E/PO ADVERTISEMENT

The WorldWide Telescope Ambassadors Program

www.cfa.harvard.edu/WWTAmbassadors/

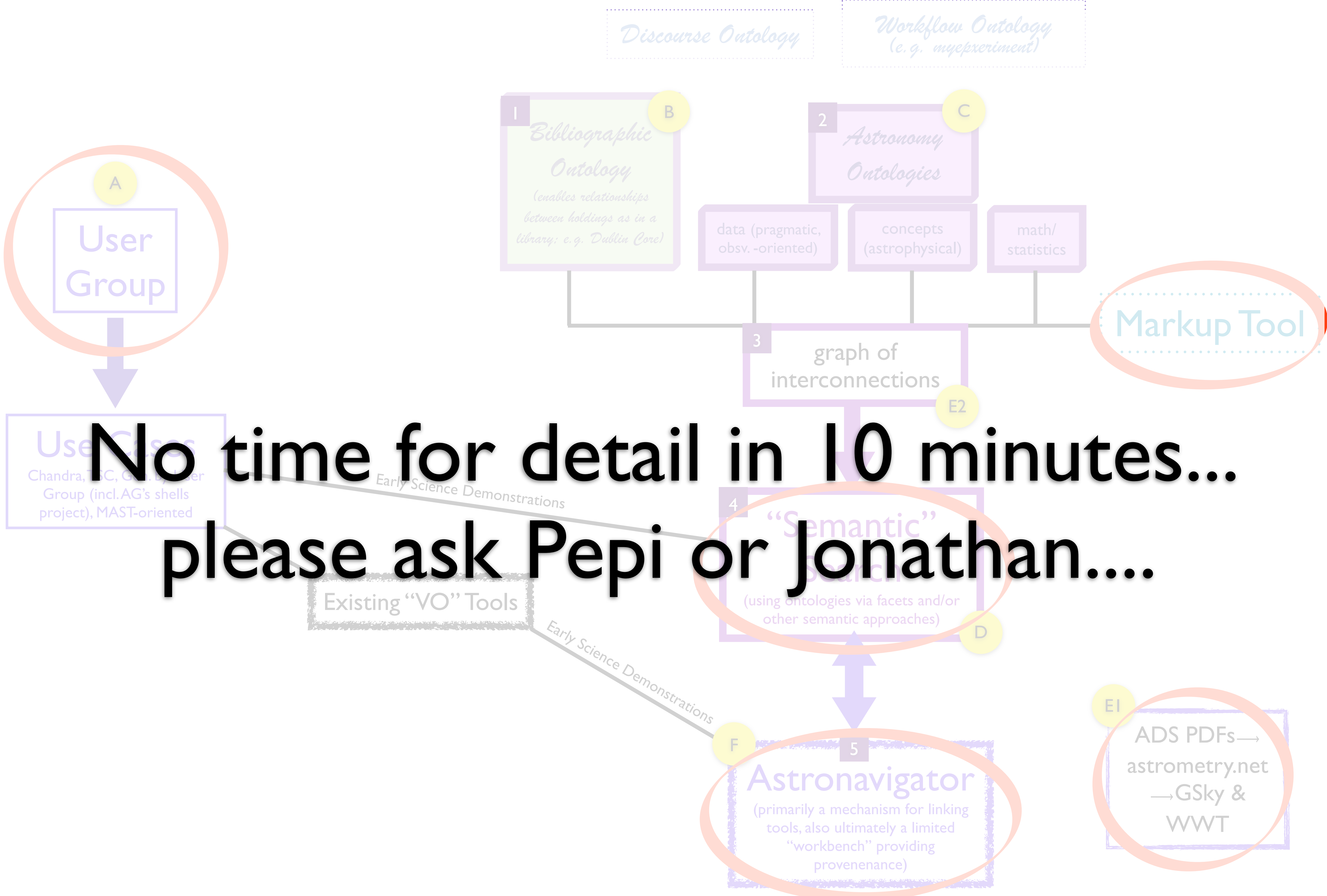
Seamless Astronomy

Alyssa A. Goodman

Harvard-Smithsonian Center for Astrophysics

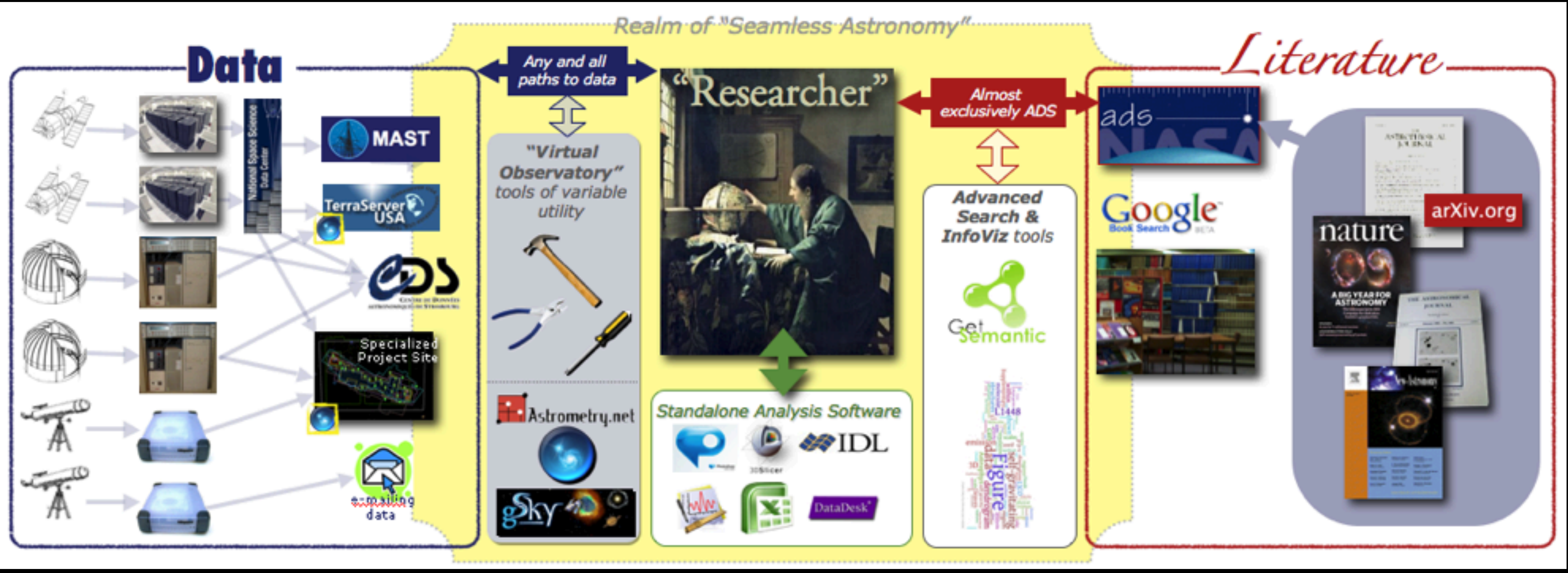
with Alberto **Accomazzi**, Rahul **Davé**,
Gus **Muench** & Michael **Kurtz** (Harvard-Smithsonian CfA);
Tim **Clark** (Massachusetts General Hospital/Harvard Medical School);
Jonathan **Fay** & Curtis **Wong** (Microsoft Research)

+extended & upcoming collaboration with Chris Borgman & Alberto Pepe* (UCLA);
Doug Burke; Sarah Block, Pepi Fabbiano, et al. (CfA); E. Bressert (U. Exeter);
J. Hendler & D. McGuinness (RPI); A. Conti & C. Christian (STScI); A. Connolly et al. (U. Washington)



No time for detail in 10 minutes... please ask Pepi or Jonathan....

Realm of Seamless Astronomy




Realm of "Seamless Astronomy"
2010
Evermore
Seamless
Astronomy
Data
"Researcher"
Advanced Search & InfoViz tools
GetSemantic
arXiv.org
nature
Astrometry.net
Literature
Standalone Analysis Software
3DSlicer
IDL
DataDesk

What should *we* do now?

Focus on interconnections/modularity interconnections/modularity

Involve more "free agents" free agents

Provide institutional data/code repositories repositories

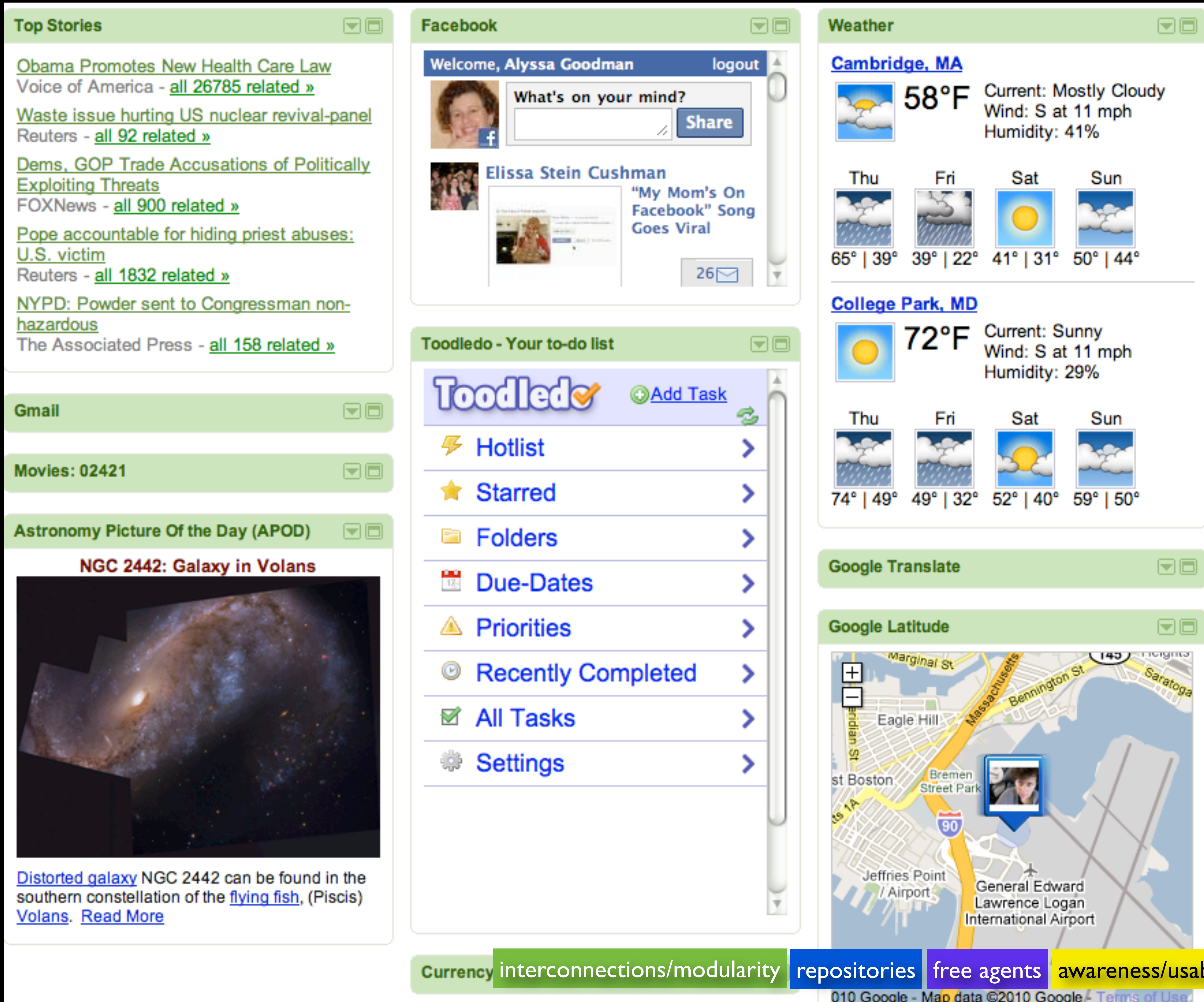
Make users aware w/o "software-speak" awareness/usability

This simple argument, first made at the 2009 WWT session at AAS, seems to be working:

"Astronomy research tools should work as seamlessly as travel research tools."

