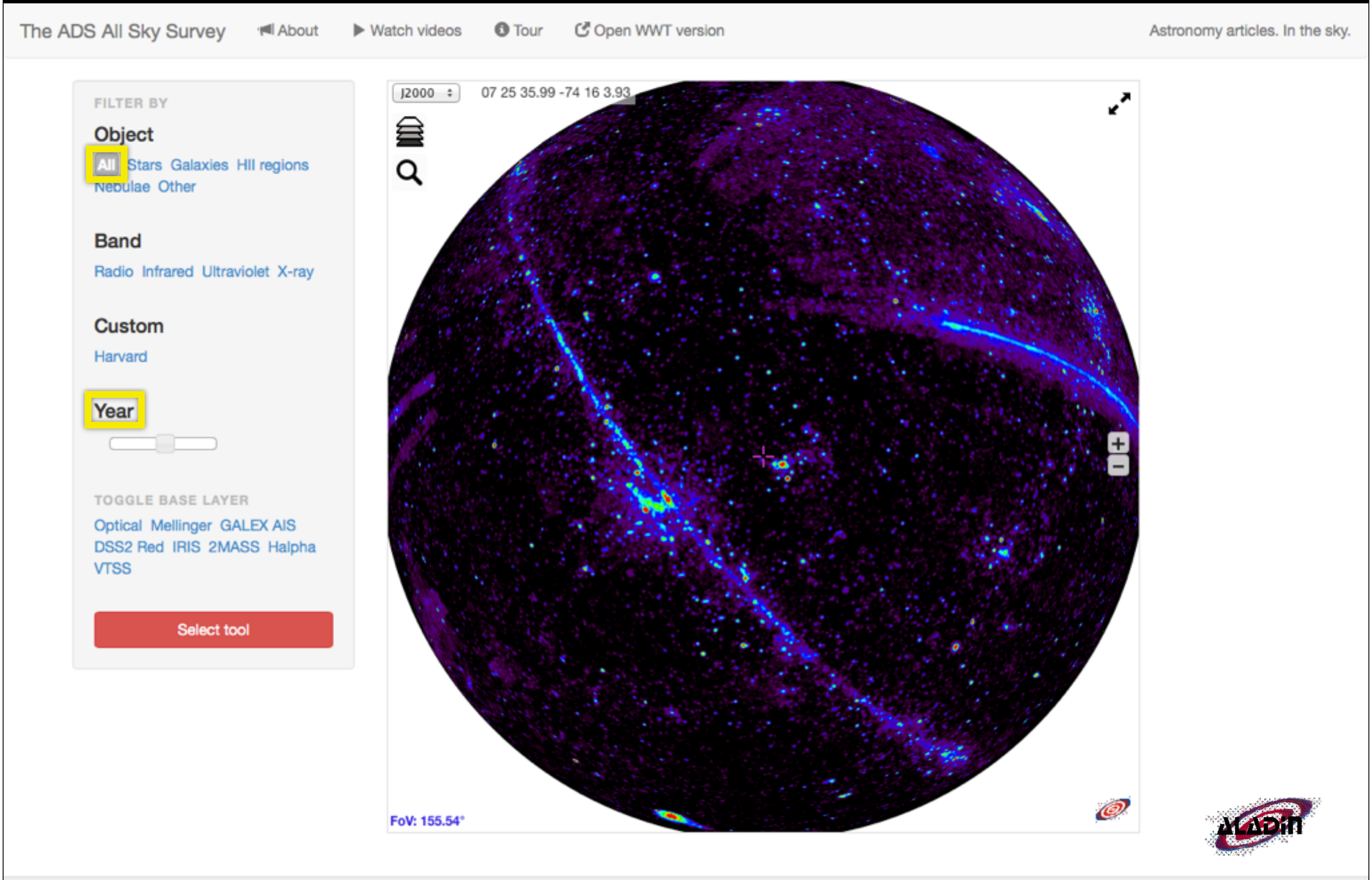
ADS ALL SKY SURVEY

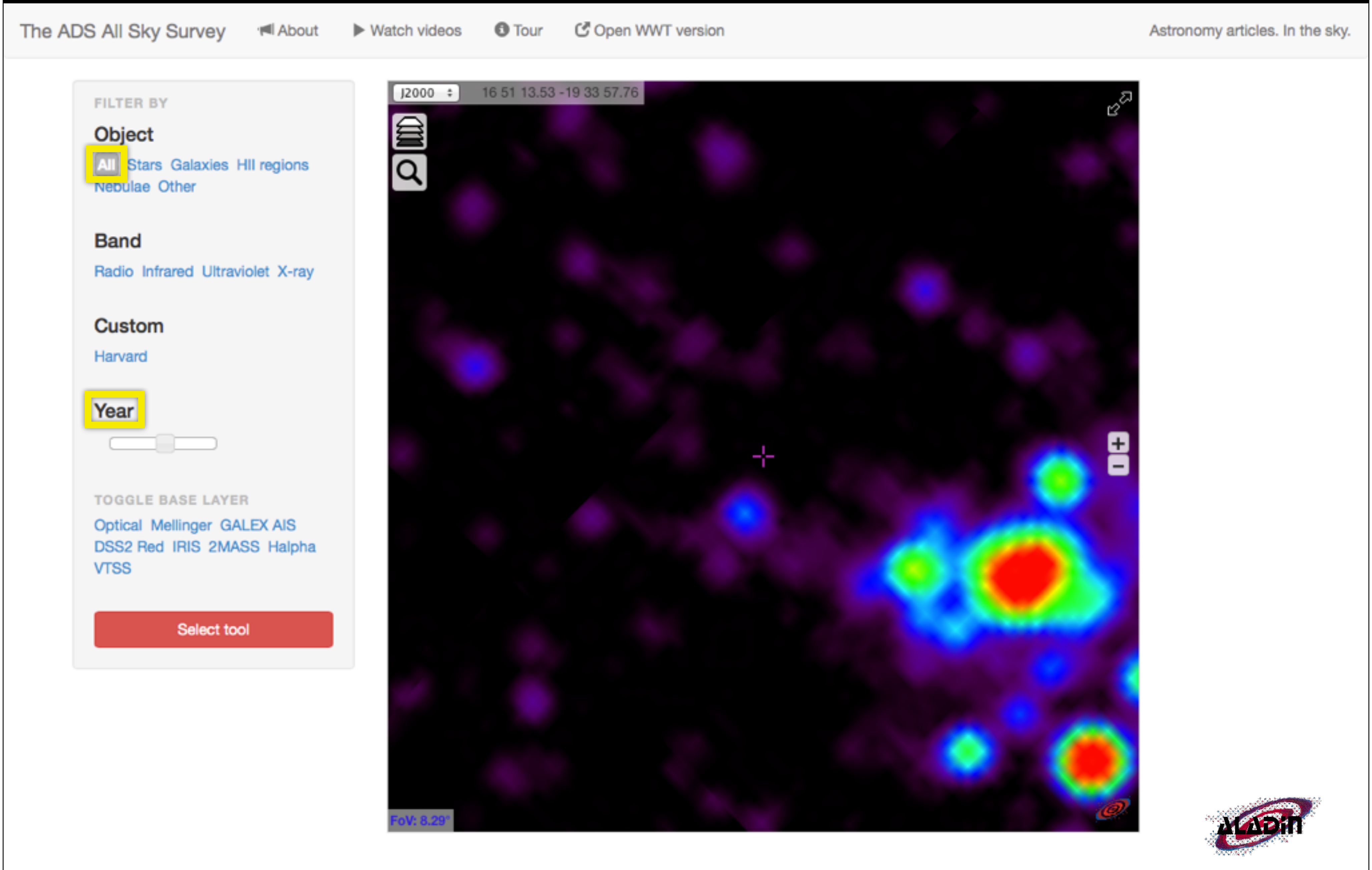
View in Aladin • View in WorldWide Telescope

adsass.org

here is a 180-degree heatmap of article density on all kinds of objects, on the Sky, over all time



let's zoom in (on Ophiuchus)



now, let's toggle on the "Mellinger" view of the Sky

...to see a nice optical image of Ophiuchus

The ADS All Sky Survey | About | Watch videos | Tour | Open WWT version | Astronomy articles. In the sky.

