Seamless Astronomy

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*RPI: Jim **Hendler** & Deborah **McGuinness***
*STScI: Alberto **Conti** & Carol **Christian***
*UCLA: Christine **Borgman***

Sea

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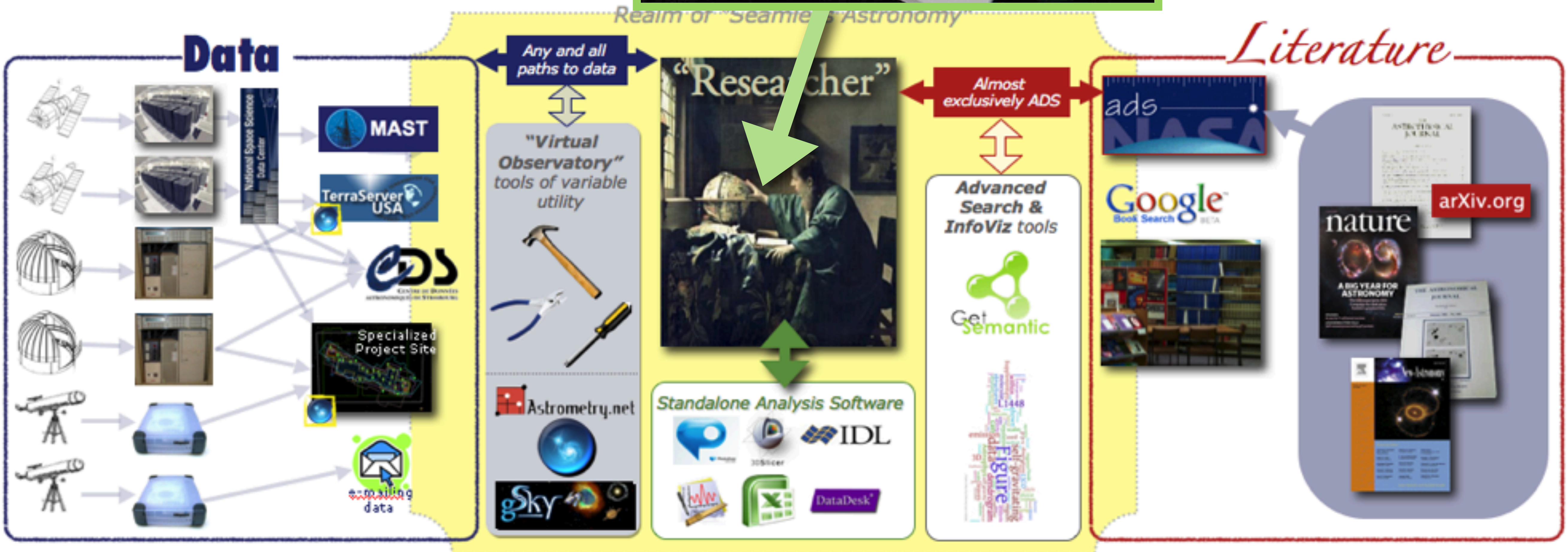


Friday, January 15, 2010

What about data visualization...

...is easier now than before?

fast computation, animation, 3D

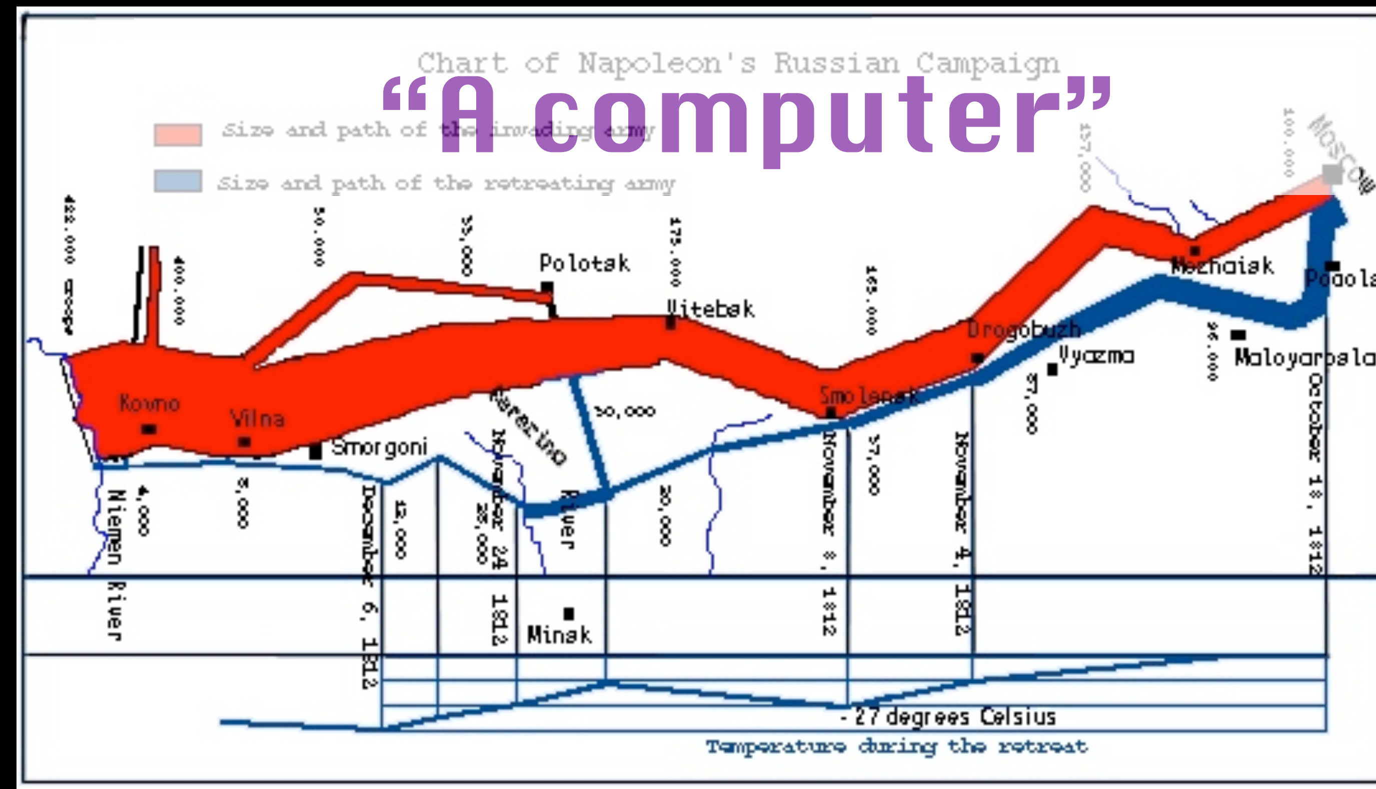
...was easier before than now?

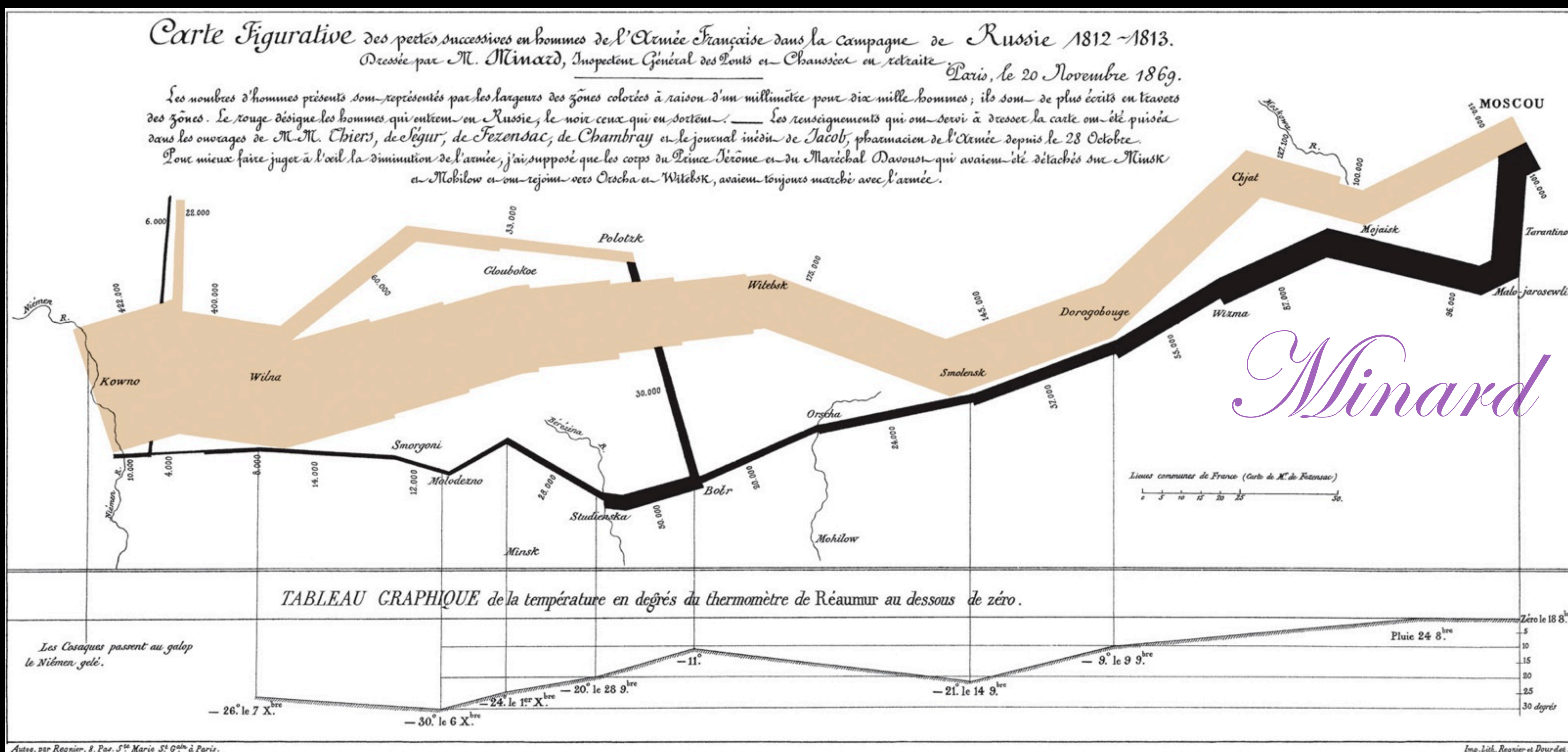
craftsmanship

...should be easier in the future?

modular craftsmanship

Are we held back by confining technological tools?