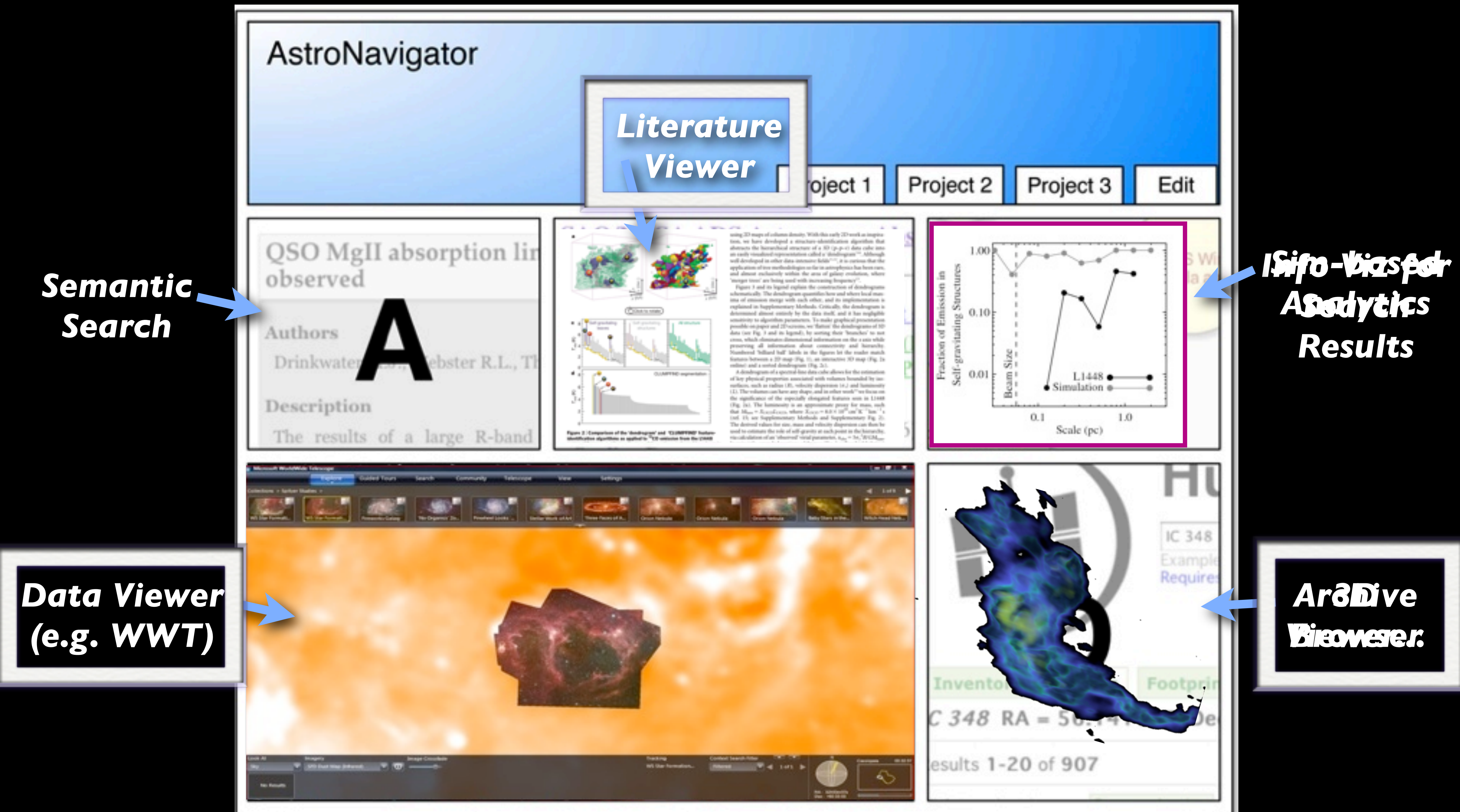
interconnections/modularity | repositories | free agents | awareness/usability

iGoogle

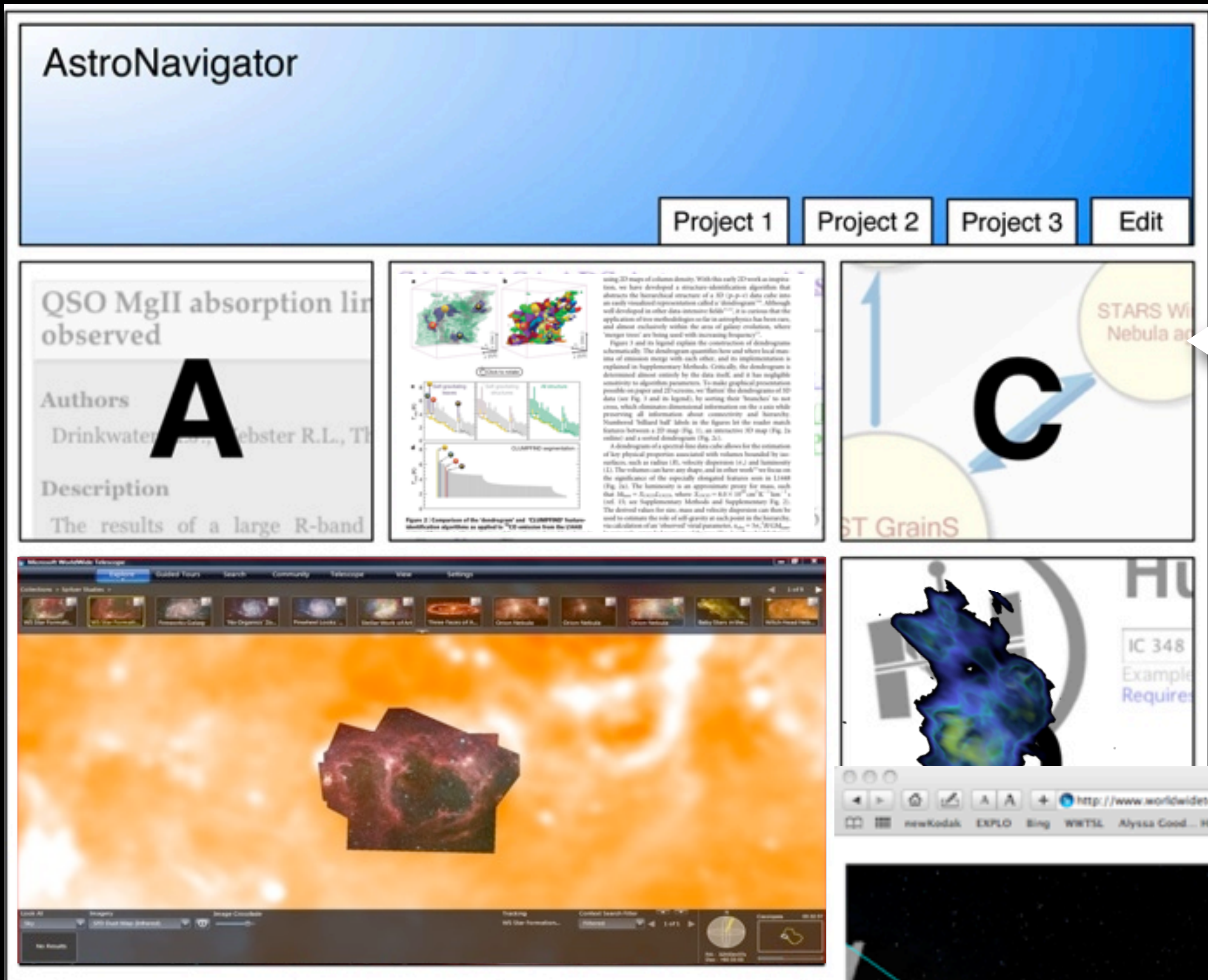


interconnections/modularity | repositories | free agents | awareness/usability free agents | interconnections/modularity | repositories

Seamless Astronomy



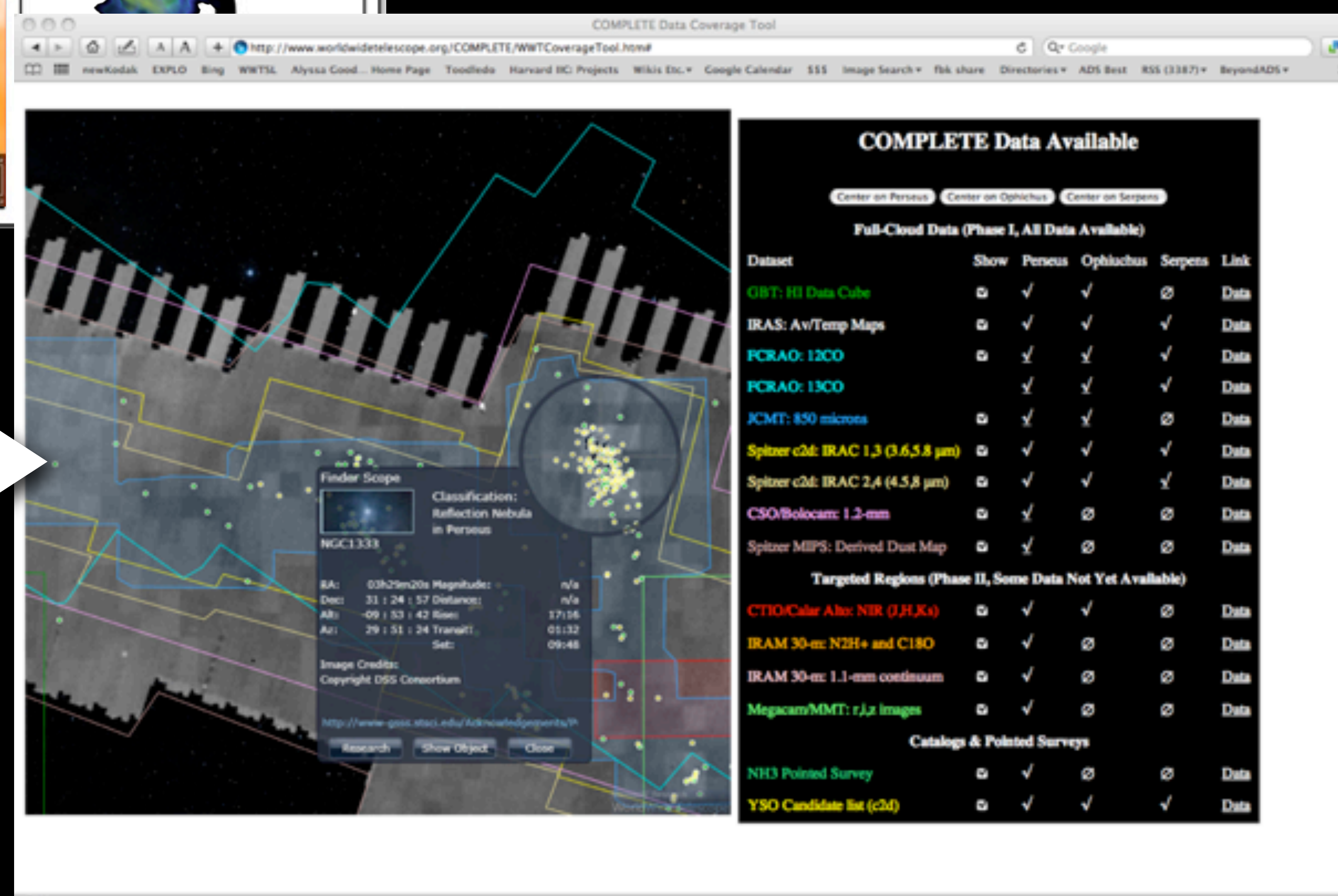
Mockup based on work of Eli Bressert, excerpted from NASA AISRP proposal by Goodman, Muench, Christian, Conti, Kurtz, Burke, Accomazzi, McGuinness, Hendler & Wong, 2008



~Fiction

very soon fact,

e.g. CfA & U.W. work!



