

vamp
VIRTUAL ASTRONOMY
MULTIMEDIA PROJECT

A VM Users Guide For Tagging Imagery

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Introduction

This guide is for those who wish to start tagging their astronomical image collections with Astronomy Visualization Metadata (AVM) using the XMP standard. We are in the process of investigating and developing stand-alone (i.e., no Photoshop or Bridge) tools for tagging and embedding the XMP data into the header of an image.

For more information on the projects:

Virtual Astronomy Multimedia Project (VAMP): <http://virtualastronomy.org>

AVM Version 1.1: http://virtualastronomy.org/avm_metadata.php

Resources

VAMP: <http://virtualastronomy.org>

AVM: http://virtualastronomy.org/avm_metadata.php

AVM Version 1.1: http://virtualastronomy.org/AVM_Version1.1May312008.pdf

FITS Liberator: http://www.spacetelescope.org/projects/fits_liberator/index.html

Technology needed

- Internet browser & internet access
- Adobe Photoshop or Adobe Bridge
- Text editor
- Admin permissions on your computer

STEP 1: Get XMP Panels for AVM

1. Download and save the XMP panels (individual .txt files or .zip files) :
http://www.virtualastronomy.org/avm_metadata.php#5
2. Unzip file into a folder (location does not matter), you should have 5 txt files:
 - AVM-1-Creator.txt
 - AVM-2-Content.txt
 - AVM-3-Observation.txt
 - AVM-4-Coordinates.txt
 - AVM-5-Publisher.txt
3. Copy & paste the 5 .txt files into the folder(s) specified below.

For Mac OS X - 2 locations (user dependent)

- {Root Volume}/Library/Application Support/Adobe/XMP/Custom File Info Panels
This path should work for all users.
- {Home Directory}/Library/Application/Adobe/XMP/Custom File Info Panels
This path is for a specific user.

Windows (XP)* – 2 locations (user dependent)

- \Program Files\Common Files\Adobe\XMP\Custom File Info Panels
This path should work for all users.
- \Documents and Settings\<user>\Application Data\Adobe\XMP\Custom File Info Panels
This path is for a specific user.

Windows Vista* – 1 location only

- \Program Files\Common Files\Adobe\XMP\Custom File Info Panels

By placing the XMP panels in these specific locations, they will be available in the File Info dialog box in both Adobe Photoshop and Adobe Bridge. Depending on your system, it may also make them available in other Adobe Creative Suite applications.

For more detailed information from Adobe on XMP Panels, please see:

<http://www.adobe.com/products/xmp/custompanel.html>

Note: If you have FITS Liberator Version 2.1 installed, then you may have a slightly older version of the AVM XMP Panels. You can replace with this newer version of the File Info panels referenced above.

* A common Windows error can occur. The user account you are logged in as needs to have Administrator privileges, else an administrator on that machine needs to change the permissions on the Adobe program folders to allow modification of the contents. We have fewer problems with Vista finding/accessing the AVM panels if you change the Custom File Info Panels to have “Full” rights for all users on the machine. If you need to make this change, follow it by logging out and logging back in with your user account so the folder permission changes are recognized by Bridge/Photoshop.

STEP 2: Resolve WCS information

If your images (JPEGs, TIFFs, etc.) do not have WCS information, you should try to resolve it. Images with WCS information can be placed into celestial sky grids and can be found with cone searches. Images do not need WCS information to successfully submit to VAMP.

We strongly recommend an online WCS resolving tool, Astrometry.net at <http://www.astrometry.net>. You can sign up to be an alpha tester here: <http://astrometry.net/use.html>. Please contact Adrienne (agauthier@as.arizona.edu) if you are not given alpha tester status.

If an image resolves on Astrometry.net, you will receive the WCS data on your image as information on a webpage and also as a FITS header. You can open the FITS header in most all text editor programs to extract the relevant information for the AVM. Please note that the FITS header will not open in FITS Liberator (it needs an actual image).

Sample Astrometry.net Results Using Crimson Editor:

```
newheader.fits  wcs.fits
SIMPLE = T / Standard FITS file
NAXIS = 0 / Minimal header
CTYPE1 = 'RA---TAN-SIP' / TAN (gnomic) projection + SIP distortions
WCSAXES = 2 / no comment
LONPOLE = 180.0 / no comment
CRVAL1 = 185.626572619 / RA of reference point
CRPIX1 = 468.256660461 / X reference pixel
CUNIT1 = 'deg' / X pixel scale units
CD1_1 = 0.000198049690457 / Transformation matrix
CD2_1 = -2.55442103347e-06 /
A_ORDER = 2 / Polynomial order, axis 1
A_1_1 = -5.53663153506e-07 / no comment
B_ORDER = 2 / Polynomial order, axis 2
B_1_1 = -4.84548253357e-07 / no comment
AP_ORDER = 2 / Inv polynomial order, axis 1
AP_0_2 = -4.89163835336e-07 / no comment
AP_1_1 = 5.55013529888e-07 / no comment
BP_ORDER = 2 / Inv polynomial order, axis 2
BP_0_2 = 6.98227094304e-07 / no comment
BP_1_1 = 4.83337092178e-07 / no comment
IMAGEW = 1600 / Width of the image used to solve this WCS.
WCS. DATE = '2007-07-10T10:45:41' / Date this file was created.
HISTORY For more details, see http://astrometry.net .
HISTORY svn+ssh://astrometry.net/svn/trunk/src/quads/

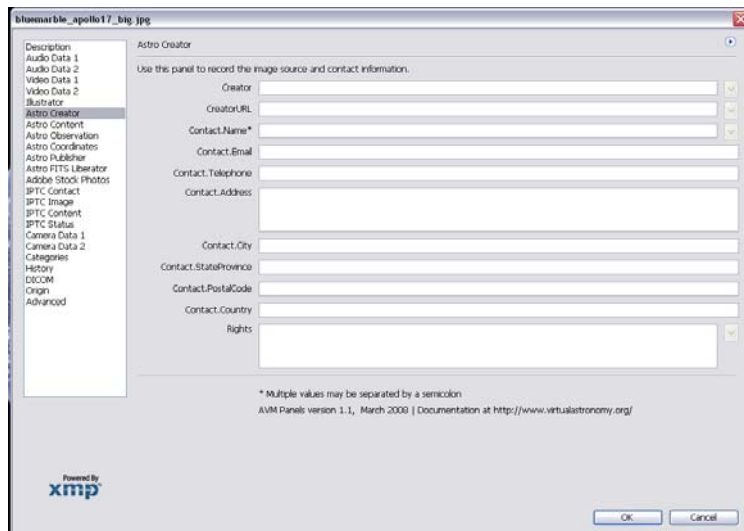
EXTEND = T / There may be FITS ext
CTYPE2 = 'DEC--TAN-SIP' / TAN (gnomic) projection + SIP distortions
EQUINOX = 2000.0 / Epoch (yr) of celestial coordinates
LATPOLE = 0.0 / no comment
CRVAL2 = 15.7983140352 / DEC of reference point
CRPIX2 = 779.977218628 / Y reference pixel
CUNIT2 = 'deg' / Y pixel scale units
CD1_2 = -2.44096652004e-06 /
CD2_2 = -0.000198281089074 /
A_0_2 = 4.89517602105e-07 / no comment
A_2_0 = -6.85641398767e-07 / no comment
B_0_2 = -6.97971511399e-07 / no comment
B_2_0 = 5.72869829622e-07 / no comment
AP_0_1 = 8.4598765808e-08 / no comment
AP_1_0 = 2.65771477038e-07 / no comment
AP_2_0 = 6.85785895954e-07 / no comment
BP_0_1 = 1.96123983988e-07 / no comment
BP_1_0 = -6.93933560875e-08 / no comment
BP_2_0 = -5.7360632073e-07 / no comment
IMAGEH = 1200 / Height of the image used to solve this
HISTORY Created by the Astrometry.net suite.
HISTORY Subversion URL
HISTORY Subversion revision 4138
```

STEP 3a: Basic: Add AVM Tags

To add AVM tags you can use either Adobe Photoshop or Adobe Bridge. The File Info Panels are the same.

