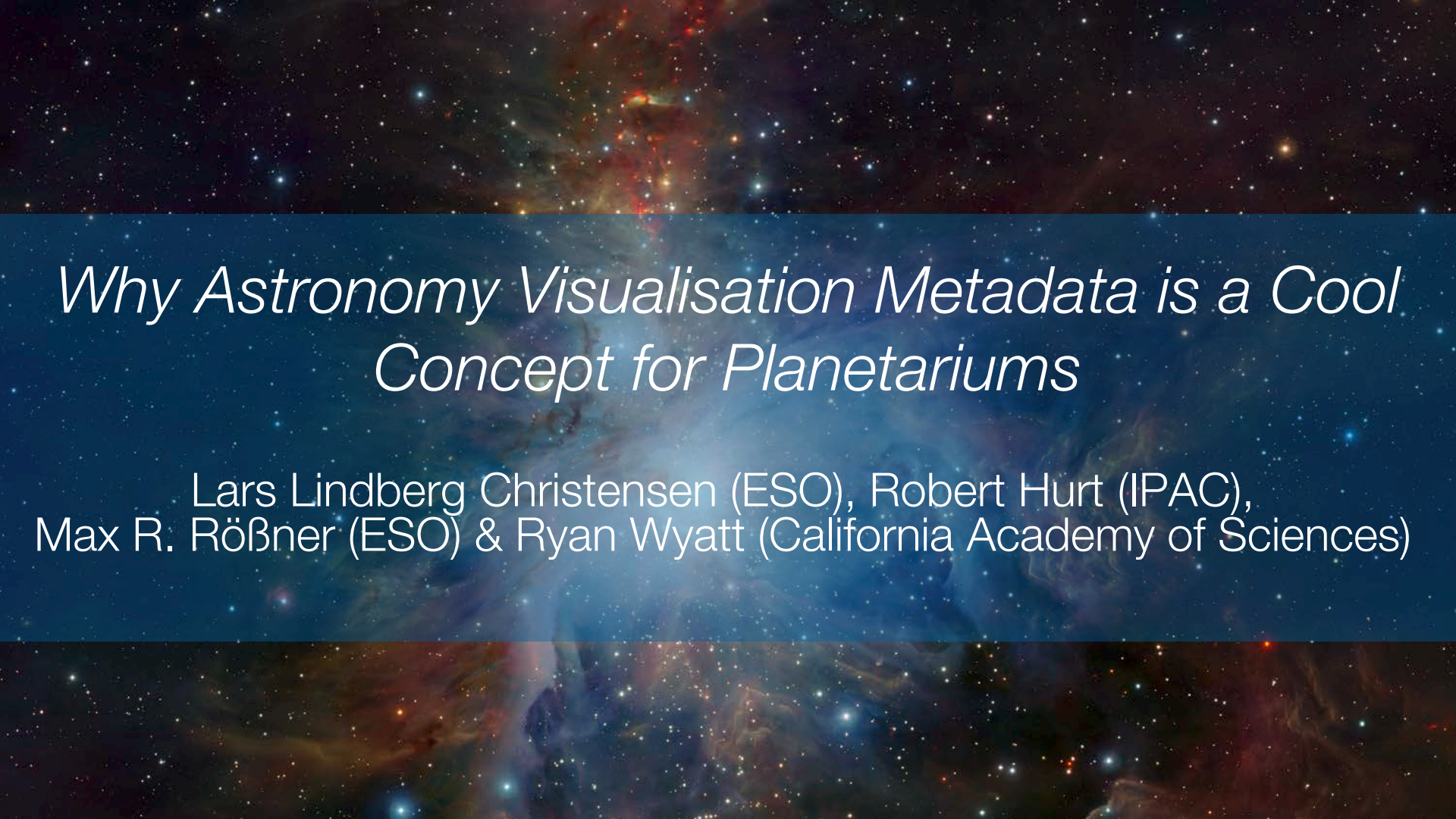
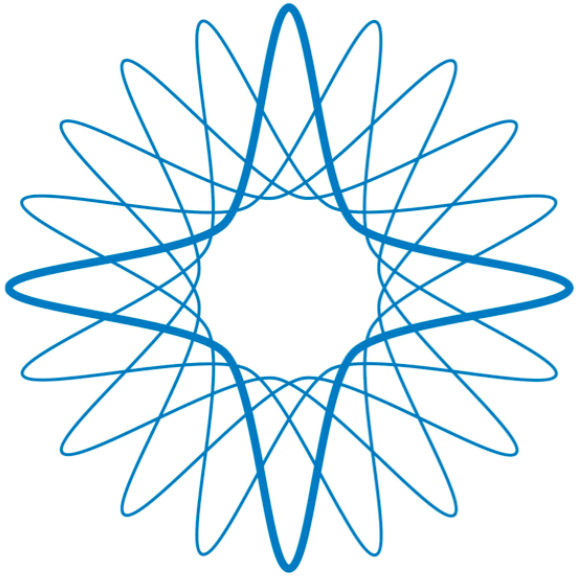