Fact

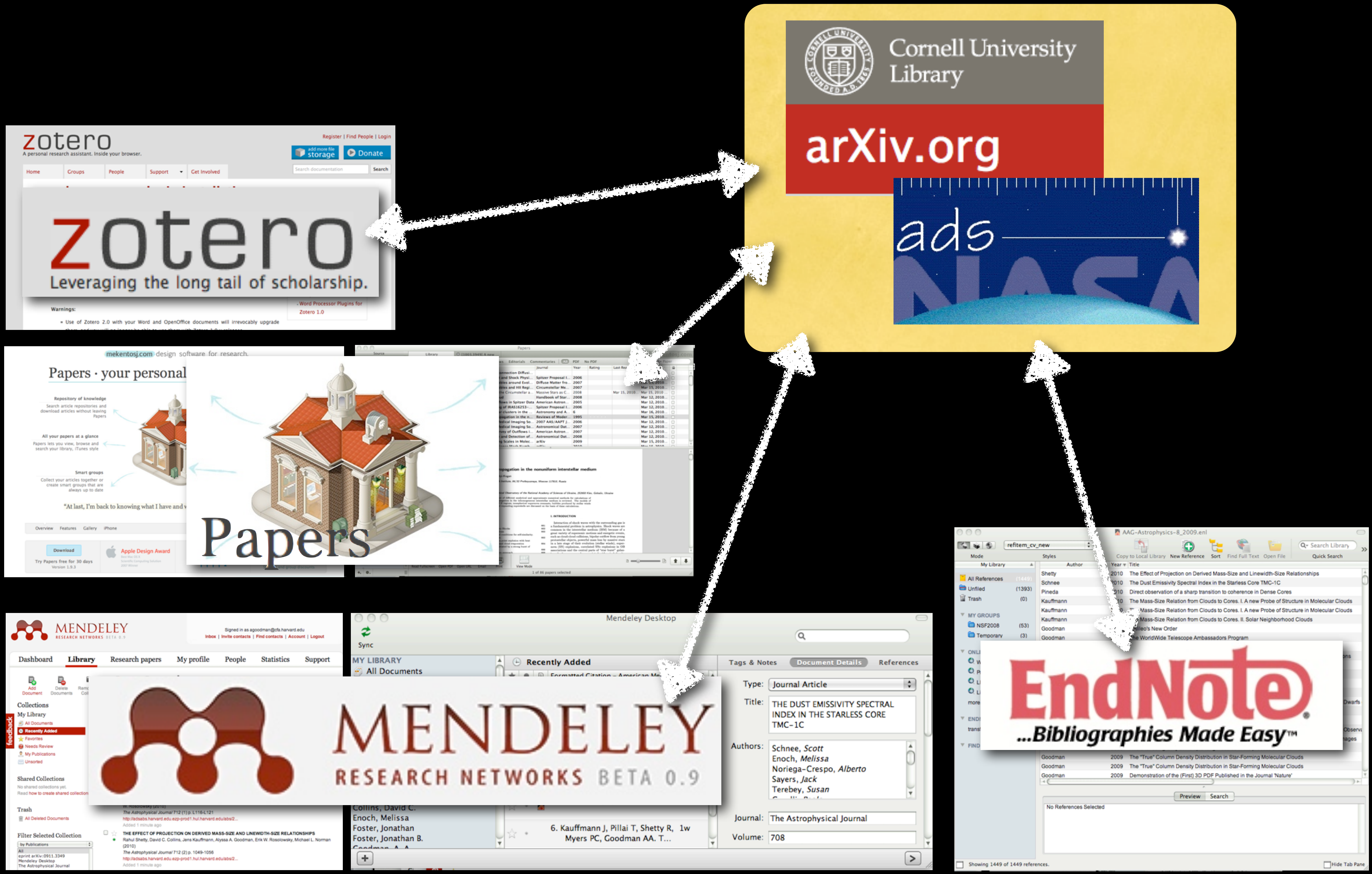
right now,

e.g.

www.cfa.harvard.edu/~COMPLETE/

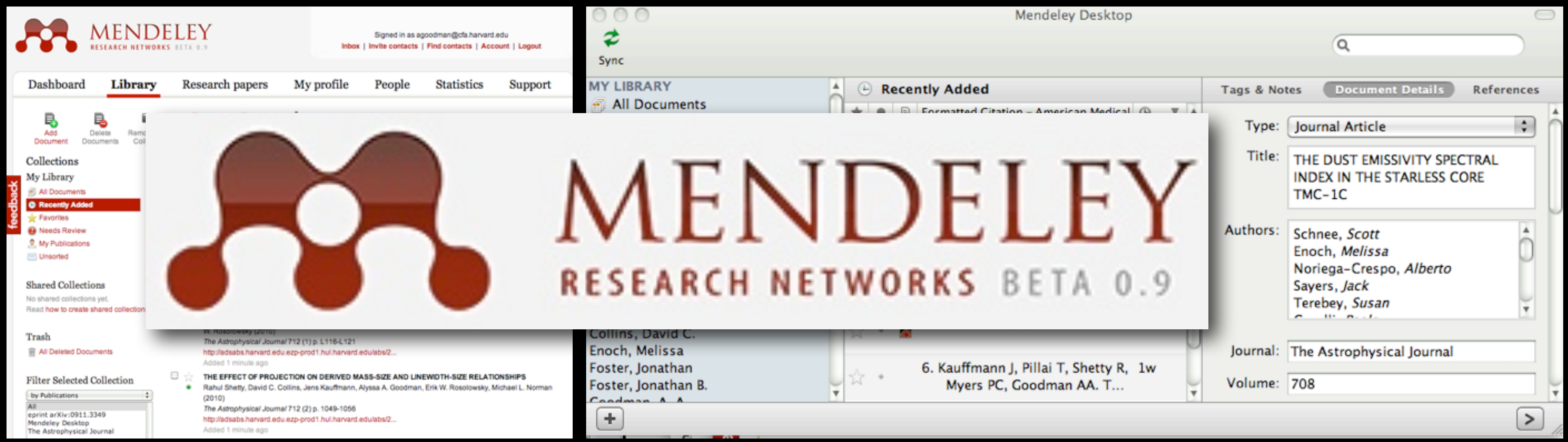
interconnections/modularity repositories free agents

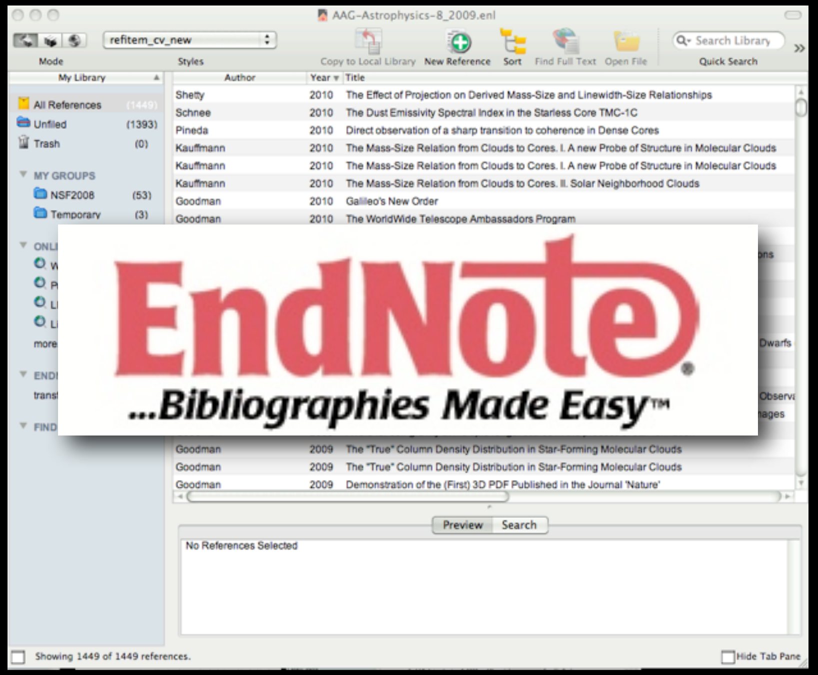
Literature Handling: *Diverse Apps*, *Common Data*

