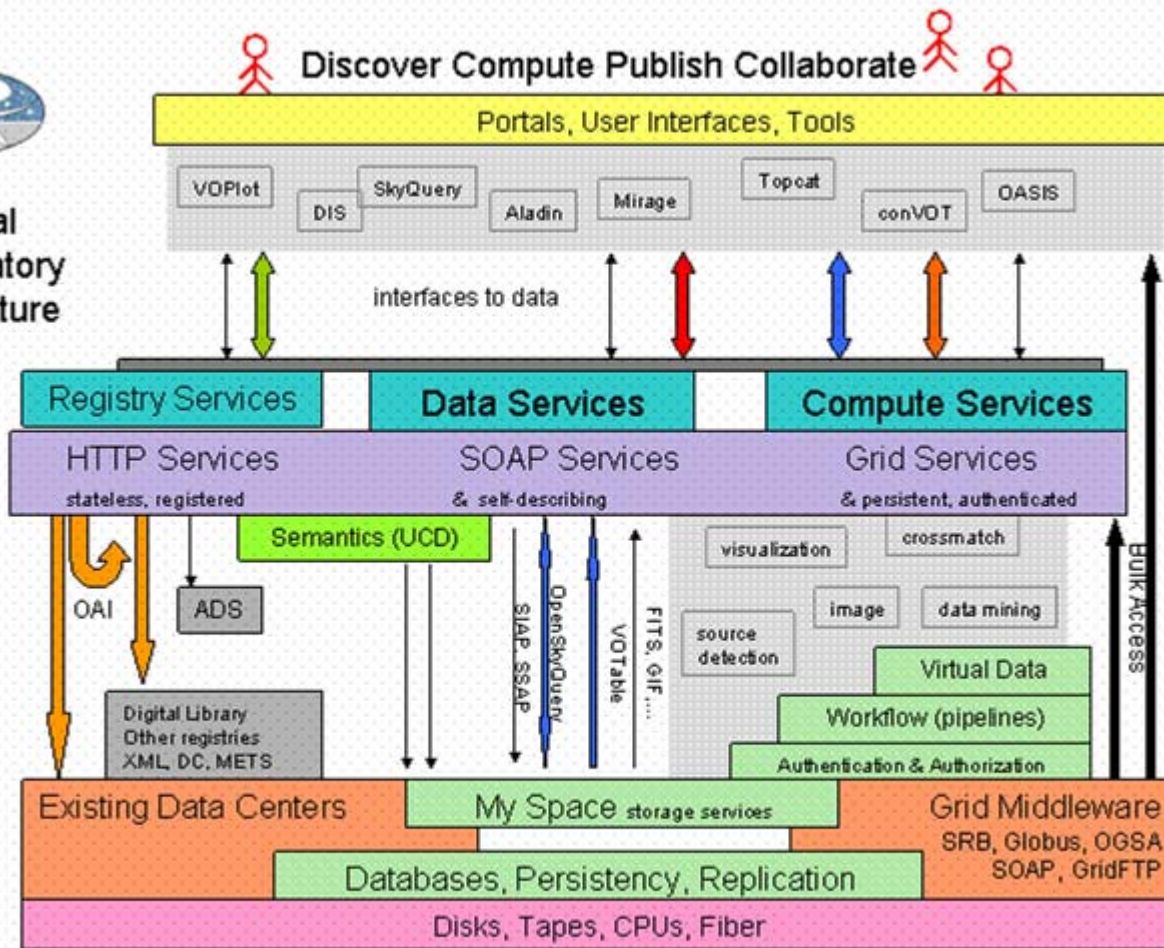


Critical points for IVOA (1)