FILTER BY

Object

All Stars Galaxies HII regions Nebulae Other

Band

Radio Infrared Ultraviolet X-ray

Custom

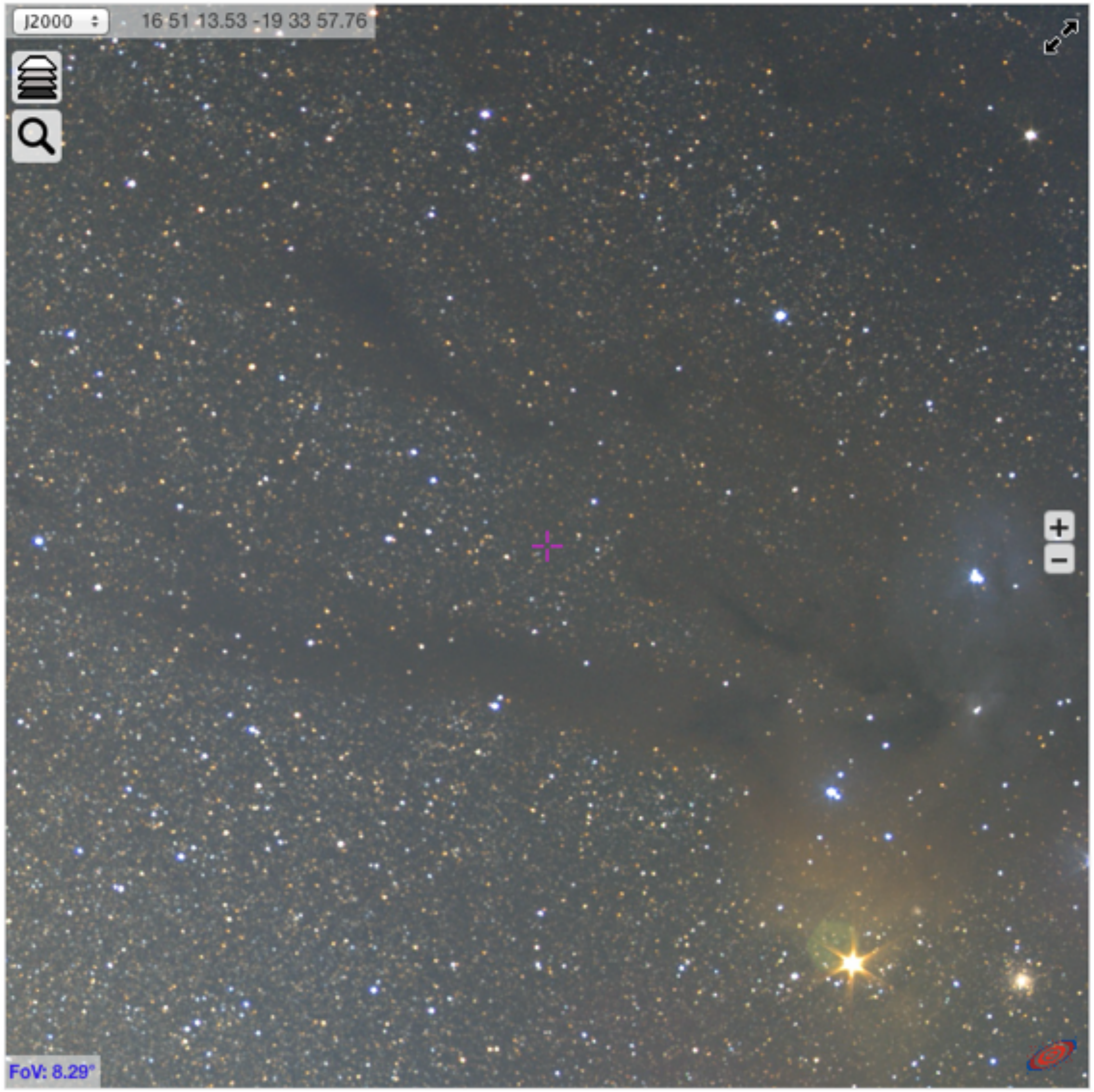
Harvard

Year

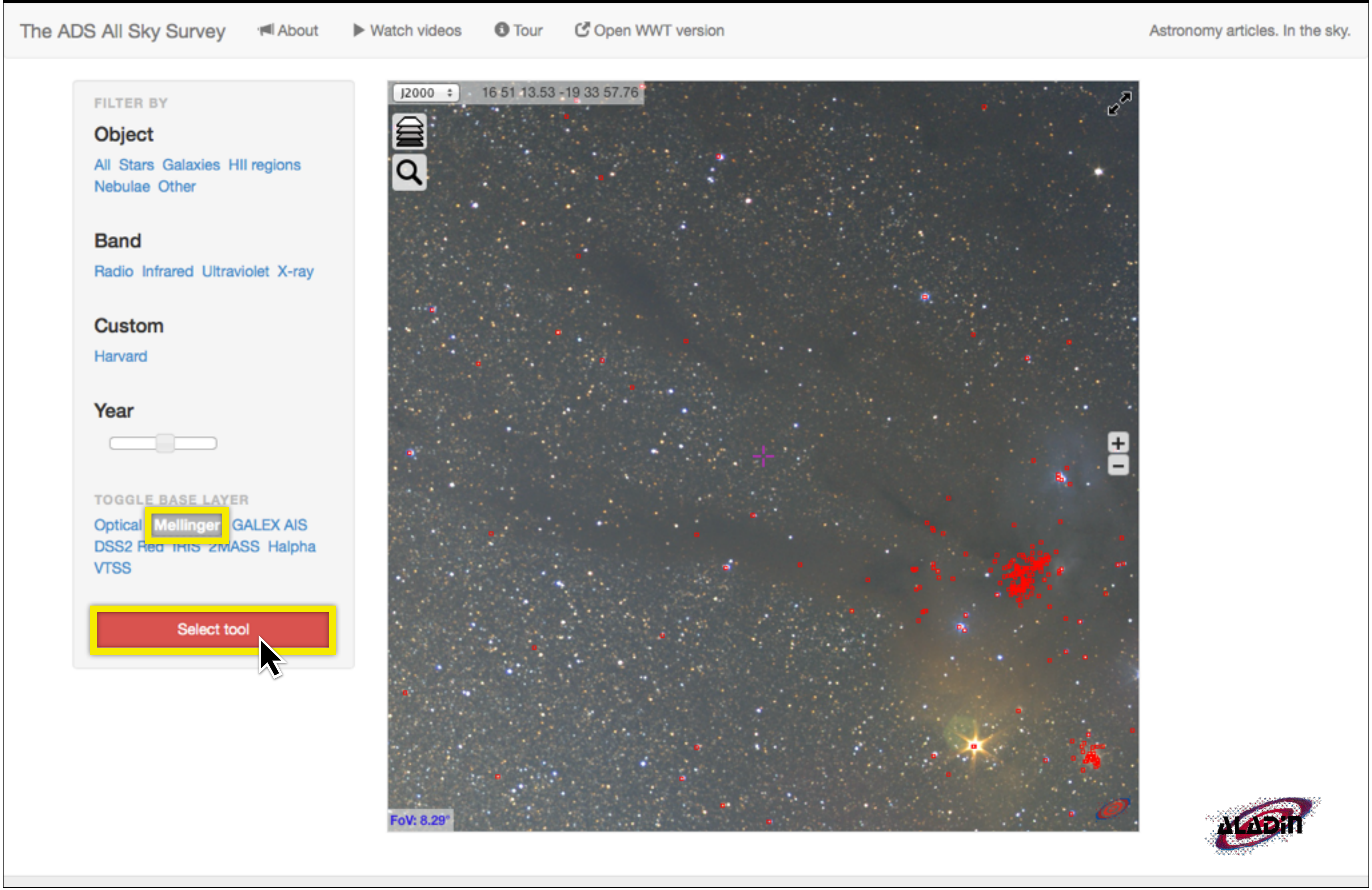
TOGGLE BASE LAYER

Optical **Mellinger** GALEX AIS DSS2 Red IRIS 2MASS Halpha VTSS

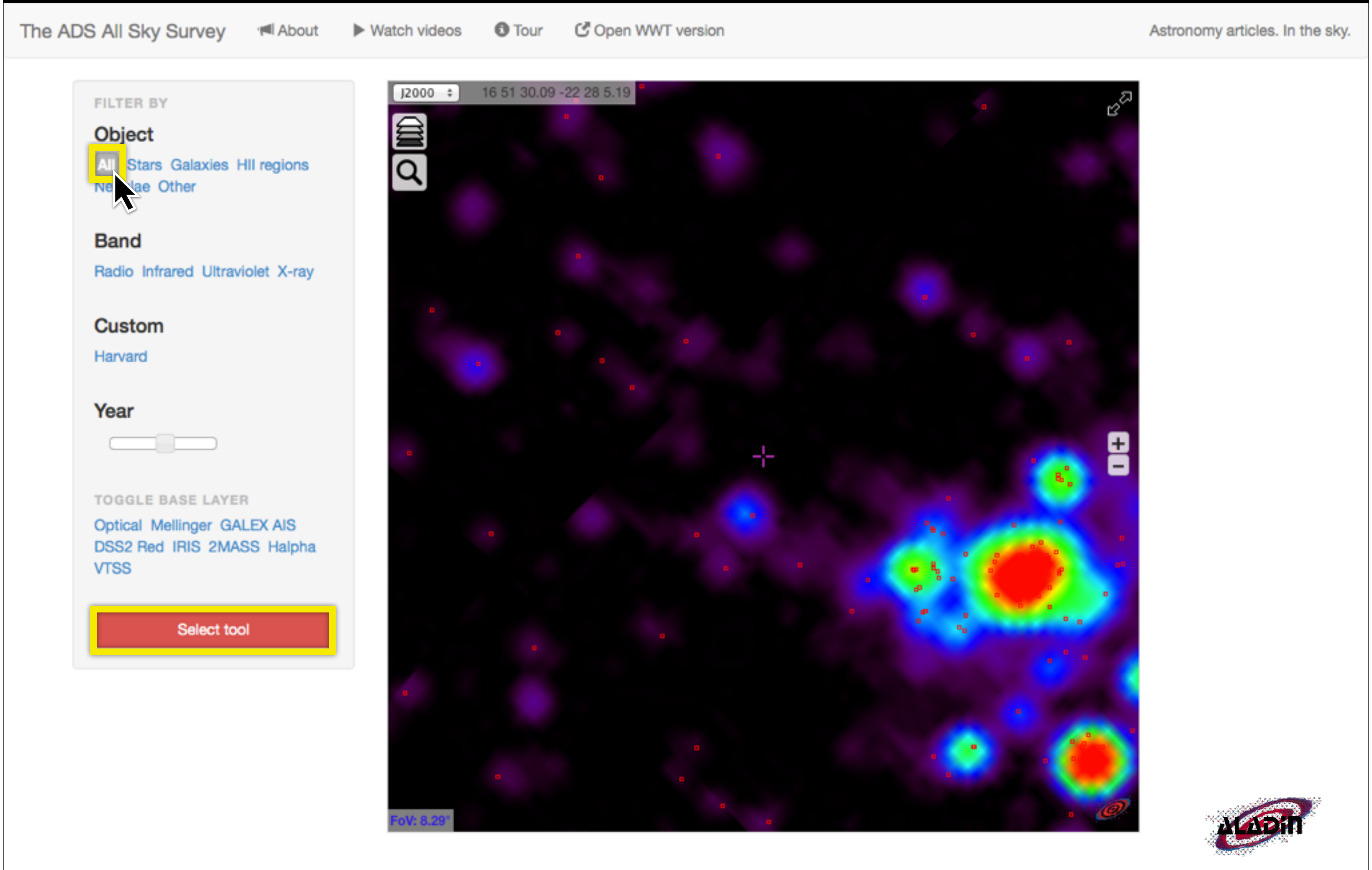
Select tool



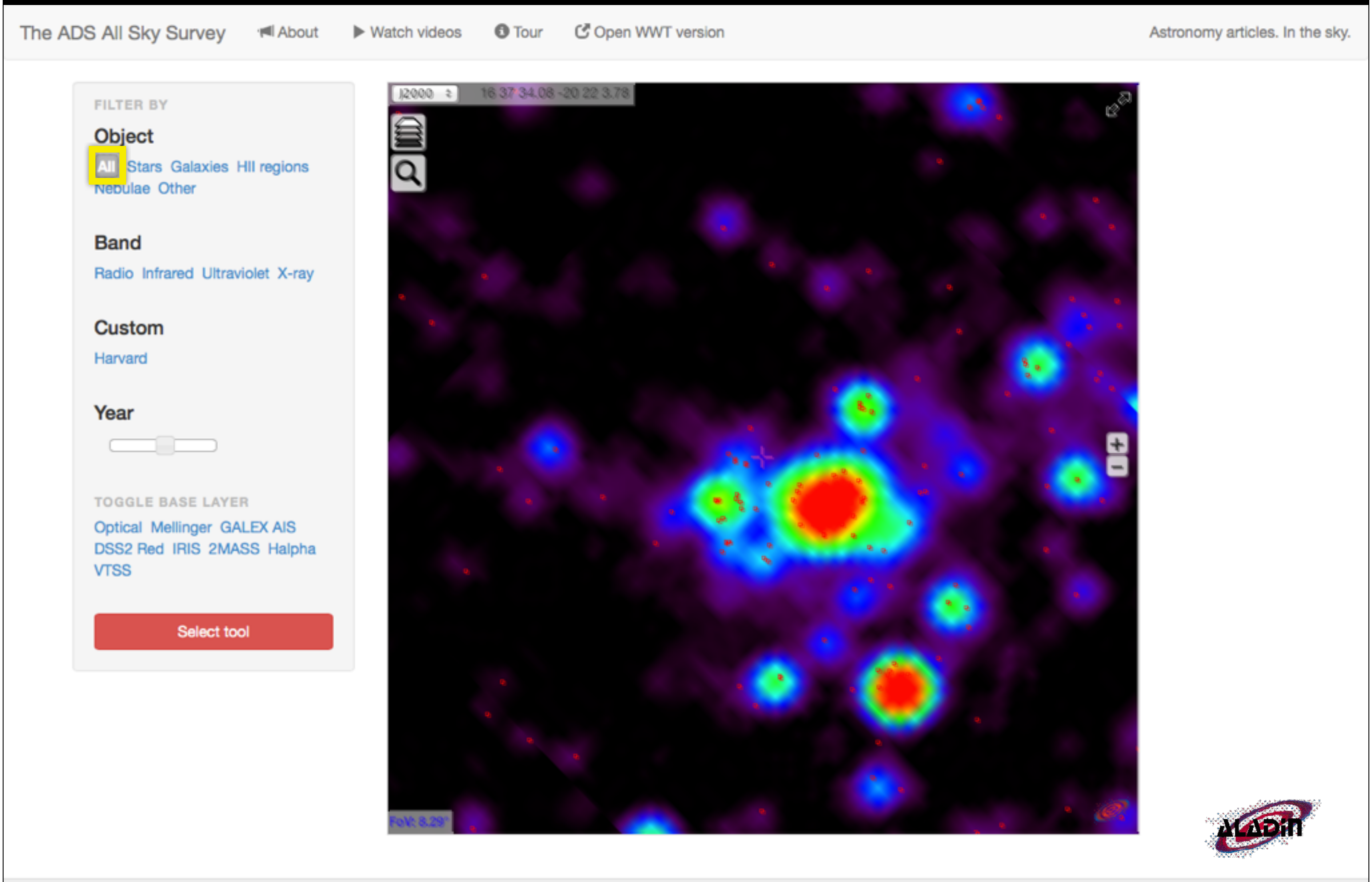
to add markers for SIMBAD sources, we can click the Select Tool



now, if we re-select "All," we see sources on article distribution



panning over a bit, we can center our region of interest



let's change the color table from rainbow to greyscale to make sources more apparent

The ADS All Sky Survey | About | Watch videos | Tour | Open WWT version | Astronomy articles. In the sky.

FILTER BY

Object

All Stars Galaxies HII regions Nebulae Other

Band

Radio Infrared Ultraviolet X-ray

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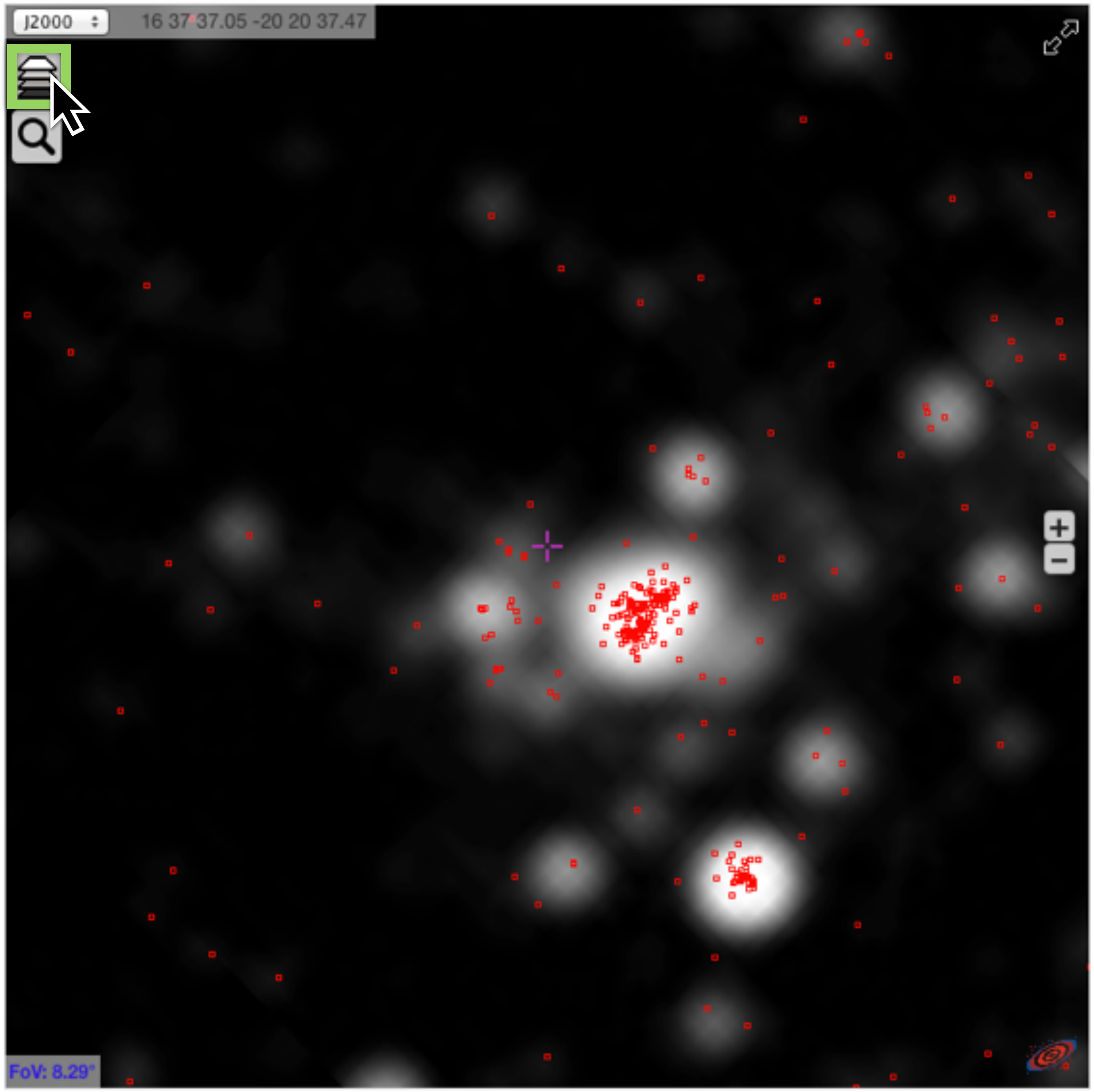
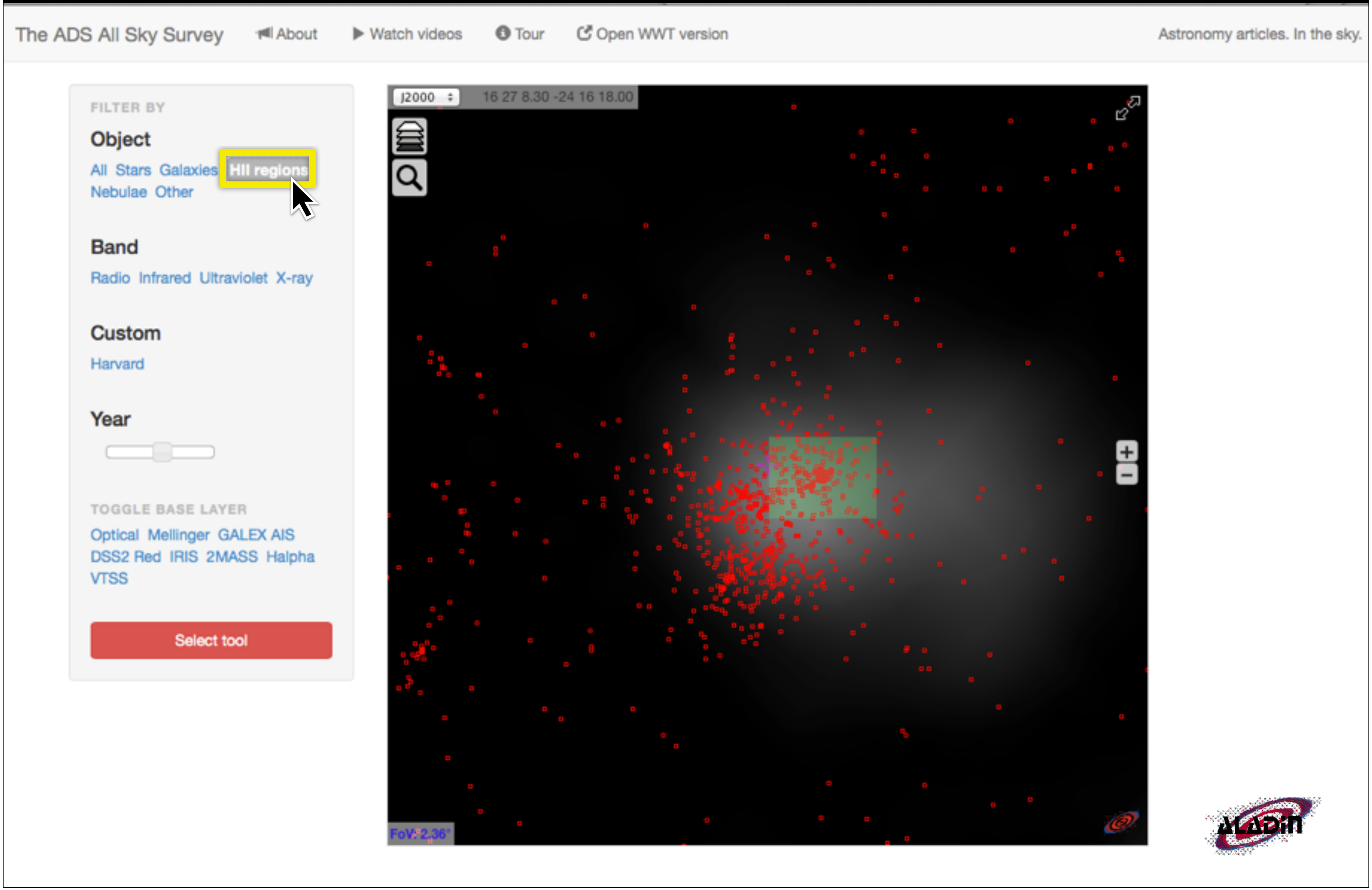
TOGGLE BASE LAYER

Optical Mellinger GALEX AIS DSS2 Red IRIS 2MASS Halpha VTSS

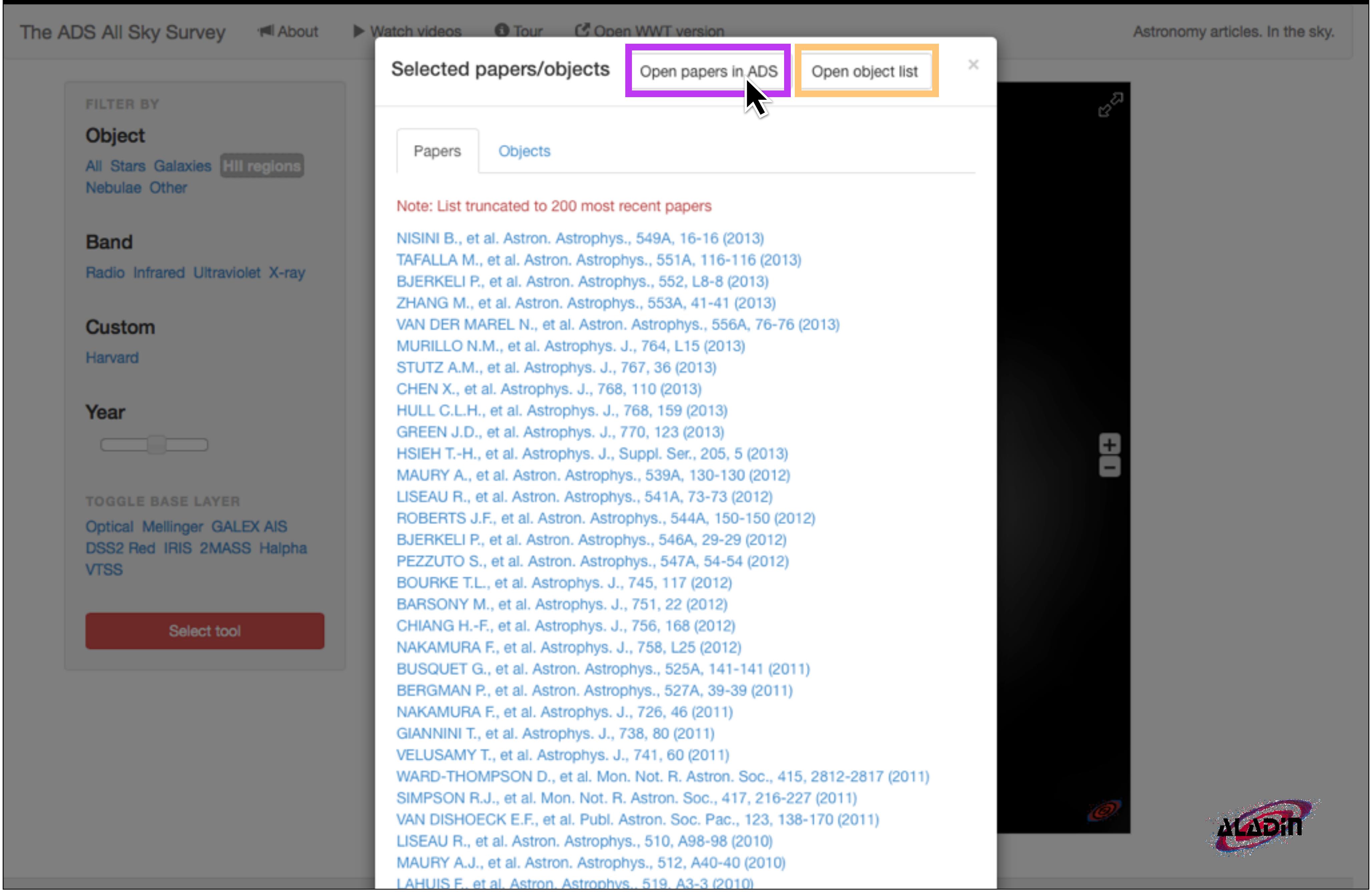
Select tool



let's look now at the distribution of articles about "HII regions" and *select* an area we're curious about

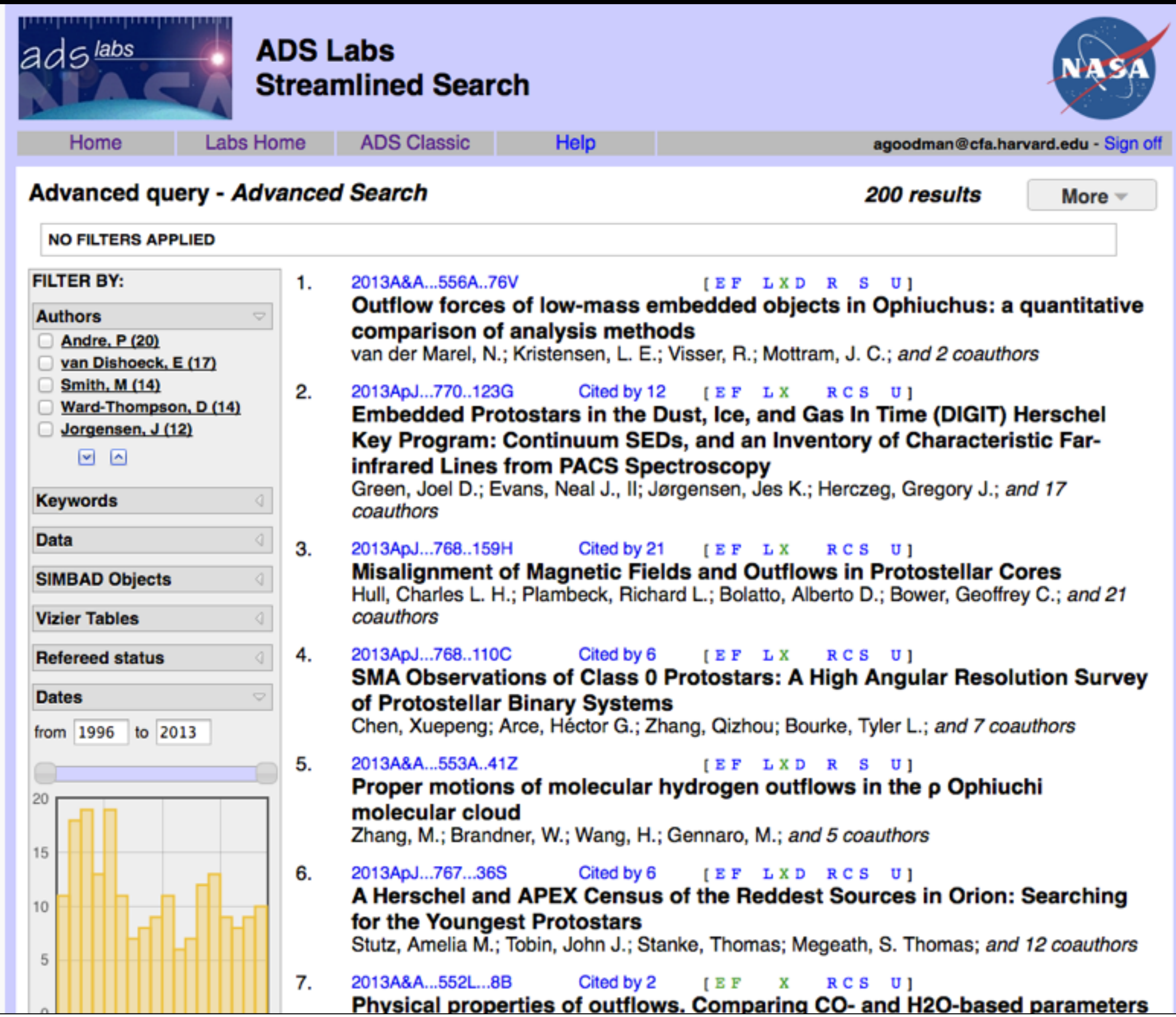


when we *release* the selection rectangle, we get a pop-up list of papers (ADS) mentioning these objects, or a list of the objects (CDS/SIMBAD) we highlighted