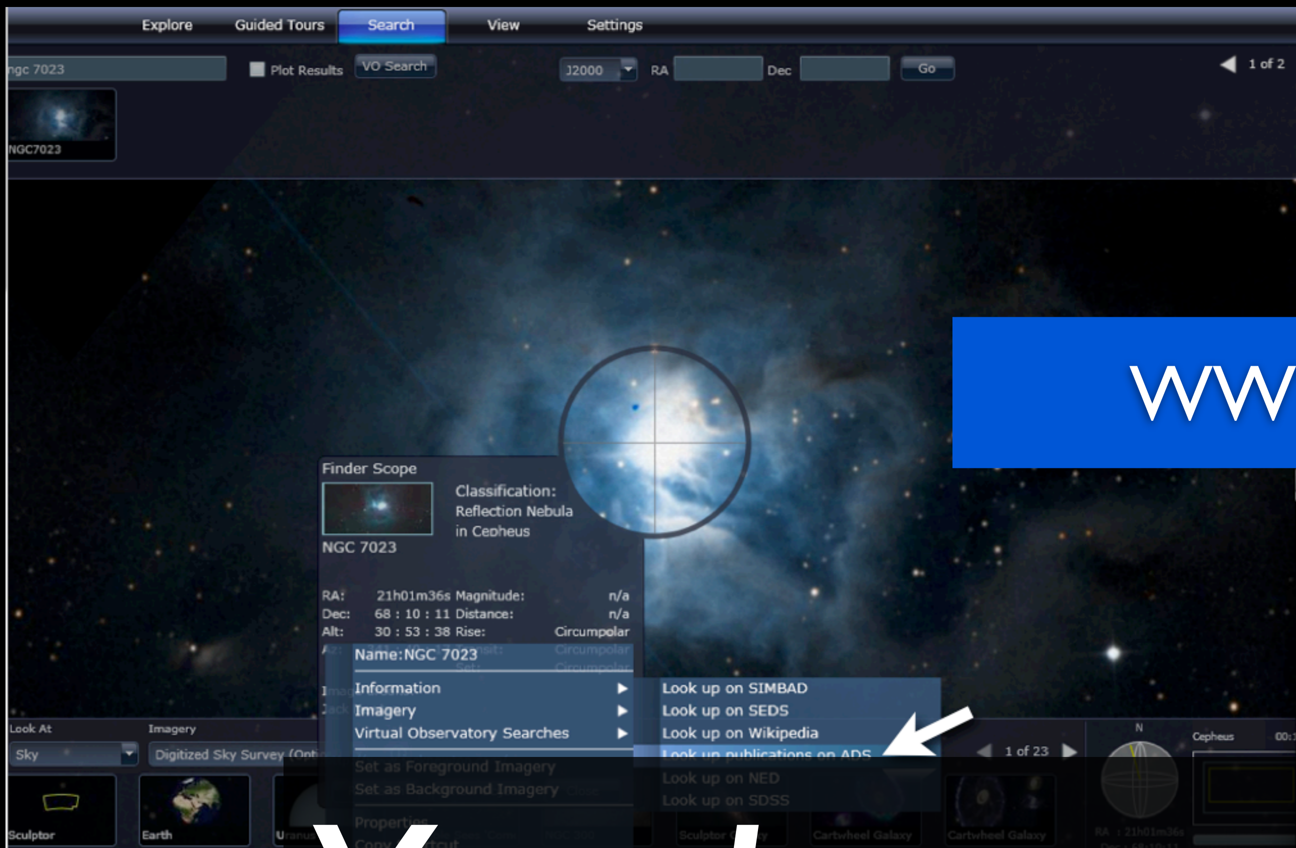


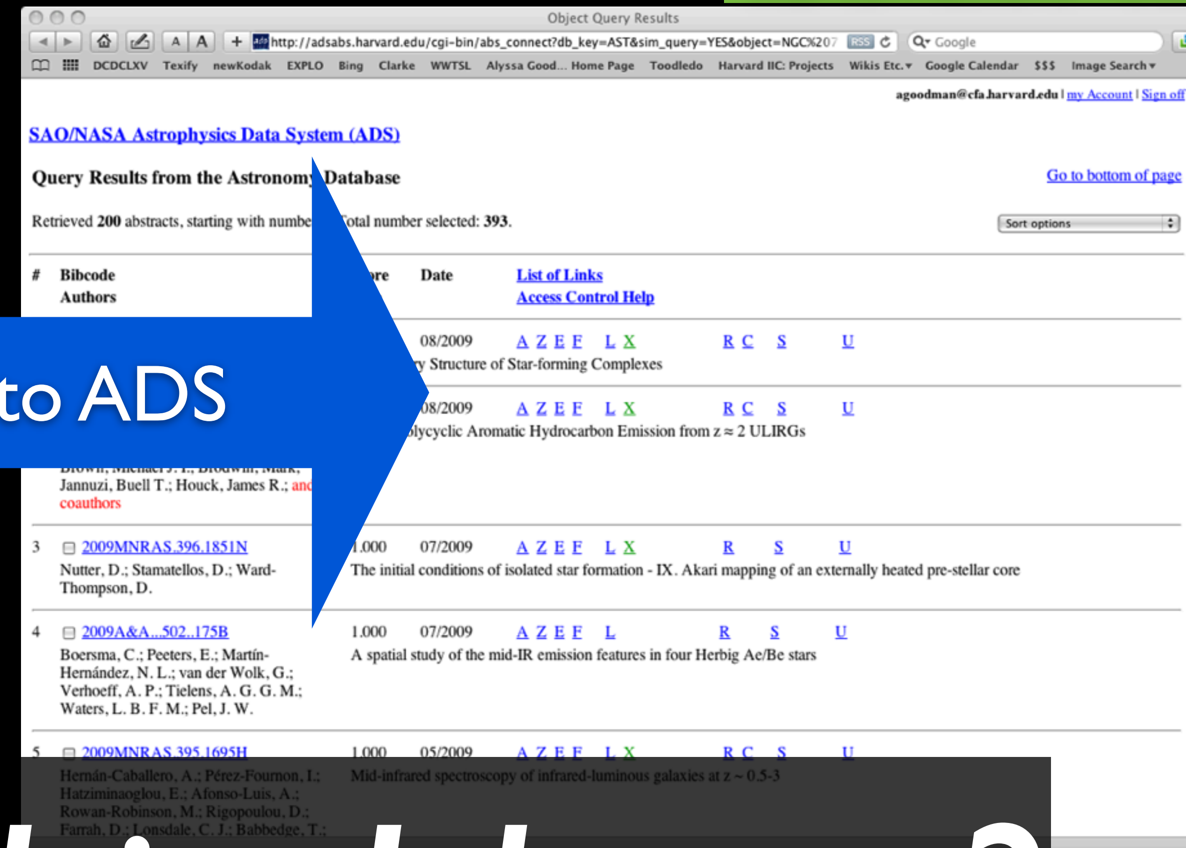
awareness/usability

What fraction of astronomy researchers know about these tools?



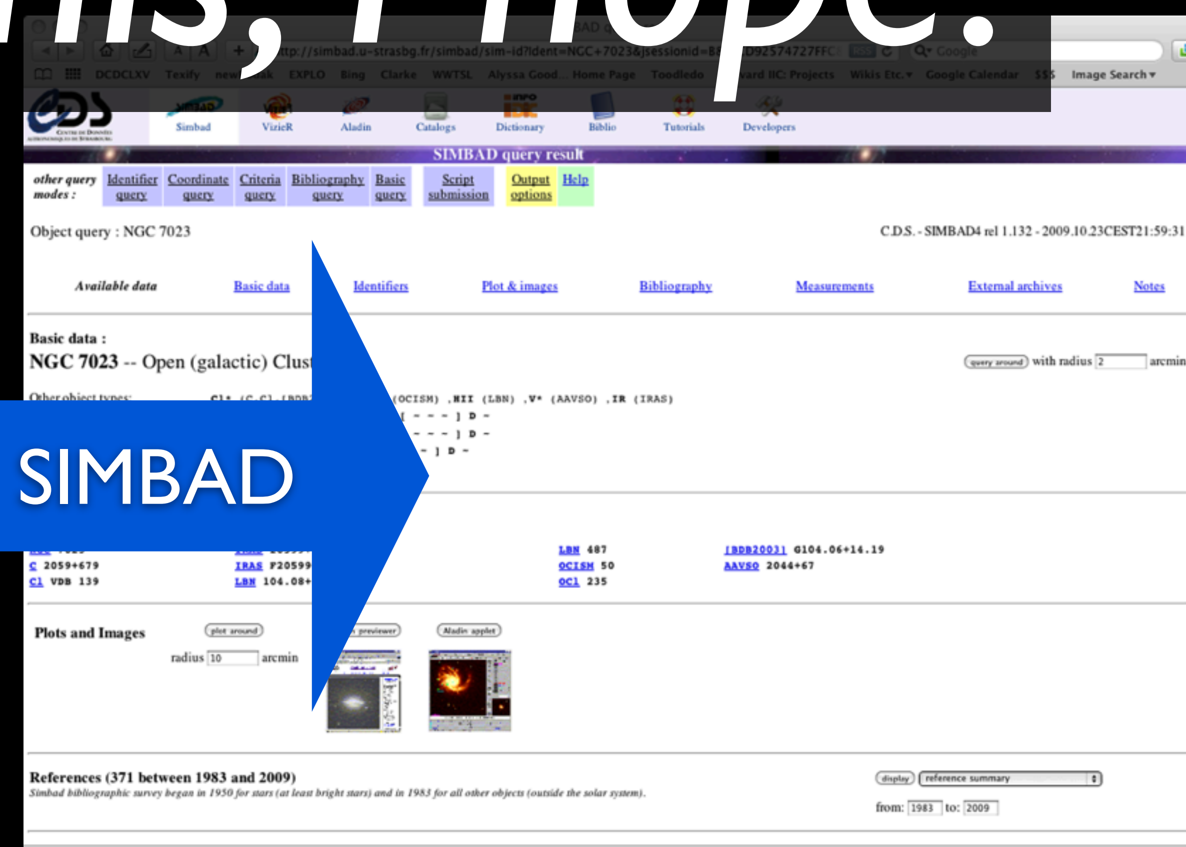




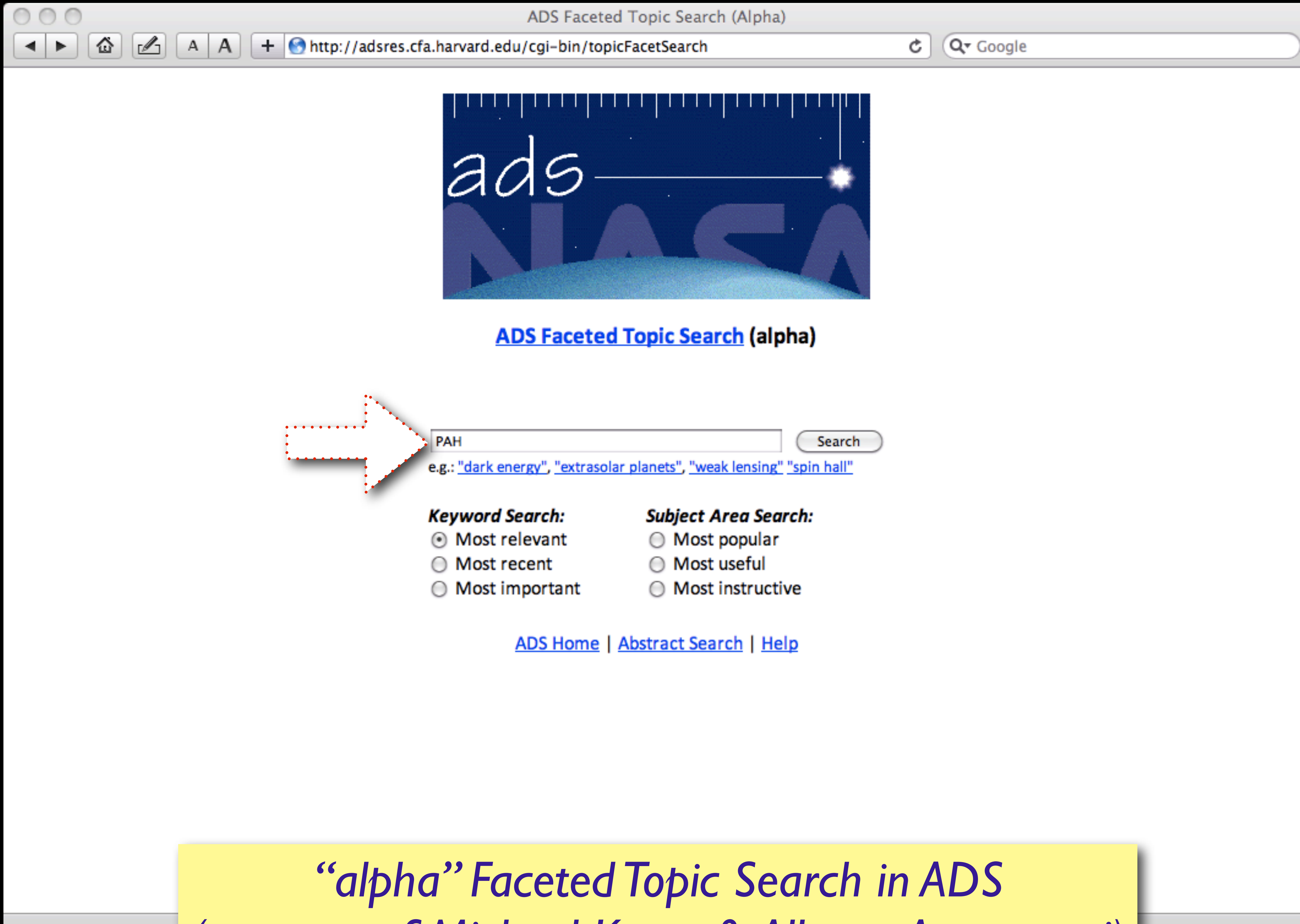


WWT to ADS

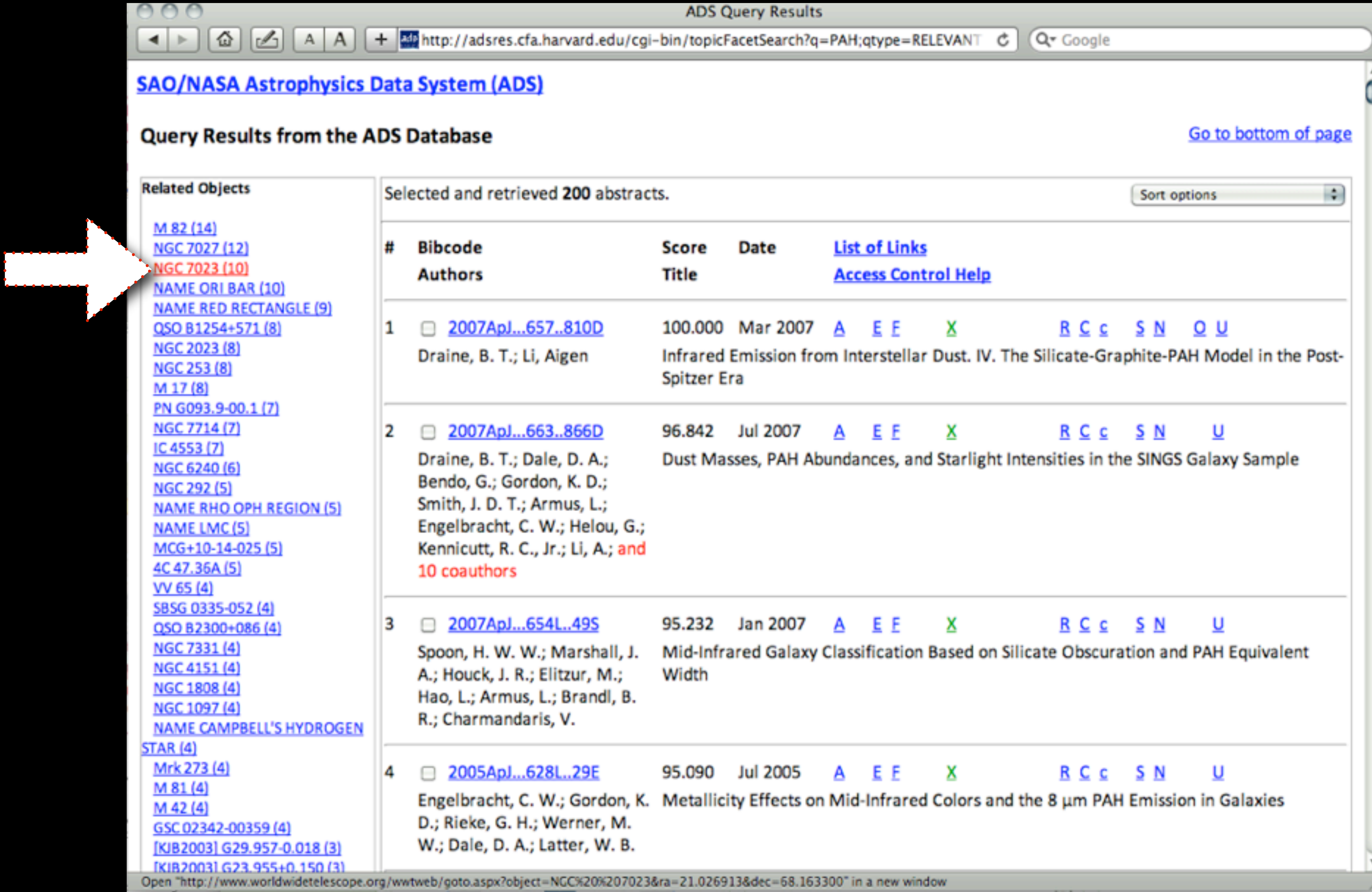
You know this, I hope?