This is a general basic method for adding AVM to individual images. Please see the Advanced Techniques for making templates and adding AVM to groups of images using fewer steps.

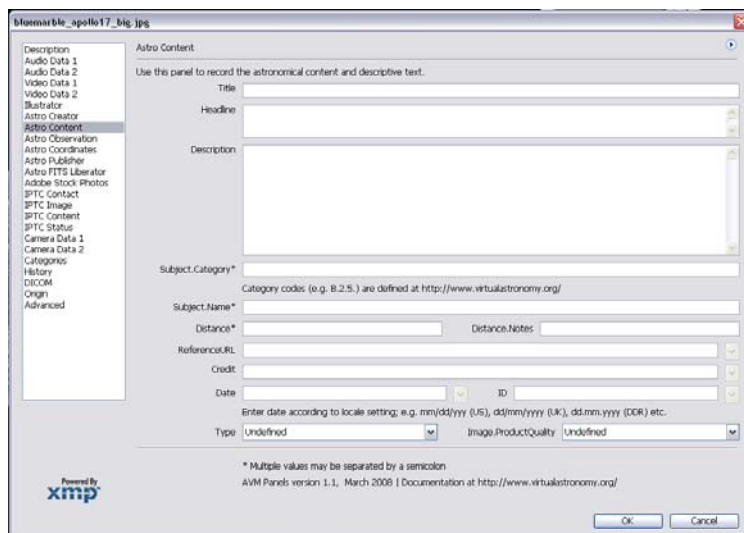
1. Open the image file in Photoshop or navigate to the folder in Bridge and select the image to be your active file.
2. Open the File Info Dialog by choosing from the top menu: File > File Info (same in Photoshop and bridge)
3. The File Info XMP Panels come up, and you will see the 5 AVM panels (Astro Creator, Astro Content, Astro Observation, Astro Coordinates, Astro Publisher) listed on the left. These are the only 5 panels you should be using for the AVM.



The screenshot shows the 'Astro Creator' panel in the File Info dialog. The panel title is 'Astro Creator' and it contains the following fields: Creator, CreatorURL, Contact.Name*, Contact.Email, Contact.Telephone, Contact.Address, Contact.City, Contact.StateProvince, Contact.PostalCode, Contact.Country, and Rights. A note at the bottom states: '* Multiple values may be separated by a semicolon. AVM Panels version 1.1.1, March 2008 | Documentation at <http://www.virtualastronomy.org/>'.

AVM tags on Creator panel

Creator
CreatorURL
Contact.Name
Contact.Email
Contact.Telephone
Contact.Address
Contact.City
Contact.StateProvince
Contact.PostalCode
Contact.Country
Rights



The screenshot shows the 'Astro Content' panel in the File Info dialog. The panel title is 'Astro Content' and it contains the following fields: Title, Headline, Description, Subject.Category*, Subject.Name*, Distance*, Distance.Notes, ReferenceURL, Credit, Date, ID, Type, and Image.ProductQuality. A note at the bottom states: '* Multiple values may be separated by a semicolon. AVM Panels version 1.1.1, March 2008 | Documentation at <http://www.virtualastronomy.org/>'.

AVM tags on Content panel

Title
Headline
Description
Subject.Category
Subject.Name
Distance
Distance.Notes
ReferenceURL
Credit
Date
ID
Type
Image.ProductQuality

Astro Observation

Use this panel to record information about all observations contributing to an astronomical image.

Facility*

Instrument*

Spectral.ColorAssignment*

Spectral.Band*

Spectral.Bandpass*

Spectral.CentralWavelength*

Spectral.Notes

Temporal.StartTime*

Temporal.IntegrationTime*

DatasetID*

* Ordered values for each channel of a composite should be separated by a semicolon
AVM Panels version 1.1, March 2008 | Documentation at <http://www.virtualastronomy.org/>

AVM tags on Observation panel

Facility
Instrument
Spectral.ColorAssignment
Spectral.Band
Spectral.Bandpass
Spectral.CentralWavelength
Spectral.Notes
Temporal.StartTime
Temporal.IntegrationTime
DatasetID

Astro Coordinates

Use this panel to record WCS coordinates (e.g. RA, Dec) for astronomical observations.

Spatial.CoordinateFrame

Spatial.Equinox

Spatial.ReferenceValue*

Spatial.ReferenceDimension*

Spatial.ReferencePixel*

Spatial.Scale*

Spatial.Rotation*

Spatial.CoordsystemProjection

Spatial.Quality

Spatial.Notes

Spatial.FITSHeader

Spatial.CDMatrix*

Spatial.CDMatrix has been deprecated in AVM 1.1; it is included here only for 1.0 backwards compatibility.

* Multiple values may be separated by a semicolon
Note that rotation/cropping/resizing of an image will invalidate any WCS solution.
AVM Panels version 1.1, March 2008 | Documentation at <http://www.virtualastronomy.org/>

AVM tags on Coordinates panel

Spatial.CoordinateFrame
Spatial.Equinox
Spatial.ReferenceValue
Spatial.ReferenceDimension
Spatial.ReferencePixel
Spatial.Scale
Spatial.Rotation
Spatial.CoordsystemProjection
Spatial.Quality
Spatial.Notes
Spatial.FITSHeader
Spatial.CDMatrix (deprecated tag)

Astro Publisher

Use this panel to identify the publisher/provider of this resource (may be different than the creator).

Publisher

PublisherID

ResourceID

ResourceURL

RelatedResources*

MetadataDate

MetadataVersion

Publisher IDs will be assigned once the VAMP Archive Service is running.

This should be a unique URL for the online image file.

Enter date according to locale setting: e.g. mm/dd/yyyy (US), dd/mm/yyyy (UK), dd.mm.yyyy (DDR) etc.

* Multiple values may be separated by a semicolon
AVM Panels version 1.1, March 2008 | Documentation at <http://www.virtualastronomy.org/>

AVM tags on Publisher panel

Publisher
PublisherID
ResourceID
ResourceURL
RelatedResources
MetadataDate
MetadataVersion (you should be tagging version 1.1)

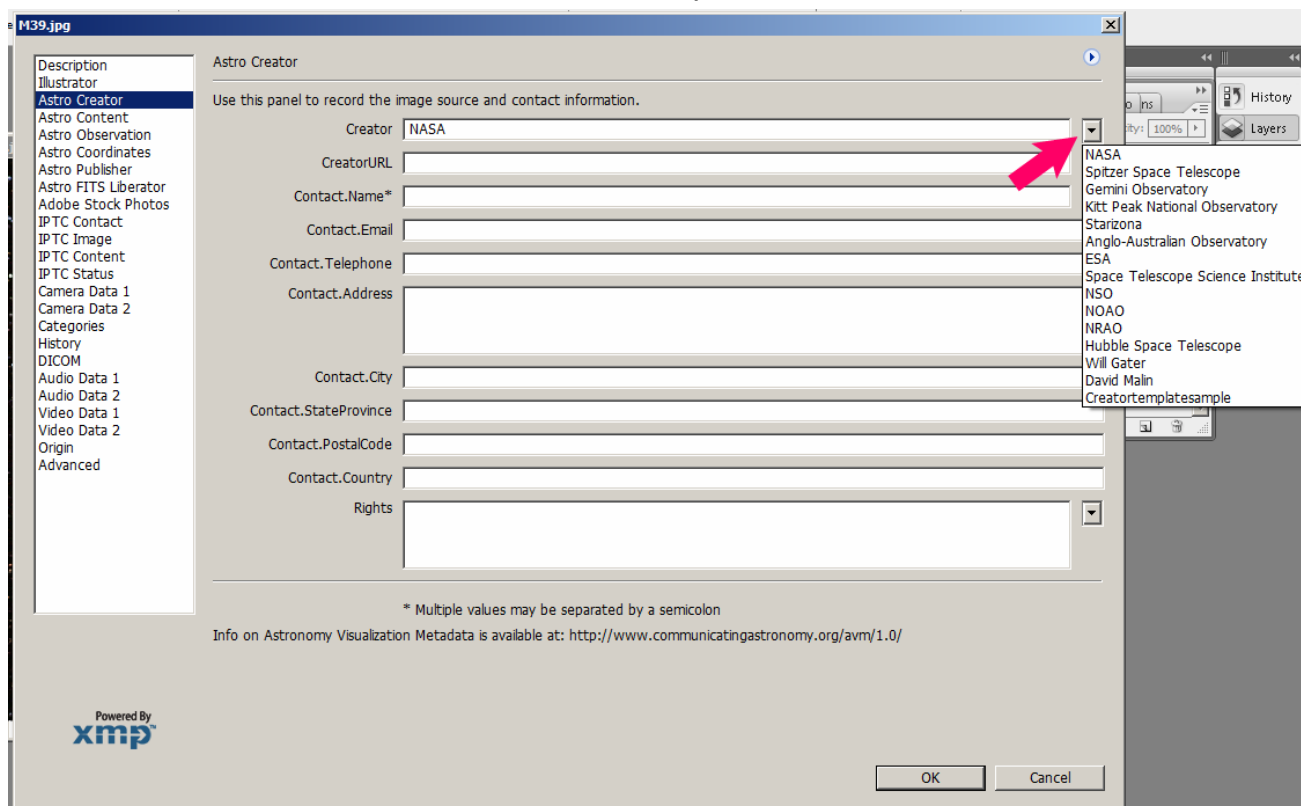
- Manually enter in the metadata for the fields. Please refer to the latest AVM document (Version 1.1) as a guide: http://virtualastronomy.org/avm_metadata.php
- Click OK when finished. Save the file to save the metadata entered. The AVM is now written into the header of the image via the XMP standard.