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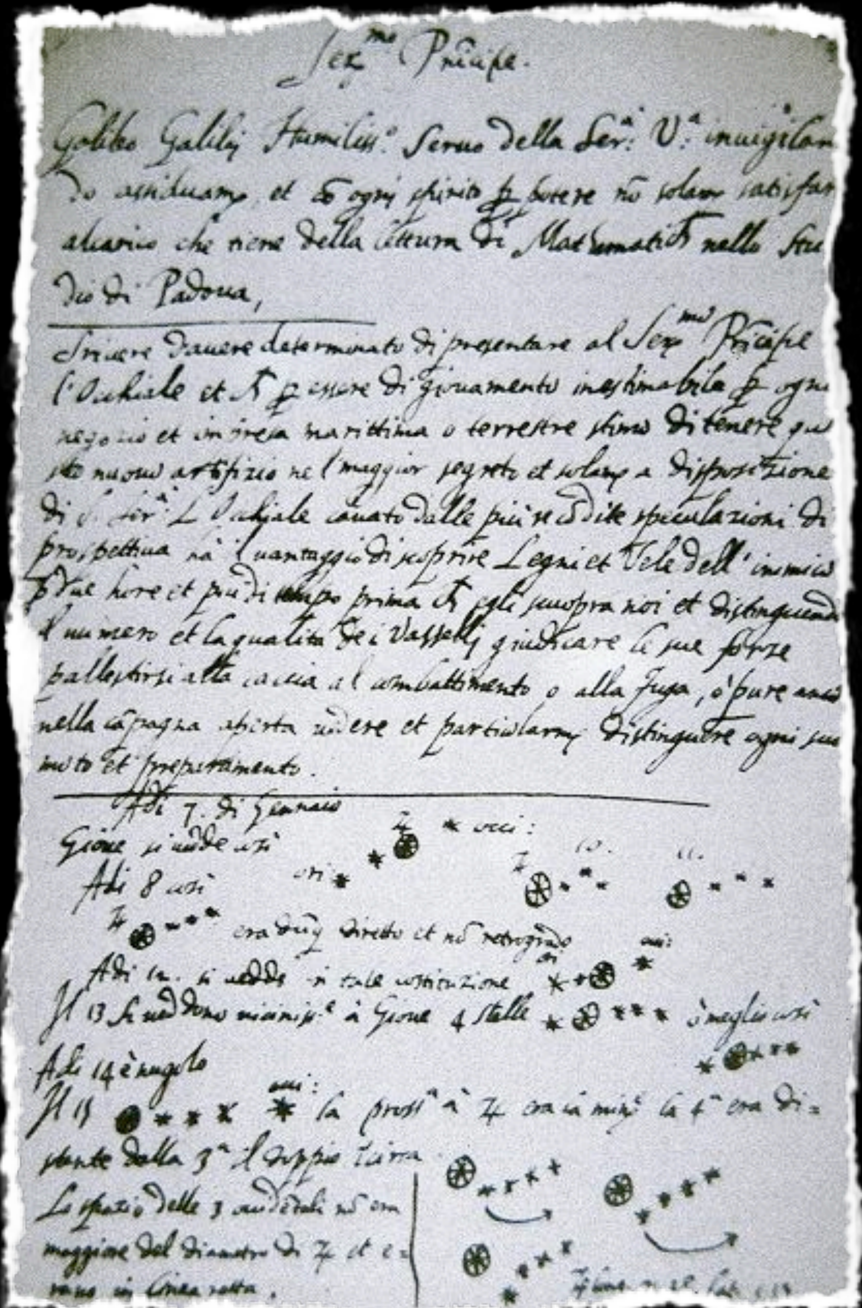
scotch tape story... what about professionals? Minard: 1869; Contest: 1999

Galileo & the Moons of Jupiter



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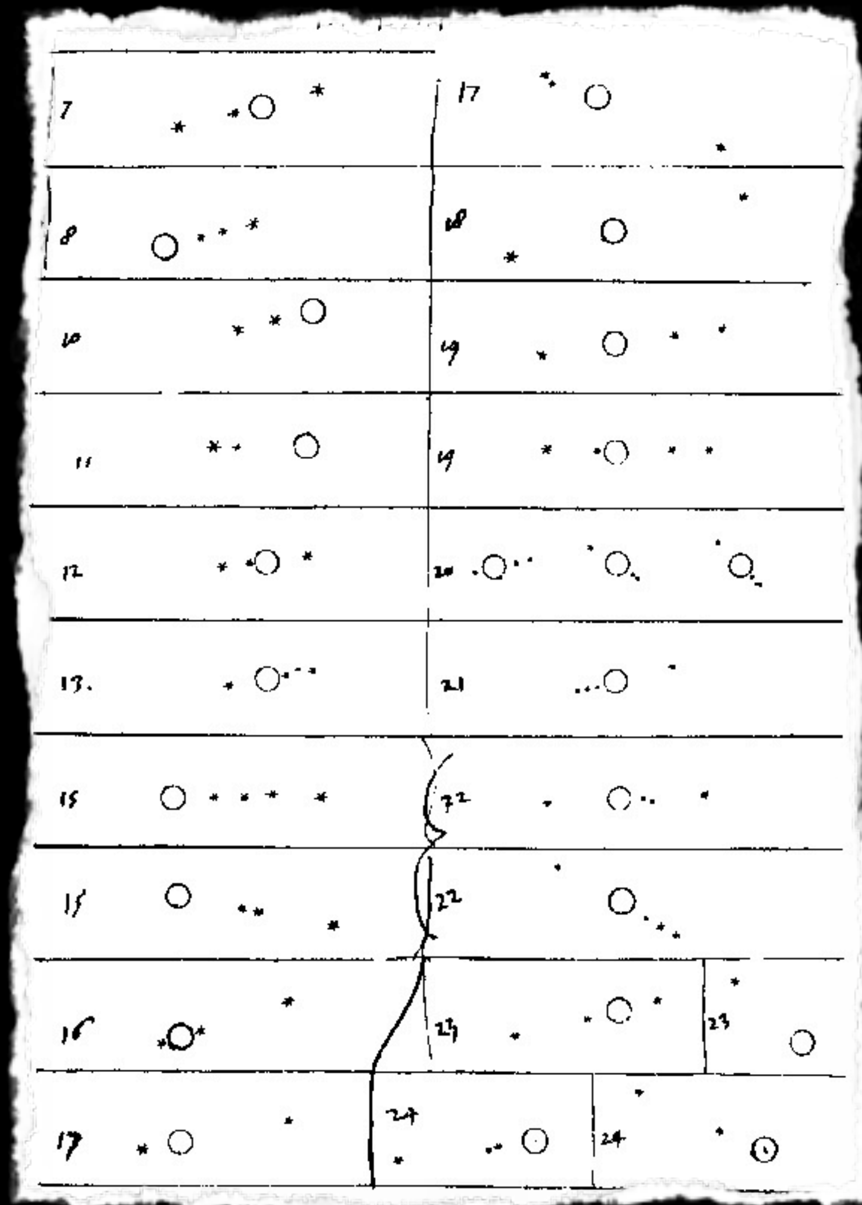

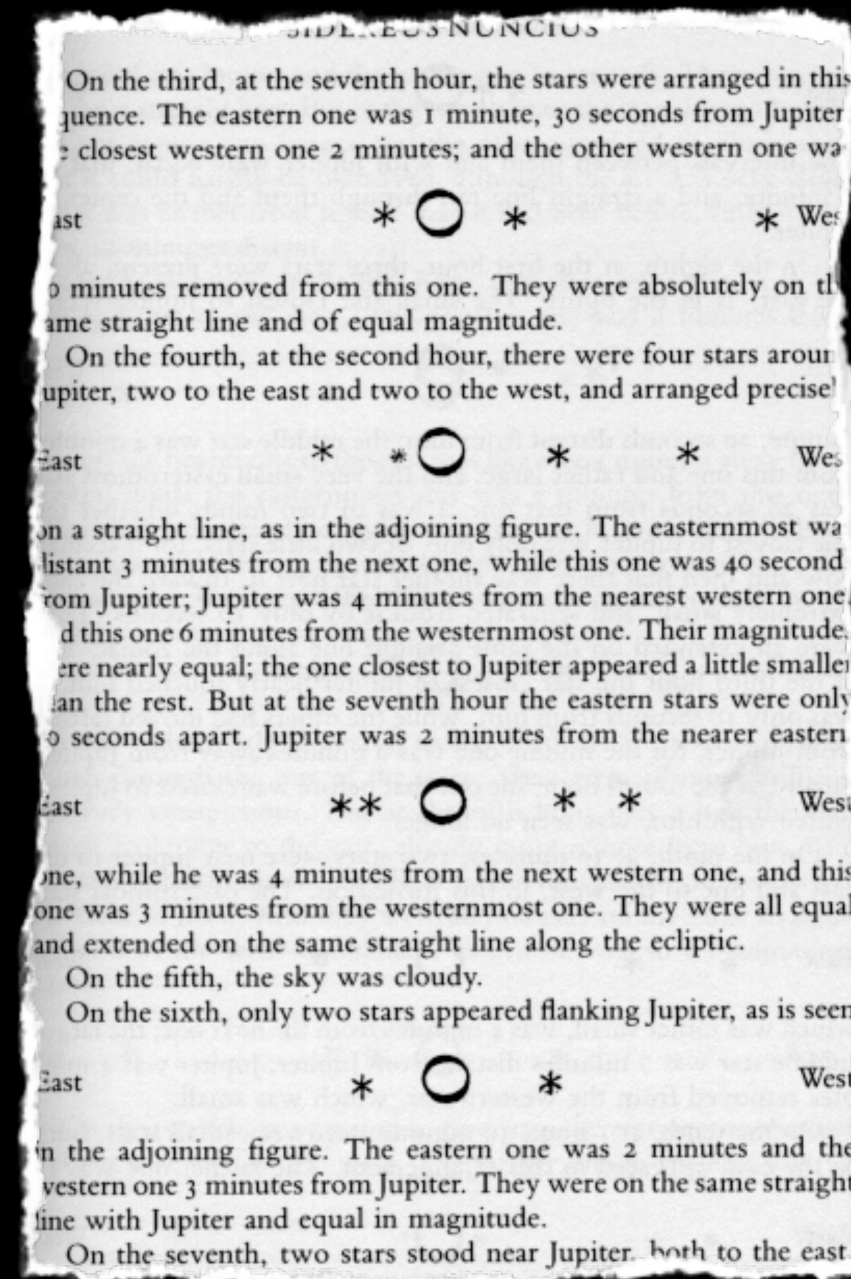

SIDEREUS NUNCIUS

On the third, at the seventh hour, the stars were arranged in this
quence. The eastern one was 1 minute, 30 seconds from Jupiter
closest western one 2 minutes; and the other western one wa

ast * O * * Wes

o minutes removed from this one. They were absolutely on th
ame straight line and of equal magnitude.

On the fourth, at the second hour, there were four stars arour
upiter, two to the east and two to the west, and arranged precise

East * *O * * Wes

on a straight line, as in the adjoining figure. The easternmost wa
listant 3 minutes from the next one, while this one was 40 second
rom Jupiter; Jupiter was 4 minutes from the nearest western one
d this one 6 minutes from the westernmost one. Their magnitude
ere nearly equal; the one closest to Jupiter appeared a little smalle
an the rest. But at the seventh hour the eastern stars were only
o seconds apart. Jupiter was 2 minutes from the nearer eastern

East ** O * * West

ne, while he was 4 minutes from the next western one, and this
one was 3 minutes from the westernmost one. They were all equal
and extended on the same straight line along the ecliptic.

On the fifth, the sky was cloudy.

On the sixth, only two stars appeared flanking Jupiter, as is seen

East * O * West

in the adjoining figure. The eastern one was 2 minutes and the
western one 3 minutes from Jupiter. They were on the same straight
line with Jupiter and equal in magnitude.

On the seventh, two stars stood near Jupiter, both to the east

Notes for & re-productions of Siderius Nuncius (1610)

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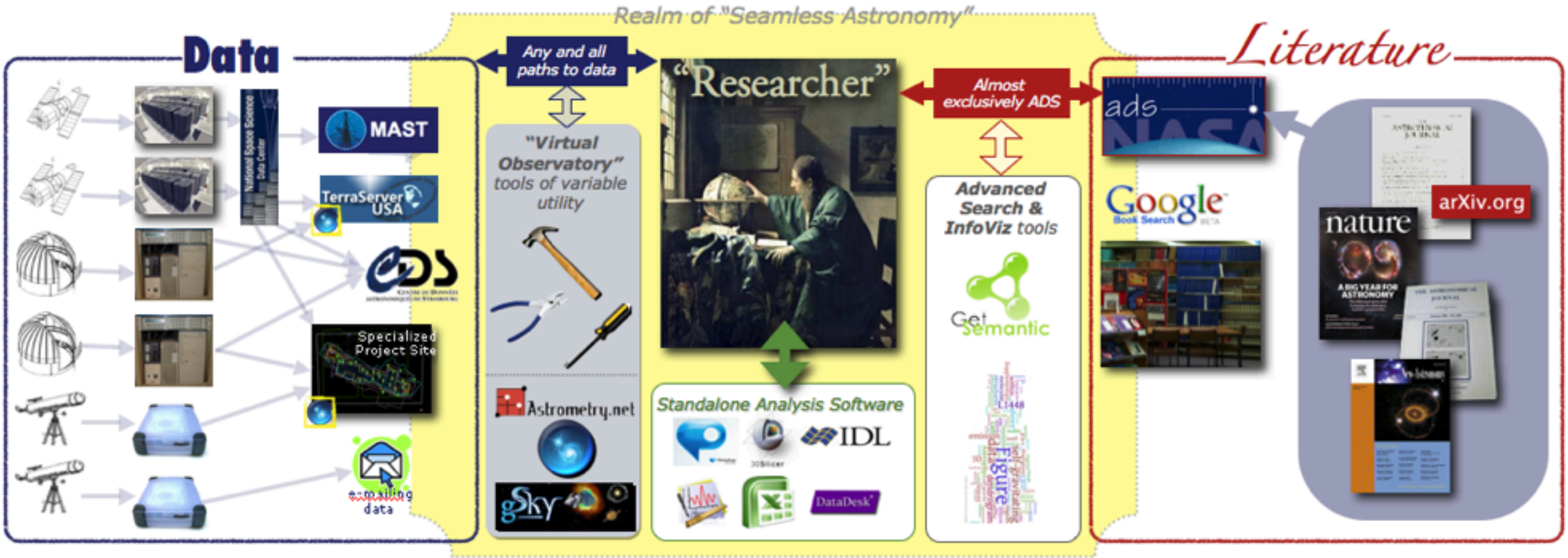