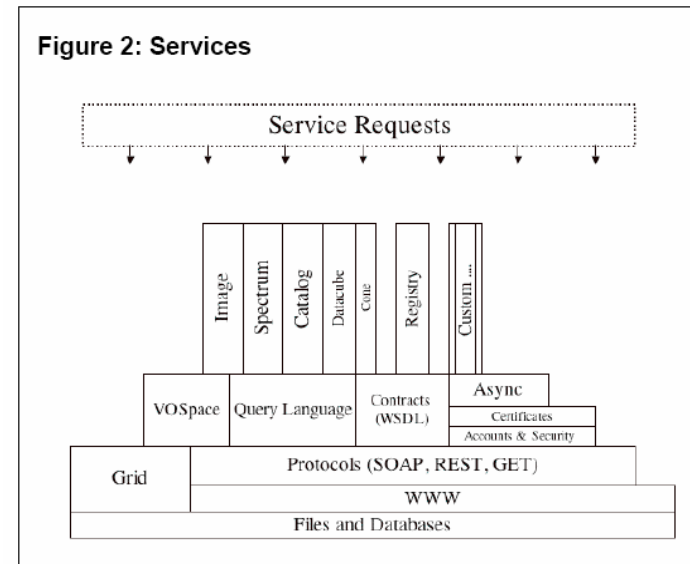
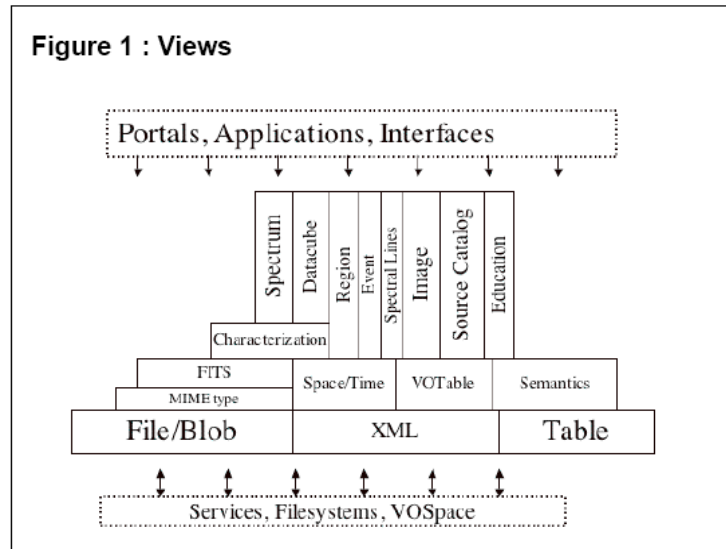
- Implementation has begun
- We need the basic standards!
- Useful and usable standards
- We have to support take-up by data centres, gather implementation feedback, and take it into account
 - Many types of data and service providers, from large agencies to small teams
- New roles for IVOA, national projects?
 - VO compliance assessment?
 - Metadata from data pipelines, theoretical services



Virtual Observatory Architecture

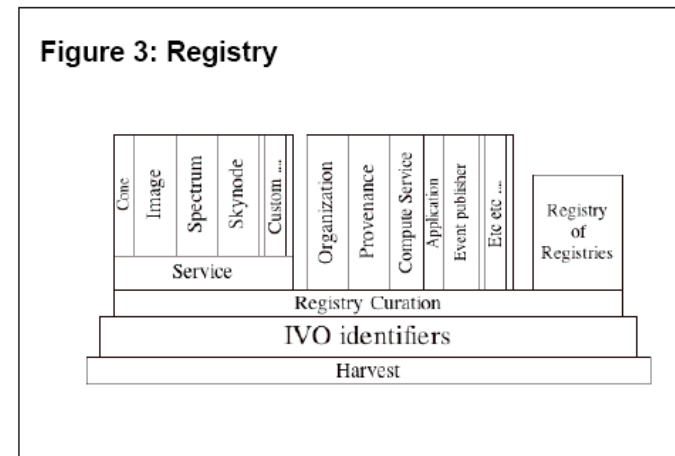


Very diverse data, organized in data models, with semantics



Standard curation information (OAI/Dublin Core)
+ Service definitions

Several harvestable registries from different partners
Several implementations



Critical points for IVOA (2)

- New kinds of services, in particular emergence of theoretical services, providing modelling results, matching models and observations, but also software suites, data analysis tools and algorithms, specific services dedicated to help to study well defined science questions, and full data analysis and research environments – *Applications and Theory Interest Group*

Critical points for IVOA (3)

- Quality is a must and a community concern
- ‘Private’ publication is a risk, quality assessment required
- Who is in charge of quality?

IVOA is not willing nor able at present to be the quality police

National projects have certainly a role to play

Critical points for IVOA (4)

- Not only demos, there are users
 - Multi-wavelength, multi-instrument astronomy – integration of heterogeneous data
 - Comparison between modelling and observations
 - Data analysis
 - Statistical analysis “high fidelity statistics”
 - Search for diamonds in haystacks
 - ...
- All communities are concerned (from users of large surveys to the ‘(not so) old-fashioned stellar spectroscopy’!) – need their requirements, can provide tools
- Diversity of science needs > diversity of portals

Critical points for VO (5)

- How to help users (in particular for advanced usage of tools)?
 - A real role for national projects (help-desk, Euro-VO Facility Centre)
 - A good model: NVO Summer Schools and research grants
 - Also important to target students in astronomy courses
- People will use VO in tools, no acknowledgement in publications, usage statistics

Changing role for IVOA

- 4 years of existence: lessons learnt
- Evolution of the context
- Projects submit proposals for next phases
- Action on the IVOA Exec:

Assessment of goals and organization

Comments are welcome



Message to this meeting

We need the standards!



F. Genova, Interoperability meeting, Moscow,
September 2006