STEP 3b. Advanced Techniques

These little gems may make your tagging work a little bit easier to tag image en mass, but certainly not as easy as having a standalone web application for creating/attaching XMP files to images. We hope to have a standalone XMP AVM application built soon.

Cached Data

Some of the AVM fields in the File Info Dialog will cache the last 15 entries for that field. If the field caches, it will have a triangle/arrow next to the data entry field. When you select the arrow, you will see the last 15 entered values. From there, you can select a value to auto-place in the field. This cached data is user account dependent.



If for some reason you'd like to clear this cache of values or fill it quickly you can manually edit the XML file. Only do this if you are familiar with XML and have a good editor program to auto-format the page for easy readability. If you are familiar with XML files, once you open it you will be able to see where to edit/add/delete data.

Path of the file in Mac:

{user}/Library/Preferences/Adobe/XMP/FileInfoLibPrefs.txt

(or search for FileInfoLibPrefs.txt to find the location if not where expected)

Path of the file in Windows XP:

Documents and Settings\{user}\Application Data\Adobe\XMP\FileInfoLibPrefs.txt

Path of the file in Windows Vista:

Users\{user}\AppData\Roaming\Adobe\XMP\FileInfoLibPrefs.txt

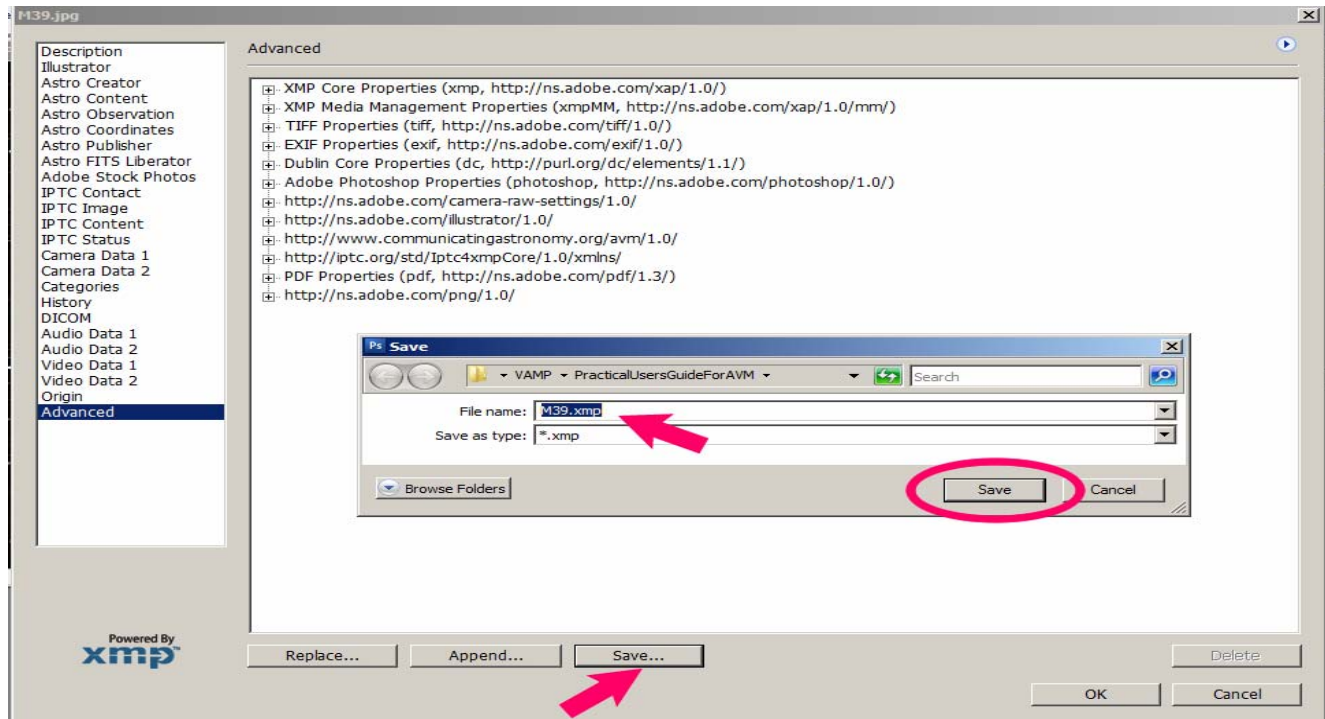
XMP Templates

Many of the AVM tags will be common across your image collection: the Creator information, some of the Observation information, and once the VAMP Archive & Service is live also some of the Publisher information. You can create base “template xmp” files to apply to each image as a first step to tagging.

There are a few ways to create XMP templates using Adobe tools. We suggest the following method as a starting place.

In Bridge, do not use the Tools > Create Metadata Template widget. It does not display some of the AVM Panels correctly. If you choose to use the widget, be sure to note the differences to avoid errors.

To create an XMP template in Photoshop/Bridge:



1. Initially create a template by using the File Info dialog method. Complete only those fields that are common for your given set/subset of images.
2. In the File Info navigation (left), choose Advanced at the bottom.