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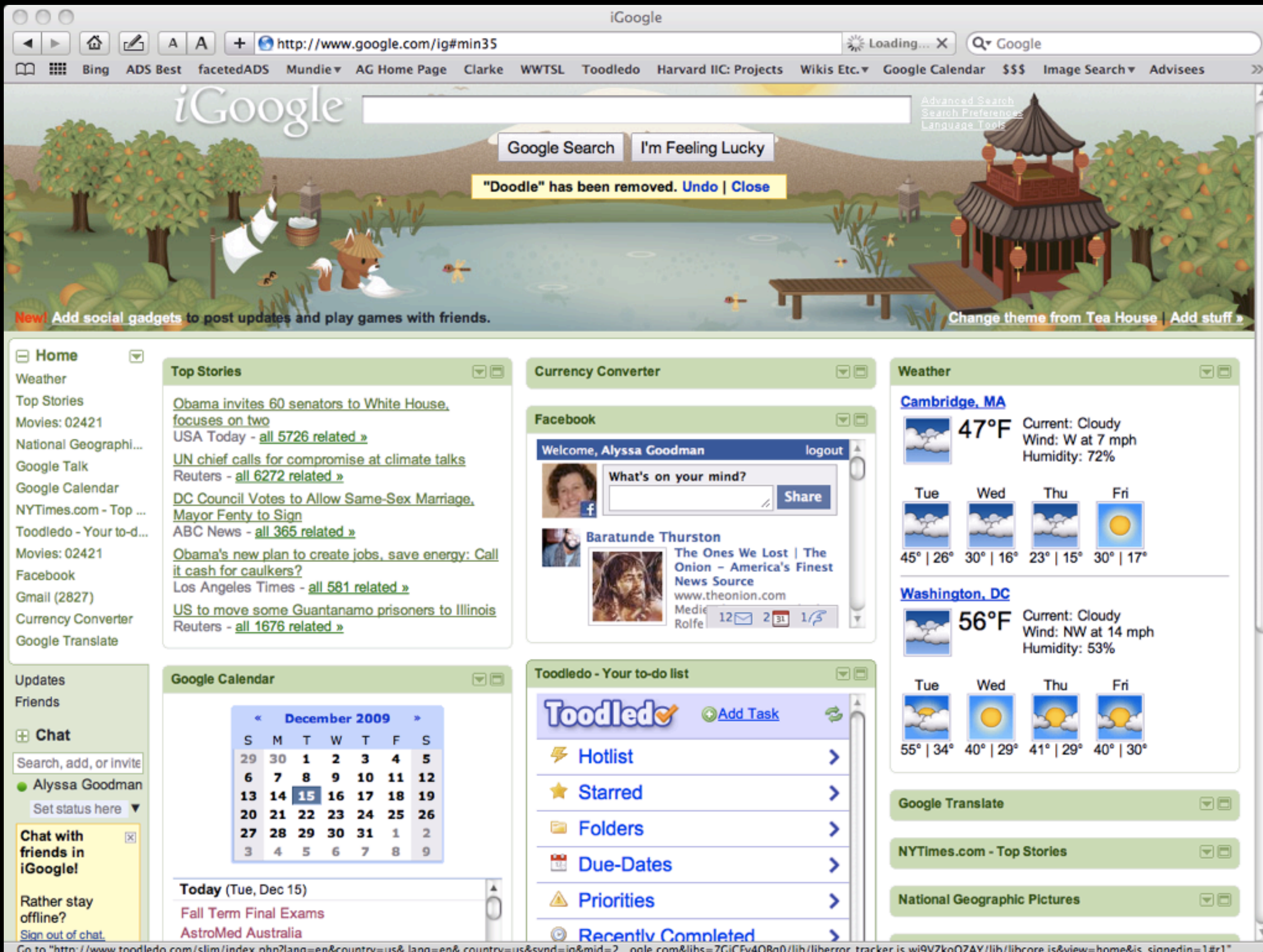

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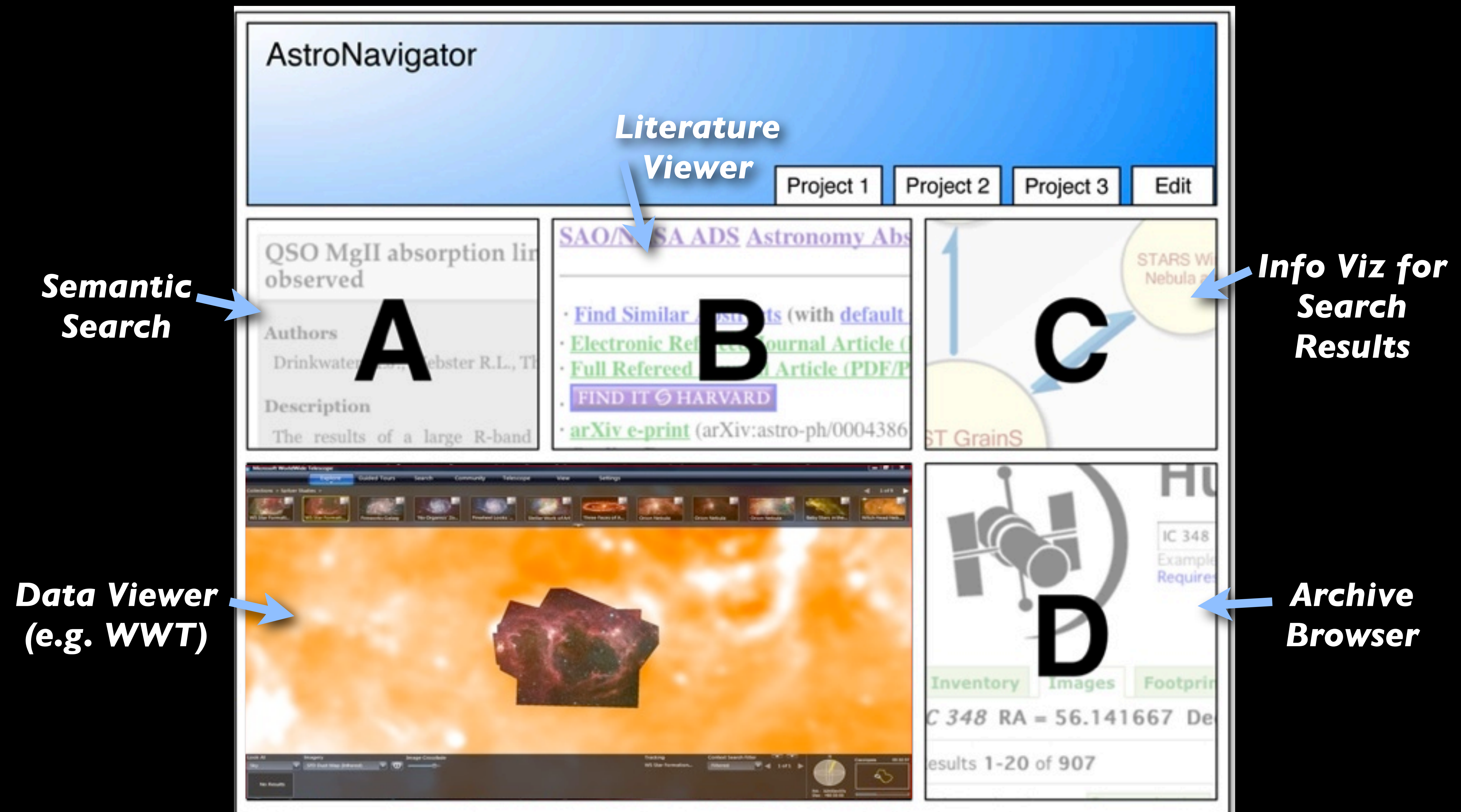

Mockup based on work of Eli Bressert, excerpted from NASA AISRP proposal by Goodman, Muench, Christian, Conti, Kurtz, Burke, Accomazzi, McGuinness, Hendler & Wong, 2008

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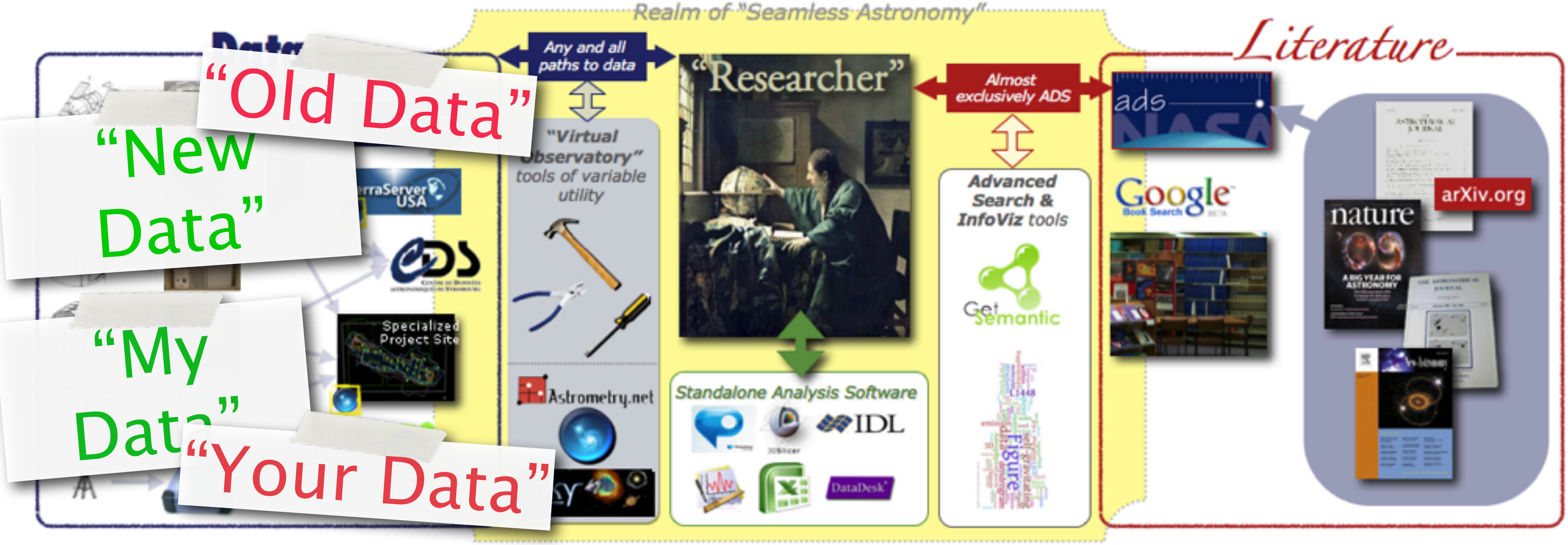