WWT to SIMBAD

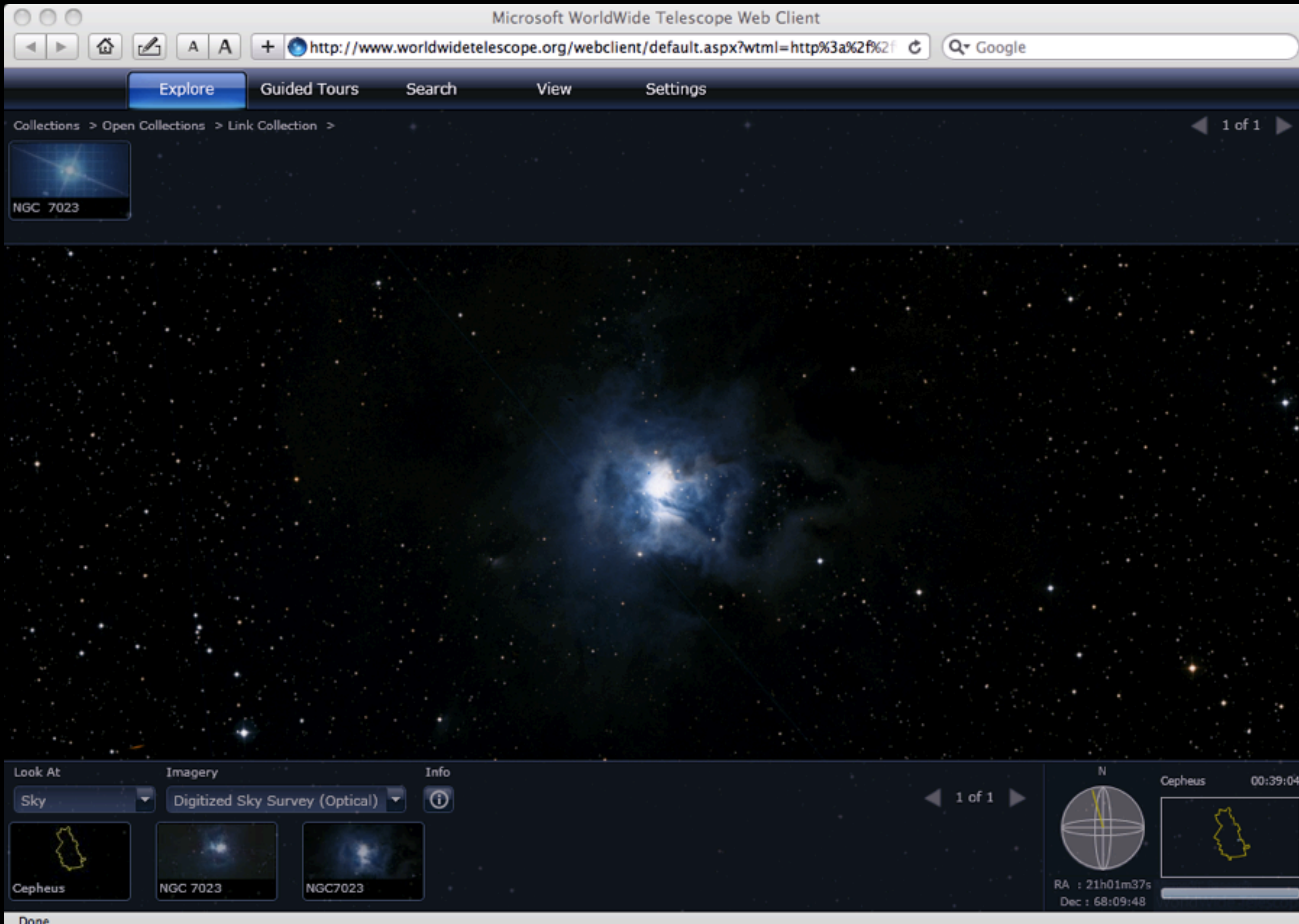


"alpha" Faceted Topic Search in ADS
(courtesy of Michael Kurtz & Alberto Accomazzi)



list of objects with links to WWT browser
(thanks to ADS team & Jonathan Fay)

Now we got to NGC 7023 by using the literature as a filter.



interconnections/modularity

Seamlessness through...

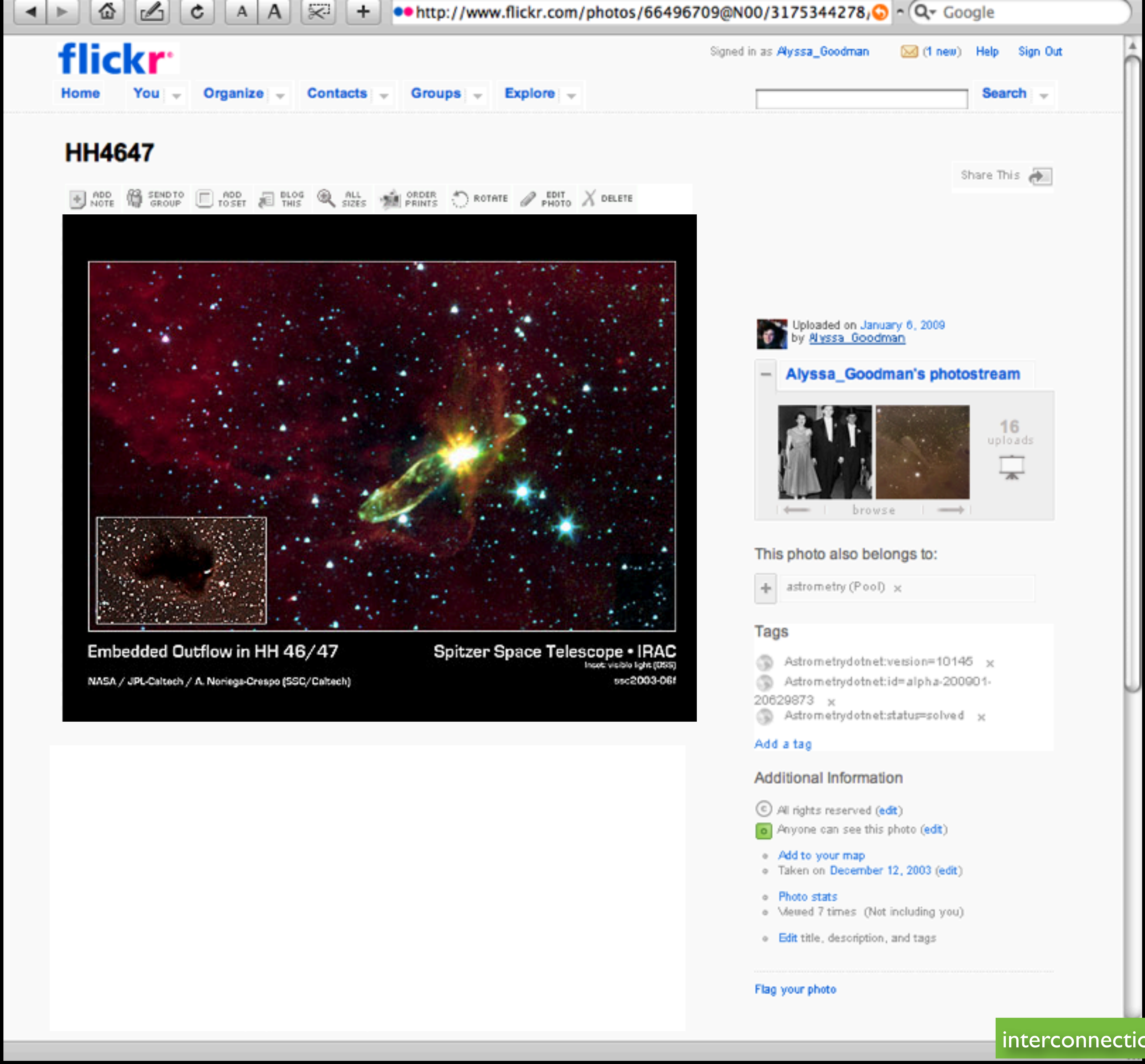
flickr

+

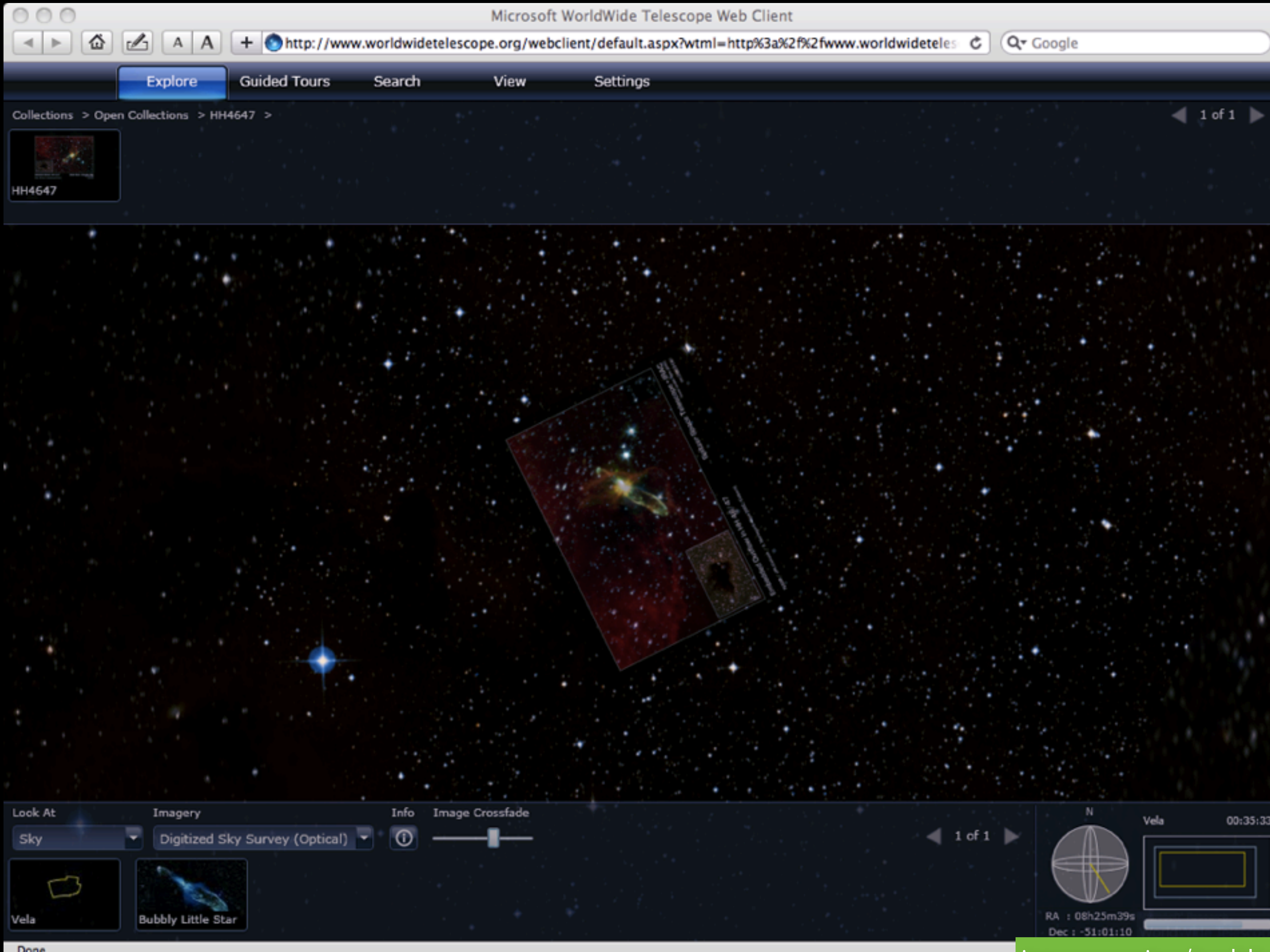
astrometry.net

+

WWT !?