3. Choose Save/OK and name your XMP file.

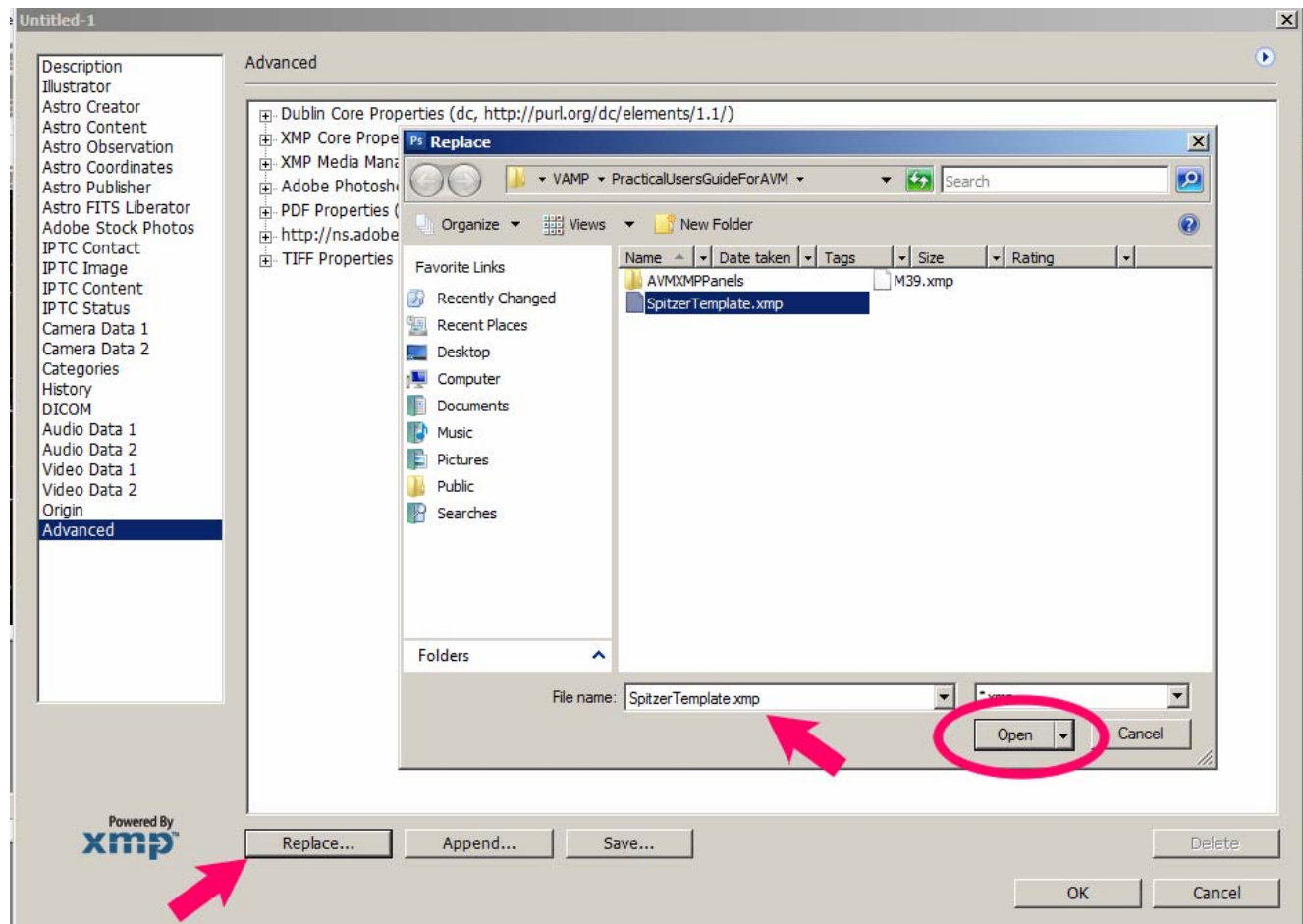
Photoshop - save in any location you like.

Bridge - save in the following system folder:

- Mac - {Home Directory}/Library/Application/Support/Adobe/XMP/Metadata Templates
- Windows - C:\Users\{user}\AppData\Roaming\Adobe\XMP\Metadata Templates

Note for Bridge: the XMP Templates, as far as we can see, are user-specific files as they reside under the user accounts in both Mac and Windows.

To use an XMP Template in Photoshop:



1. Open the image you want to apply metadata to.

2. In the File Info navigation (left), choose Advanced at the bottom.

3. Click Replace and choose the XMP file you want to use. This command completely replaces any existing metadata in the file with the metadata in the template. It will not delete existing metadata in the image if that particular field is empty in the template.

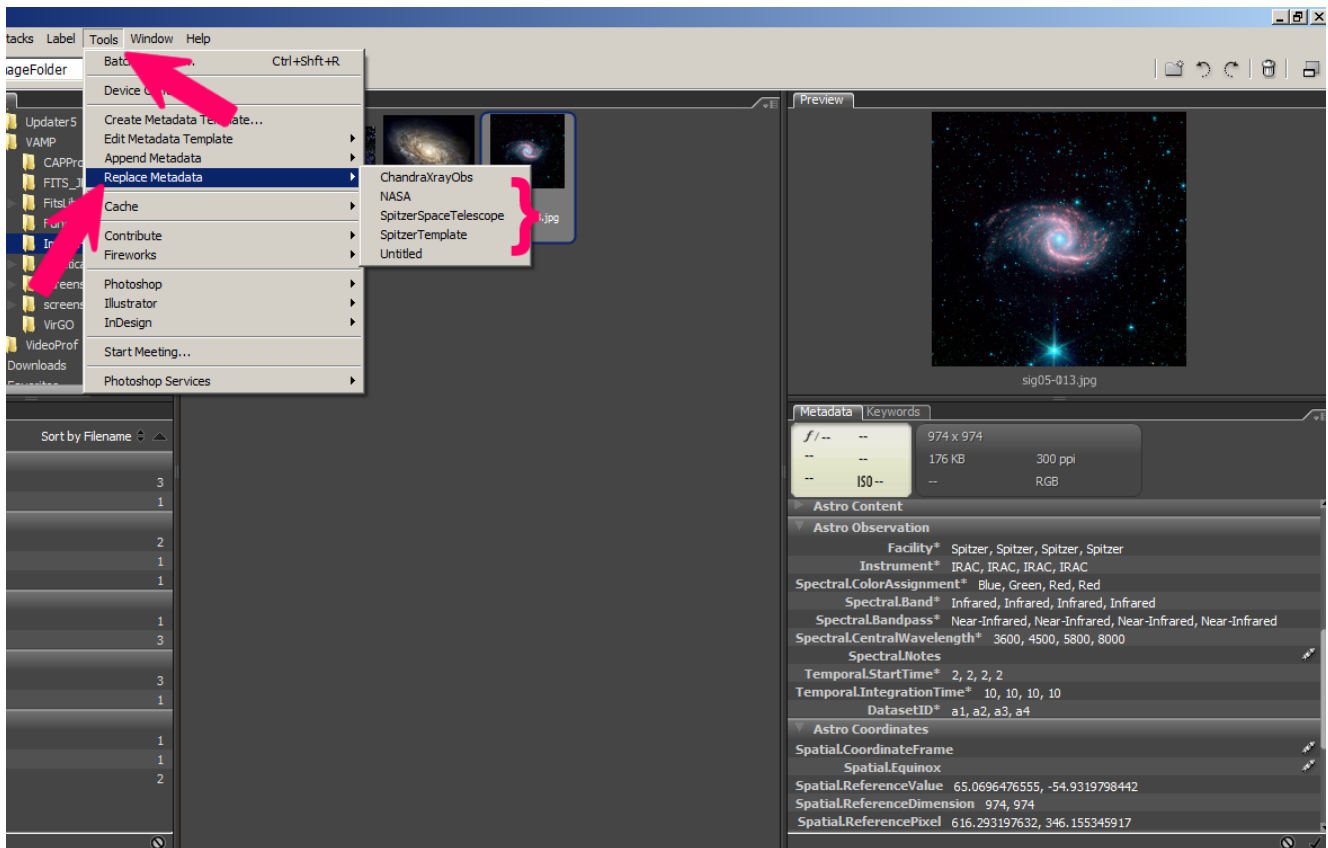
4. Confirm application of template by checking the File Info. The metadata in the template should have transferred into the applicable AVM fields in File Info.

To use an XMP Template in Bridge (2 methods)

Method 1

1. Select the image(s) you want to apply the XMP Template to.
2. In the File Info navigation (left), choose Advanced at the bottom.
3. Click Replace and choose the XMP file you want to use. This command completely replaces any existing metadata in the file with the metadata in the template. It will not delete existing metadata in the image if that particular field is empty in the template.
4. Confirm application of template by checking the File Info. The metadata in the template should have transferred into the applicable AVM fields in File Info.

Method 2



1. Select the image(s) you want to apply the XMP Template to
2. From the top menu, choose Tools > Replace Metadata and then choose the template. The templates listed in this menu are from the special Adobe folder "Adobe>XMP>Metadata Templates" described above in 'To create an XMP template in Photoshop/Bridge'. This command completely replaces any existing metadata in the file with the metadata in the template. It will not delete existing metadata in the image if that particular field is empty in the template.
3. Confirm application of template by checking the File Info. The metadata in the template should have transferred into the applicable AVM fields in File Info.