Why Astronomy Visualisation Metadata is a Cool Concept for Planetariums

Lars Lindberg Christensen (ESO), Robert Hurt (IPAC),
Max R. Rößner (ESO) & Ryan Wyatt (California Academy of Sciences)



ESO Supernova

Planetarium & Visitor Centre

supernova.eso.org

A cooperation between ESO and the Heidelberg Institute for Theoretical Studies (HITS), the research institute of the Klaus Tschira Stiftung (KTS)

Klaus Tschira Stiftung gemeinnützige GmbH

KTS

ESO

Heidelberg Institute for Theoretical Studies

HITS

Q4 2017

Why we need to change the way we operate

We want to connect laypeople directly with the scientific discoveries!

The “Chelyabinsk event” needs to be shared as soon after it happens as possible. (24. Data to Dome session)

- By using modern technologies — SQL databases, Internet, push technology, metadata standards, news aggregation…. — the “sky at night” module will change on an almost daily basis to showcase the latest scientific discoveries from ESO, NASA, MPE, MPA, Gemini etc., as well as phenomena in the night sky (events, texts, images, videos)
- We want to be the forerunner with this innovative distribution system, which will all planetariums worldwide to use the same content (a pillar for the ESO Supernova).
- Planetarium presenters world-wide can select interesting news and dataset previews to include in their show segments every morning — an “astronomical weather man”!
- Requested by users in the planetarium community (the International Planetarium Society Science and Data Visualization Task Force).

What is necessary?

1. News aggregation in one database
2. Instant access to fulldome content world-wide
3. Alert the planetariums
4. Menu overview for presenter
5. Historical events, sky events
6. Streamlining educational curricula
7. **Gathering the community around one set of tools and standards: the Astronomy Visualisation Metadata** and the Data2Dome
8. Liberal licensing: Creative Commons Attribution.

Data2Dome and Astronomy Visualisation Metadata: Metadata fully characterising the image resource

What is AVM?

- A standard for tagging digital astronomical images stored as JPEGs, PNGs and TIFFs
- Extends the concept of Extensible Metadata Platform (XMP) headers to include useful astronomical information about:
  - The creator of the image
  - The content (including a description and subject category)
  - The method of observation (the facility, instrument and spectral information)
  - The World Coordinate System (WCS) position in the sky (for “cosmic” images)
  - The publisher of the image
  - And much more …

What is AVM?

Specifically tailored to address the needs and interests of the general public and outreach community, AVM ensures that relevant information is transferred with the image when it is shared with others

The History of AVM

- Conceived by Lars Lindberg Christensen, Robert Hurt, Ryan Wyatt and Adrienne Gauthier
- Proposed by the Virtual Astronomy Multimedia Project — part of the IAU Commission 55/C.2 and the International Virtual Observatory Alliance (IVOA)
- Reached version 1.1 on 14 May 2008 (now in v1.2)

- The standard is currently used to tag images from:
  - NASA's Chandra X-ray Observatory
  - European Southern Observatory (ESO)
  - NASA's Galaxy Evolution Explorer (GALEX)
  - ESA's Herschel Space Observatory via NASA Herschel Science Center
  - NASA/ESA Hubble Space Telescope via STScI & ESA/Hubble
  - NASA's Nuclear Spectroscopic Telescope Array (NuSTAR)
  - ESA's Planck Satellite via Planck U.S. Data Center
  - NASA's Spitzer Space Telescope
  - NASA's Wide-Field Infrared Survey Explorer (WISE)