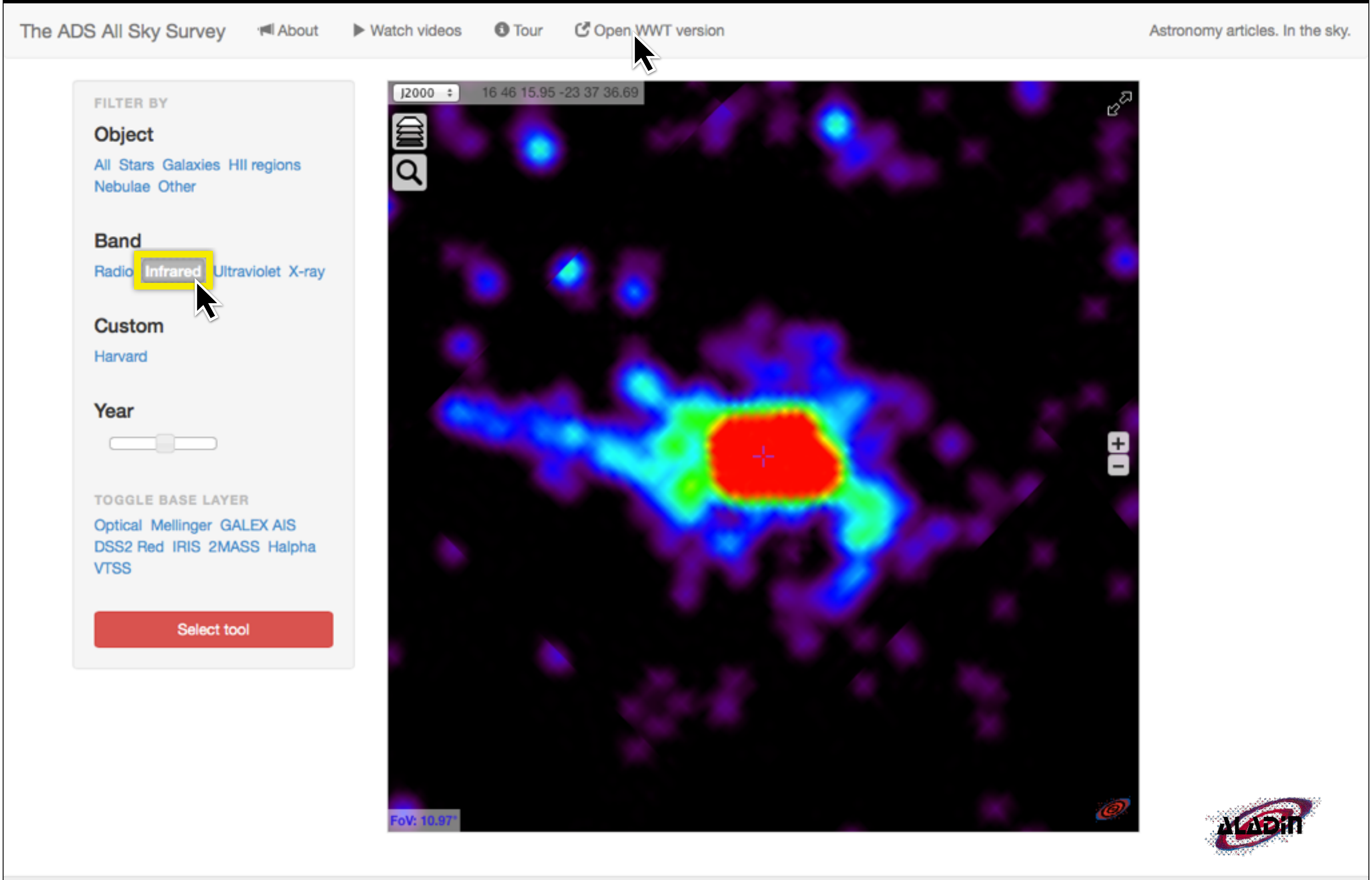


selecting "Open Papers in ADS" opens the paper list in ADS Labs

(From here, we can filter the list more, and more. e.g. clicking "SIMBAD Objects" lets us see particular objects in context on the Sky in WWT or Aladin.)

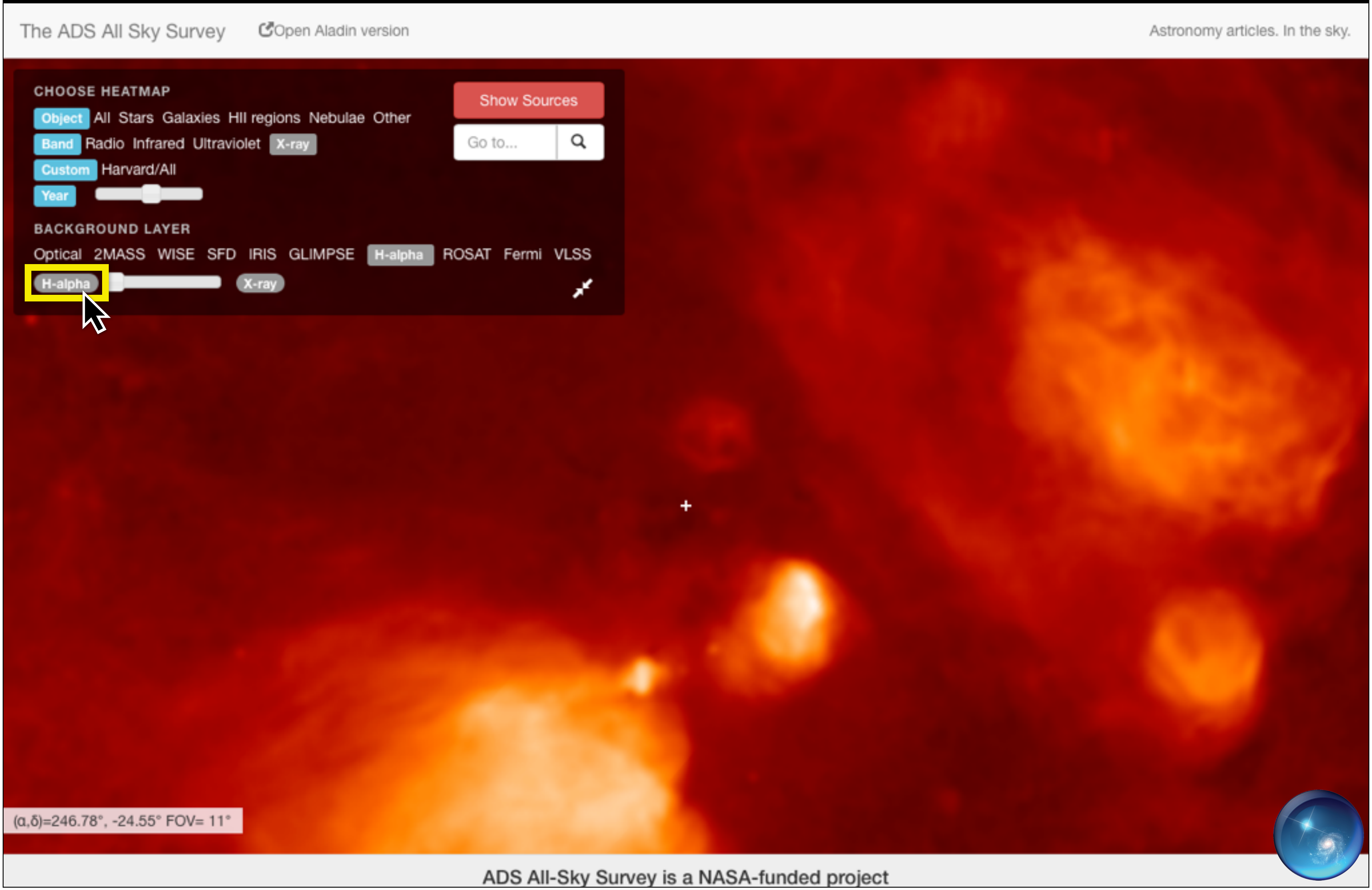


let's try "Open WWT Version," so we can see this same view in WWT, and use a transparency slider

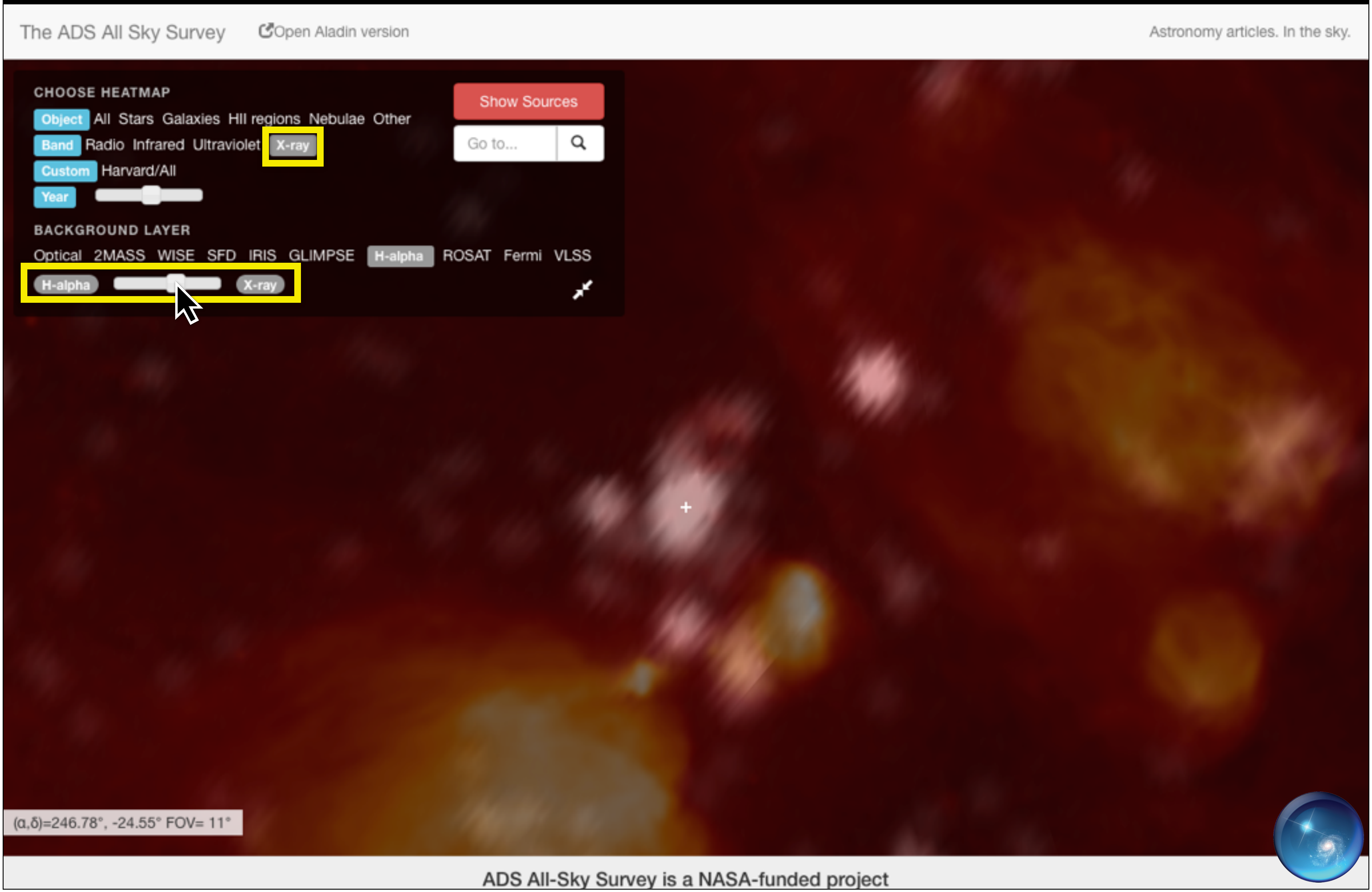


let's try the transparency (layer) slider in WorldWide Telescope

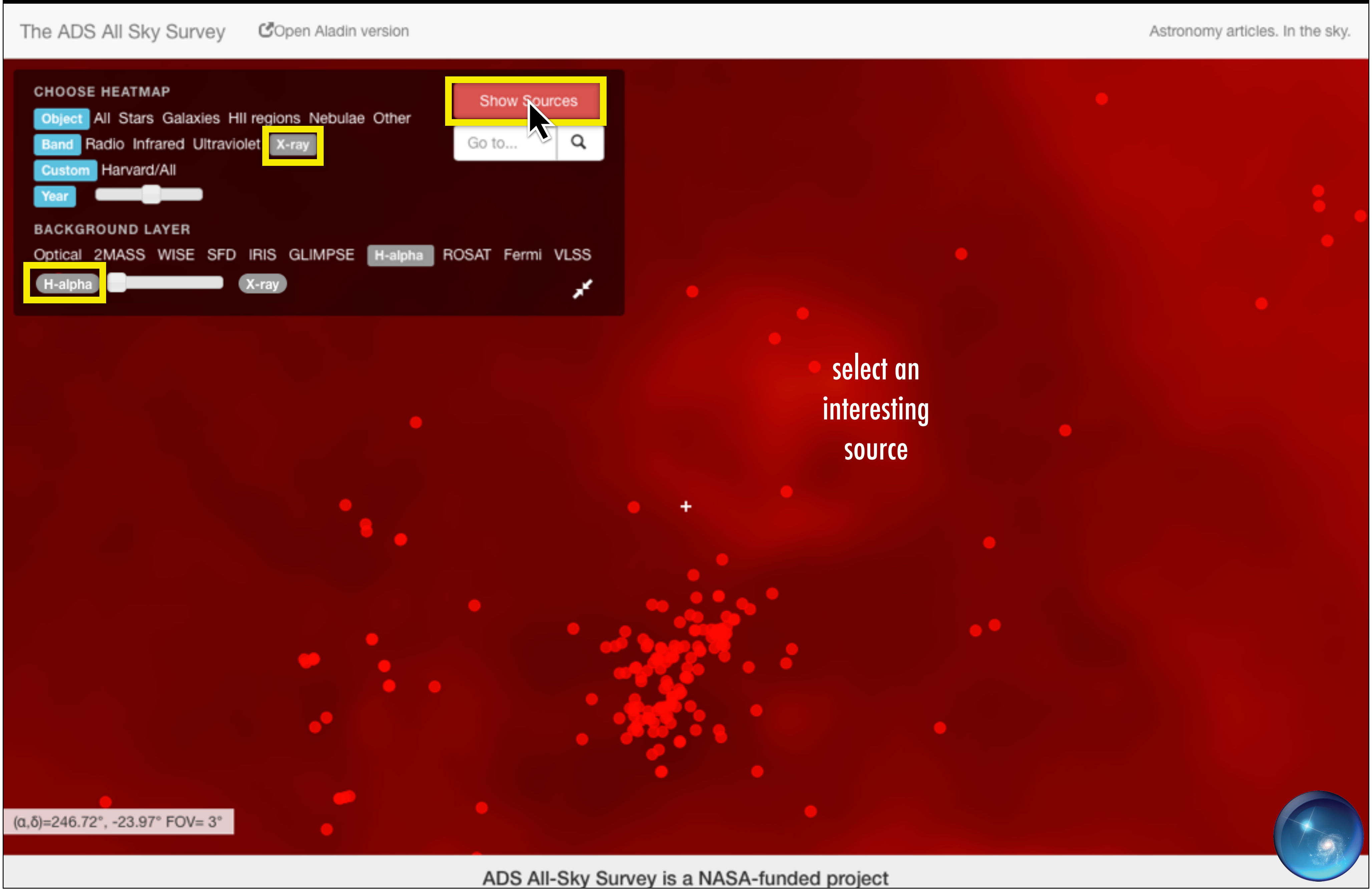
dust is nice, but we're curious about HII regions, let's change view to H-alpha



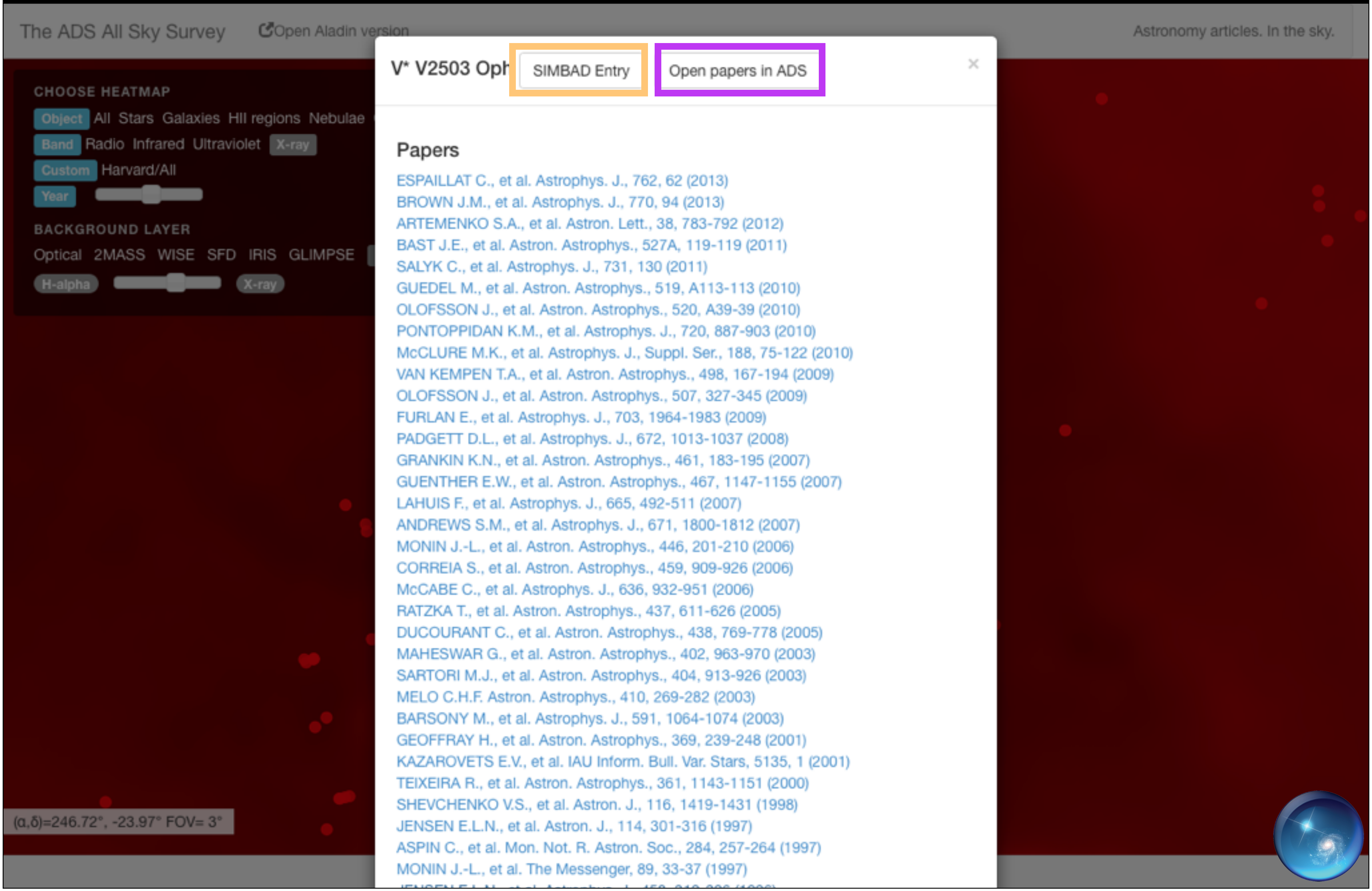
now we want to find X-ray observations and see if any are near the HII regions, so we can slide between H-alpha and X-ray



now let's zoom in, and try "Show Sources" to see what the SIMBAD X-ray sources really are



and, we can have plenty of information on the source, via CDS/SIMBAD or via ADS.