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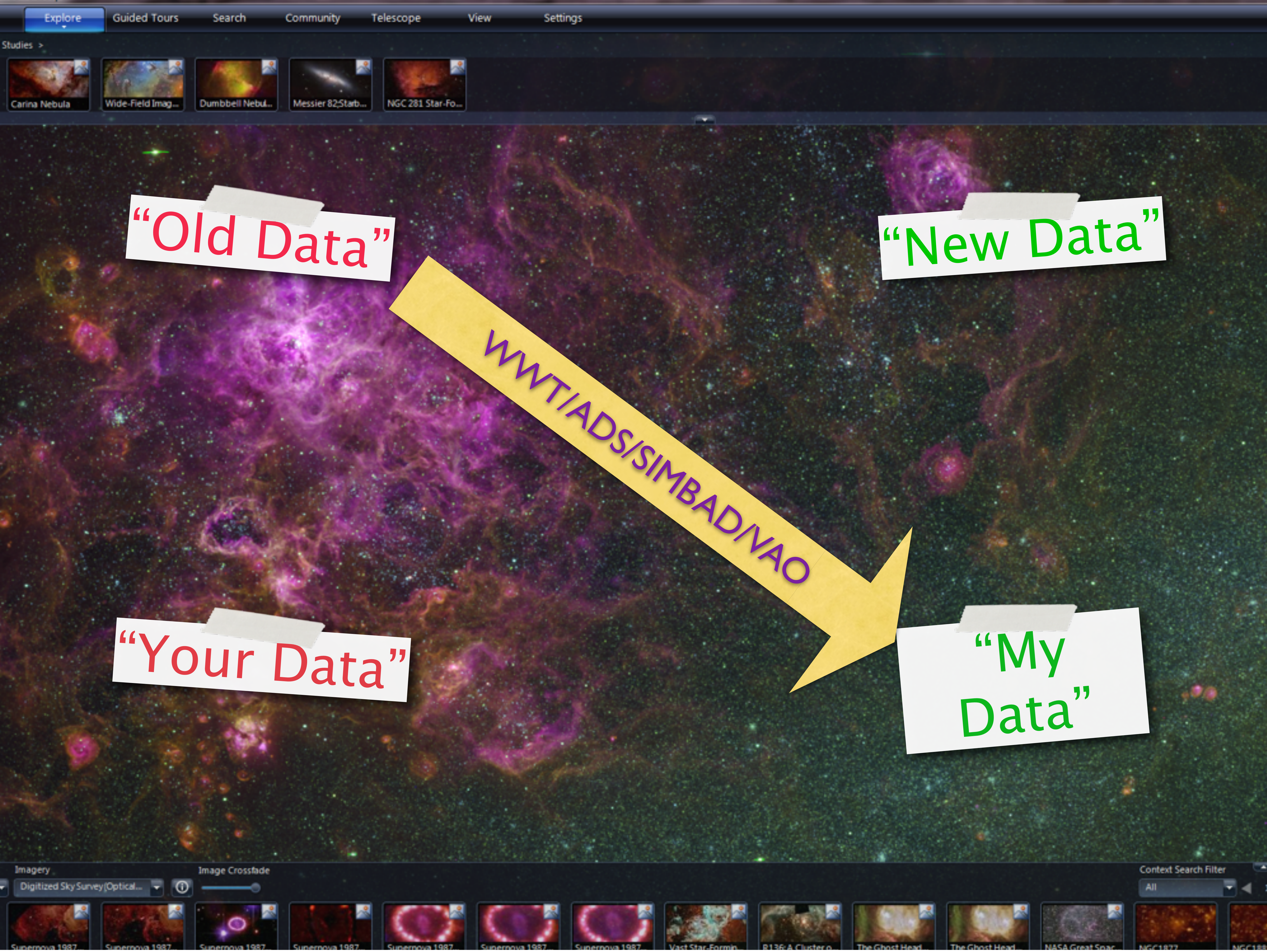
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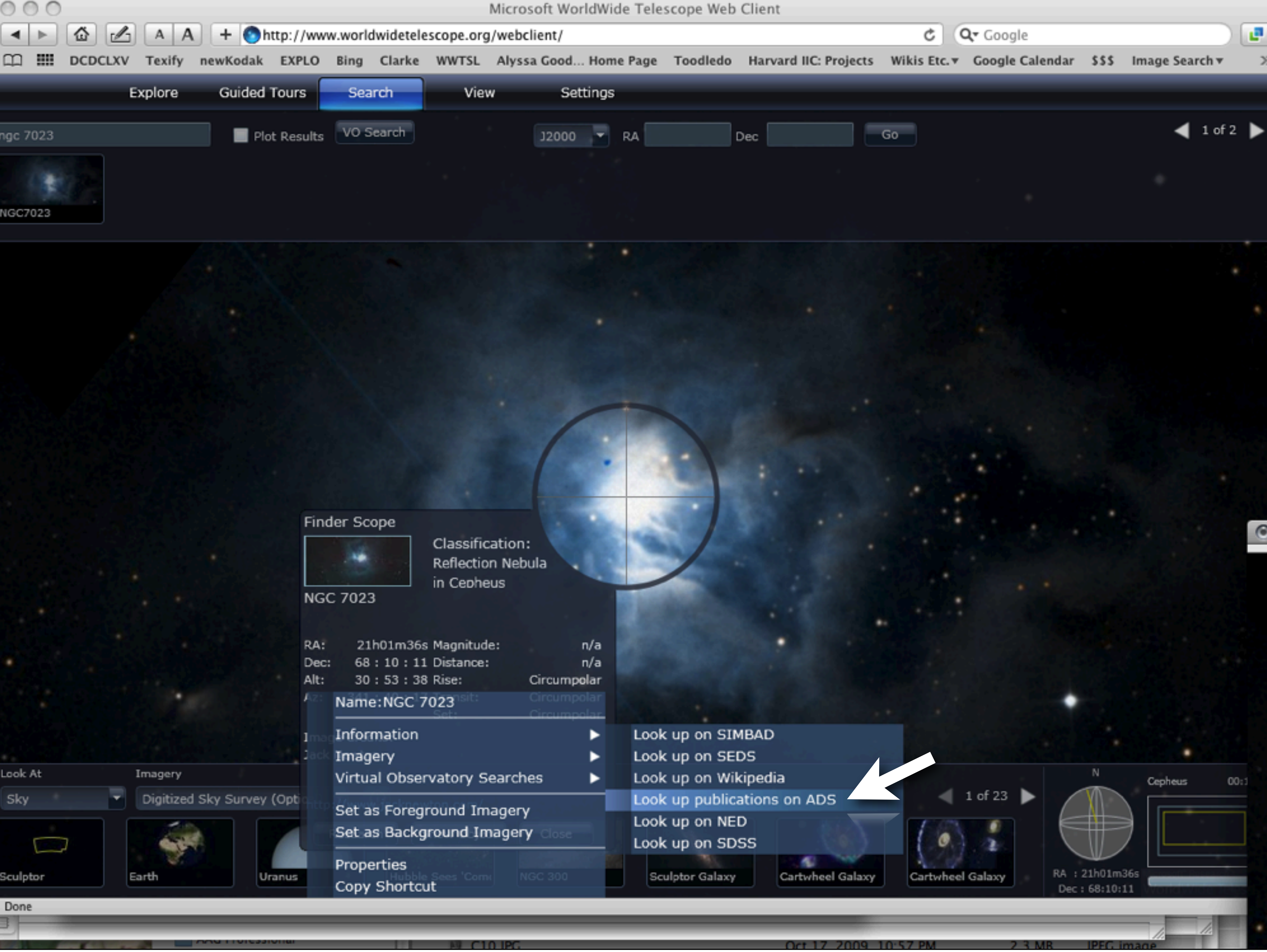
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Title:	PV Cephei: Young Star Caught Speeding?
Authors:	Goodman, Alyssa A.; Arce, Héctor G.
Affiliation:	AA(Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138; agoodman@cfa.harvard.edu), AB(California Institute of Technology, 1200 East California Boulevard, Pasadena, CA; harce@astro.caltech.edu)
Publication:	The Astrophysical Journal, Volume 608, Issue 2, pp. 831-845. (ApJ Homepage)
Publication Date:	06/2004
Origin:	UCP
ApJ Keywords:	ISM: Herbig-Haro Objects, ISM: Individual: Alphanumeric: HH 315, ISM: Jets and Outflows, Stars: Formation, Stars: Individual: Constellation Name: PV Cephei, Stars: Kinematics
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DOI:	10.1086/383139
Bibliographic Code:	2004ApJ...608..831G

Abstract

Three independent lines of evidence imply that the young star PV Cep is moving at roughly 20 km s^{-1} through the interstellar medium. The first and strongest suggestion of motion comes from the geometry of the Herbig-Haro (HH) knots in the ``giant'' HH flow associated with PV Cep. Bisectors of lines drawn between pairs of knots at nearly equal distances

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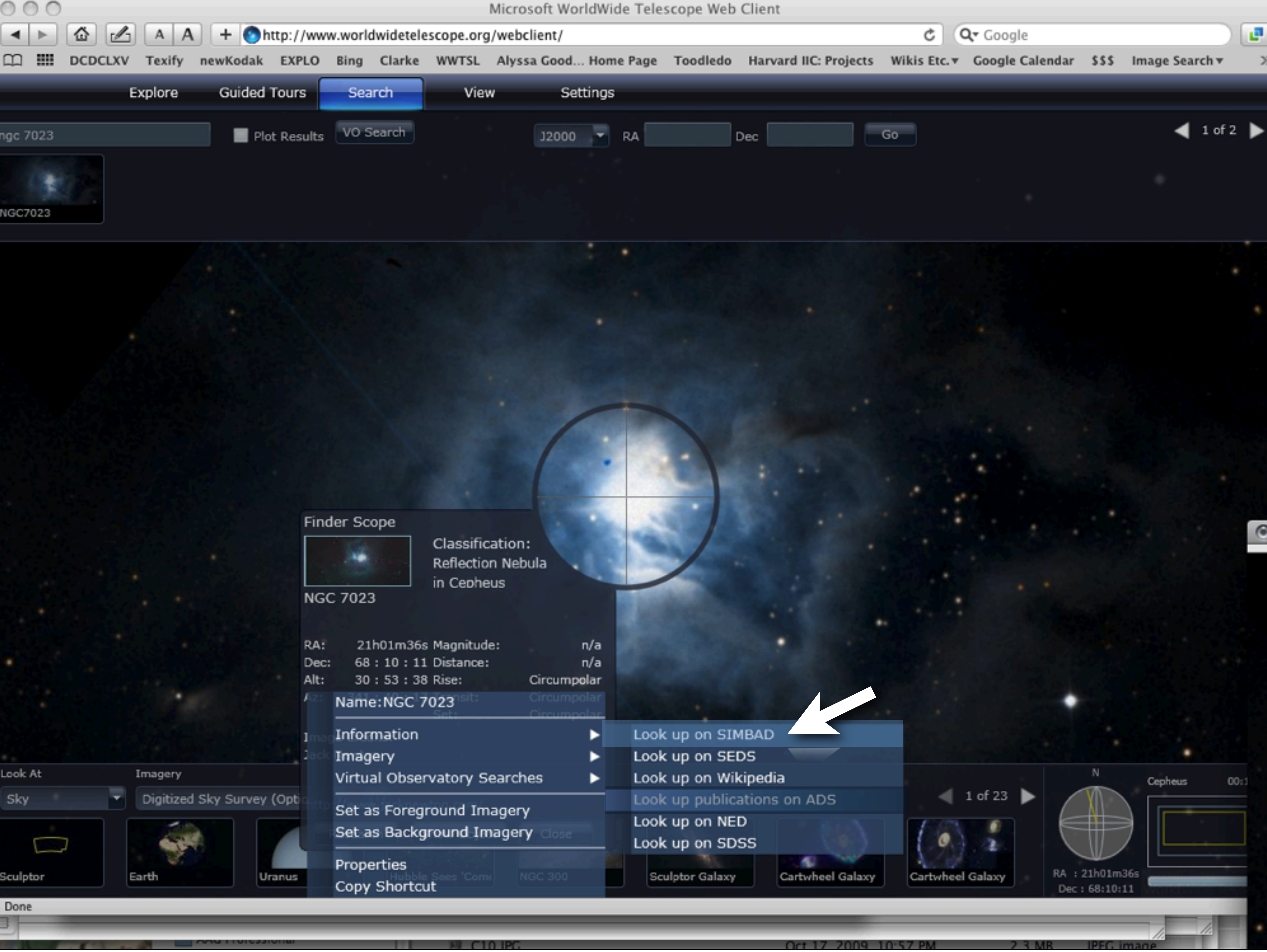