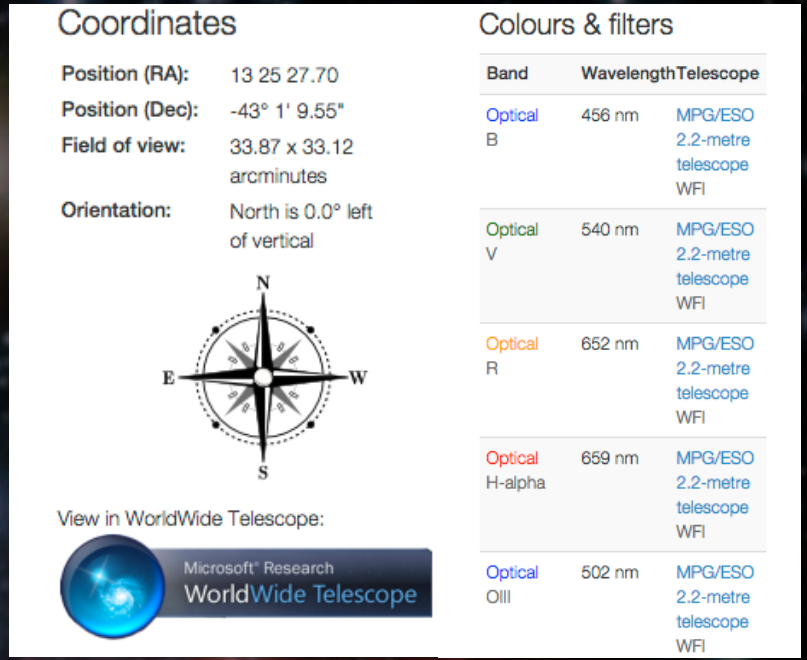
What can AVM be used for?

As well as Spitzer and others, the ESO and ESA/Hubble image galleries have AVM tagging running ”behind the scenes”.

All ESO and Hubble images are now fully tagged (!)

All the information you see on the webpage is also embedded in the highest and medium quality versions of the images (not thumbnails).

This integration allows all of the information to be carried along and used by other applications.