Credits

funding **NASA ADAP** program

PI: Alyssa **Goodman**, Harvard-CfA

Co-I: Alberto **Pepe**, Harvard-CfA & Authorea

Co-I: August **Muench**, Smithsonian-CfA

with

Alberto **Accomazzi**, Smithsonian Institution, NASA/ADS

Christopher **Beaumont**, Harvard-CfA

Thomas **Boch**, CDS Strasbourg

Jonathan **Fay**, Microsoft Research

David **Hogg**, NYU, astrometry.net

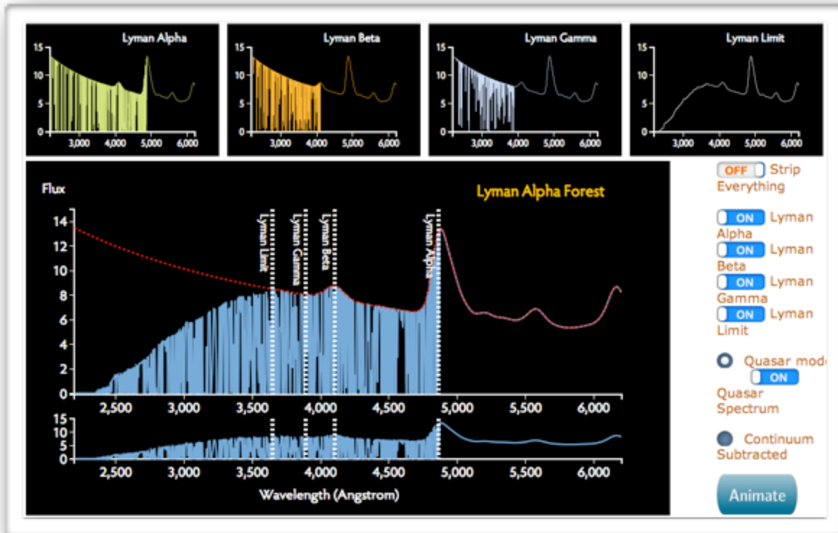
Alberto **Conti**, NASA/STScI, Northrup Grumman

Stephen

all lines SII 6716/6731 Å Hα 6563 Å OIII 5007 Å

Yuan-Sen **Ting**

Interstellar Absorption and the Lyman Alpha Forest



JavaScript **JavaScript** https://www.cfa.harvard.edu/~yuan-sen.ting/lyman_alpha.html

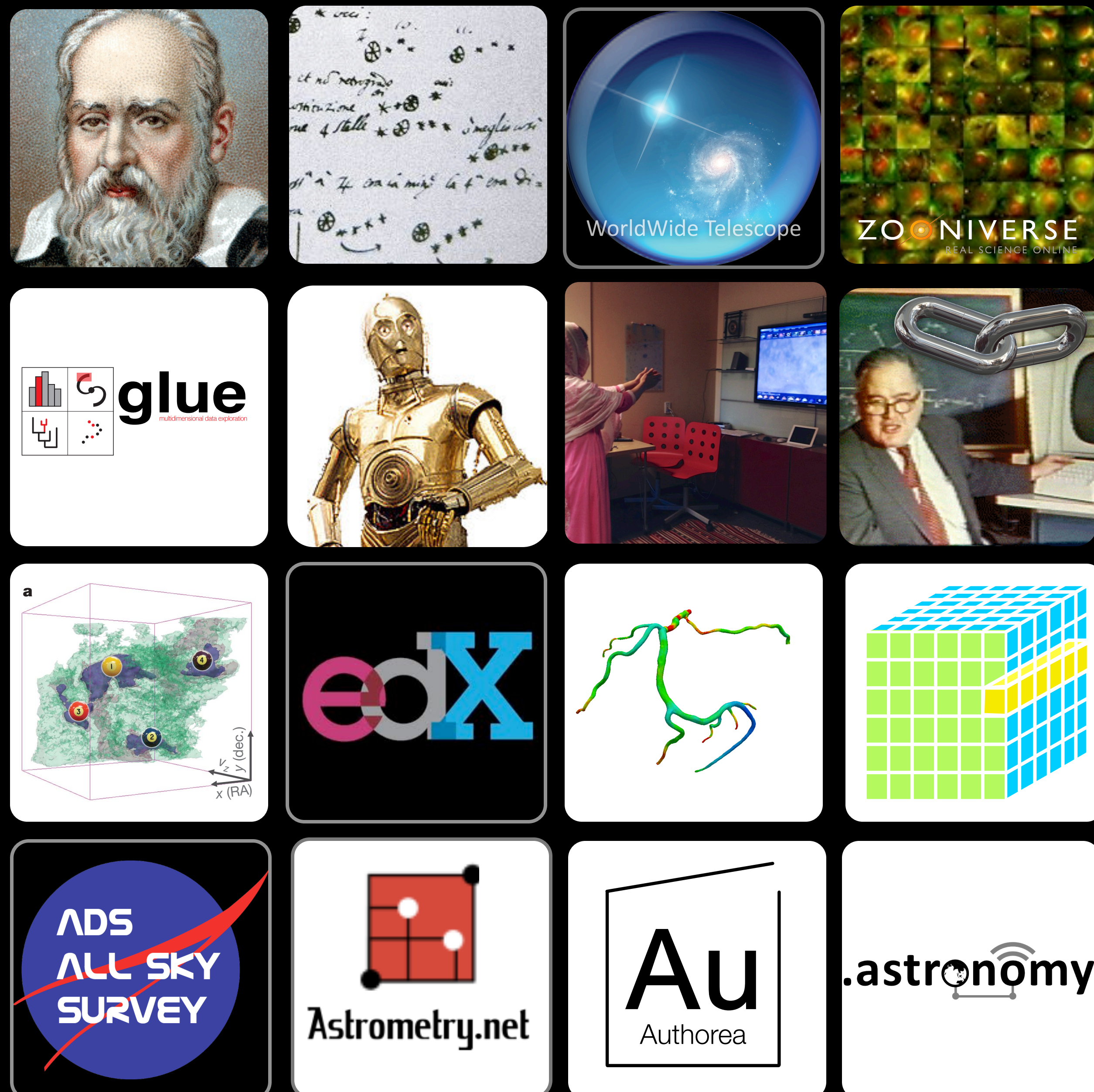
JavaScript **JavaScript** http://portillo.ca/nebula/

see: A New Approach to Developing Interactive Software Modules through Graduate Education, Sanders, Faesi & Goodman 2013

Experience WorldWide Telescope, free from Microsoft Research at **worldwidetelescope.org**

LINKING VISUALIZATION & UNDERSTANDING IN ASTRONOMY

ALYSSA A. GOODMAN
HARVARD-SMITHSONIAN CENTER FOR ASTROPHYSICS
@AAGIE

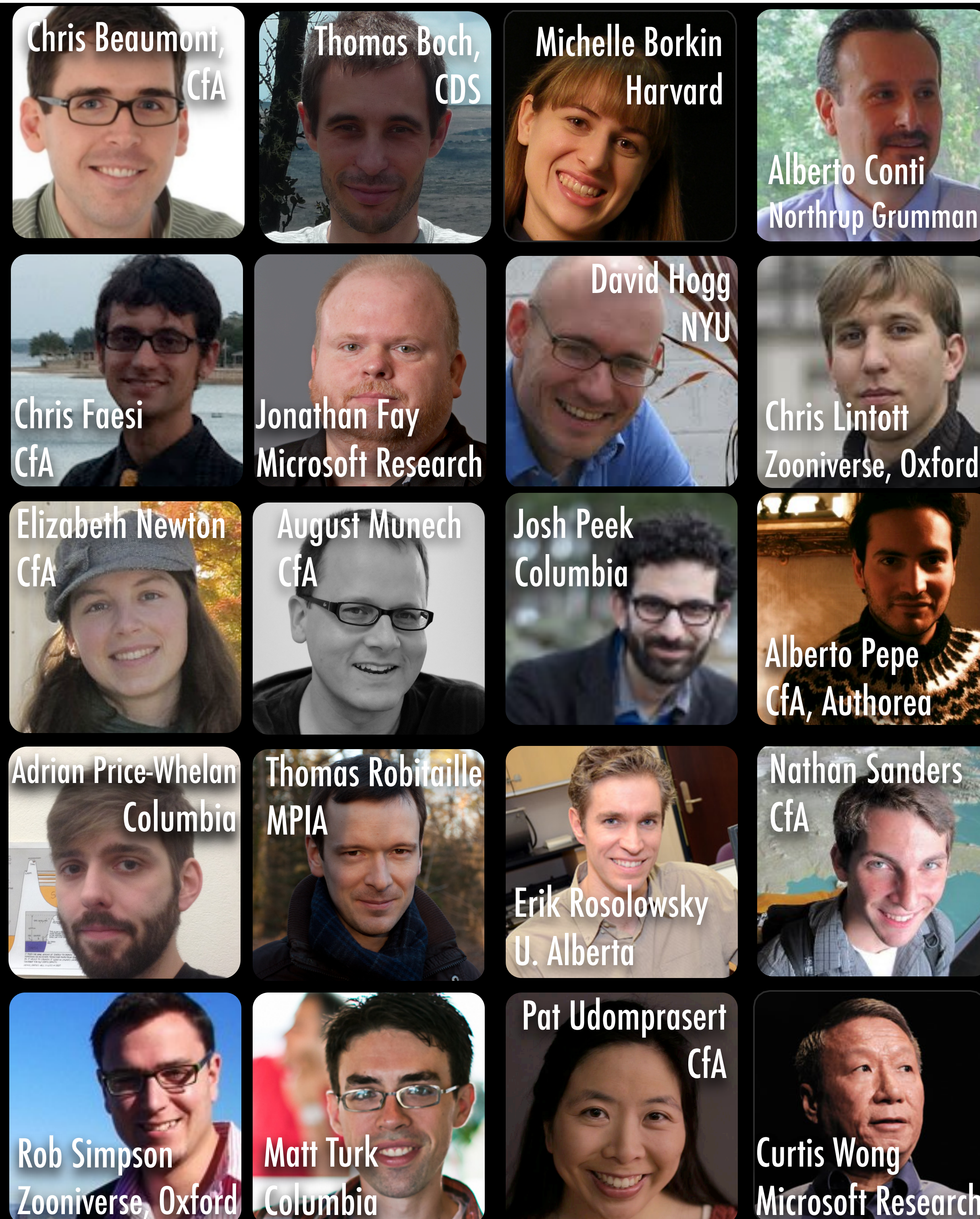


LINKING VISUALIZATION & UNDERSTANDING IN ASTRONOMY

ALYSSA A. GOODMAN
HARVARD-SMITHSONIAN
CENTER FOR ASTROPHYSICS

http://www.astrobetter.com/linking-visualization-and-understanding-in-astronomy-aas223

COLLABORATORS



SEAMLESS ASTRONOMY

Linking scientific data, publications, and communities

projects.iq.harvard.edu/seamlessastronomy

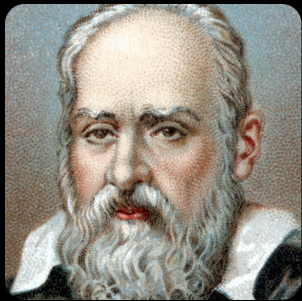
...including ADS team (Alberto Accomazzi, Michael Kurtz, Edwin Henneken, et al.) and Wolbach Library staff (Christopher Erdmann et al.)

RELATIVE STRENGTHS

Pattern Recognition
Creativity

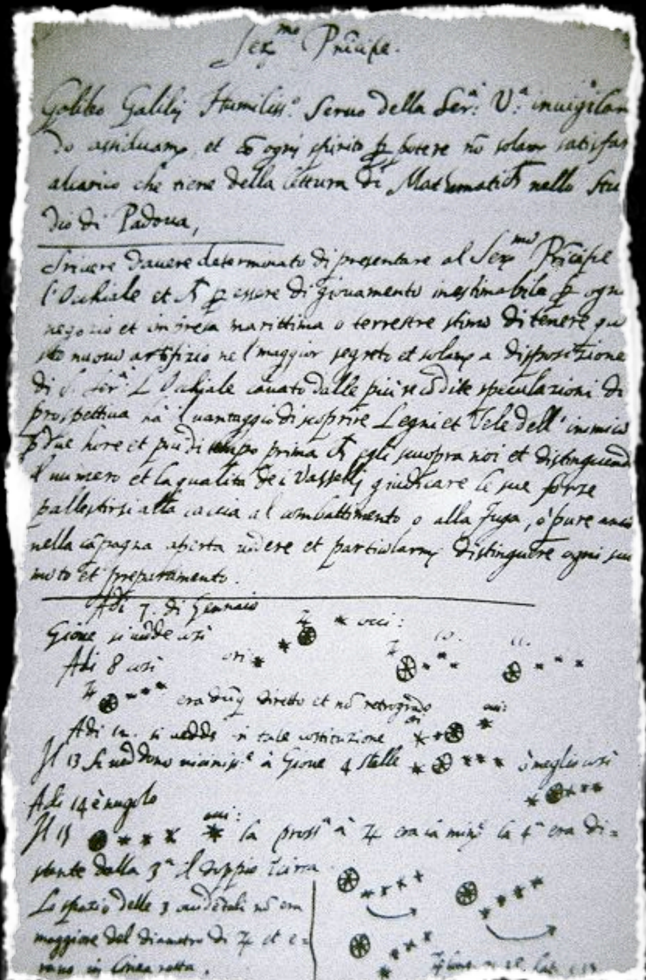
Calculations

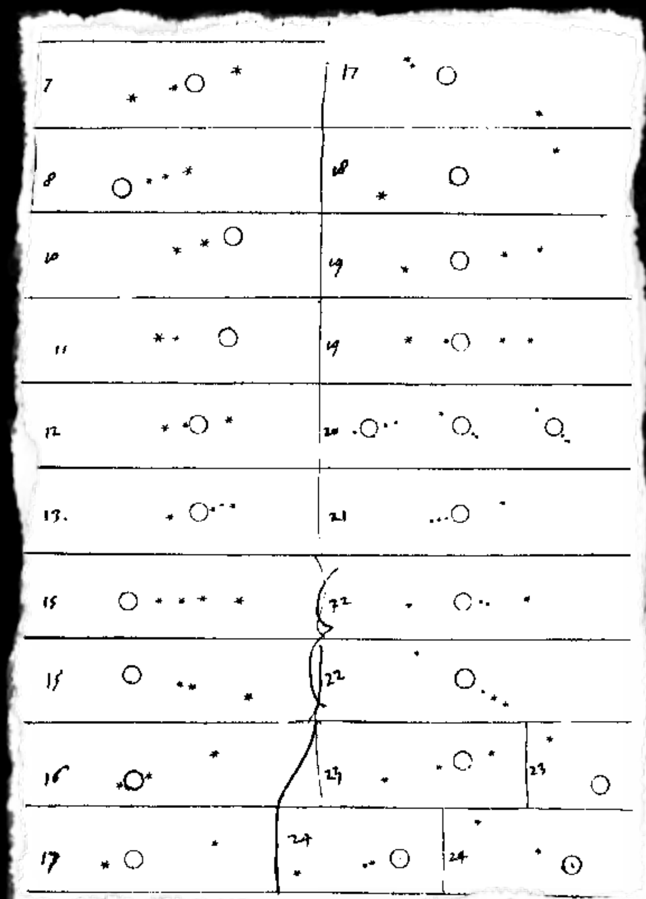
LINKING VISUALIZATION & UNDERSTANDING IN ASTRONOMY

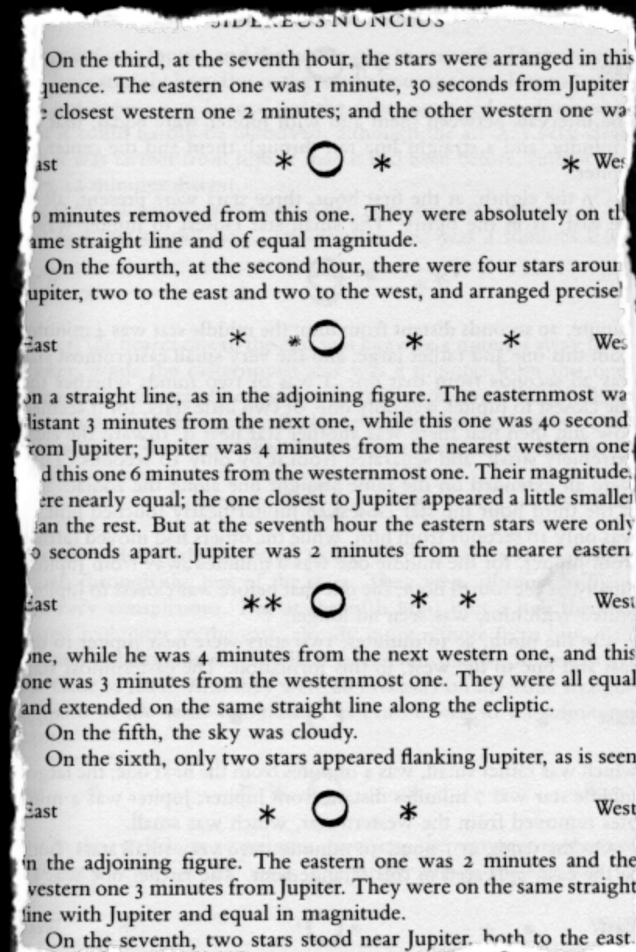


GALILEO GALILEI

(1564-1642)







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

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

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 easter

one, 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.

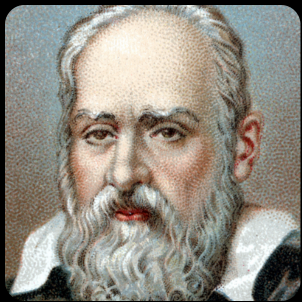
On the fifth, the sky was cloudy.

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

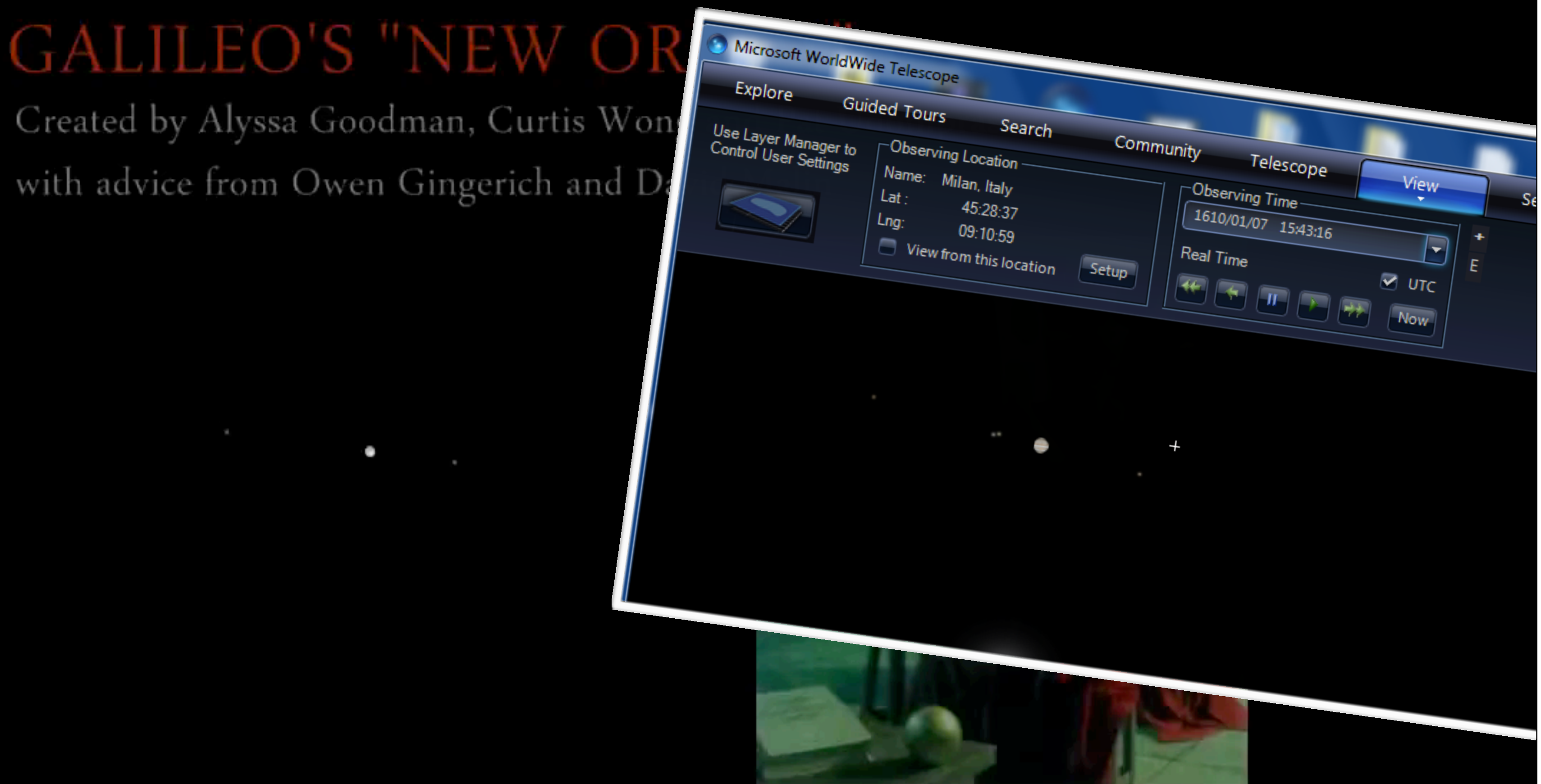
in the adjoining figure. The eastern one was 2 minutes and the western one 3 minutes from Jupiter. They were on the same straight line with Jupiter and equal in magnitude.