interconnections/modularity

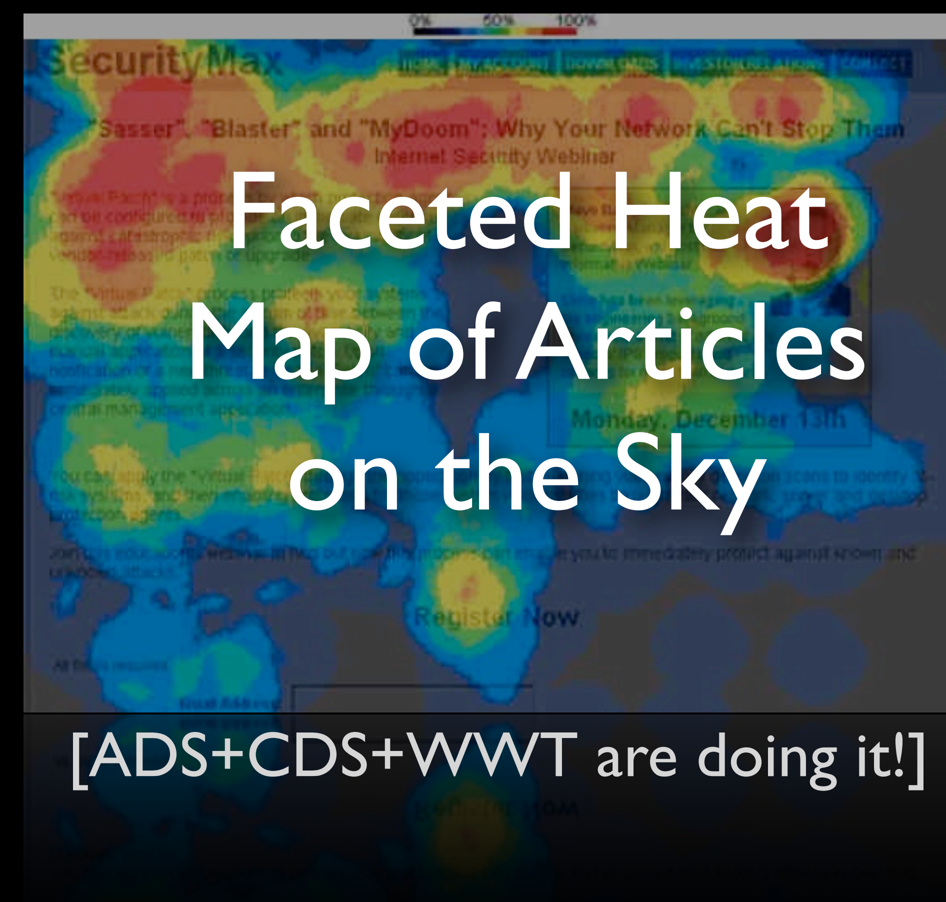


interconnections/modularity

Coming (Very) Soon...

Historical Image Layer Extracted from ALL ADS holdings (using astrometry.net)

[ADS+WWT+who wants to help?]

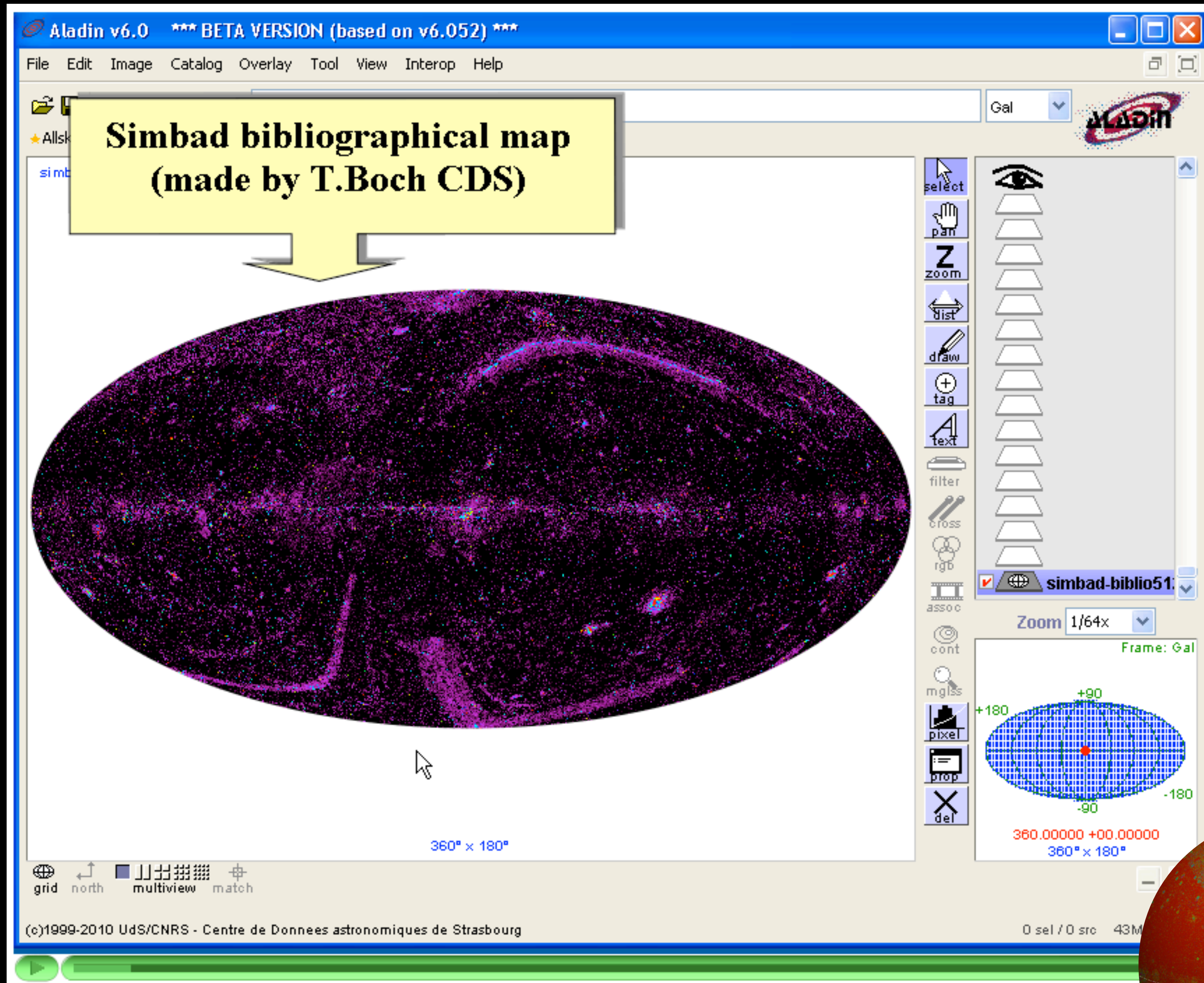


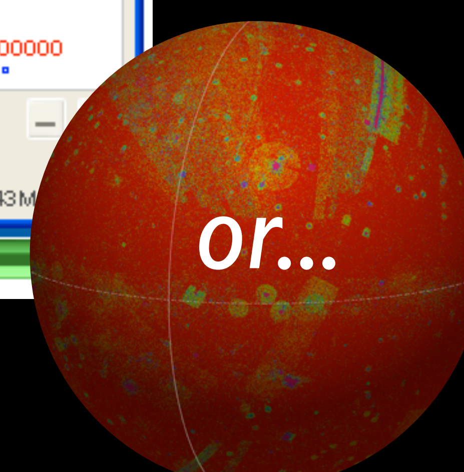
Faceted Heat Map of Articles on the Sky

[ADS+CDS+WWT are doing it!]

interconnections/modularity | repositories | free agents

Prototype of Articles on the Sky (April 2010)





with thanks to CDS/Pierre Fernique

interconnections/modularity

The future is here... data *IN* articles

interconnections/modularity

free agents

repositories

awareness/usability

Note: This work came from the "AstroMed" project am.iic.harvard.edu

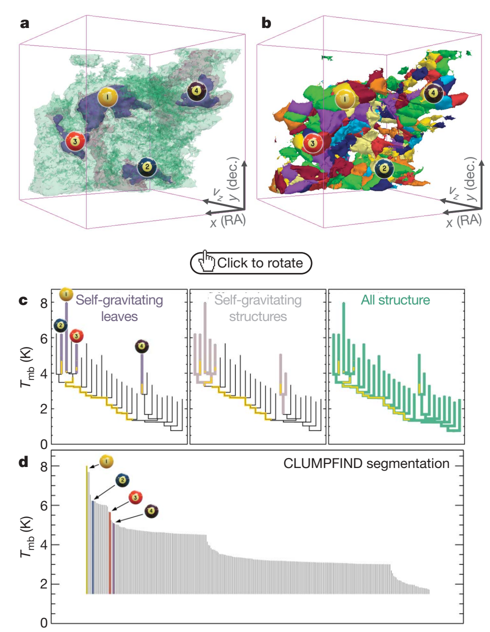


Figure 2 | Comparison of the 'dendrogram' and 'CLUMPFIND' feature-identification algorithms as applied to ^{13}CO emission from the L1448 region of Perseus. a, 3D visualization of the surfaces indicated by colours in the dendrogram shown in **c**. Purple illustrates the smallest scale self-gravitating 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 ($-0.5\ \mathrm{km\,s^{-1}}$) to back ($8\ \mathrm{km\,s^{-1}}$).

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 $M_{\mathrm{lum}} = X_{13\mathrm{CO}} L_{13\mathrm{CO}}$, where $X_{13\mathrm{CO}} = 8.0 \times 10^{20}\ \mathrm{cm^2\,K^{-1}\,km^{-1}\,s}$ (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, $\alpha_{\mathrm{obs}} = 5\sigma_v^2 R/GM_{\mathrm{lum}}$. In principle, extended portions of the tree (Fig. 2, yellow highlighting) where $\alpha_{\mathrm{obs}} < 2$ (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.

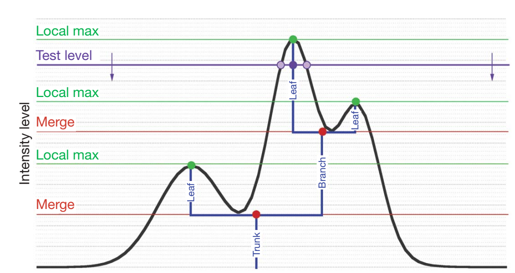


Figure 3 | Schematic illustration of the dendrogram process. Shown is the construction of a dendrogram from a hypothetical one-dimensional emission profile (black). The dendrogram (blue) can be constructed by 'dropping' a test constant emission level (purple) from above in tiny steps (exaggerated in 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

awareness/usability

How do we increase the fraction of astronomy researchers who know about these tools?

WIKIBOOKS
Open books for an open world

User Groups
(CfA now has one)

YouTube

+Suggestions?!

awareness/usability

User Groups (CfA now has one)

WIKIBOOKS
Open books for an open world

ASTROBETTER
Tips and Tricks for Professional Astronomers

.astronomy

YouTube

my experiment

free agents

How do we increase the number of people who create and interlink new tools?