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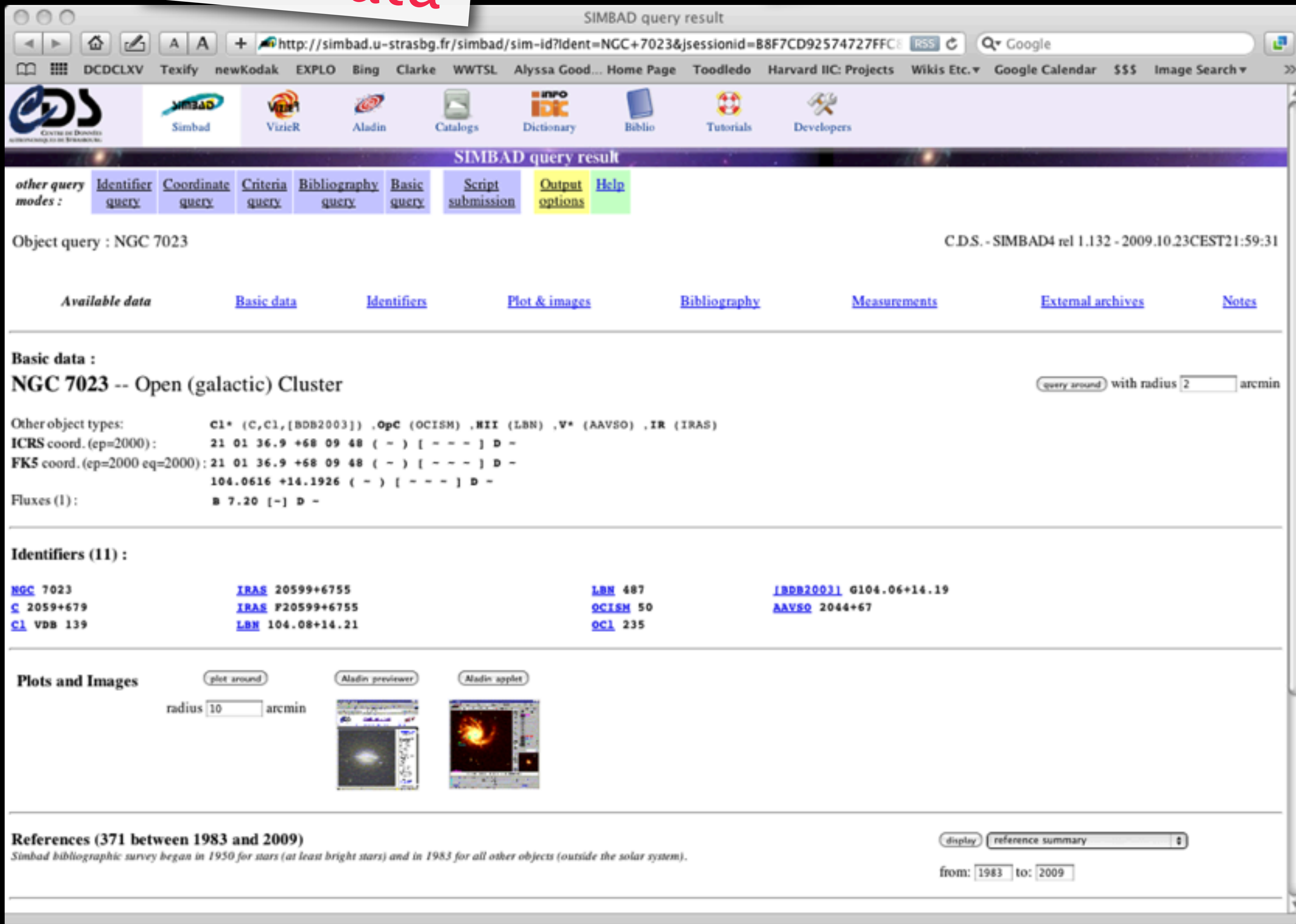

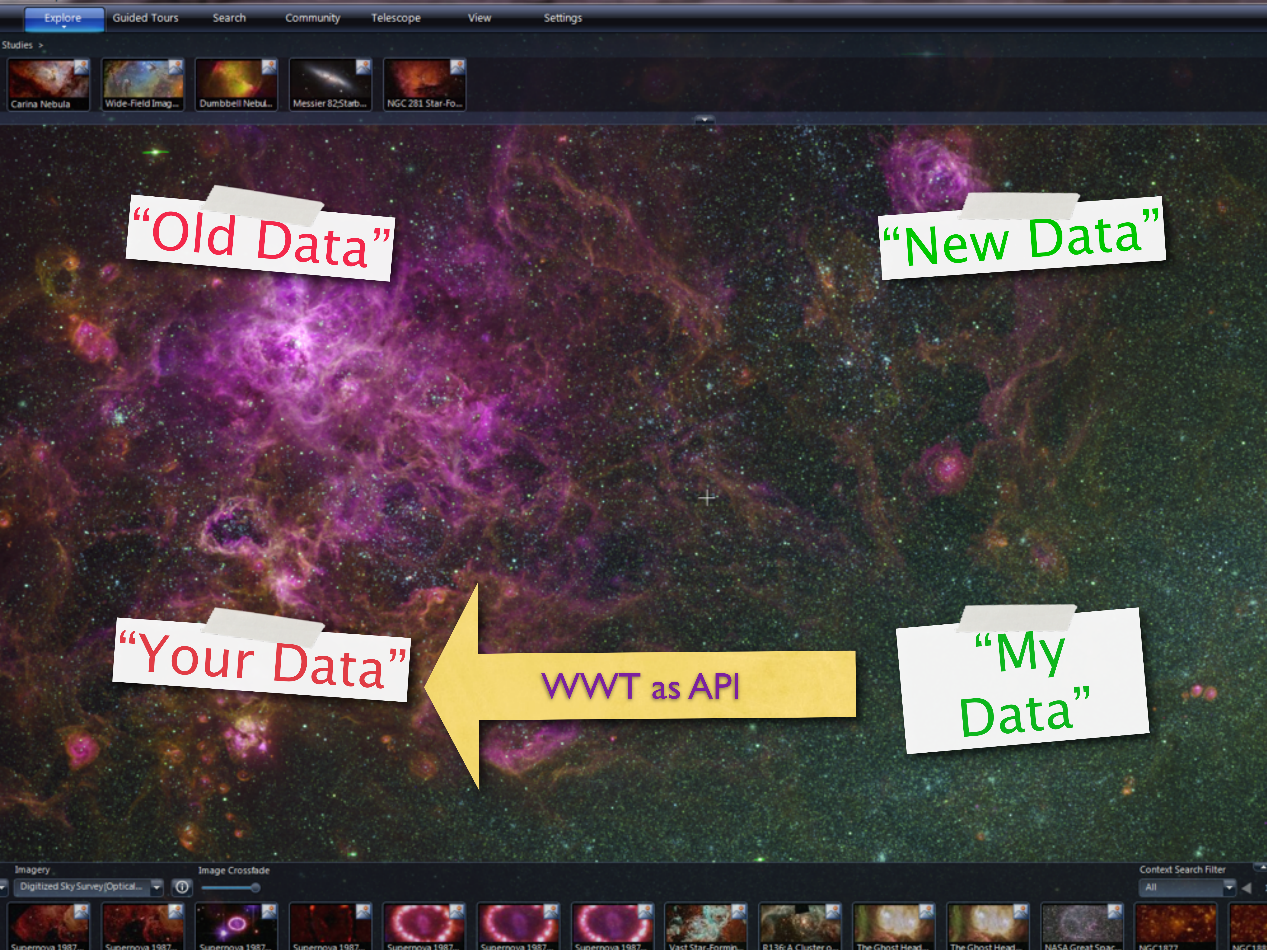
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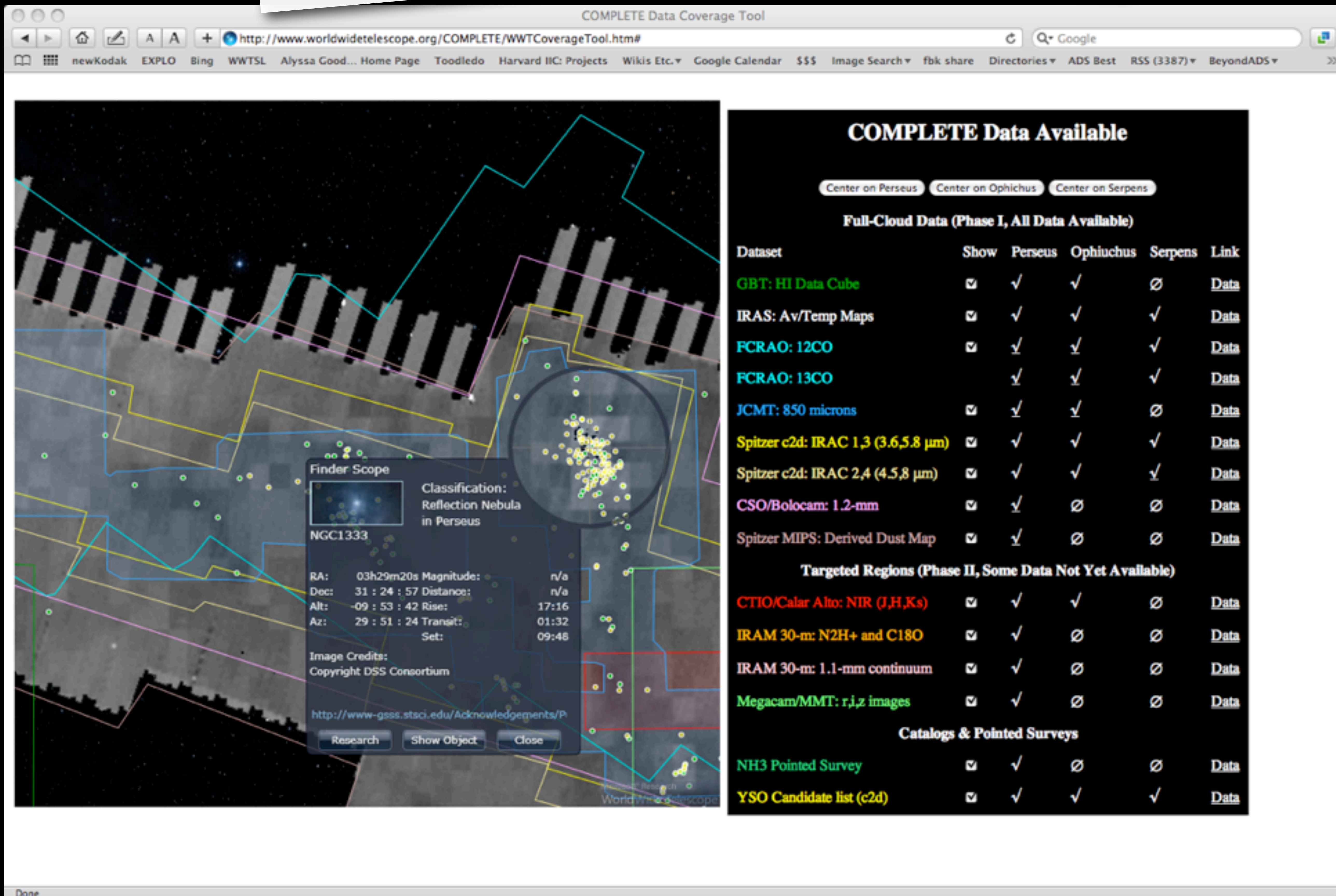