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

Notes for & re-productions of Siderius Nuncius



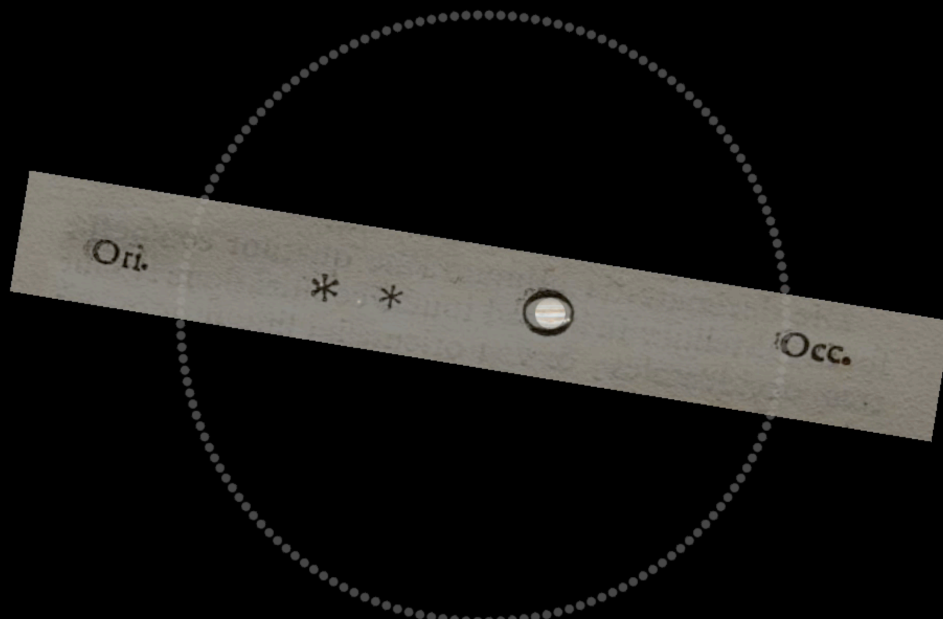
GALILEO GALILEI

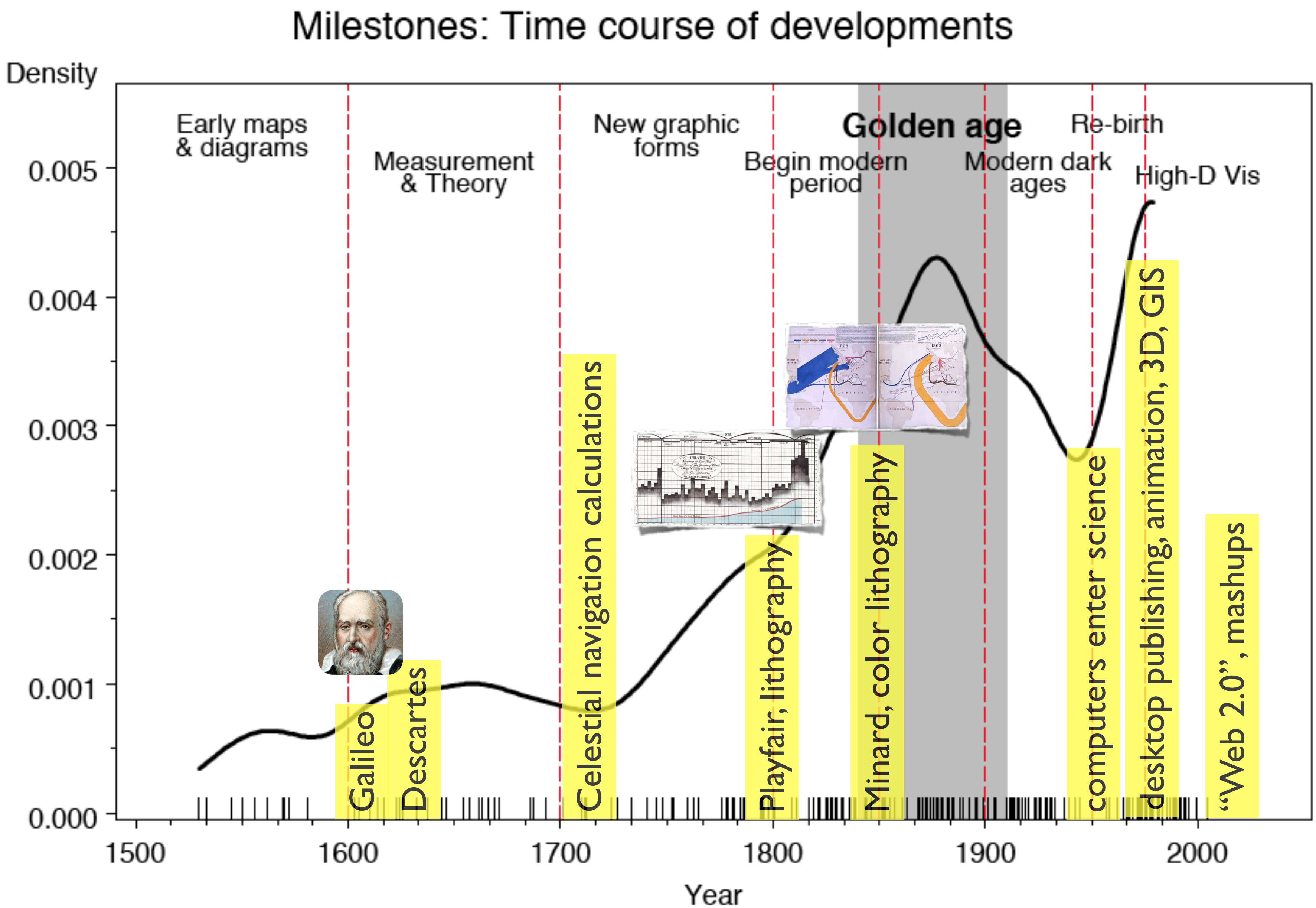


Galileo's New Order, A WorldWide Telescope Tour by Goodman, Wong & Udomprasert 2010

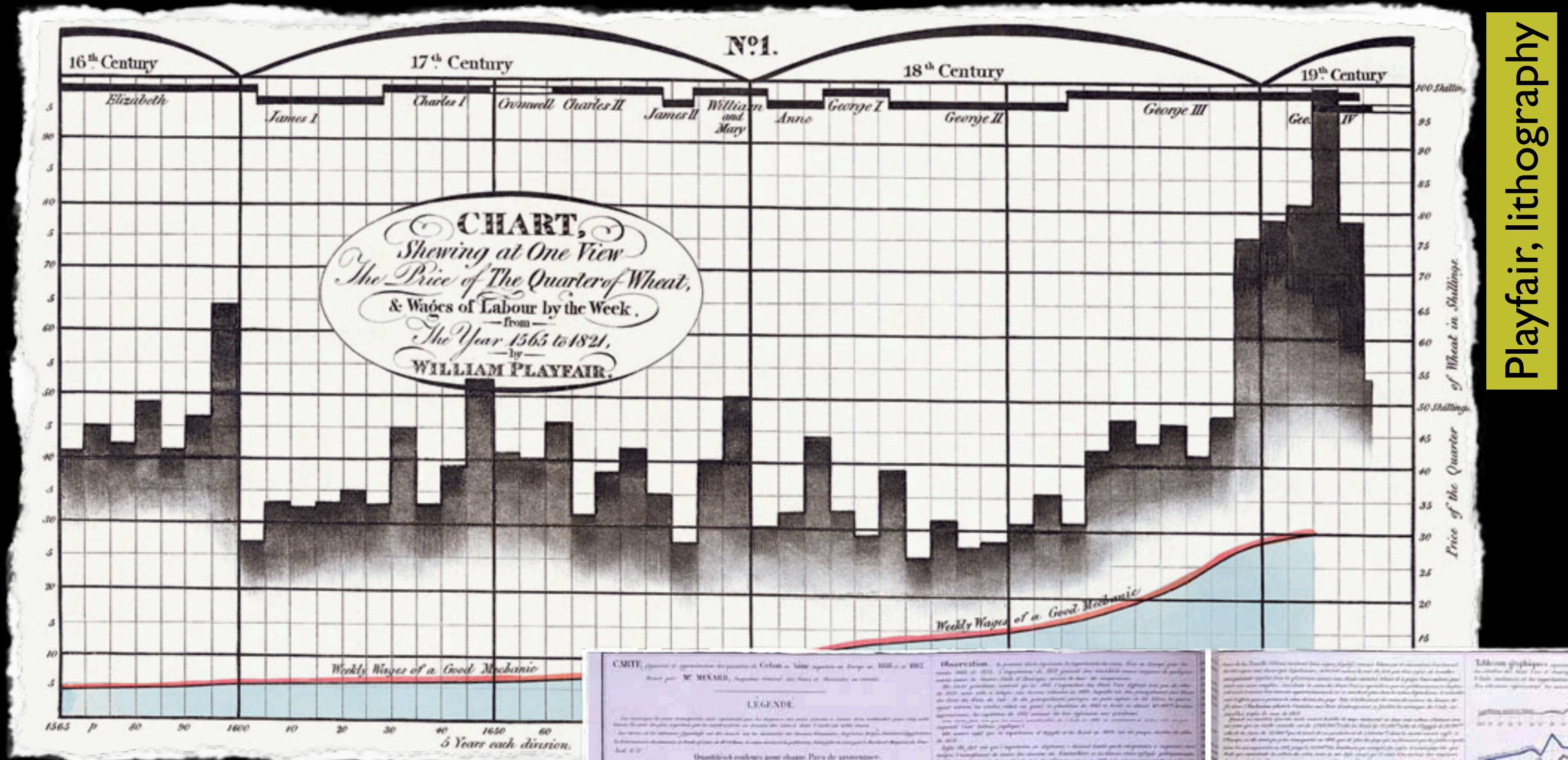
GALILEO GALILEI

January 11, 1610



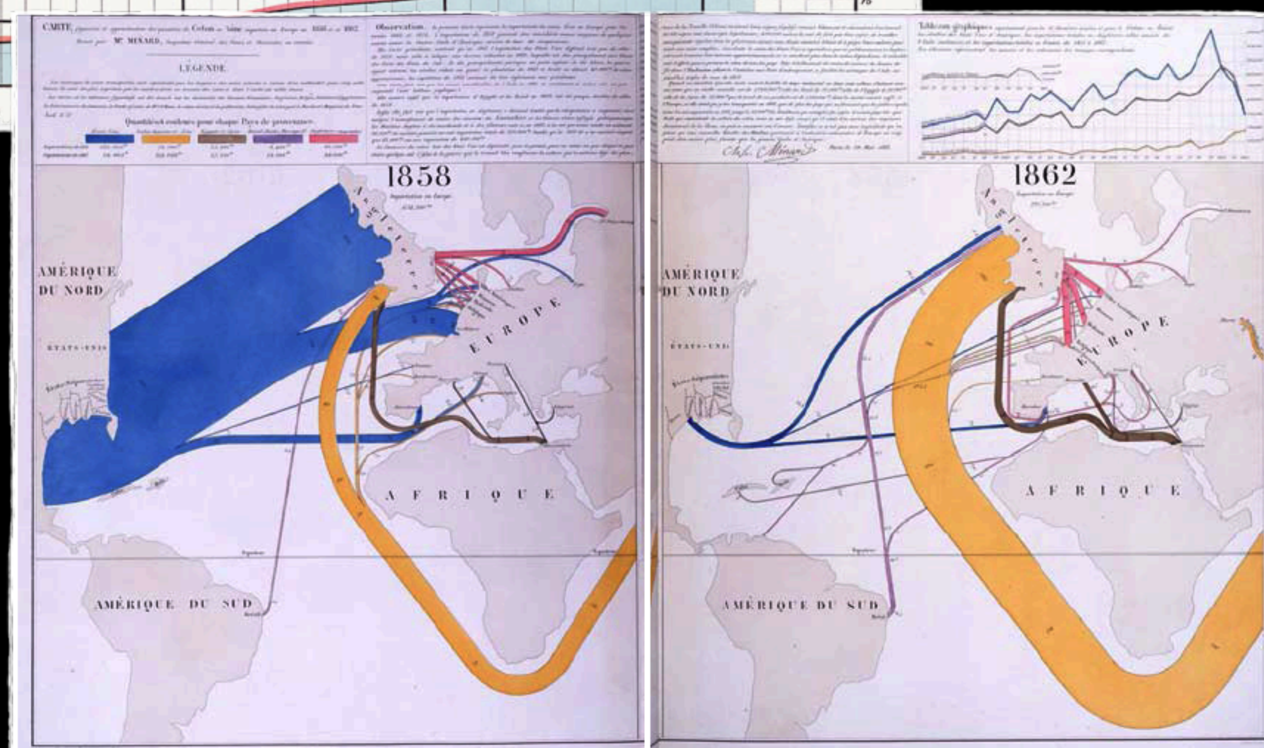


adapted from Friendly, "The Golden Age of Statistical Graphics," *Statistical Science*, 2009



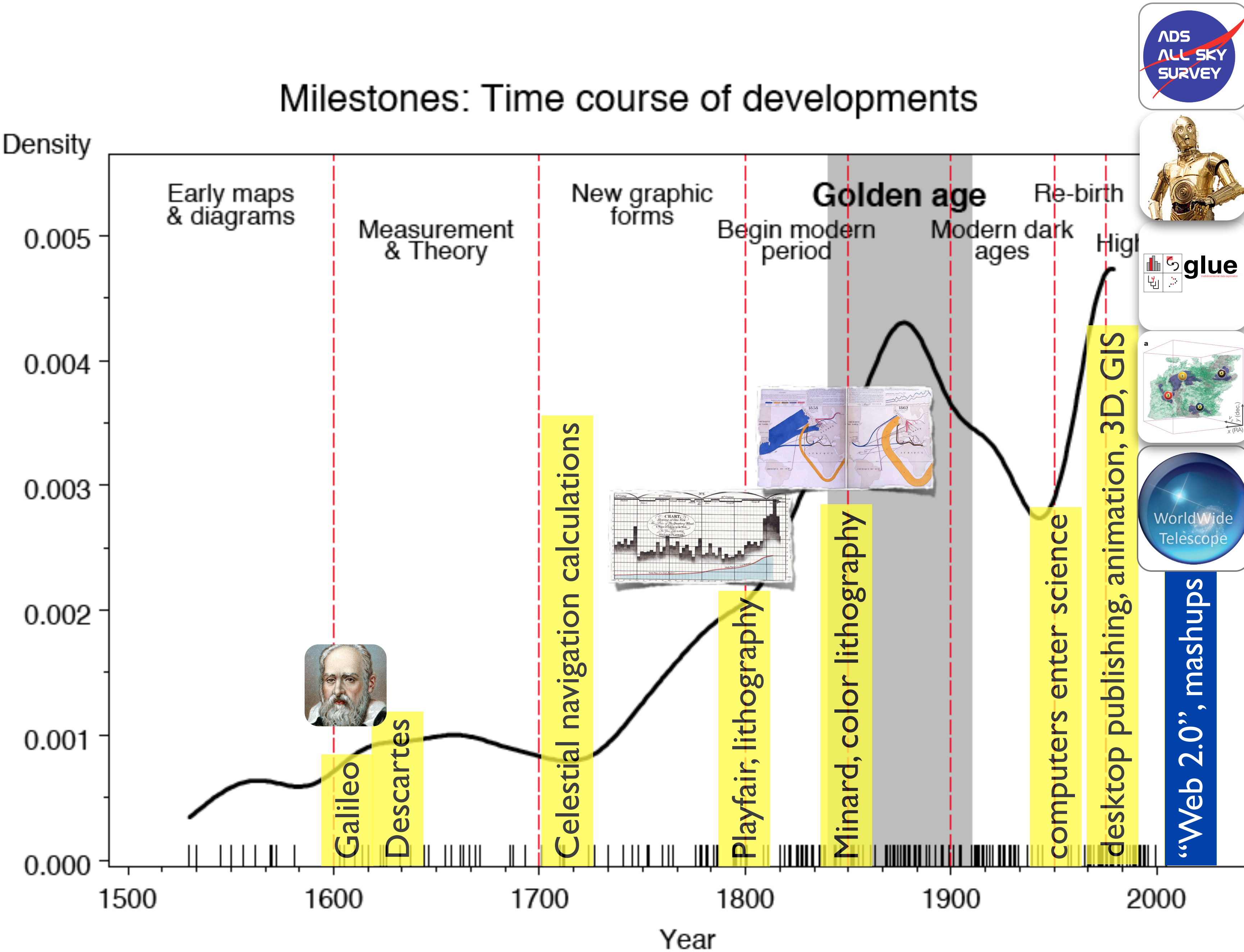
Playfair, lithography

William Playfair (1759-1823)