Kiva model proposed at MSR in semi-jest in 2009...

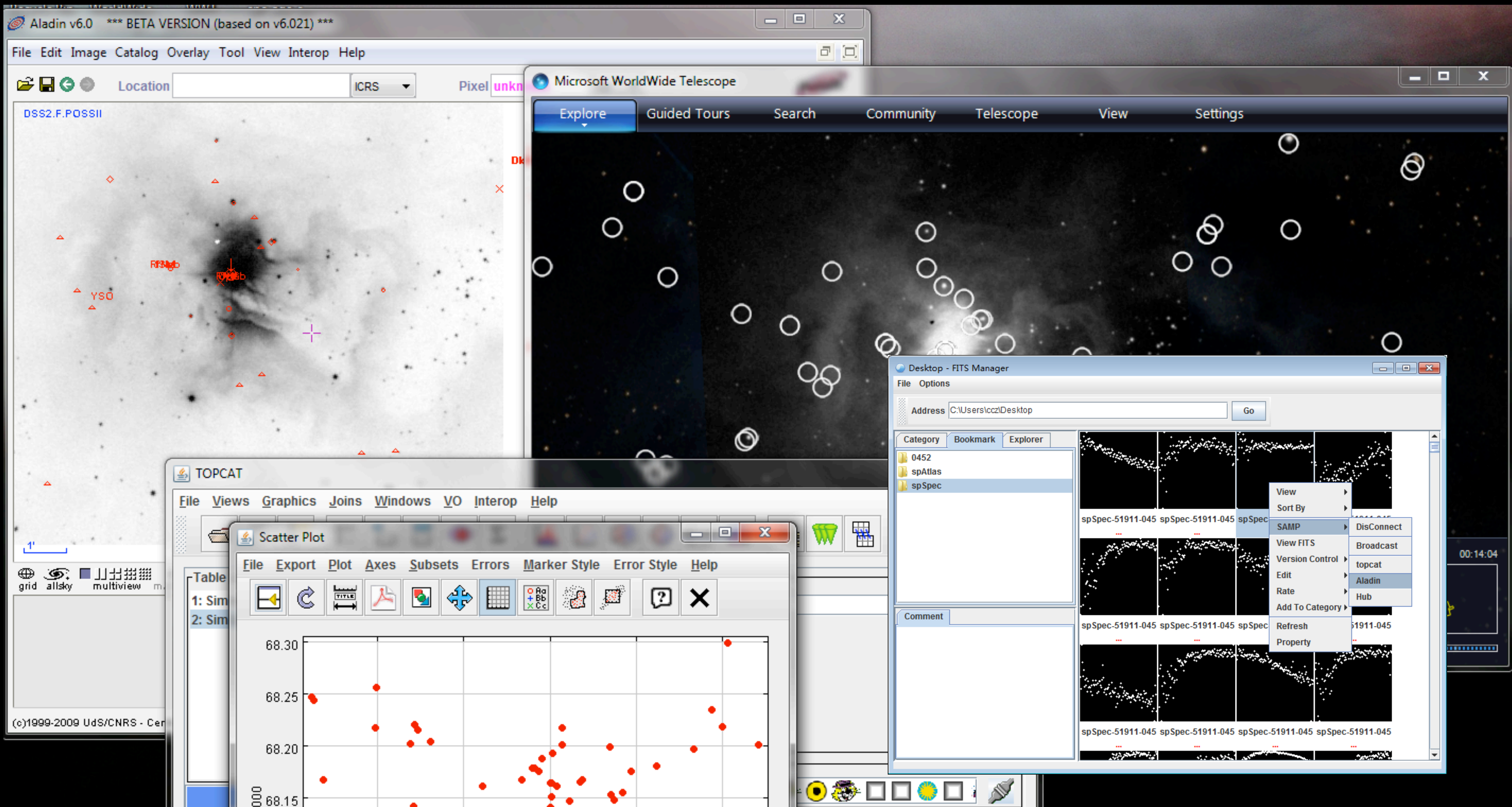
Should implemented through VAO “Associates,” WWT Partners, and more.

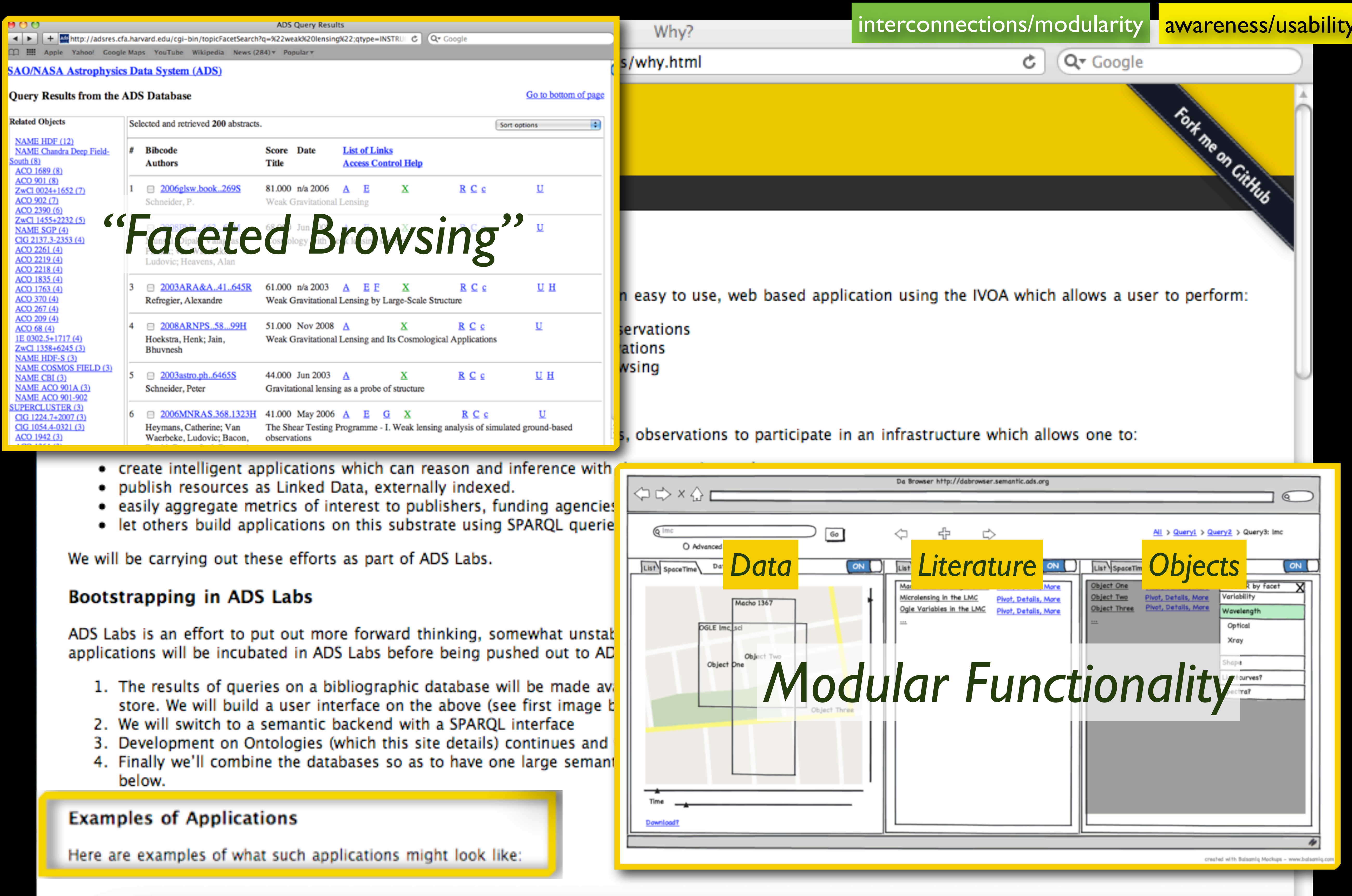
How do we organize such diverse tools, so as to make them interoperably useful?....

“SAMP” is a great technical start, but offers a very significant user interface challenge.

interconnections/modularity

SAMP





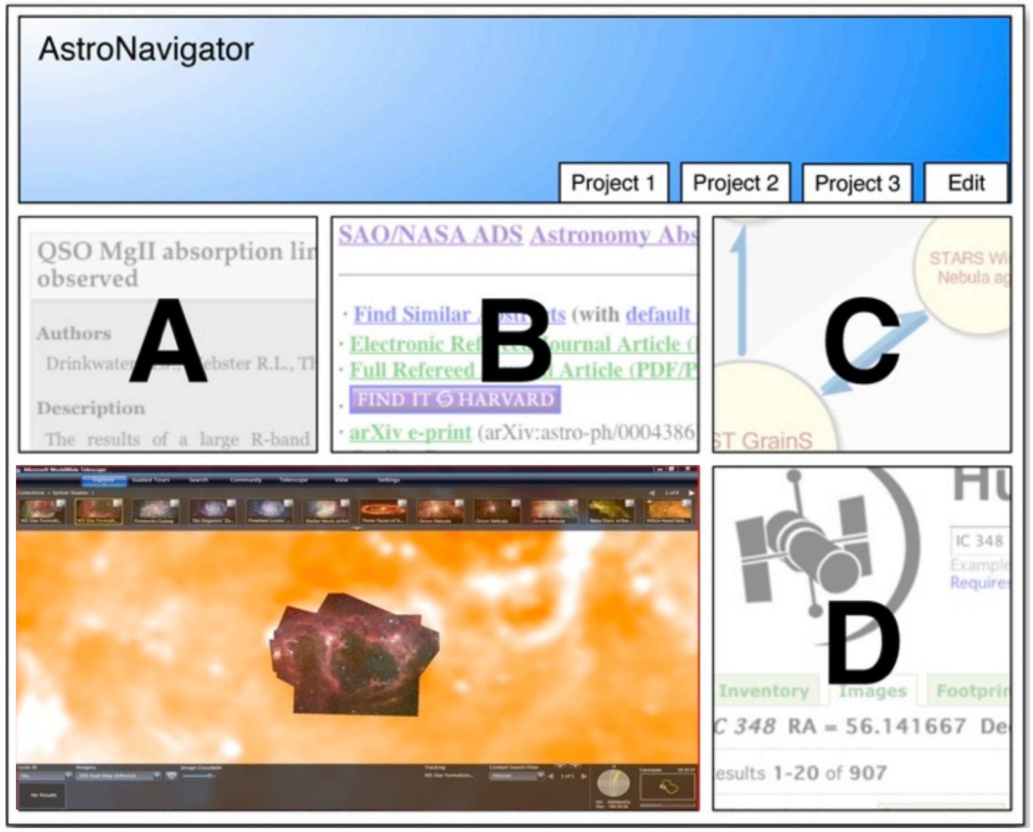
Ongoing “ADS Labs” Work: Rahul Davé, Alberto Accomazzi, Michael Kurtz, AG

Thanks to ADS (NASA)/VAO(NASA+NSF)/MSFT funding.