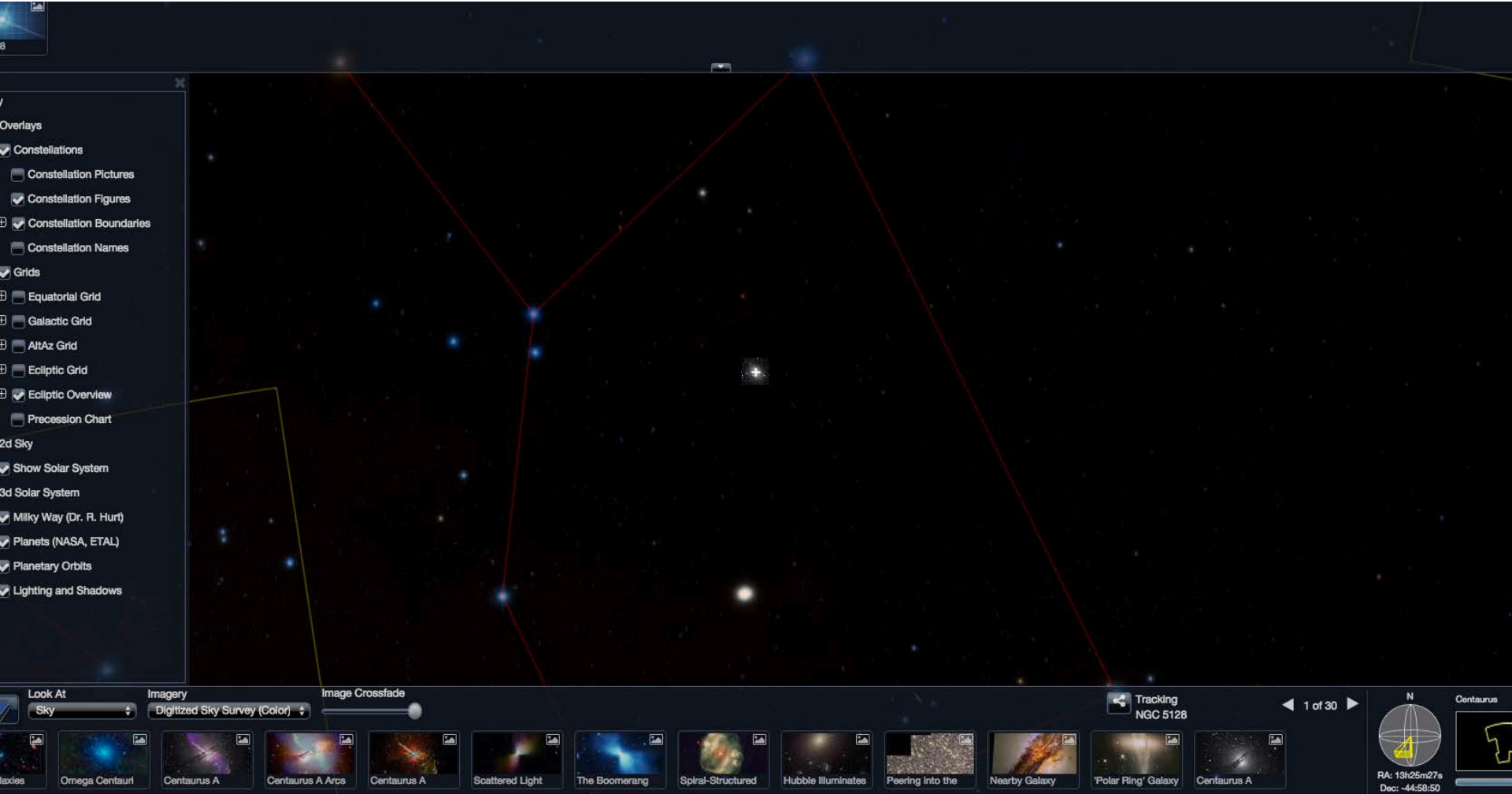


What can AVM be used for?

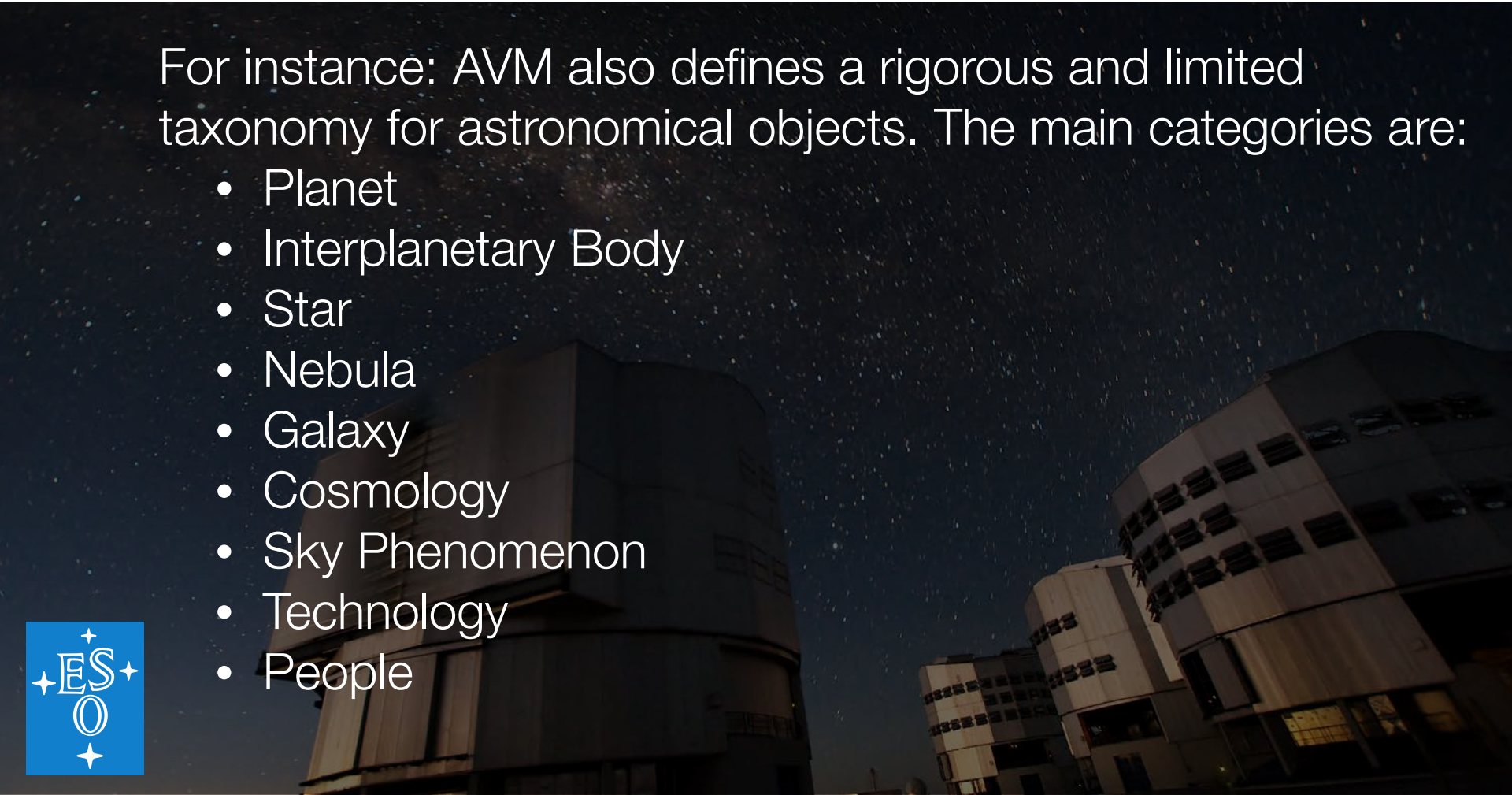
Just a few examples:

- All images taken with — and of — specific telescopes and instruments can be displayed with one click
- World Coordinate System tags can be used to describe the position, orientation, and scale of an image, so that images can be easily used in virtual atlases of the sky and other such applications where coordinates are essential
- Images now have links that take the visitor to Microsoft's WorldWide Telescope
- Images of the same object taken with different telescopes, different wavelengths and at different times can be compared
- Brand-new (or even unpublished) images can be displayed instantly in the right place in the sky

WorldWide Telescope



What is AVM?



For instance: AVM also defines a rigorous and limited taxonomy for astronomical objects. The main categories are:

- Planet
- Interplanetary Body
- Star
- Nebula
- Galaxy
- Cosmology
- Sky Phenomenon
- Technology
- People

So how does this AVM-stuff look?

AVM Tag Name	Format	XMP Tag	Inner Tags	IPTC Equiv.	Related UCD1+	Definition	Comments	Status	Example
Spectral.Band	string-CV, list(s)	<avm:Spectral.Band>	<rdf:Seq><rdf:li>	–	em.[*band*], referring to one of the following: em.radio, em.mm, em.IR, em.opt, em.UV, em.X-ray, em.gamma.	Ordered list identifying the broad regions of the spectrum covered by the observations.	This list specifically includes text controlled vocabulary descriptors of the general part of the electromagnetic spectrum in which the observation was made (e.g. Radio, Optical, Gamma-ray, etc.). See Appendix A for a full discussion of the accepted values in this controlled vocabulary.	Data	X-ray; Optical; Optical; Infrared
Spectral.Bandpass	string, list(s)	<avm:Spectral.Bandpass>	<rdf:Seq><rdf:li>	–	em.[*band*].[*range*] E.g. em.IR.3-4um. See The UCD1+ controlled vocabulary Version 1.23	Ordered list defining the bandpass of the observation.	This free-form string allows the spectral coverage to be identified more precisely. Ideally this should refer to commonly used bandpasses (e.g. B, V, R, I, etc.), specific line excitations or transitions (H-alpha, SIII, CO(3-2), etc.), or if appropriate, instrument specific channels or filters (only if a more general descriptor is not adequate). This tag is intended to help users understand the nature of the observations, but its unrestricted format makes it of little use as a search criterion.		Hard X-ray; B-band; R-band; Mid-IR
Spectral.CentralWavelength	float, list(s)	<avm:Spectral.CentralWavelength>	<rdf:Seq><rdf:li>	–	em.wl.central	Ordered list defining the central wavelengths (in nanometers) of the observations.	This tag identifies the average/central wavelenths in a filter. It does not accommodate range specifications; notations indicating wide/narrow band bandpasses may be added under **Spectral.Bandpass**. Even if exact values are unavailable, approximate wavelengths should still be included when possible.	Data	0.5;440;700;8000
Spectral.Notes	string	<avm:Spectral.Notes>	<rdf:Alt><rdf:li xml:lang="x-default">	–	–	Free-text field to allow for more detailed discussions of bandpasses and color mappings.	Any information that can not be represented in the various Spectral tags can be described in free text in this field. It can also be used with other image types like "Chart" for providing more information on source observations.		X-ray bandpass wavelengths are approximate
Temporal.StartTime	date, list(s)	<avm:Temporal.StartTime>	<rdf:Seq><rdf:li>	–	time.start	Ordered list specifying the start times of the observations.	The date should utilize the ISO 8601 format "yyyy-mm-ddThh:mm" (UT; time portion is optional). This field can be populated from the FITS keyword DATE-OBS. If multiple datasets have been combined from different observint times it is recommended to use the earliest date. This field is intended to give the user a general idea of the onset of observations, not a detailed breakdown of multi-epoch datasets. More detailed information should go into **Spectral.Notes**.		-; 2005-02-05; 2005-02-05; 2004-07-03T12:00
Temporal.IntegrationTime	float, list(s)	<avm:Temporal.IntegrationTime>	<rdf:Seq><rdf:li>	–	obs.exposure	Ordered list specifying the exposure times in seconds.	This should be considered to be an approximate measure of the total length of the observation, but not an indication of the specific ending time (if added to **Temporal.StartTime**). This field can be populated from the FITS keyword EXPTIME.		-; -; -; 240