Minard, color lithography

Charles Joseph Minard (1781-1870)



adapted from Friendly, "The Golden Age of Statistical Graphics," *Statistical Science*, 2009

python

SciPy

IP[y]: IPython
Interactive Computing

astropy
A Community Python Library for Astronomy

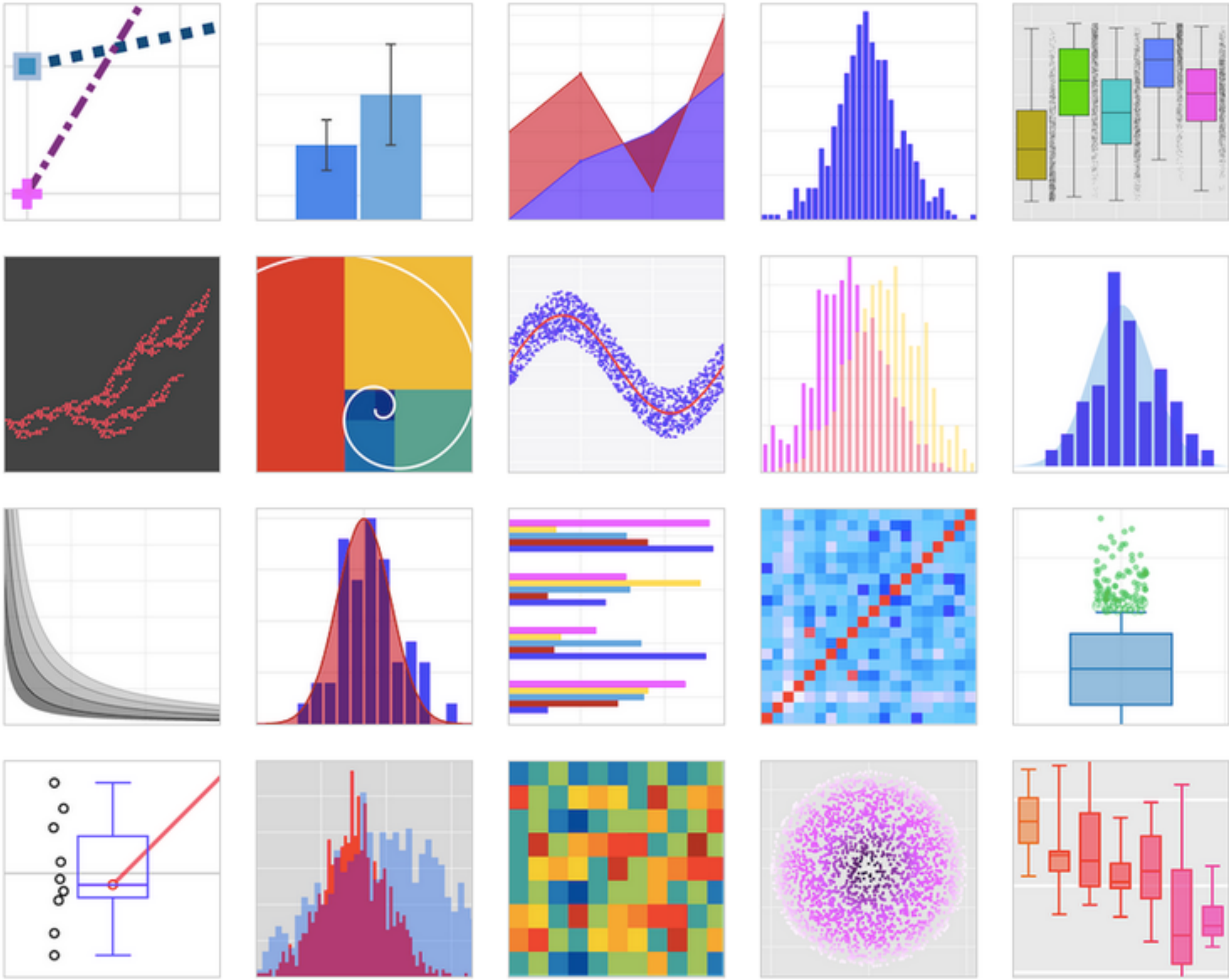
JavaScript

d3.js

HTML

“Web 2.0”, mashups

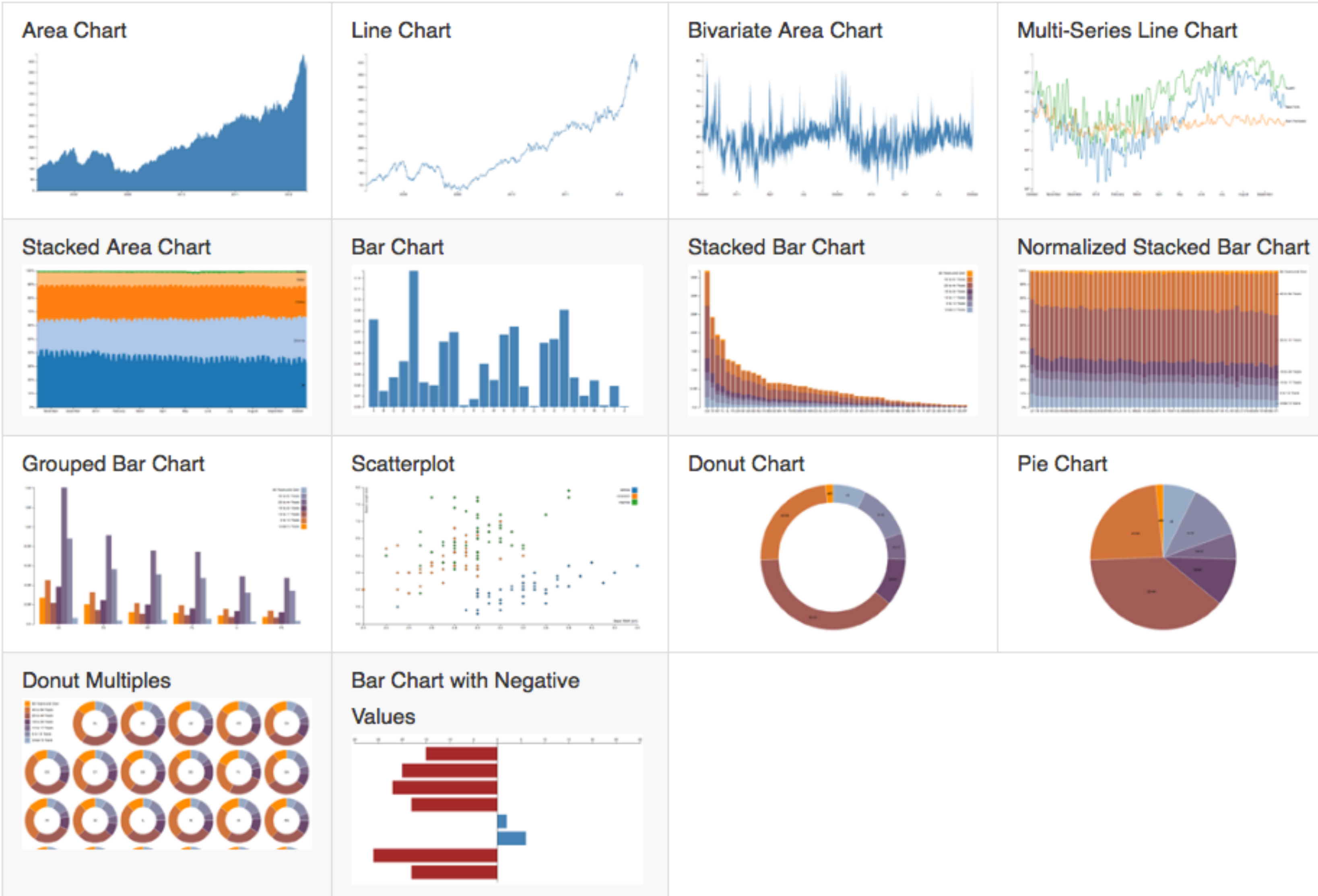
“Web 2.0”, mashups



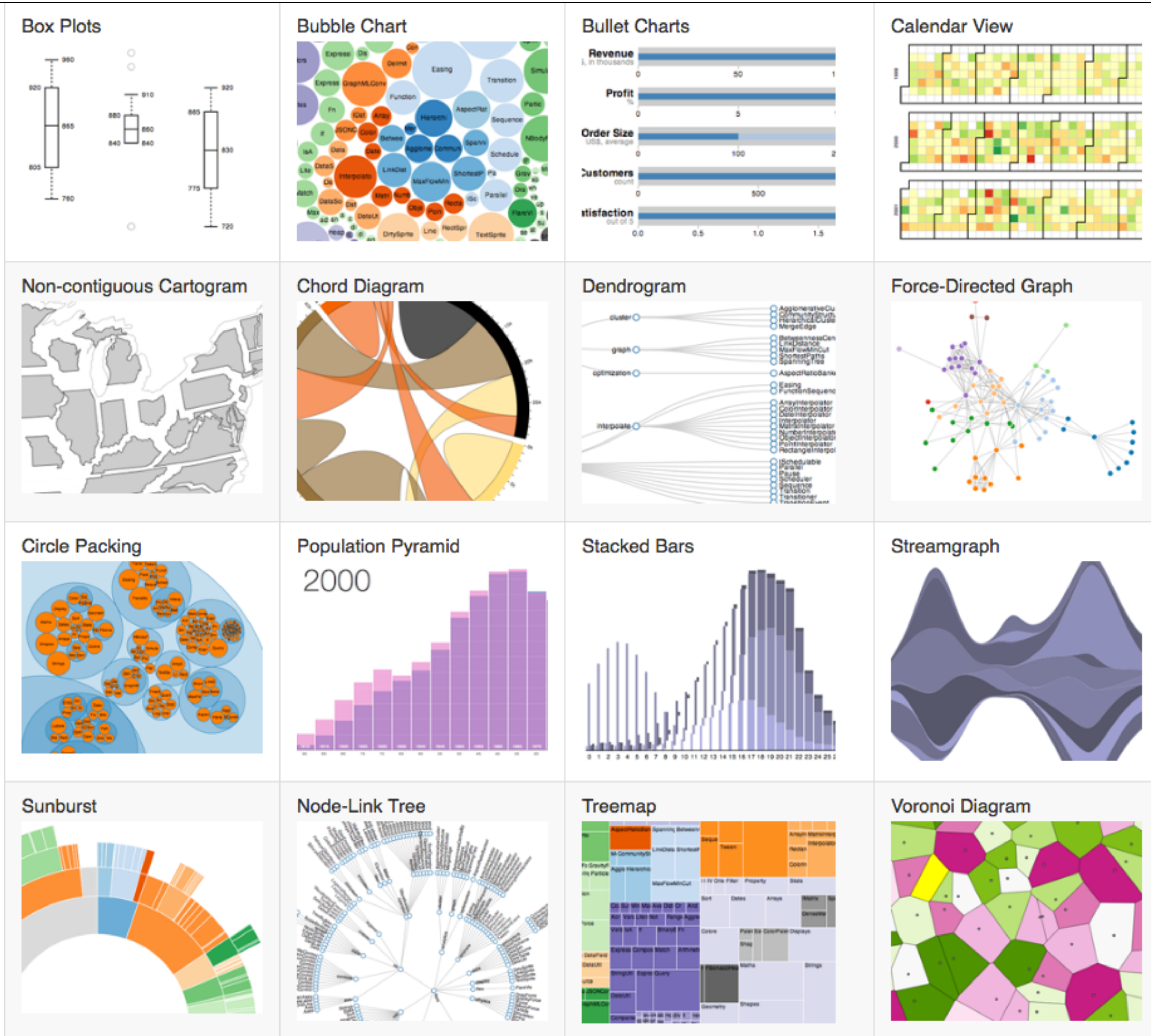
PLOTLY

D3.JS

“Web 2.0”, mashups

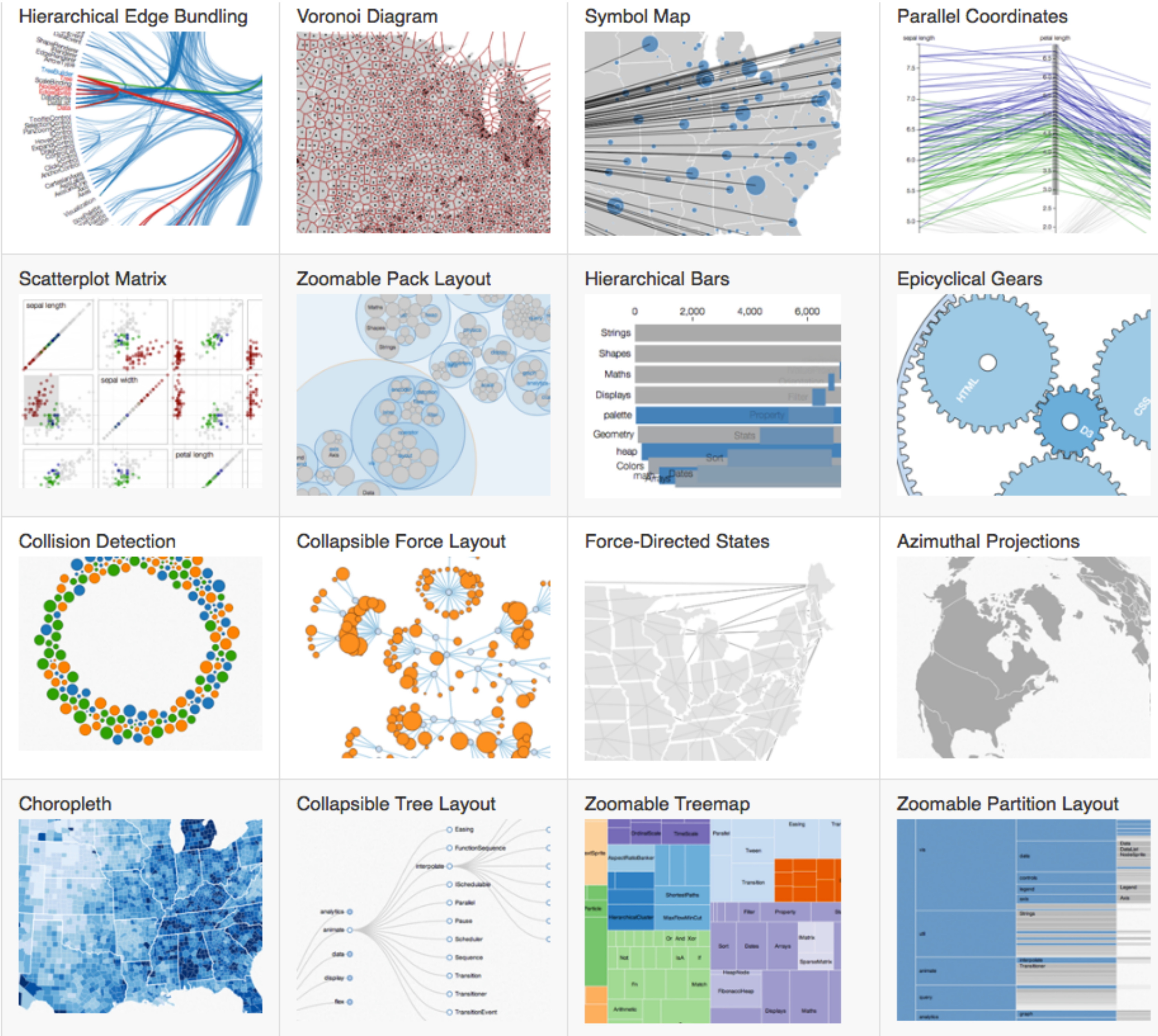


“Web 2.0”, mashups



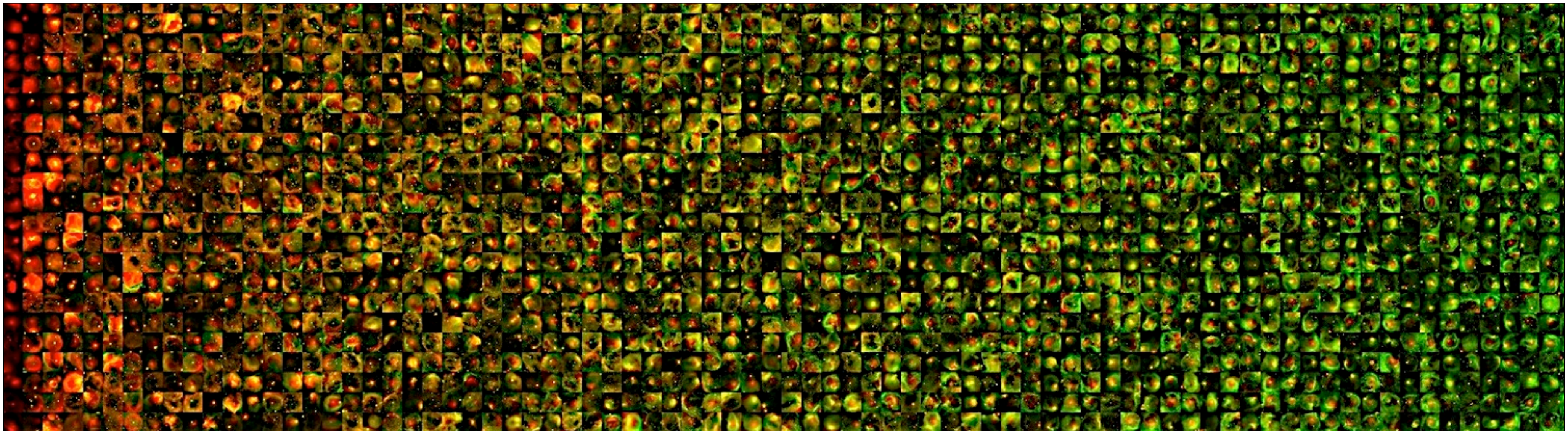
D3.JS

“Web 2.0”, mashups

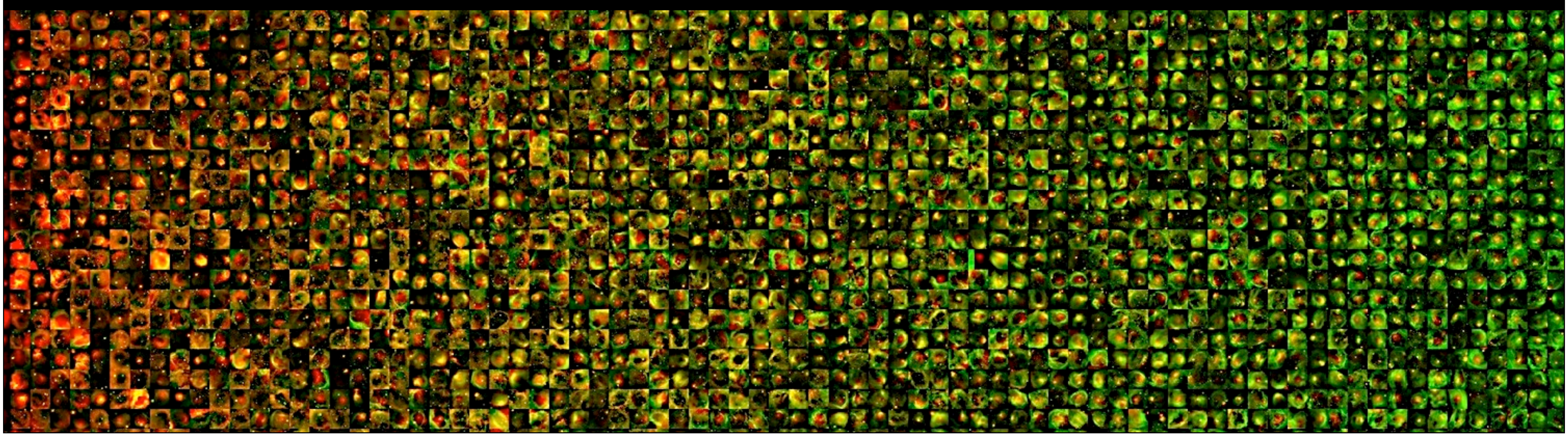


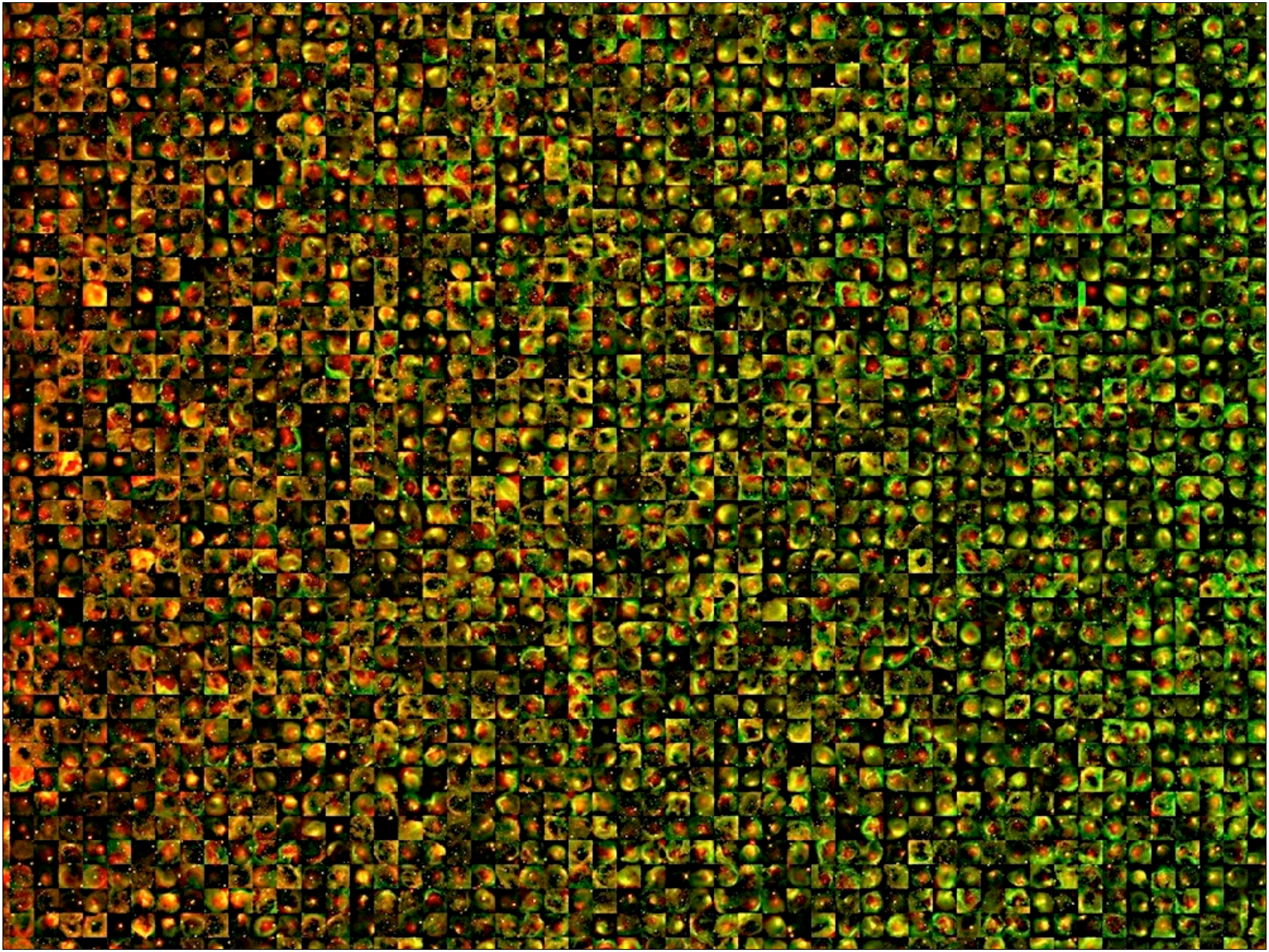
D3.JS

[redacted]