Note: You can manually move XMP files into the Bridge "Metadata Templates" folder. They will show up in the list of templates.

AVM Tagging Tool

The alpha version of the AVM Tagging Tool is now online! This web form will create an XMP formatted XML file of the AVM tags. This file can then be imported to Adobe Photoshop or Bridge to attach the metadata to the image via the XMP standard. You will still need the AVM Panels (see STEP 1) to verify the metadata once in Adobe Photoshop/Bridge. Without the panels, you will not be able to review the tags from within the program(s).

Please find the AVM Tagging Tool here: <http://www.virtualastronomy.org/avmwebtool/>

The tool works best with Mozilla Firefox or Safari web browsers.

Suggested Workflow

1. Enter the metadata into the web-based form. Pay special attention to the **Date** tag and the **Temporal.StartTime** tag and follow the required format for the web form. Once imported into Photoshop/Bridge, these fields will change over to your “local date settings” format.
2. If you have list-ordered fields (Facility, Instrument, Spectral,ColorAssignment, Spectral.Band, Spectral.Bandpass, Spectral.CentralWavelength, Temporal.StartTime, Temporal.IntegrationTime and DatasetID) then you can add fields for the number of ordered items in your list at the beginning of the Observation area by using the +/- button.
3. When you have completed the form (not all fields needs to be filled out), name your file in the File box and then click “Convert to XMP”. You will be prompted to save the xml file.
4. Open Bridge or Photoshop, and following directions in **STEP3b Advanced Techniques** of this guide for applying a metadata template. You may need to allow “all file types” to be seen in the file selector, this is an XML file not an XMP file. However, Photoshop/Bridge will read it in correctly as a template file.

General Tagging Notes

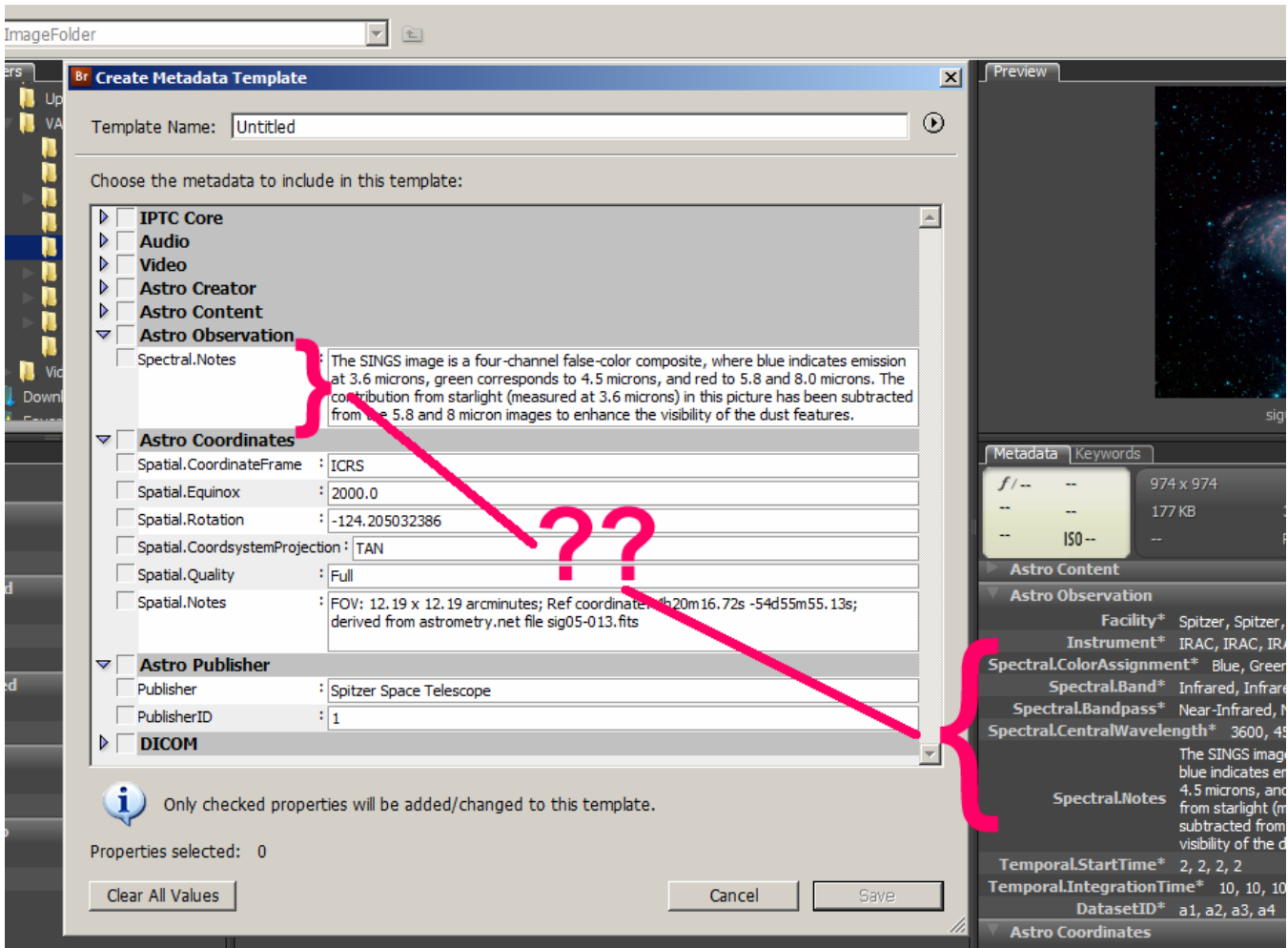
In this section you will find user experience notes on tagging. Common issues, solutions and work-arounds are placed here. If in your experience of tagging images you have words of wisdom to add or wish to report buggy software and modifications to the proposed methods, please email Adrienne (agauthier@as.arizona.edu) so that they can be added to the next version of our guide and shared live on our website.