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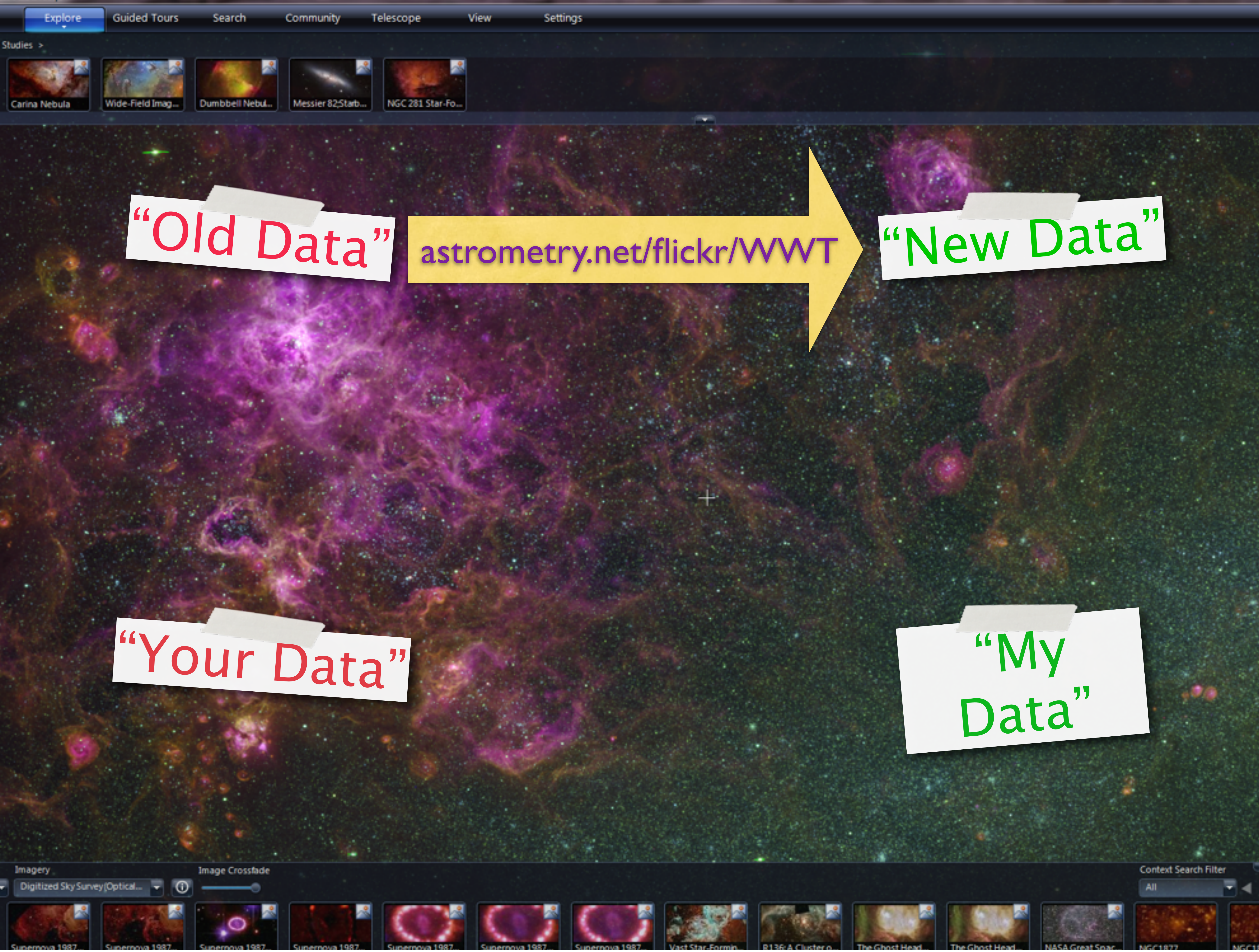

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HH46/47

This image from NASA's Spitzer Space Telescope transforms a dark cloud into a silky translucent veil, revealing the molecular outflow from an otherwise hidden newborn star. Using near-infrared light, Spitzer pierces through the dark cloud to detect the embedded outflow in an object called HH 46/47. Herbig-Haro (HH) objects are bright, nebulous regions of gas and dust that are usually buried within dark clouds. They are formed when supersonic gas ejected from a forming protostar, or embryonic star, interacts with the surrounding interstellar medium. These young stars are often detected only in the infrared.

The Spitzer image was obtained with the infrared array camera. Emission at 3.6 microns is shown as blue, emission from 4.5 and 5.8 microns has been combined as green, and 8.0 micron emission is depicted as red.

HH 46/47 is a striking example of a low-mass protostar ejecting a jet and creating a bipolar, or two-sided, outflow. The central http://www.flickr.com/photos/66496709@N00/3175344278/

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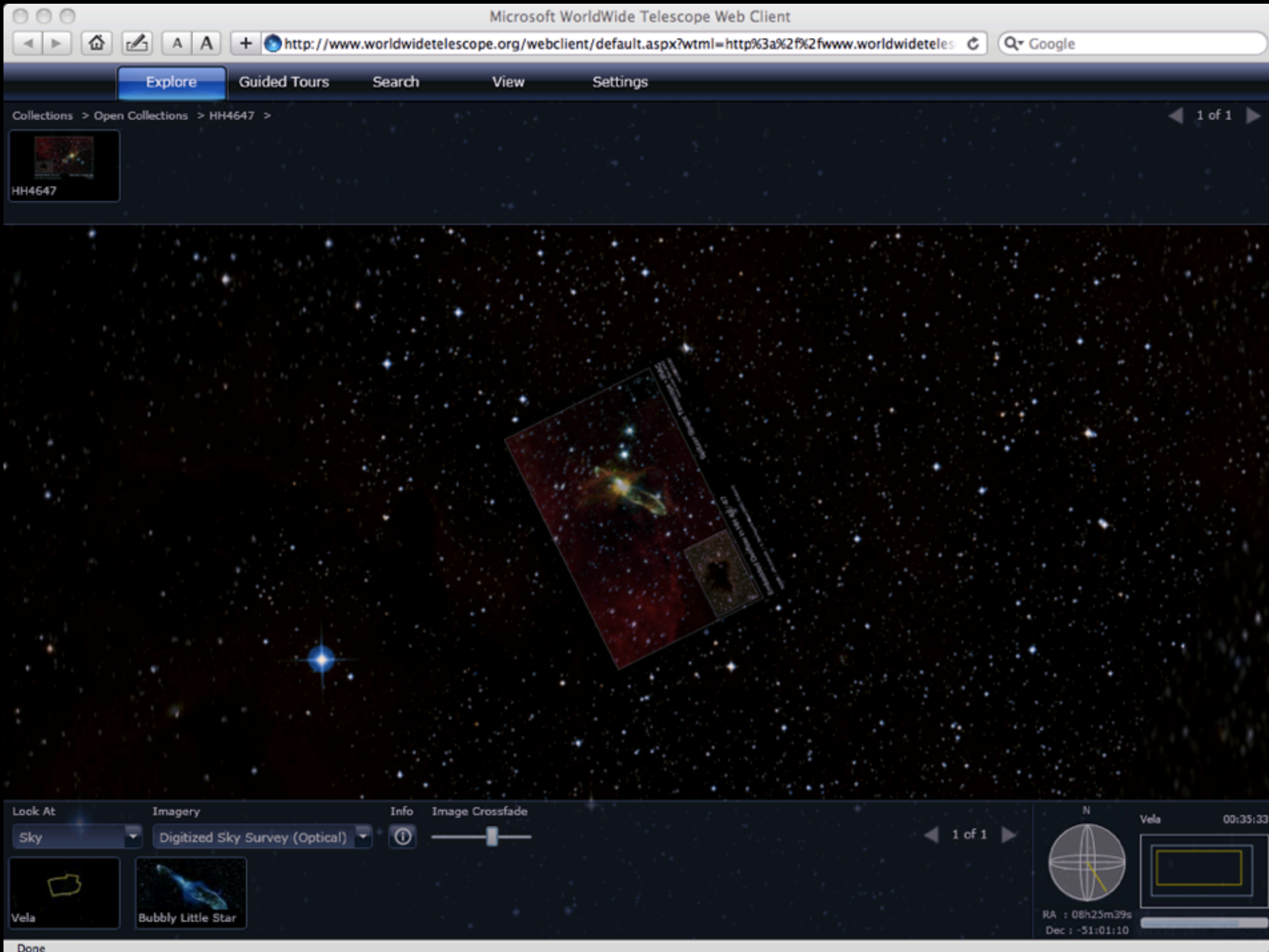
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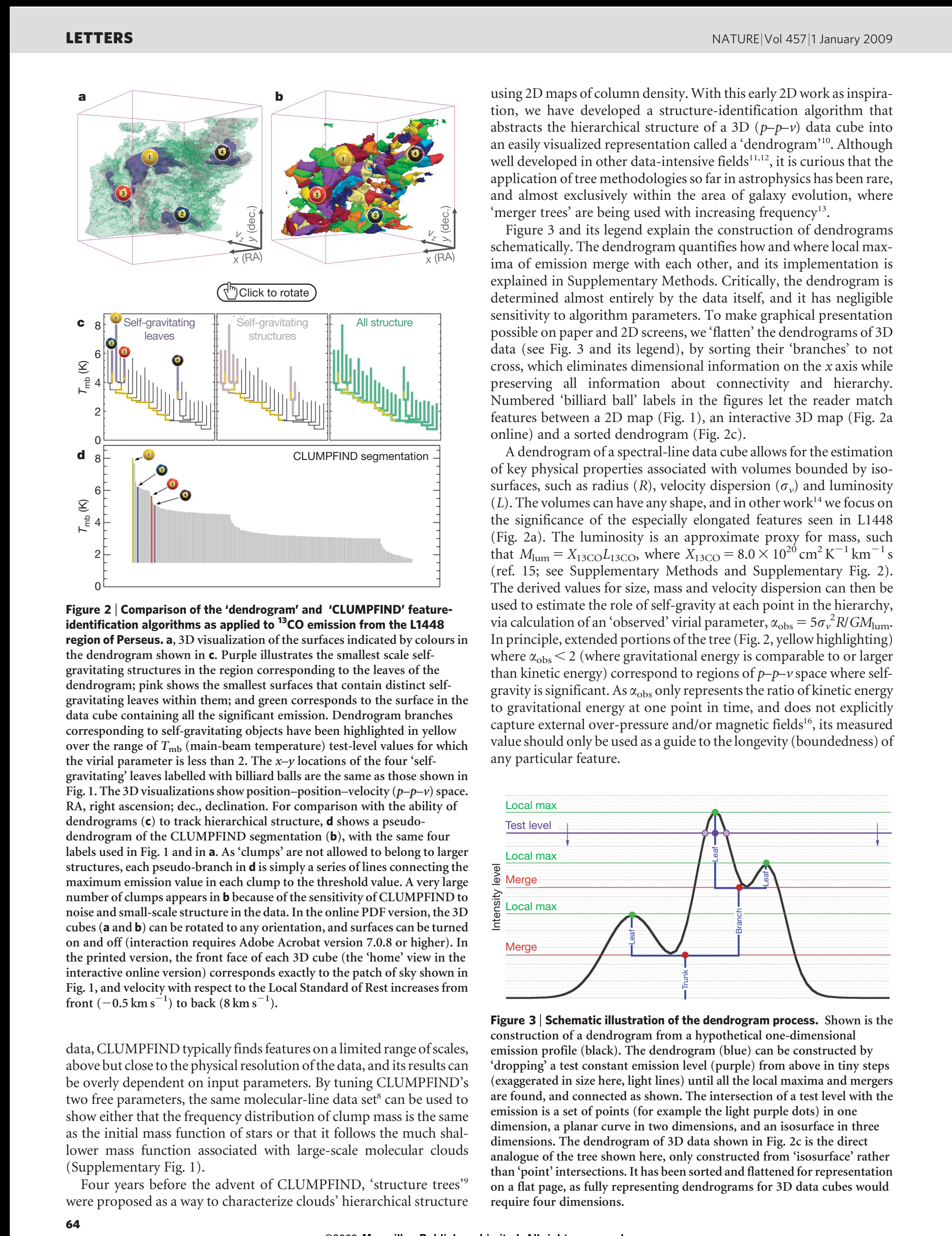

Figure 2 | Comparison of the 'dendrogram' and 'CLUMPFIND' feature-identification algorithms as applied to ^{13}CO emission from the L1448 region of Perseus. a, 3D visualization of the surfaces indicated by colours in the dendrogram shown in **c**. Purple illustrates the smallest scale self-gravitating structures in the region corresponding to the leaves of the dendrogram; pink shows the smallest surfaces that contain distinct self-gravitating leaves within them; and green corresponds to the surface in the data cube containing all the significant emission. Dendrogram branches corresponding to self-gravitating objects have been highlighted in yellow over the range of T_{mb} (main-beam temperature) test-level values for which the virial parameter is less than 2. The x–y locations of the four 'self-gravitating' leaves labelled with billiard balls are the same as those shown in Fig. 1. The 3D visualizations show position–position–velocity (p–p–v) space. RA, right ascension; dec., declination. For comparison with the ability of dendrograms (**c**) to track hierarchical structure, **d** shows a pseudo-dendrogram of the CLUMPFIND segmentation (**b**), with the same four labels used in Fig. 1 and in **a**. As 'clumps' are not allowed to belong to larger structures, each pseudo-branch in **d** is simply a series of lines connecting the maximum emission value in each clump to the threshold value. A very large number of clumps appears in **b** because of the sensitivity of CLUMPFIND to noise and small-scale structure in the data. In the online PDF version, the 3D cubes (**a** and **b**) can be rotated to any orientation, and surfaces can be turned on and off (interaction requires Adobe Acrobat version 7.0.8 or higher). In the printed version, the front face of each 3D cube (the 'home' view in the interactive online version) corresponds exactly to the patch of sky shown in Fig. 1, and velocity with respect to the Local Standard of Rest increases from front ($-0.5\ km\ s^{-1}$) to back ($8\ km\ s^{-1}$).

data, CLUMPFIND typically finds features on a limited range of scales, above but close to the physical resolution of the data, and its results can be overly dependent on input parameters. By tuning CLUMPFIND's two free parameters, the same molecular-line data set[8] can be used to show either that the frequency distribution of clump mass is the same as the initial mass function of stars or that it follows the much shallower mass function associated with large-scale molecular clouds (Supplementary Fig. 1).