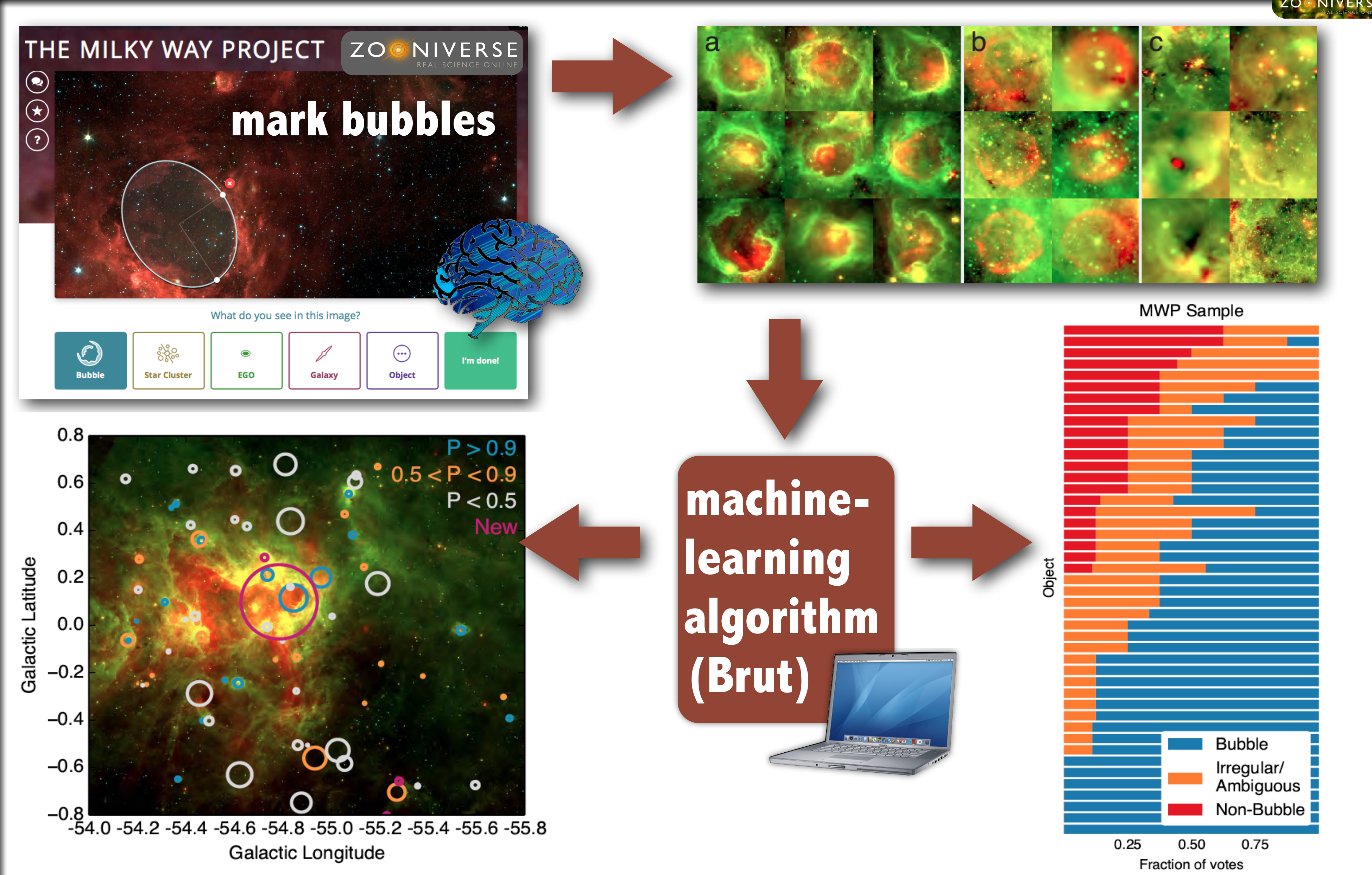


BIG DATA, WIDE DATA

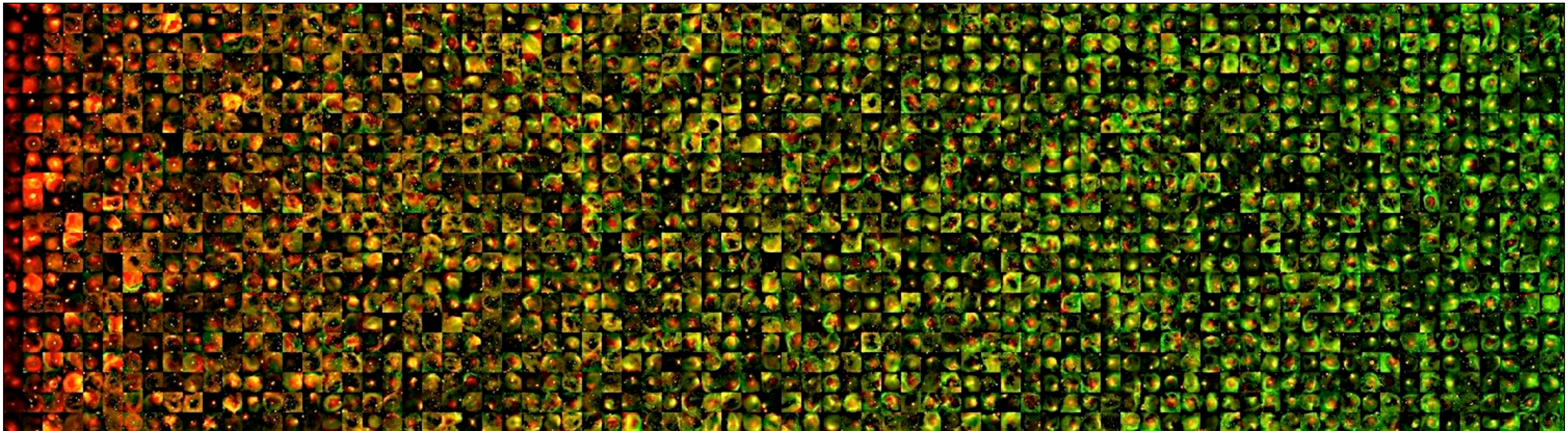




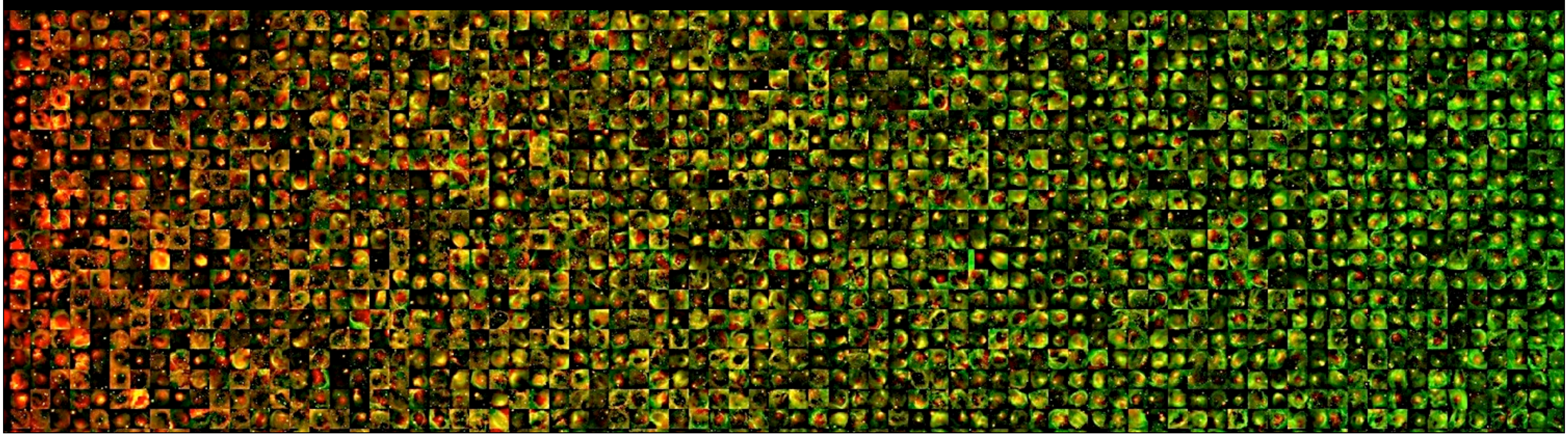
BIG DATA AND "HUMAN-AIDED COMPUTING"



example here from: ***Beaumont****, Goodman, Kendrew, Williams & Simpson 2014; based on* ***Milky Way Project*** *catalog (Simpson et al. 2013), which came from* ***Spitzer/GLIMPSE*** *(Churchwell et al. 2009, Benjamin et al. 2003), cf. Shenoy & Tan 2008 for discussion of HAC;* ***astroml.org*** *for machine learning advice/tools*

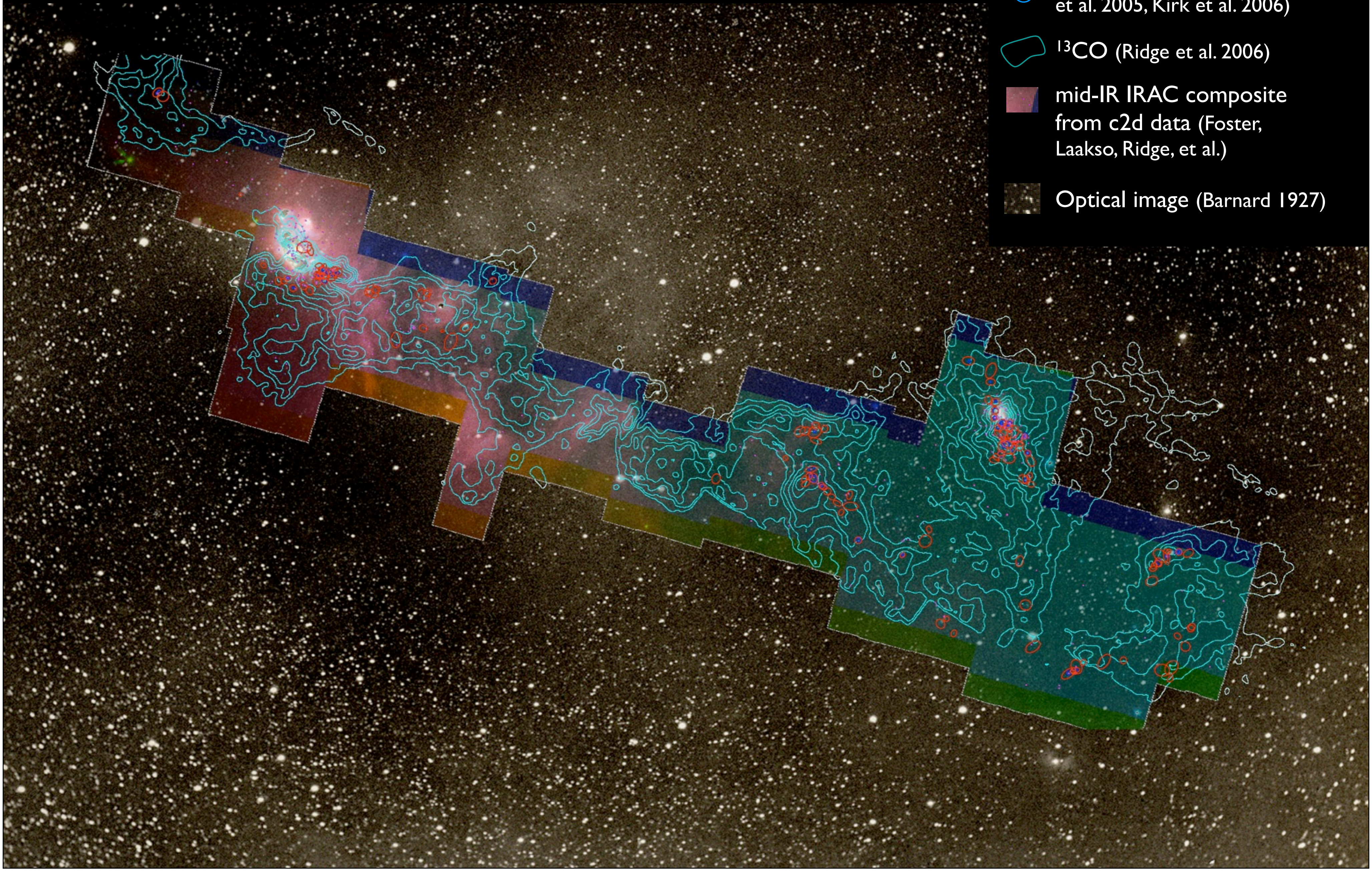


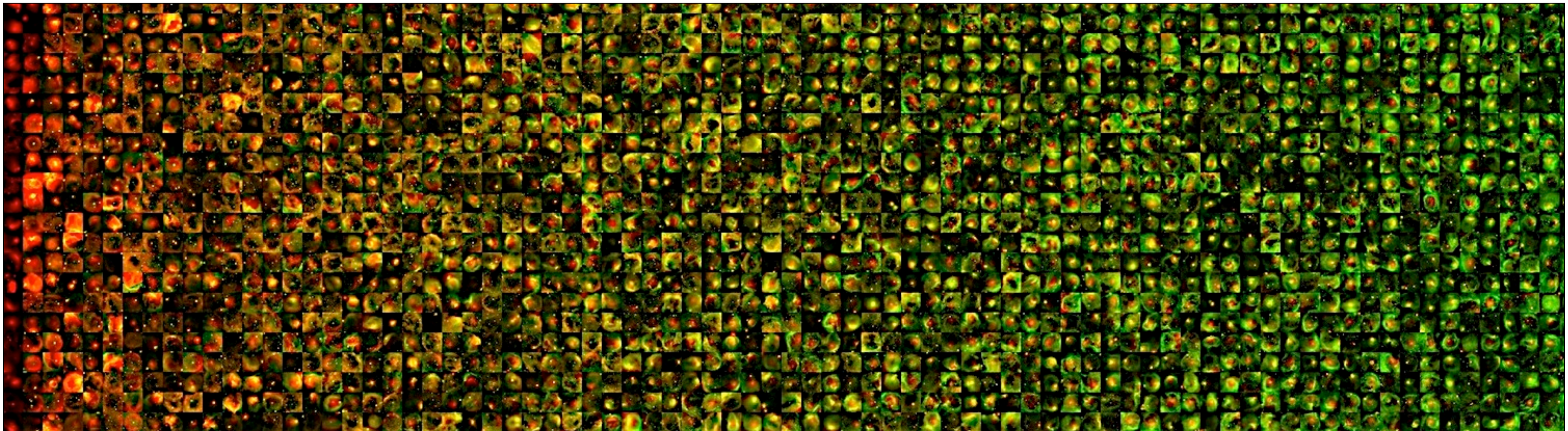
BIG DATA, WIDE DATA



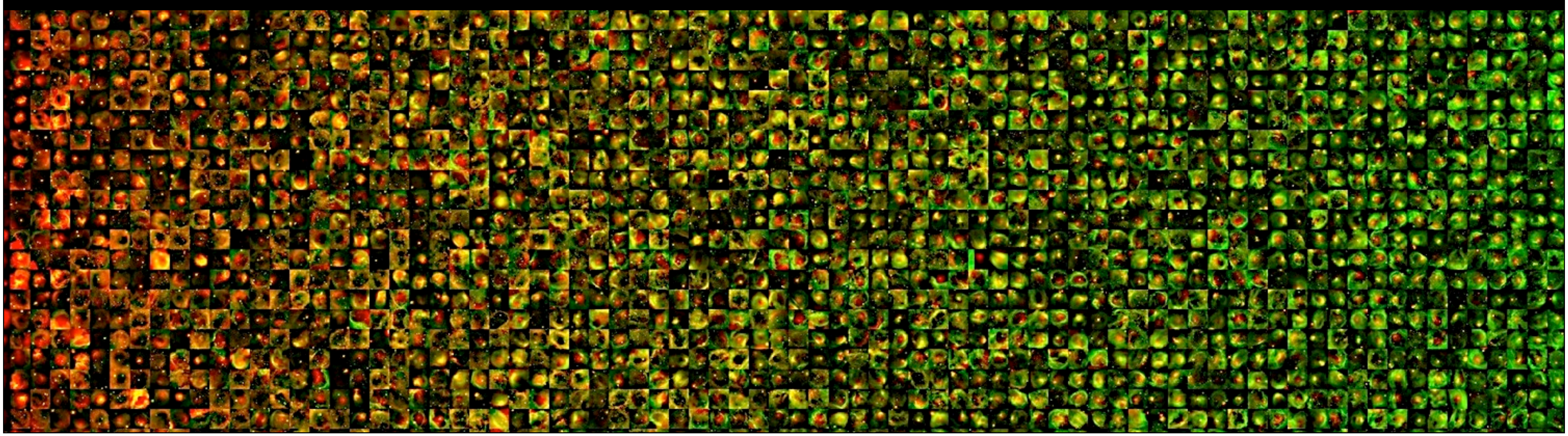
WIDE DATA

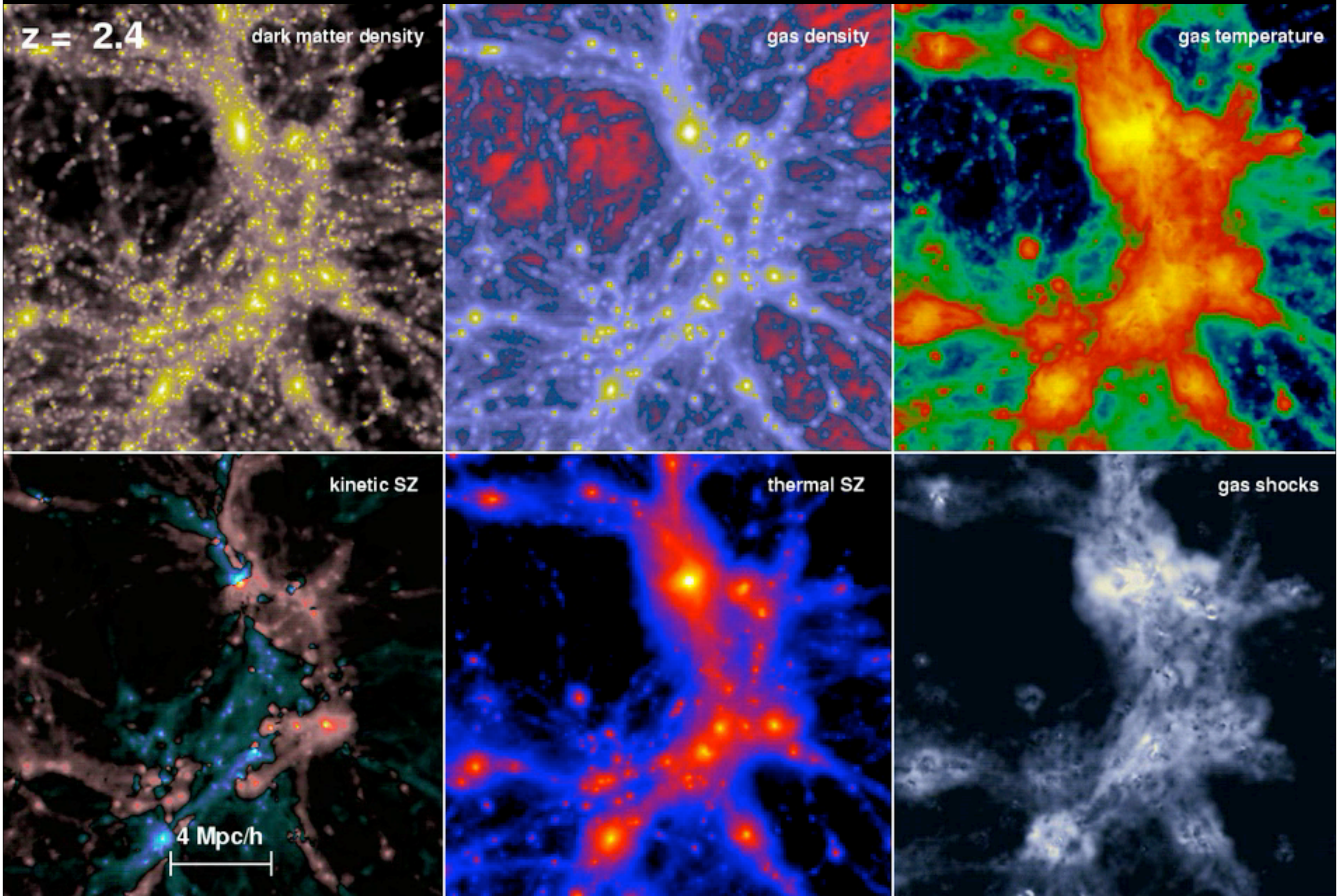
COMPLETE



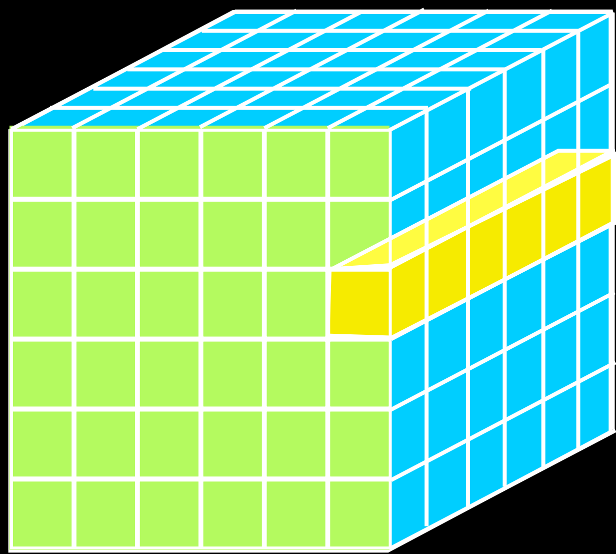


BIG AND WIDE DATA





Movie: Volker Springel, formation of a cluster of galaxies



"DATA, DIMENSIONS, DISPLAY"