Helpful Hints and Cautions

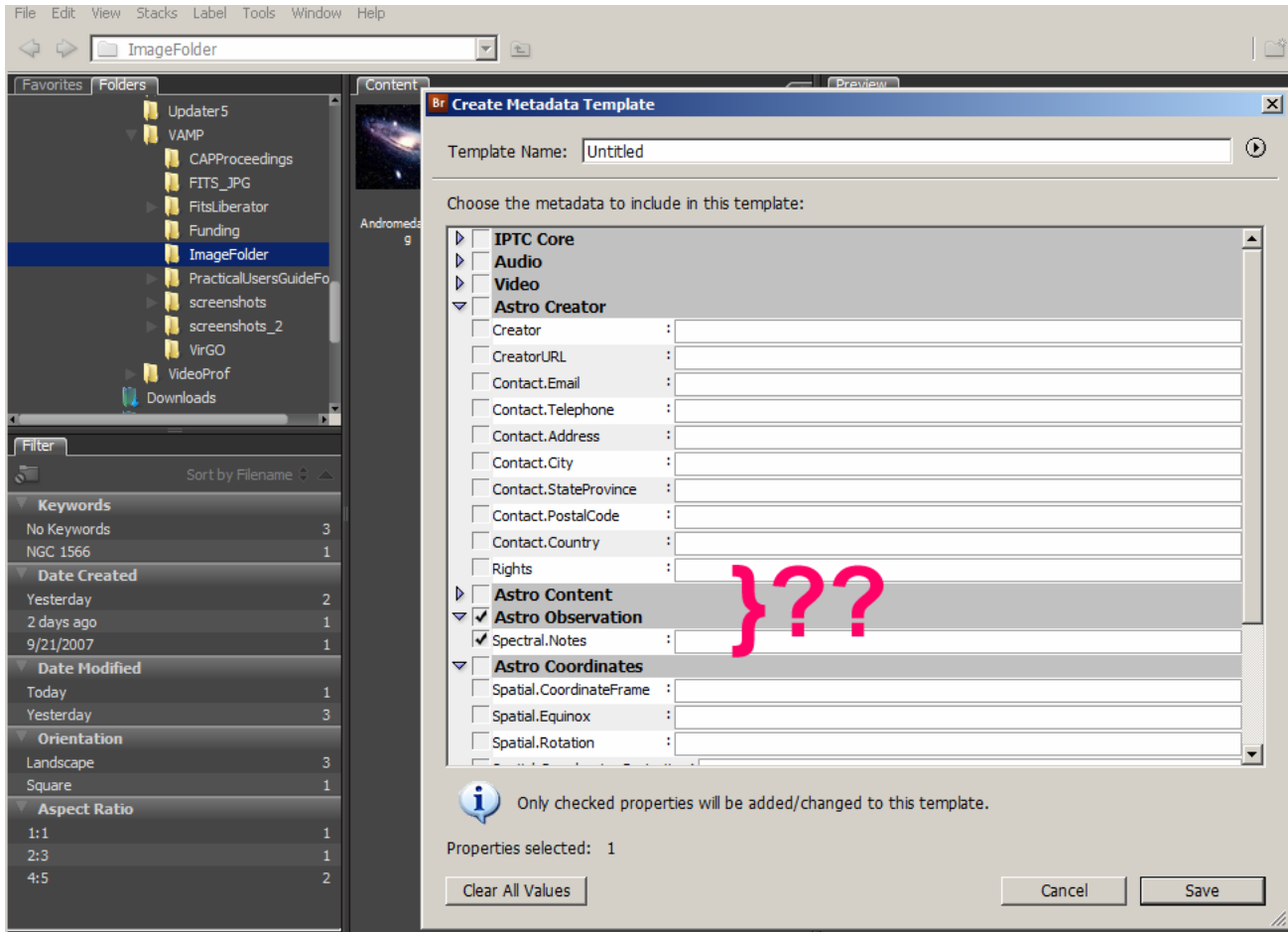
- Some tags fields can have multiple metadata entries. For multiple entries, please use a semicolon ; as a delimiter between tags
- Tags that have a controlled vocabulary (see **Chart 1. Controlled Vocabulary Cheat-Sheet**):
 - Subject.Category
 - Type
 - Image.ProductQuality
 - Spectral.ColorAssignment
 - Spectral.Band
 - Spatial.CoordinateFrame
 - Spatial.CoordinateSystemProjection
 - Spatial.Quality
- Controlled vocabulary tags that have only 1 metadata entry have pull-down menus with the vocabulary listed.
- Controlled vocabulary tags that can have multiple metadata entries (Subject.Category, Spectral.ColorAssignment, Spectral.Band) do not have pull down menus in Photoshop/Bridge and the user needs to enter the controlled vocabulary terms manually, separated by a semicolon. The controlled vocabulary terms for Spectral.ColorAssignment and Spectral.Band are listed under the data entry field. Watch your typos!
- Enter the Subject.Category tags using the designated first letter and number system. Please see **Chart 2. Subject.Category Cheat-sheet** or **Section 5.1 Subject.Category: Astronomical Object Taxonomy** of the latest AVM Document, http://virtualastronomy.org/avm_metadata.php

Issues with Bridge

1. Bridge has a Metadata panel, seen in this screenshot on the lower right side. Unfortunately, Bridge does not read in the AVM XMP Panels completely. Some fields are missing, controlled vocabularies are not presented, and it does not match the metadata that appears in the File Info dialog box. We suggest that you do not use the Bridge Metadata panel to enter/modify metadata.



2. This same issue as above occurs with the Tools>Create Metadata Template widget. Many of the fields are missing, further the controlled vocabularies are missing.



Issues with Photoshop

There are no issues with Photoshop to report at this time.

Need Assistance?

Please contact Adrienne at agauthier@as.arizona.edu if you have any issues/concerns/suggestions for tagging with the AVM.

Chart 1. Controlled Vocabulary Cheat-sheet

Image.ProductQuality	<p>Good – Clean, publication-ready image Moderate – Some flaws in the image, but of good quality Poor – Degraded quality; significant artifacts, but still acceptable for reference</p>	
Spatial.CoordinateFrame	<p>ICRS – celestial epoch-independent system FK5 – celestial, default J2000 epoch FK4 – celestial, default B1950 epoch ECL – ecliptic coordinates GAL – galactic coordinates SGAL – supergalactic coordinates</p>	
Spatial.CoordinateSystemProjection	<p>TAN – tangent SIN – sinusoidal ARC – arc sky AIT – AITOFF full-sky CAR – Plate –Careé (rectilinear coordinates) CEA – cylindrical equal-area</p>	
Spatial.Quality	<p>Full – Verified full WCS information (though may exclude CD matrix) Position – Spatial.ReferenceValue describes a coordinate contained somewhere within the image; other WCS info is approximate or unreliable</p>	
Spectral.Band	Radio	$\lambda \geq 10 \text{ mm}, \nu \geq 30 \text{ GHz}$
	Millimeter	$0.1 \text{ mm} \leq \lambda \leq 10 \text{ mm}$ $3000 \text{ GHz} \geq \nu \geq 30 \text{ GHz}$
	Infrared	$1 \mu \leq \lambda \leq 100 \mu$
	Optical	$0.3 \mu \leq \lambda \leq 1 \mu$ $300 \text{ nm} \leq \lambda \leq 1000 \text{ nm}$ $3000 \text{ \AA} \leq \lambda \leq 10000 \text{ \AA}$
	Ultraviolet	$0.01 \mu \leq \lambda \leq 0.3 \mu$ $100 \text{ \AA} \leq \lambda \leq 3000 \text{ \AA}$ $1.2 \text{ eV} \leq E \leq 120 \text{ eV}$
	X-ray	$0.12 \text{ keV} \leq E \leq 120 \text{ keV}$
	Gamma Ray	$E \geq 120 \text{ keV}$
Spectral.ColorAssignment	<p>Purple Blue Cyan Green</p>	<p>Yellow Orange Red Magenta</p>
	<p>Grayscale – for single-channel image Pseudocolor – for single channel image with color mapped to intensity</p>	
Subject.Category	see Chart 2. Subject.Category Summary	
Type	<p>Observation – An astronomical image rendered from telescopic data. Artwork – Artists’ renderings of astronomical phenomena or objects. Photographic – Photos from film/digital cameras. Planetary – Images from planetary orbiters/landers. Simulation – Digital renderings of simulated/computed datasets. Chart – A graph or diagram based on data Collage – Any image that has multiple elements and/or image types.</p>	

Chart 2. Subject.Category Cheat-sheet

Top Level Hierarchy

- A. Solar System: local to our solar system
- B. Milky Way: contained within the Milky Way galaxy
- C. Local Universe: current "era" of the universe
- D. Early Universe: era of galaxy formation and before
- E. Unspecified: for generic instance of subject

1. Planet

- 1.1. [Type]
 - 1.1.1. Terrestrial
 - 1.1.2. Gas Giant
- 1.2. [Feature]
 - 1.2.1. Surface
 - 1.2.1.1. Mountain
 - 1.2.1.2. Canyon
 - 1.2.1.3. Volcanic
 - 1.2.1.4. Impact
 - 1.2.1.5. Erosion
 - 1.2.1.6. Liquid
 - 1.2.1.7. Ice
 - 1.2.2. Atmosphere
 - 1.2.2.1. Cloud
 - 1.2.2.2. Storm
 - 1.2.2.3. Belt
 - 1.2.2.4. Aurora
- 1.3. [Special Cases]
 - 1.3.1. Transiting
 - 1.3.2. Hot Jupiter
 - 1.3.3. Pulsar planet
- 1.4. Satellite
 - 1.4.1. [Feature]
 - 1.4.1.1. Surface
 - 1.4.1.1.1. Mountain
 - 1.4.1.1.2. Canyon
 - 1.4.1.1.3. Volcanic
 - 1.4.1.1.4. Impact
 - 1.4.1.1.5. Erosion
 - 1.4.1.1.6. Liquid
 - 1.4.1.1.7. Ice
 - 1.4.1.2. Atmosphere
- 1.5. Ring