Four years before the advent of CLUMPFIND, 'structure trees'[9] were proposed as a way to characterize clouds' hierarchical structure using 2D maps of column density. With this early 2D work as inspiration, we have developed a structure-identification algorithm that abstracts the hierarchical structure of a 3D (p–p–v) data cube into an easily visualized representation called a 'dendrogram'[10]. Although well developed in other data-intensive fields[11,12], it is curious that the application of tree methodologies so far in astrophysics has been rare, and almost exclusively within the area of galaxy evolution, where 'merger trees' are being used with increasing frequency[13].

Figure 3 and its legend explain the construction of dendrograms schematically. The dendrogram quantifies how and where local maxima of emission merge with each other, and its implementation is explained in Supplementary Methods. Critically, the dendrogram is determined almost entirely by the data itself, and it has negligible sensitivity to algorithm parameters. To make graphical presentation possible on paper and 2D screens, we 'flatten' the dendrograms of 3D data (see Fig. 3 and its legend), by sorting their 'branches' to not cross, which eliminates dimensional information on the x axis while preserving all information about connectivity and hierarchy. Numbered 'billiard ball' labels in the figures let the reader match features between a 2D map (Fig. 1), an interactive 3D map (Fig. 2a online) and a sorted dendrogram (Fig. 2c).

A dendrogram of a spectral-line data cube allows for the estimation of key physical properties associated with volumes bounded by isosurfaces, such as radius (R), velocity dispersion (σ_v) and luminosity (L). The volumes can have any shape, and in other work[14] we focus on the significance of the especially elongated features seen in L1448 (Fig. 2a). The luminosity is an approximate proxy for mass, such that $M_{lum} = X_{13CO} L_{13CO}$, where $X_{13CO} = 8.0 \times 10^{20}\ cm^2\ K^{-1}\ km^{-1}\ s$ (ref. 15; see Supplementary Methods and Supplementary Fig. 2). The derived values for size, mass and velocity dispersion can then be used to estimate the role of self-gravity at each point in the hierarchy, via calculation of an 'observed' virial parameter, $\alpha_{obs} = 5\sigma_v^2 R/GM_{lum}$. In principle, extended portions of the tree (Fig. 2, yellow highlighting) where $\alpha_{obs} < 2$ (where gravitational energy is comparable to or larger than kinetic energy) correspond to regions of p–p–v space where self-gravity is significant. As α_{obs} only represents the ratio of kinetic energy to gravitational energy at one point in time, and does not explicitly capture external over-pressure and/or magnetic fields[16], its measured value should only be used as a guide to the longevity (boundedness) of any particular feature.

Figure 3 | Schematic illustration of the dendrogram process. Shown is the construction of a dendrogram from a hypothetical one-dimensional emission profile (black). The dendrogram (blue) can be constructed by 'dropping' a test constant emission level (purple) from above in tiny steps (exaggerated in size here, light lines) until all the local maxima and mergers are found, and connected as shown. The intersection of a test level with the emission is a set of points (for example the light purple dots) in one dimension, a planar curve in two dimensions, and an isosurface in three dimensions. The dendrogram of 3D data shown in Fig. 2c is the direct analogue of the tree shown here, only constructed from 'isosurface' rather than 'point' intersections. It has been sorted and flattened for representation on a flat page, as fully representing dendrograms for 3D data cubes would require four dimensions.

Goodman et al. *Nature*, 2009

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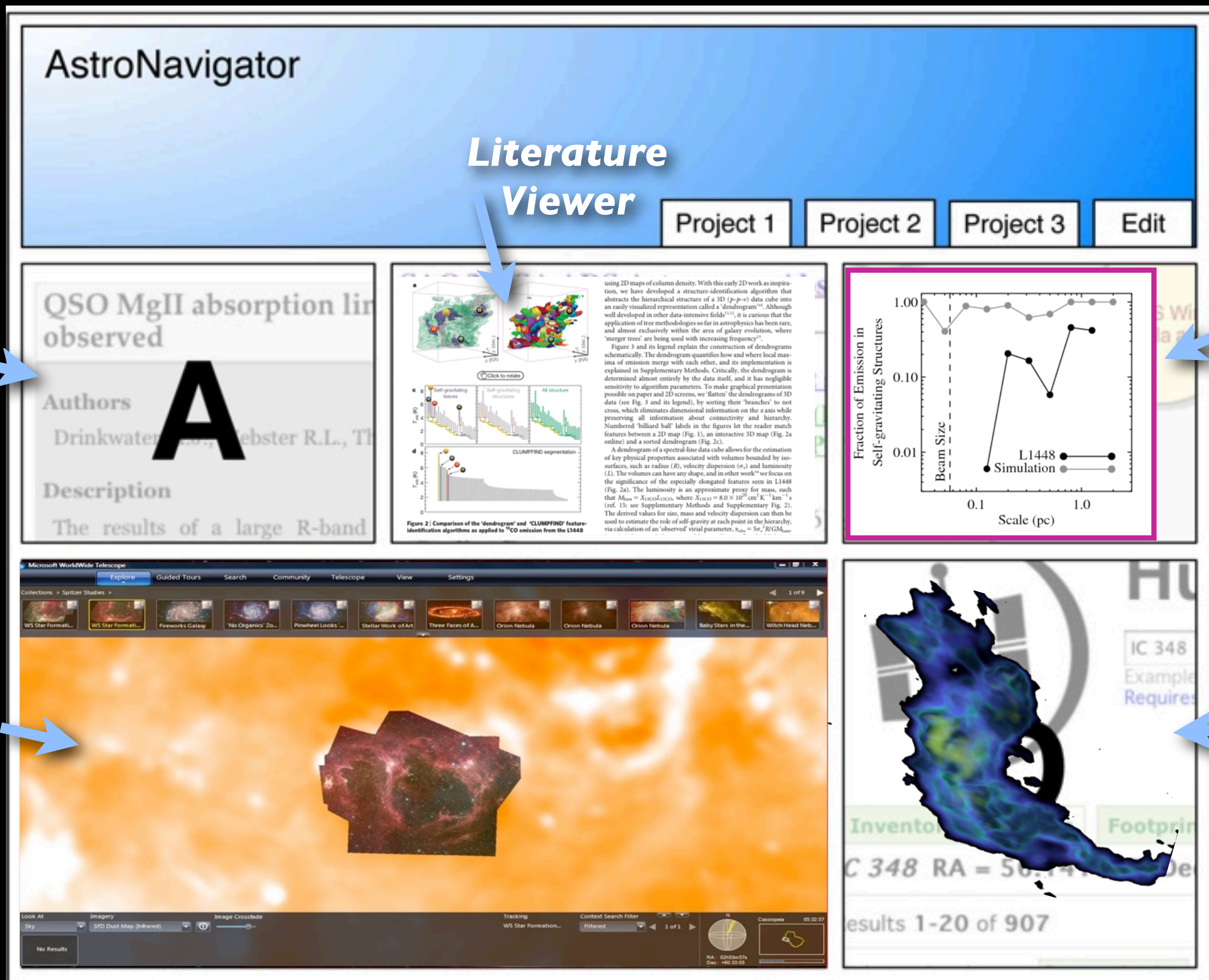

Mockup based on work of Eli Bressert, excerpted from NASA AISRP proposal by Goodman, Muench, Christian, Conti, Kurtz, Burke, Accomazzi, McGuinness, Hendler & Wong, 2008

ASTROBETTER

Tips and Tricks for Professional Astronomers

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FROM THE CATEGORY ARCHIVES:

analysis

Fitting surface brightness profiles

by Jane December 14, 2009

It's time for another session of, "Which tool do you use to accomplish a given astro-task, and why that tool?" The topic: fitting surface brightness profiles. Two likely suspects: the Archangel package, and iraf's stsdas.analysis.isophote. OK, go.

3 comments **Read more →**

Better ways to make large image mosaics?

by Kelle October 21, 2009

Given the useful responses to Jane's question about spectral line analysis, here's another query for the community. This one is about making large image mosaics and it comes from Adam Ginsburg, a grad student at the University of Colorado, Boulder.
I want to make a large-scale mosaic of the Galactic Plane covering 90-180 degrees x a [...]

10 comments **Read more →**

The Integral Field Spectroscopy Wiki

by Kelle October 19, 2009

Here's a guest post from Mark Westmoquette at the University College London

Spectral line analysis tools

by Jane October 2, 2009

This is an embarrassing post, but I'm going to forge ahead. Time was, we used IRAF and we hated it, but what else was there? Now, there are many choices, lots of them buggy

Contributors

- Eli (4)
- Jane (9)
- Jessica (4)
- Kelle (37)
- Tom (3)