DatasetID	string, list(s)	<avm:DatasetID>	<rdf:Seq><rdf:li>	–	meta.dataset	Depreacated identifiers for the source FITS dataset for the observations rendered in the image.	This tag was deprecated in AVM 1.2 in favor of a more general ProposalID tag. The suggested format is a VO-compliant reference to the dataset [ivo://AuthorityID/ResourceKey].	Deprecated	
Spatial.CoordinateFrame	string-CV	<avm:Spatial.CoordinateFrame>		–	pos.frame	Coordinate system reference frame.	The coordinate system defines the reference frame to which the coordinates refer. This field can be populated from the FITS keyword: CFRAME. Options include FK5 (celestial J2000), GAL (galactic) etc. See Appendix A for a full discussion of the accepted values in this controlled vocabulary. Default interpretation (if left blank) is ICRS.	WCS-Base	ICRS
Spatial.ReferenceValue	float, list(2)	<avm:Spatial.ReferenceValue>	<rdf:Seq><rdf:li>	–	pos.wcs.crval	Reference coordinates (typically RA and Dec) for the image (2 element list in decimal degrees).	The reference coordinates specify the sky location of a single pixel in the image. The reference frame is specified by **Spatial.CoordinateFrame**. The corresponding pixel in the image is identified in the **Spatial.ReferencePixel** tag.This field can be populated from the FITS keywords: CRVAL1, 2.	WCS-Base	149.11051168; 69.7053749827
Spatial.ReferenceDimension	float, list(2)	<avm:Spatial.ReferenceDimension>	<rdf:Seq><rdf:li>	–	pos.wcs.naxis	Size of the image in pixels (2 element list).	This field specifies the original size of the image for which the WCS applies. Comparing these values to the actual image size allows the same WCS solution to be used with any resized version of the image by proportionally rescaling the **Spatial.ReferencePixel** and **Spatial.Scale**. This field can be populated from the FITS keywords: NAXIS1,2	WCS-Full	4299; 3490
Spatial.ReferencePixel	float, list(2)	<avm:Spatial.ReferencePixel>	<rdf:Seq><rdf:li>	–	pos.wcs.crpix	X,Y coordinates of the pixel in the image to which the reference coordinate (**Spatial.ReferenceValue**) refers (2 element list).	This coordinate is measured relative to the bottom left pixel in the image, which is considered to be the origin of the X,Y grid and has a value of (1, 1). This field can be populated from the FITS keywords: CRPIX1,2; In many common FITS files the reference pixel is not the center pixel in the image.	WCS-Full	922.146820068; 1153.85690308
Spatial.Scale	float, list(2)	<avm:Spatial.Scale>	<rdf:Seq><rdf:li>	–	pos.wcs.scale	Spatial scale of the image in number of degrees/pixel (2 element list).	The scale should follow the standard FITS convention for sky projections in which the first element is negative (indicating increasing RA/longitude to the left) and the second is positive. In practice, only the absolute value of the first term should be necessary to identify the pixel scale since images should always be presented in an undistorted 1:1 aspect ratio as they appear in the sky when viewed from Earth.This field can be populated from the FITS keywords: CDELT1, CDELT2 (or derived from CD matrix).	WCS-Full	-4.1635027032331E-05; 4.1635027032331E-05
Spatial.Rotation	float	<avm:Spatial.Rotation>		–	–	Position angle of the Y axis in degrees measured east (counter-clockwise) from north.	This angle identifies how the vertical axis of the reference coordinate frame is orientated on the image as it is displayed with respect to the reference pixel. This rotation is measured east from north which, for astronomical images, is counter-clockwise (in sky projections, East is to the left of North). This field can be populated from the FITS keywords: CROT/CROTA1/CROTA2.	WCS-Full	49.936065630295
Spatial.CoordsystemProjection	string-CV	<avm:Spatial.CoordsystemProjection>		–	pos.wcs.ctype	The geometric projection of the image.	Typical projections include "TAN" (tangent), "SIN" (sine), "CAR" (equirectangular) and "AIT" (AITOFF equal-area all-sky), among others. This keyword is derived from the contents of the standard FITS Keywords: CTYPE1,2. See Appendix A for a full discussion of the accepted values in this controlled vocabulary.	WCS-Full	TAN