Collaborative Astronomy at University of Washington

- **Research in a Browser**
  - **"iGoogle" for Astronomy**
    - Collections of simple atomic applications (gadgets)
    - Users choose the view they want
    - All gadgets can communicate with each other
  - **Customizable and sharable**
    - Users can build and share "mashups"
    - Widgets are simple to create
    - Widgets call virtual observatory resources
  - **Efficient**
    - Communication is within the browser (fast)
    - Built from javascript (standard)

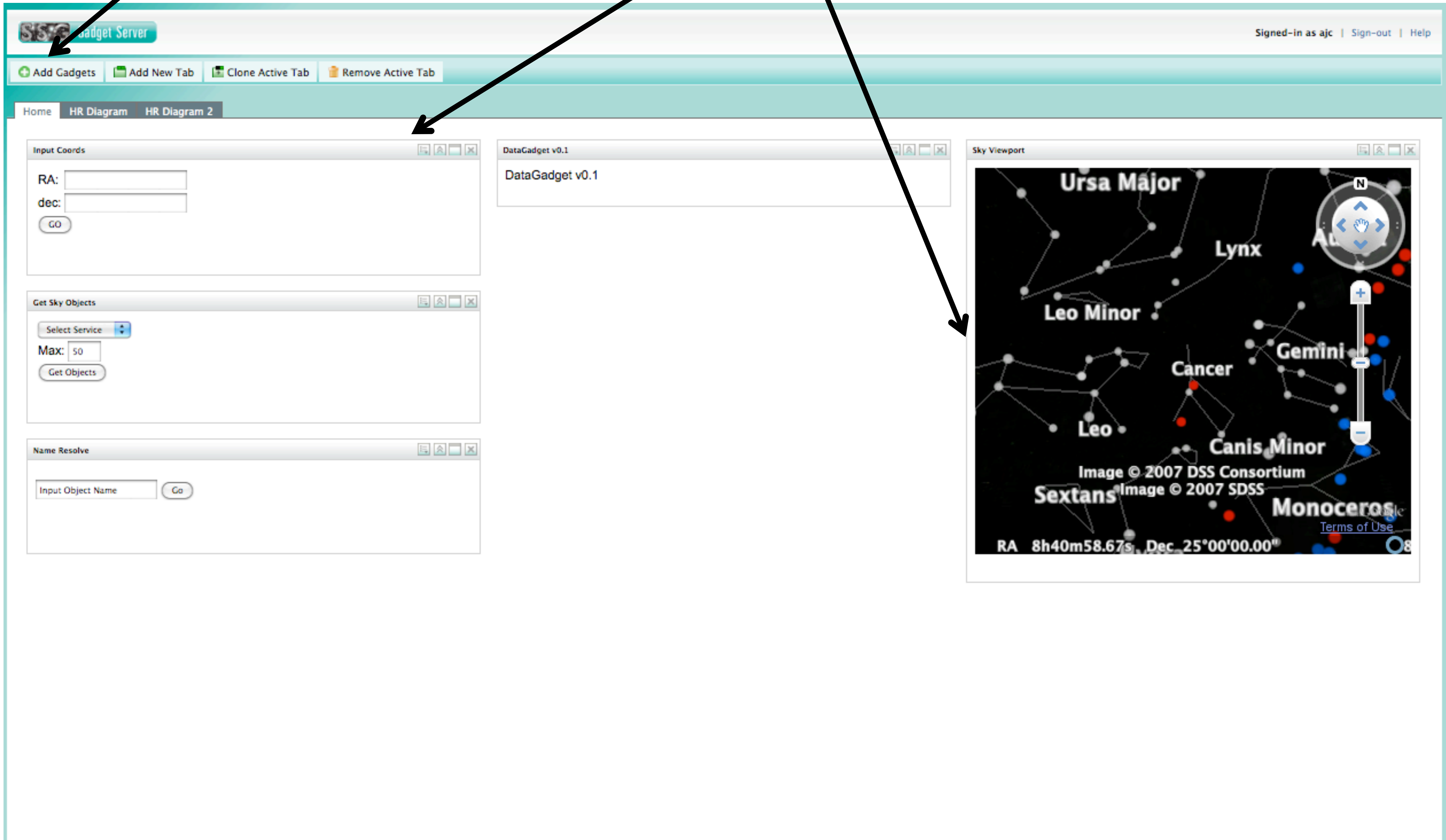
Show Andy Connolly's Movie....



Collaborative Astronomy (Connolly, Gibson, Krughoff, Sayers, Smith 2010)

Select Gadgets

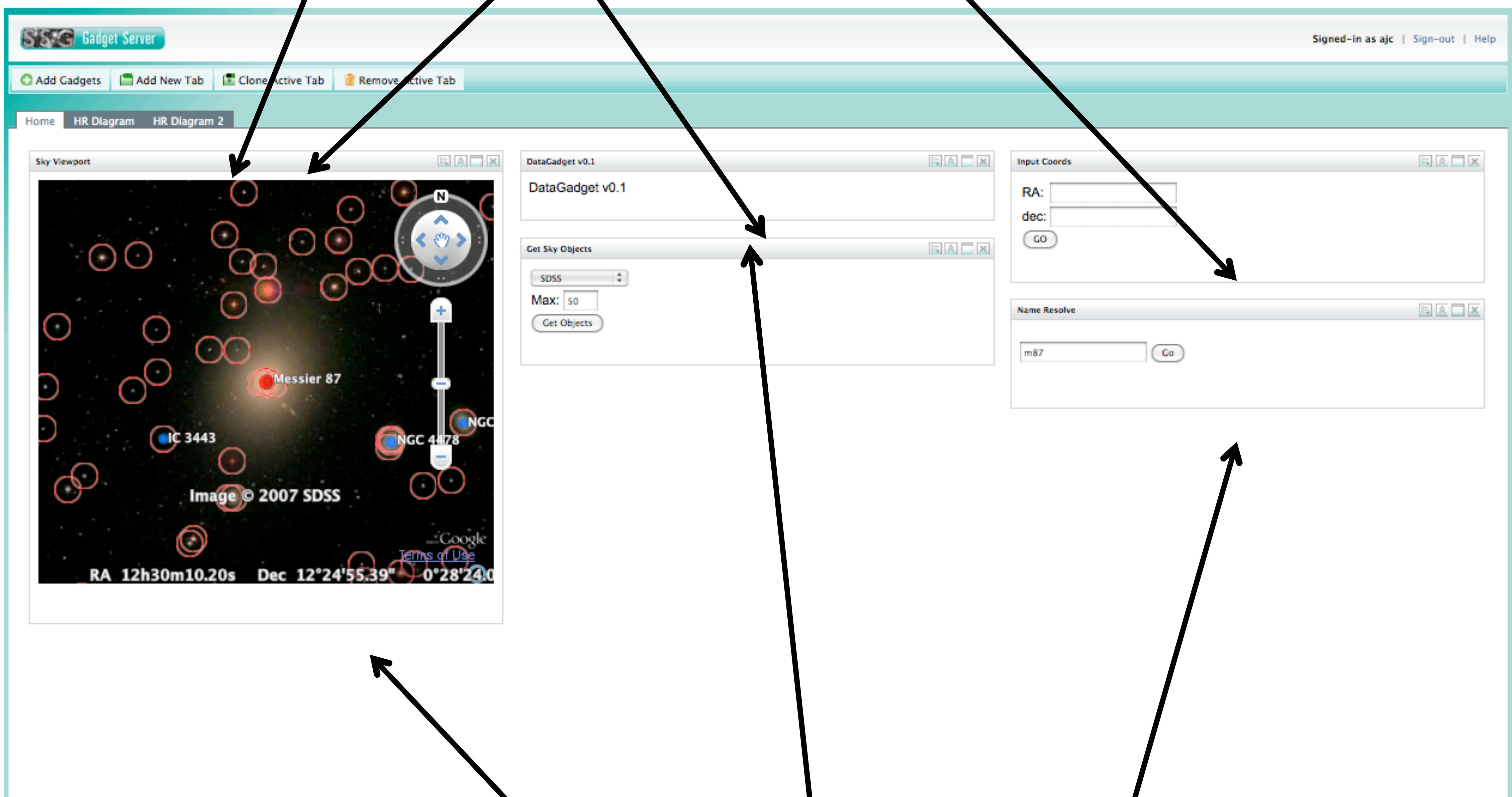
Rearrange based on your preference



Collaborative Astronomy (Connolly, Gibson, Krughoff, Sayers, Smith 2010)

Query the SDSS based on viewport and return the source overlaid on images

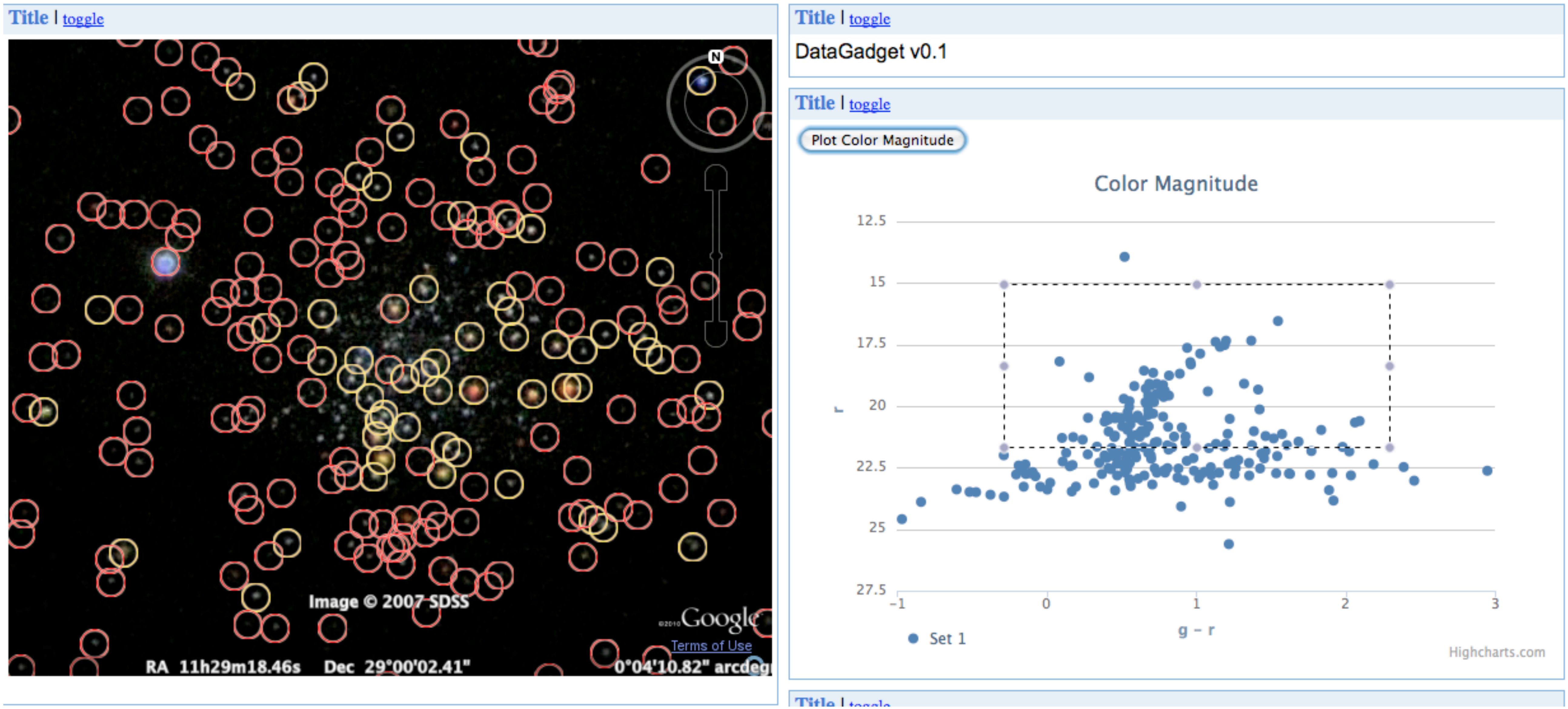
Name resolver and zoom to field



All gadgets communicate through the data gadget

Collaborative Astronomy (Connolly, Gibson, Krughoff, Sayers, Smith 2010)

Create, store and share multiple views of gadgets



Interaction allows selections to be shown on the viewport

Collaborative Astronomy (Connolly, Gibson, Krughoff, Sayers, Smith 2010)

WorldWide Telescope Ambassadors Program

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Annie Valva

WGBH Interactive, Director of Research & Development

Pat Udomprasert

WWT Program Coordinator

How?

Using new WWT platform to give experts and learners access to the Universe

WWT Ambassadors Program

Recruiting, Vetting, Coordination

"I never knew programs like this could even exist. It's just amazing."

–Clarke Middle School 6th grade student

<u>More quotes from Clarke 6th Graders</u>

"Learning about our Universe by actually seeing and exploring it makes it easier to contemplate and more fun."

"You can explore the Universe yourself and you don't always have to only learn from the teacher."

"It gave me a better mental map of the universe."

(And of the 72 surveys we've collected, 71 are positive toward WWT Ambassadors.)