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- Making Fonts Better in IDL Postscript Output
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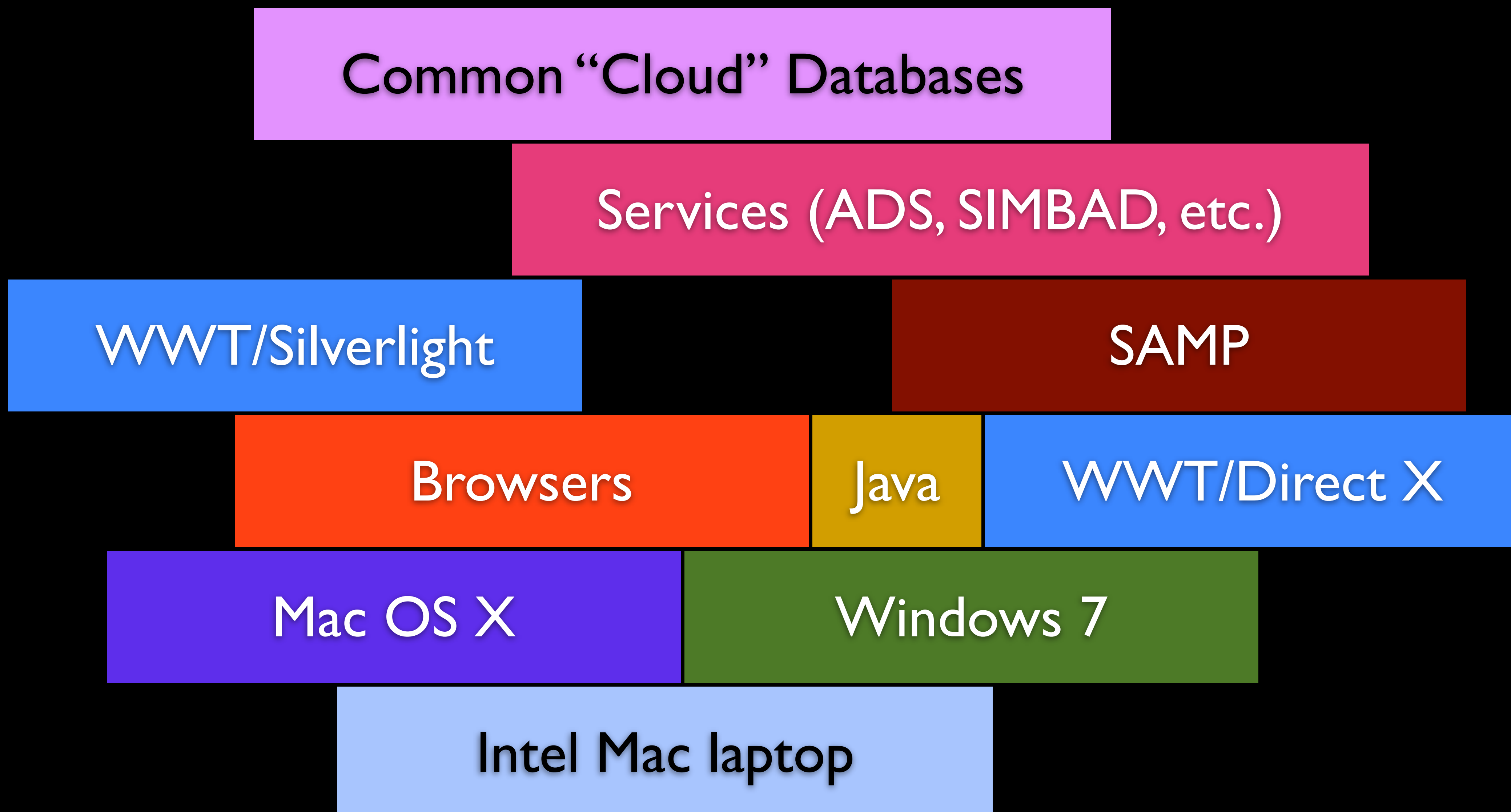
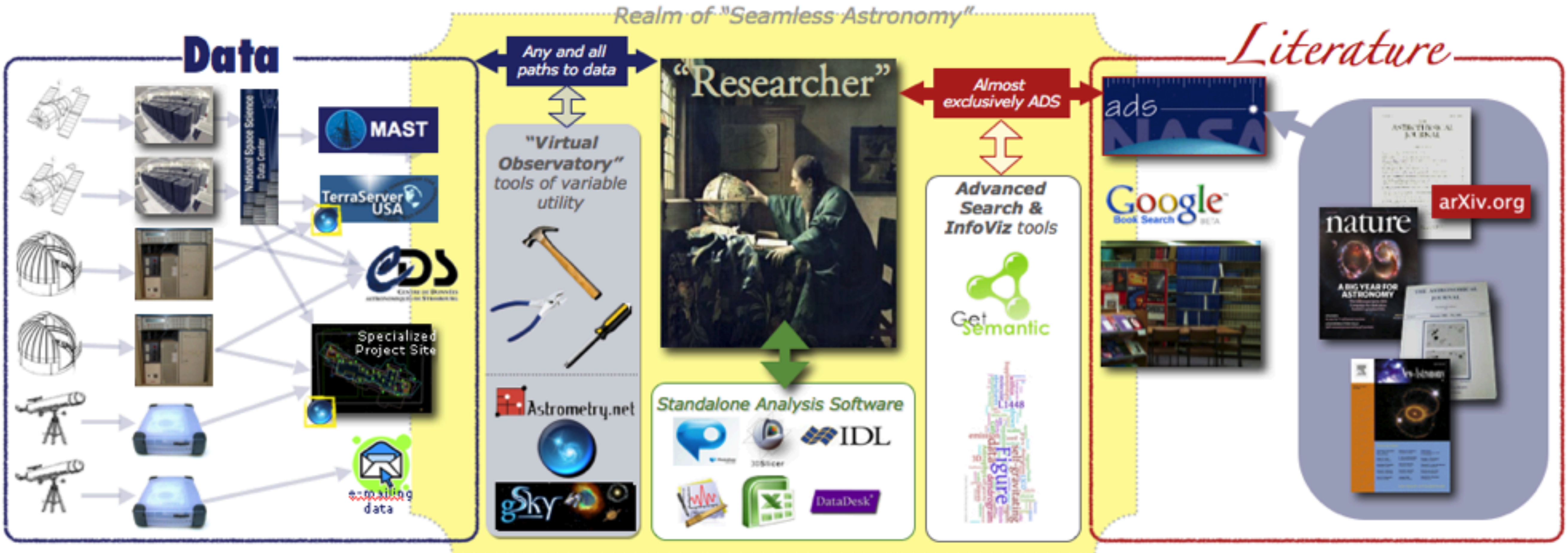
www.astrobetter.com

Think about the "modules" needed to make this work...but do the details matter, to your research, if the system works seamlessly?



Seamless Astronomy

www.cfa.harvard.edu/~agoodman and worldwidetelescope.org



Seamless Astronomy

Alyssa A. Goodman

Harvard-Smithsonian Center for Astrophysics
Initiative in Innovative Computing @ Harvard

Collaborators

*Harvard-Smithsonian Center for Astrophysics & SEAS: Alberto **Accomazzi**, Eli **Bressert**, Douglas **Burke**, Rahul **Davé**, Pepi **Fabbiano**, Michael **Kurtz**, Gus **Muench**, Pavlos **Protopapas***
*Massachusetts General Hospital: Tim **Clark** & Sudeshna **Das***
*Microsoft Research: Jonathan **Fay**, Curtis **Wong***
*RPI: Jim **Hendler** & Deborah **McGuinness***
*STScI: Alberto **Conti** & Carol **Christian***
*UCLA: Christine **Borgman***

Extra Slides

MASSACHUSETTS GENERAL HOSPITAL

April 2009
ISSUE 16

CARDIOVASCULAR IMAGES

A joint publication of the Department of Radiology and Heart Center

New-Onset Chest Pain

Ricardo J. Benenstein, MD, Rahul Kakkar, MD, Wilfred Mamuya, MD, PhD, Suhny Abbara, MD

Clinical History

A 48 year-old woman with a history of mitral valve insufficiency presented to the emergency room with a subacute (4 days) chest pain syndrome. The day of admission, she was awakened from sleep with substernal chest pressure which was non-radiating, worsened with exercise and was relieved by rest. She denied difficulty breathing, palpitations, diaphoresis, or syncope. She was referred to Massachusetts General Hospital, where her presenting EKG showed ST-elevations in V2–V3 and T wave inversions in I and aVL. Her presenting biomarkers were unremarkable. She was given aspirin, metoprolol and intravenous heparin and transferred to the Catheterization Laboratory. Cardiac catheterization revealed an occluded left main (LM) coronary artery, with left anterior descending artery (LAD) and left circumflex artery (LCx) filling from the right coronary artery (RCA). No intervention was performed and medical management with aspirin, beta-blockers, HMG CoA reductase inhibitors and ACE-inhibitors was initiated.

Following catheterization, she continued to have episodes of chest pain with associated ST segment depression and T wave inversion in the anterior leads. A symptom-limited perfusion study was suboptimal, but suspicious for reversible anterior wall myocardial ischemia. A decision was made to proceed with cardiac revascularization with a single bypass graft left internal mammary artery (LIMA) to LAD; and a prospectively triggered dual source 64 slice coronary CTA was requested prior to surgical revascularization to further delineate coronary anatomy and mammary arteries.

Findings

Cardiac CTA revealed a short left main with an absent ostium. The RCA was markedly enlarged, and the LAD and LCx were opacified via collateral flow from a right-sided posterior left ventricular branch (PLVB). All three main coronary arteries were free of evidence of epicardial coronary artery disease. This constellation of findings is consistent with congenital left main coronary atresia (LMCA).

Discussion

LMCA is a rare coronary anomaly in which there is no left main ostium, and the proximal left main trunk ends blindly. Blood flows retrograde from the right coronary artery to the left circulation via collaterals. The collateral vessels feeding the left coronary system may include the conal, intraseptal, apical, anterior, and posterior ventricular arteries. Most patients are symptomatic at the time of diagnosis; with syncope, failure to thrive and myocardial infarction being the commonest presentation in the pediatric population. Older patients usually present with complaints of exertional dyspnea or angina in the absence of atherosclerotic disease, and sudden death is a rare presenting symptom. Medical therapy does not appear to be helpful.

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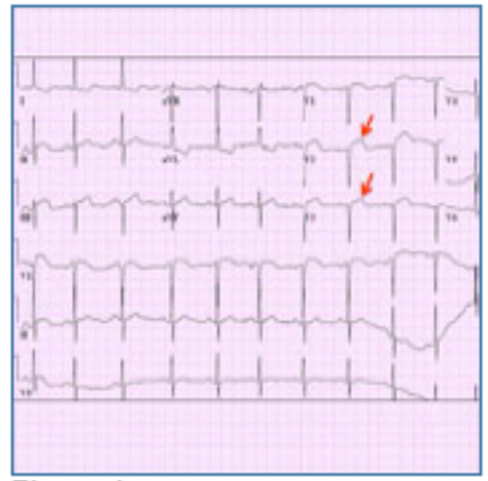

Figure 1.

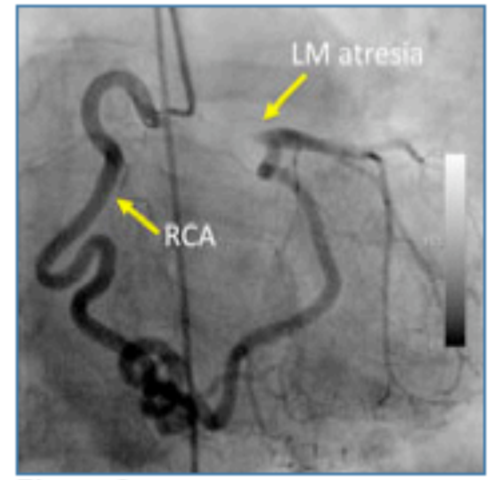

Figure 2.

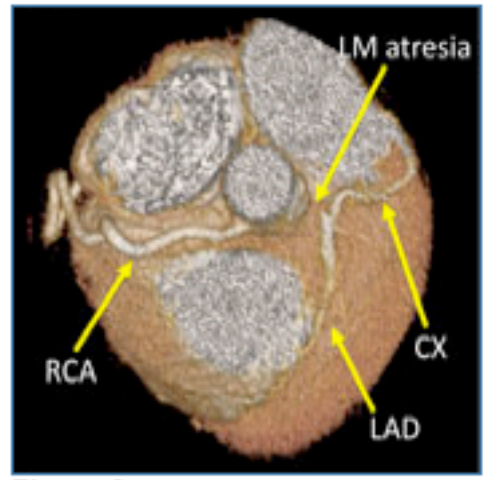

Figure 3.

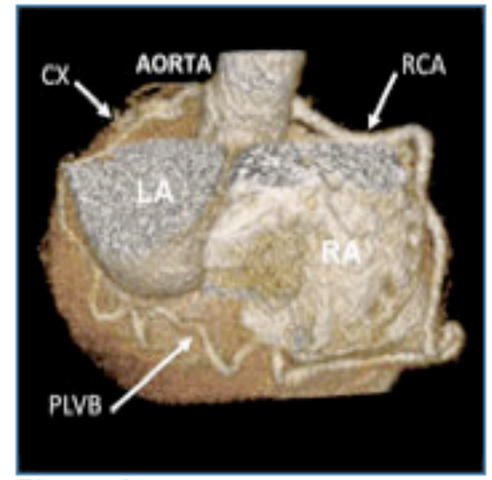

Figure 4.

(Click on images to enlarge)

Figure 1. Presenting EKG with ST-T elevation in V2 – V3 (arrows).

Figure 2. CATH: RAO view showing an enlarged RCA with a large terminal PLV branch. The left main appears to be occluded LM. The LCx and LAD fill with retrograde flow from the PLV branch.

Figure 3. 3D volume rendered CTA showing the LM Atresia.

Figure 4. 3D volume rendered CTA showing an enlarged RCA with a large terminal PLV branch connecting to the LCx.

How would this be as an interactive tour?

http://www.mgh-cardiovascimages.org/index.php?src=gendocs&ref=cv_april_2009

“GIS/Layering”

“Ontology”

“Search”

What’s needed?

“Progressive Resolve”

“Registration”

“Selection”

“Side-by-Side Comparison”

“Readable Labels”

“Highlighting”

“Zoom”

“Custom Site”

“Measurement”

“Inference”

“Off-the-Desktop”