2. Interplanetary Body

- 2.1. Dwarf planet
- 2.2. Comet
 - 2.2.1. Nucleus
 - 2.2.2. Coma
 - 2.2.3. Tail
 - 2.2.3.1. Dust
 - 2.2.3.2. Gas
- 2.3. Asteroid
- 2.4. Meteoroid

3. Star

- 3.1. [Evolutionary Stage]
 - 3.1.1. Protostar
 - 3.1.2. Young Stellar Object
 - 3.1.3. Main Sequence
 - 3.1.4. Red Giant
 - 3.1.5. Red Supergiant
 - 3.1.6. Blue Supergiant
 - 3.1.7. White Dwarf

- 3.1.8. Supernova
- 3.1.9. Neutron Star
 - 3.1.9.1. Pulsar
 - 3.1.9.2. Magnetar
- 3.1.10. Black Hole
- 3.2. [Type]
 - 3.2.1. Variable
 - 3.2.1.1. Pulsating
 - 3.2.1.2. Irregular
 - 3.2.1.3. Eclipsing
 - 3.2.1.4. Flare Star
 - 3.2.1.5. Nova
 - 3.2.2. Carbon
 - 3.2.3. Brown Dwarf
 - 3.2.4. Wolf-Rayet
 - 3.2.5. Blue Straggler
 - 3.2.6. Exotic
- 3.3. [Spectral Type]
 - 3.3.1. O
 - 3.3.2. B
 - 3.3.3. A
 - 3.3.4. F
 - 3.3.5. G
 - 3.3.6. K
 - 3.3.7. M
 - 3.3.8. L
 - 3.3.9. T
- 3.4. [Population]
 - 3.4.1. I
 - 3.4.2. II
 - 3.4.3. III
- 3.5. [Feature]
 - 3.5.1. Photosphere
 - 3.5.1.1. Granulation
 - 3.5.1.2. Sunspot
 - 3.5.2. Chromosphere
 - 3.5.2.1. Flare
 - 3.5.2.2. Facula
 - 3.5.3. Corona
 - 3.5.3.1. Prominence
- 3.6. [Grouping]
 - 3.6.1. Binary
 - 3.6.2. Triple
 - 3.6.3. Multiple
 - 3.6.4. Cluster
 - 3.6.4.1. Open
 - 3.6.4.2. Globular
- 3.7. Circumstellar Material
 - 3.7.1. Planetary System
 - 3.7.2. Disk
 - 3.7.2.1. Protoplanetary
 - 3.7.2.2. Accretion
 - 3.7.2.3. Debris
 - 3.7.3. Outflow
 - 3.7.3.1. Solar Wind
 - 3.7.3.2. Coronal Mass Ejection

4. Nebula

- 4.1. [Type]
 - 4.1.1. Interstellar Medium
 - 4.1.2. Star Formation
 - 4.1.3. Planetary
 - 4.1.4. Supernova Remnant
 - 4.1.5. Jet

- 4.2. [Appearance]
 - 4.2.1. Emission
 - 4.2.1.1. H II Region
 - 4.2.2. Reflection
 - 4.2.2.1. Light Echo
 - 4.2.3. Dark
 - 4.2.3.1. Molecular Cloud
 - 4.2.3.2. Bok Globule
 - 4.2.3.3. Proplyd

5. Galaxy

- 5.1. [Type]
 - 5.1.1. Spiral
 - 5.1.2. Barred
 - 5.1.3. Lenticular
 - 5.1.4. Elliptical
 - 5.1.5. Ring
 - 5.1.6. Irregular
 - 5.1.7. Interacting
 - 5.1.8. Gravitationally Lensed
- 5.2. [Size]
 - 5.2.1. Giant
 - 5.2.2. Dwarf
- 5.3. [Activity]
 - 5.3.1. Normal
 - 5.3.2. AGN
 - 5.3.2.1. Quasar
 - 5.3.2.2. Seyfert
 - 5.3.2.3. Blazar
 - 5.3.2.4. Liner
 - 5.3.3. Starburst
 - 5.3.4. Ultraluminous
- 5.4. [Component]
 - 5.4.1. Bulge
 - 5.4.2. Bar
 - 5.4.3. Disk
 - 5.4.4. Halo
 - 5.4.5. Ring
 - 5.4.6. Central Black Hole
 - 5.4.7. Spiral Arm
 - 5.4.8. Dust Lane
 - 5.4.9. Center/Core
- 5.5. [Grouping]
 - 5.5.1. Pair
 - 5.5.2. Multiple
 - 5.5.3. Cluster
 - 5.5.4. Supercluster

6. Cosmology

- 6.1. [Morphology]
 - 6.1.1. Deep Field
 - 6.1.2. Large-Scale Structure
 - 6.1.3. Cosmic Background
- 6.2. [Phenomenon]
 - 6.2.1. Lensing
 - 6.2.2. Gamma Ray Burst
 - 6.2.3. Dark Matter

7. Sky Phenomenon

- 7.1. Night Sky
 - 7.1.1. Constellation
 - 7.1.2. Asterism
 - 7.1.3. Milky Way

- 7.1.4. Trail
 - 7.1.4.1. Meteor
 - 7.1.4.2. Star
 - 7.1.4.3. Satellite
- 7.1.5. Zodiacal Light
 - 7.1.5.1. Gegenschein
- 7.1.6. Night glow
- 7.2. Eclipse
 - 7.2.1. Solar
 - 7.2.1.1. Total
 - 7.2.1.2. Partial
 - 7.2.1.3. Annular
 - 7.2.2. Lunar
 - 7.2.2.1. Total
 - 7.2.2.2. Partial
 - 7.2.2.3. Penumbral
 - 7.2.3. Occultation
 - 7.2.4. Transit
- 7.3. Light Phenomenon
 - 7.3.1. Sunrise-Sunset
 - 7.3.1.1. Green flash
 - 7.3.1.2. Refractive Distortion
 - 7.3.1.3. Sun Pillar
 - 7.3.2. Cloud
 - 7.3.2.1. Iridescent
 - 7.3.2.2. Noctilucent
 - 7.3.2.3. Nacreous
 - 7.3.2.4. Corona
 - 7.3.2.5. Glory
 - 7.3.3. Rainbow
 - 7.3.3.1. Moonbow
 - 7.3.3.2. Fogbow
 - 7.3.4. Halo
 - 7.3.4.1. Circle
 - 7.3.4.2. Parhelia
 - 7.3.4.3. Arc
 - 7.3.5. Ray-Shadow
 - 7.3.5.1. Crepuscular ray
 - 7.3.5.2. Anti-crepuscular ray
 - 7.3.5.3. Earth shadow
 - 7.3.6. Lightning
 - 7.3.7. Aurora

8. Technology

- 8.1. Observatory
 - 8.1.1. Facility
 - 8.1.2. Telescope
 - 8.1.3. Instrument
 - 8.1.4. Detector
- 8.2. Spacecraft
 - 8.2.1. Orbiter
 - 8.2.2. Probe
 - 8.2.3. Lander
 - 8.2.4. Manned
 - 8.2.5. Launch Vehicle