And the XMP schema?

<?xpacket begin="" id="W5M0MpCehiHzreSzNTczkc9d"?>
<x:xmpmeta xmlns:x="adobe:ns:meta/" x:xmptk="Adobe XMP Core 5.0-c060 61.134777, 2010/02/12-17:32:00 ">
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ETC ETC

What is AVM?

Elements of AVM:

- Interactive Tagging Tools
  - Photoshop XMP Panels
  - FITS Liberator
  - Web-based AVM form (customisable for local needs)
- WCS Recovery Utilities
  - WorldWide Telescope
  - PinpointWCS
  - Aladin
  - Astrometry.net
- Web and Scripting Resources
  - EXIFTool extensions
  - Python Library (PyAVM)
- Online Registry/Archive
  - IRSA ASTROPIX Archive

What can AVM be used for?

- The AstroPix database of astronomical images makes use of the AVM tags to offer access to collected image libraries of many of the leading astronomical observatories under a single unified interface
- Currently contains almost 8000 AVM-tagged images and counting
- Several planetarium softwares support AVM:

Package	Status
Powerdome	Partly implemented
Uniview	Planned for implementation
Digistar	Implemented
OpenSpace	Planned for implementation
SkyExplorer	Unclear
Dark Matter	Implemented
World Wide Telescope	Implemented
Mitaka	Not supported
Stellarium	Partly implemented
Redshift	Implemented
Starry Night	Implemented
Aladin	Implemented
WikiSky	Implemented
DS9	Implemented

AstroPix

AstroPix beta
Share the Universe

About Browse Advanced Search Search

Digitized Sky Survey Image of the Eagle Nebula

April 30th, 2015 eso_eso1518e

Credit: ESO/Digitized Sky Survey 2. Acknowledgment: Davide De Martin.

This image is a colour composite of the Eagle Nebula (M 16) made from exposures from the Digitized Sky Survey 2 (DSS2). The field of view is approximatelly 3.8 x 3.3 degrees.

Image Source: http://www.eso.org/public/images/eso1518e/

Curator: European Southern Observatory, Garching bei München, Germany

Image Use Policy: Creative Commons Attribution 3.0 Unported license.

View Options

Fullscreen View in WorldWide Telescope

Download Options

320 x 273 (21.9 KB)
500 x 428 (46.2 KB)
1024 x 876 (214 KB)
1280 x 1095 (353 KB)
1600 x 1369 (580 KB)
3000 x 2568 (2.1 MB)
6000 x 5137 (7.17 MB)
12000 x 10274 (20.5 MB)
13749 x 11772 (26.4 MB)

Image Details

Image Type
Observation
Object Name
Eagle Nebula • M 16 • Messier 16
Subject - Milky Way
Nebula » Type » Star Formation

Position Details

Position (ICRS)
RA = 18h 18m 47.1s
DEC = -13° 51' 9.8"
Orientation
North is 5.8° CCW
Field of View
3.8 x 3.3 degrees
Constellation
Serpens

Color Mapping

Telescope	Spectral Band	Wavelength
Digitized Sky Survey 2 (None)	Optical (B)	-
Digitized Sky Survey 2 (None)	Infrared (I)	-

What can AVM be used for?

AVM is also relevant for artist‘s concepts and diagrams, simulations, and photography, and is only the first step in a future effort to encompass all multimedia products related to astronomy, including videos and podcasts

supernova.eso.org/ips