9. People

- 9.1 Scientist
- 9.2 Astronaut
- 9.3 Other/General

Chart 3. Sample Metadata

AVM Tag Name	Format	Example
3.1 Creator Metadata		
Creator	string	Spitzer Science Center
CreatorURL	URL	http://www.spitzer.caltech.edu
Contact.Name	string, list	R. Hurt
Contact.Email	string, list	example@ipac.caltech.edu
Contact.Telephone	string, list	555-555-5555
Contact.Address	string	1200 E. California Blvd.
Contact.City	string	Pasadena
Contact.StateProvince	string	California
Contact.PostalCode	string	91125
Contact.Country	string	USA
Rights	string	Public Domain
3.2 Content Metadata		
Title	string	M 82
Headline	string	The galaxy M82 is seen across the spectrum from X-rays to infrared light. This combined view is from NASA's Chandra, Hubble, and Spitzer telescopes.
Description	string	NASA's Spitzer, Hubble, and Chandra space observatories teamed up to create this multi-wavelength, false-colored view of the M82 galaxy. High energy particles appear as blue, stars as green, dust as red.
Subject.Category	string-CV, list	C.5.1.6;C.5.3.3
Subject.Name	string, list	M 82; Messier 82; NGC 3034; Cigar Galaxy
Distance	float, list(2)	11700000; 0.000677
Distance.Notes	string	Light years from PI; redshift from NED
ReferenceURL	URL	http://gallery.spitzer.caltech.edu/Imagegallery/image.php?image_name=sig06-010
Credit	string	NASA/JPL-Caltech/STScI/CXC/UofA/ESA/AURA/JHU
Date	date	2007-04-24
ID	string	sig06-010
Type	string-CV	Observation
Image.ProductQuality	string-CV	Good
3.3 Observation Metadata		
Facility	string, list(s)	Chandra; Hubble; Hubble; Spitzer
Instrument	string, list(s)	ACIS; ACS; ACS; IRAC
Spectral.ColorAssignment	string-CV, list(s)	Blue; Green; Orange; Red
Spectral.Band	string-CV, list(s)	X-ray; Optical; Optical; Infrared
Spectral.Bandpass	string, list(s)	-.B;R;mid-infrared
Spectral.CentralWavelength	float, list(s)	0.5;440;700;8000
Spectral.Notes	string	X-ray bandpass wavelengths are approximate.
Temporal.StartTime	date, list(s)	-; 2005-02-05; 2005-02-05; 2004-07-03T12:00
Temporal.IntegrationTime	float, list(s)	-; -; -; 240

DatasetID	string, list(s)	a1;a2;a3;a4
3.4 Coordinate Metadata		
Spatial.CoordinateFrame	string-CV	ICRS
Spatial.Equinox	string	2000
Spatial.ReferenceValue	float, list(2)	149.11051168; 69.7053749827
Spatial.ReferenceDimension	float, list(2)	4299; 3490
Spatial.ReferencePixel	float, list(2)	922.146820068; 1153.85690308
Spatial.Scale	float, list(2)	-4.1635027032331E-05; 4.1635027032331E-05
Spatial.Rotation	float	49.93606563
Spatial.CoordsystemProjection	string-CV	TAN
Spatial.Quality	string-CV	Full
Spatial.Notes	string	FOV: 10.74 x 8.72 arcminutes; Ref coordinate: 9h56m26.52s 69d42m19.35s; derived from astrometry.net file sig06-010.fits
Spatial.FITSheader	string	CRVAL1 = 6.3856 CRVAL2 = 64.1784 RADESYS = 'ICRS ' EQUINOX = 2000. CTYPE1 = 'RA---TAN' CTYPE2 = 'DEC--TAN' CRPIX1 = 214. CRPIX2 = 138.
Spatial.CDMatrix (deprecated)	float, list(4)	
3.5 Publisher Metadata		
Publisher	string	Spitzer Space Telescope
PublisherID	string	vamp://spitzer
ResourceID	string	sig05-010_jpg_sm
ResourceURL	URL	http://ipac.jpl.nasa.gov/media_images/sig06-010.tif
RelatedResources	list	vamp://spitzer/sig05-010; vamp://spitzer/sig05-010
MetadataDate	date	2008-05-09
MetadataVersion	string	1.1
3.6 File Metadata		
File.Type	string-CV	TIFF
File.Dimension	float, list(2)	4299; 3490
File.Size	float, list(2)	18237
File.BitDepth	float	24

Tutorial 1: Scaling WCS Information

You will need to scale your WCS information if you have changed the image resolution/dimensions from that of the original image that you have WCS information for. The scaled image must have the same image width to height ratio as the original and must not have been cropped. If it does not have the same ratio or has been cropped, you will need to resolve new WCS information for that image.

The following WCS information needs to be recalculated:

- A. Spatial.ReferencePixel (FITS: CRPIX1, CRPIX2)
- B. Spatial.Scale (FITS: CDELT1, CDELT2)
- C. Spatial.CDMatrix (FITS: CD1_1, CD1_2, CD2_1, CD2_2)

Variable Key:

$x_{dim_{old}}$ = dimensions in pixels on the x-axis from original image

$y_{dim_{old}}$ = dimensions in pixels on the y-axis from original image

$x_{dim_{new}}$ = newly scaled x dimensions in pixels

$y_{dim_{new}}$ = newly scaled y dimensions in pixels

x_{deg} = dimension of the image in degrees along the x-axis

y_{deg} = dimension of the image in degrees along the y-axis

$x_{ref_{old}}$ = x reference pixel position from original image (CRPIX1)

$y_{ref_{old}}$ = y reference pixel position from original image (CRPIX2)

$x_{ref_{new}}$ = newly scaled x reference pixel position

$y_{ref_{new}}$ = newly scaled y reference pixel position

$x_{scale_{old}}$ = original image scale in degrees/pixel along the x-axis (CDELT1)

$y_{scale_{old}}$ = original image scale in degrees/pixel along the y-axis (CDELT2)

$x_{scale_{new}}$ = original image scale in degrees/pixel along the x-axis

$y_{scale_{new}}$ = original image scale in degrees/pixel along the y-axis

Sample Data:

WCS Data	Old Value from Original Image	New Value from Scaled Image
Spatial.ReferenceDimension (x)	3857	506
Spatial.ReferenceDimension (y)	7804	1024
Spatial.ReferencePixel (CRPIX1)	1929.5	253.13119004
Spatial.ReferencePixel (CRPIX2)	3903	512.13121476
Spatial.Scale (CDELT1)	1.38621371859793e-05	0.000105664551633
Spatial.Scale (CDELT2)	1.38824518656616e-05	0.000105799467148
CD1_1	1.66090206e-06	1.26602751886e-05
CD1_2	-1.37835696e-05	-0.000105045876131
CD2_1	-1.37622764e-05	-0.000104903359832
CD2_2	-1.65398878e-06	-1.26052035538e-05

A. To scale Spatial.ReferencePixel values

To adjust CRPIX1 and CRPIX 2 use a proportion:

$$\frac{x_{dim_{old}}}{x_{ref_{old}}} = \frac{x_{dim_{new}}}{x_{ref_{new}}} \quad \leftarrow \begin{array}{l} \text{CRPIX1-scaled} \\ \text{Solve for } x_{ref_{new}} \end{array}$$

$$\frac{y_{dim_{old}}}{y_{ref_{old}}} = \frac{y_{dim_{new}}}{y_{ref_{new}}} \quad \leftarrow \begin{array}{l} \text{CRPIX2-scaled} \\ \text{Solve for } y_{ref_{new}} \end{array}$$

B. To scale Spatial.Scale values

To adjust CDELTA1 and CDELTA2 first the size of the image in degrees must be found, then the new scale in degrees/pixel can be calculated.

$$x_{deg} = (x_{scale_{old}}) (x_{dim_{old}})$$

$$y_{deg} = (y_{scale_{old}}) (y_{dim_{old}})$$

$$x_{scale_{new}} = \frac{x_{deg}}{x_{dim_{new}}}$$

$$y_{scale_{new}} = \frac{y_{deg}}{y_{dim_{new}}}$$

C. To scale the CD Matrix (CD1_1, CD1_2, CD2_1, CD2_2)

$$CD1_{1_{new}} = CD1_{1_{old}} \left(\frac{x_{scale_{new}}}{x_{scale_{old}}} \right) \quad CD1_{2_{new}} = -CD1_{2_{old}} \left(\frac{y_{scale_{new}}}{y_{scale_{old}}} \right)$$

$$CD2_{1_{new}} = CD2_{1_{old}} \left(\frac{x_{scale_{new}}}{x_{scale_{old}}} \right) \quad CD2_{2_{new}} = CD2_{2_{old}} \left(\frac{y_{scale_{new}}}{y_{scale_{old}}} \right)$$