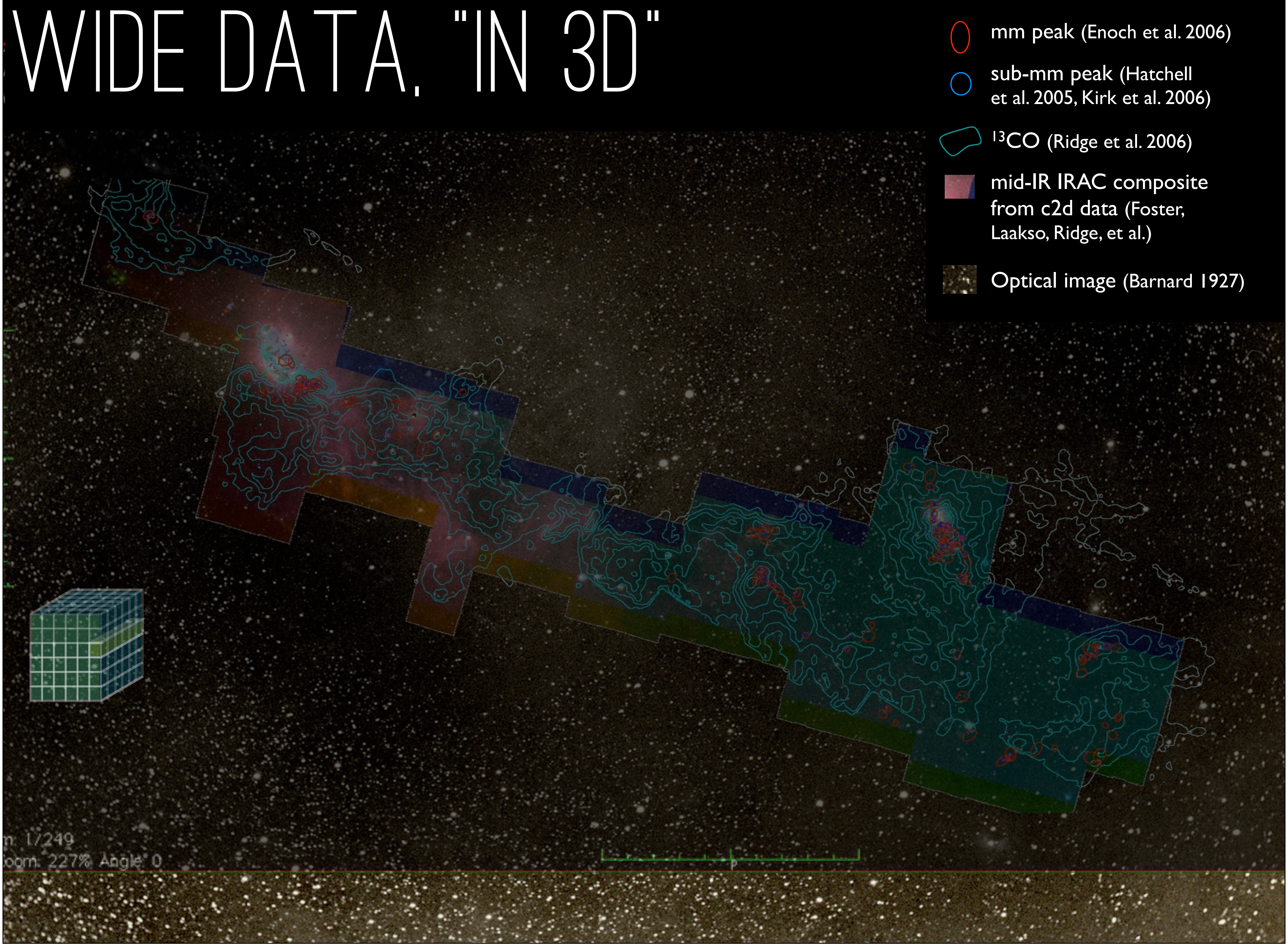
1D: Columns = "Spectra", "SEDs" or "Time Series"

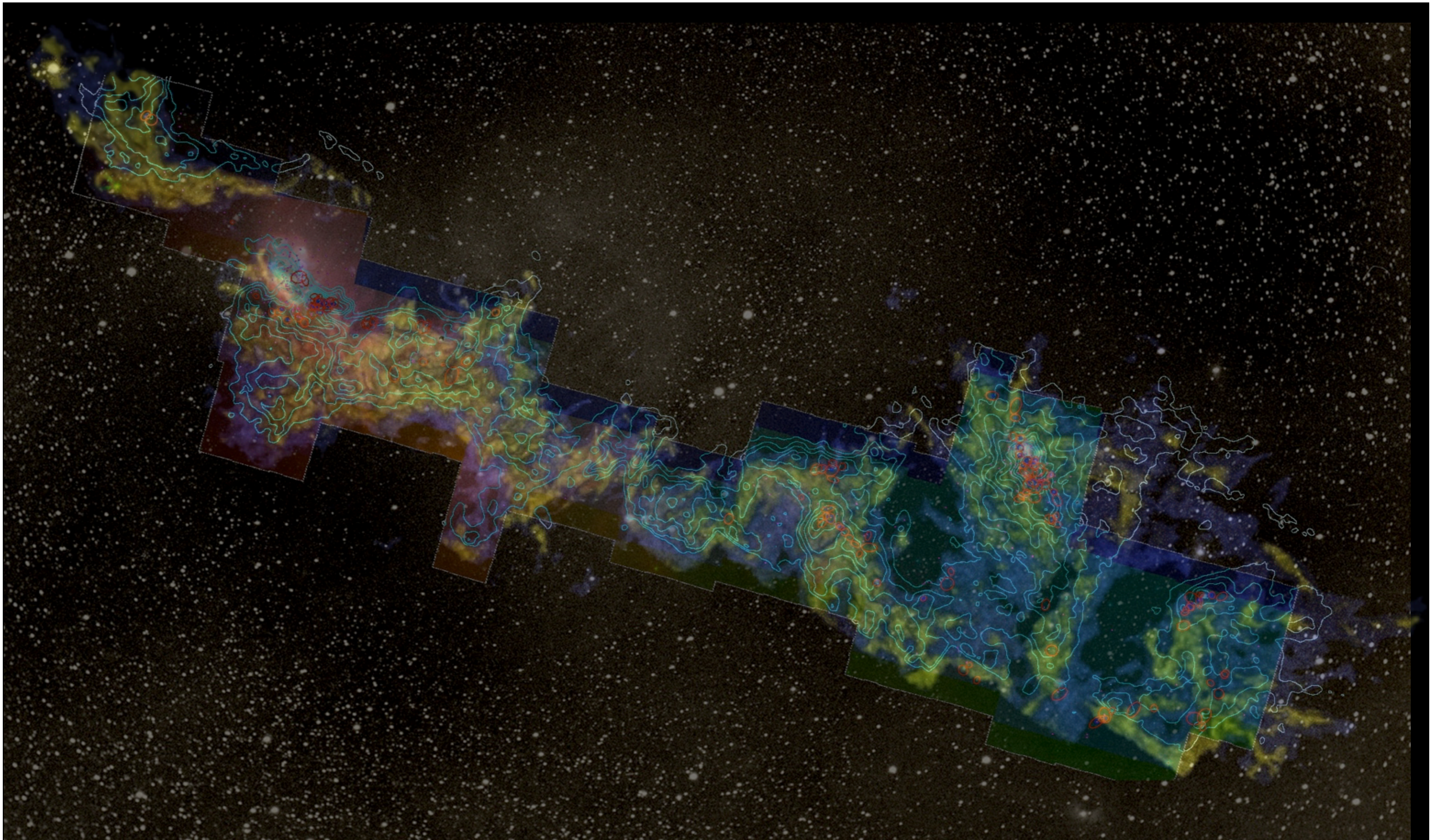
2D: Faces or Slices = "Images"

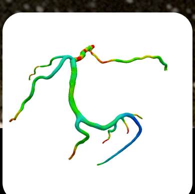
3D: Volumes = "3D Renderings", "2D Movies"

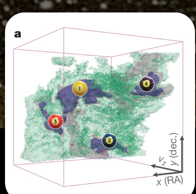
4D: Time Series of Volumes = "3D Movies"

WIDE DATA, "IN 3D"







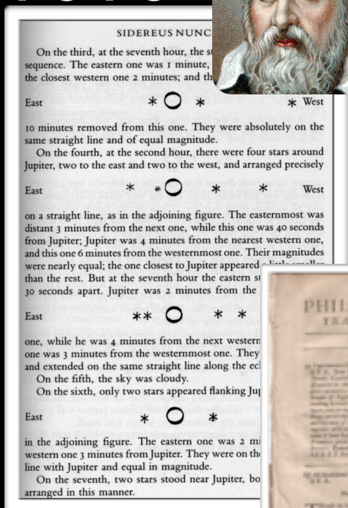


AstronomicalMedicine@IIC

COMPLETE

WHAT DO WE PUBLISH?

1610



SIDEREUS NUNC

On the third, at the seventh hour, the s
sequence. The eastern one was 1 minute,
the closest western one 2 minutes; and th

East * O * * West

10 minutes removed from this one. They were absolutely on the same straight line and of equal magnitude.
On the fourth, at the second hour, there were four stars around Jupiter, two to the east and two to the west, and arranged precisely

East * *O * * West

on a straight line, as in the adjoining figure. The easternmost was distant 3 minutes from the next one, while this one was 40 seconds from Jupiter; Jupiter was 4 minutes from the nearest western one, and this one 6 minutes from the westernmost one. Their magnitudes were nearly equal; the one closest to Jupiter appeared
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East ** O * *

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East * O *

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western one 3 minutes from Jupiter. They were on th
line with Jupiter and equal in magnitude.
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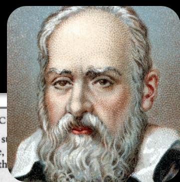
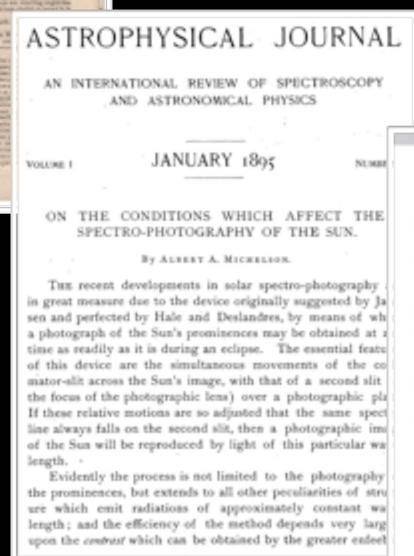
arranged in this manner.



1665

PHILOSOPHICAL TRANSACTIONS

1895



ASTROPHYSICAL JOURNAL

AN INTERNATIONAL REVIEW OF SPECTROSCOPY AND ASTRONOMICAL PHYSICS

VOLUME I JANUARY 1895 NUMBE

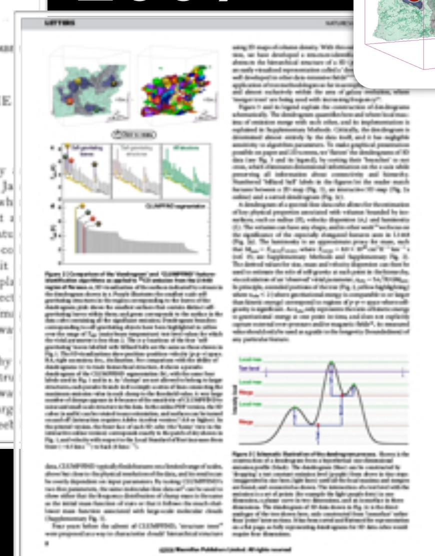
ON THE CONDITIONS WHICH AFFECT THE SPECTRO-PHOTOGRAPHY OF THE SUN.

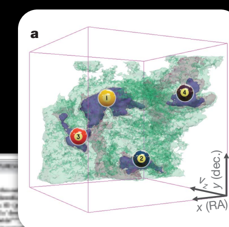
By ALBERT A. MICHELSON.

THE recent developments in solar spectro-photography in great measure due to the device originally suggested by Ja sen and perfected by Hale and Deslandres, by means of wh a photograph of the Sun's prominences may be obtained at a time as readily as it is during an eclipse. The essential featu of this device are the simultaneous movements of the co mator-slit across the Sun's image, with that of a second slit the focus of the photographic lens) over a photographic pla If these relative motions are so adjusted that the same spect line always falls on the second slit, then a photographic ima of the Sun will be reproduced by light of this particular wa length.

Evidently the process is not limited to the photography the prominences, but extends to all other peculiarities of stru are which emit radiations of approximately constant wa length; and the efficiency of the method depends very larg upon the *contrast* which can be obtained by the greater enfeeb

2009





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3D PDF

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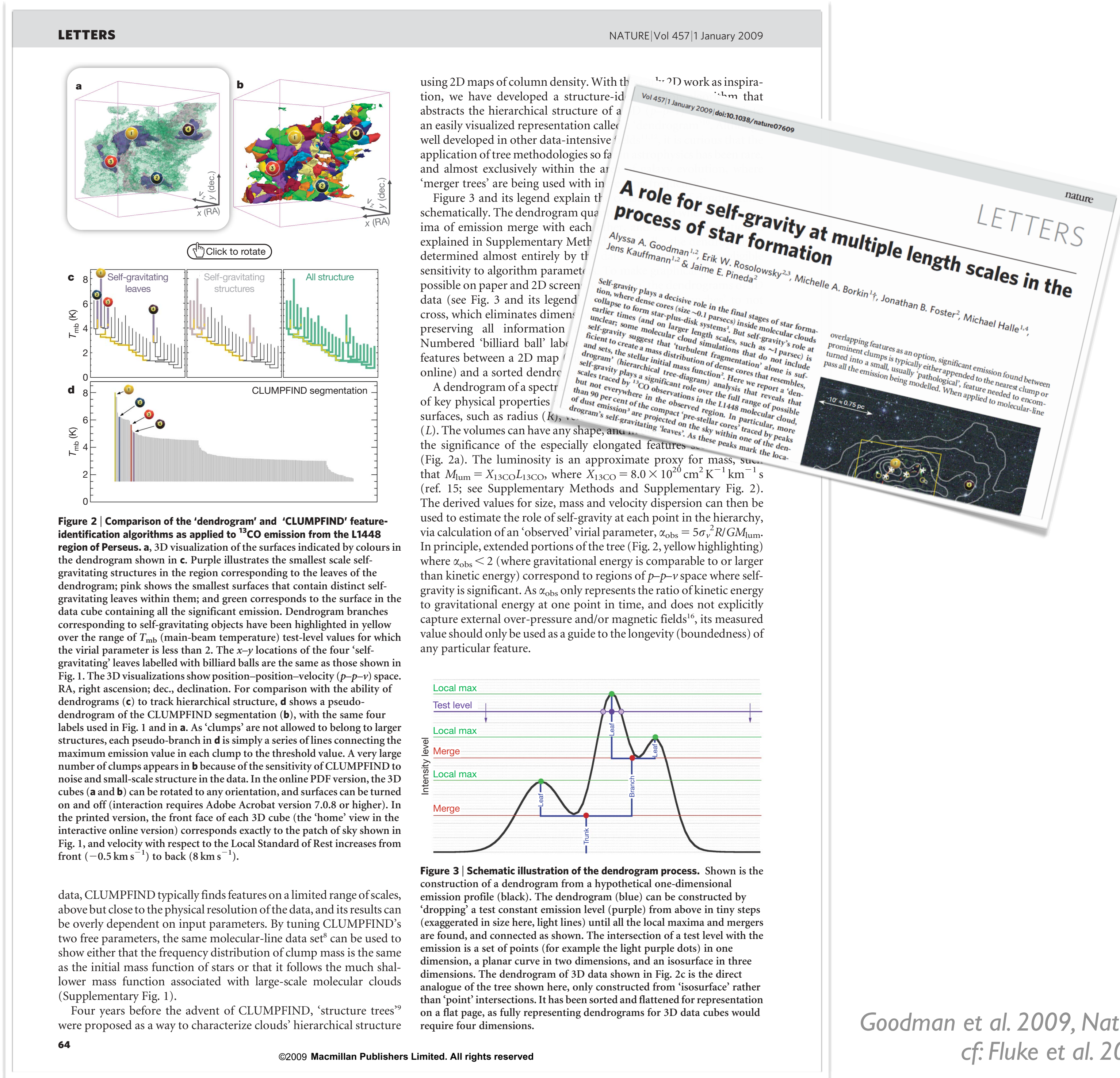
LETTERS NATURE|Vol 457|1 January 2009

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 th... 2D work as inspiration, we have developed a structure-id... that abstracts the hierarchical structure of a... an easily visualized representation calle... well developed in other data-intensive... application of tree methodologies so fa... and almost exclusively within the a... 'merger trees' are being used with i...

Figure 3 and its legend explain th... schematically. The dendrogram qua... ima of emission merge with each... explained in Supplementary Meth... determined almost entirely by th... sensitivity to algorithm paramet... possible on paper and 2D screen... data (see Fig. 3 and its legend... cross, which eliminates dimen... preserving all information... Numbered 'billiard ball' lab... features between a 2D map... online) and a sorted dendr...

A dendrogram of a spectr... of key physical properties... surfaces, such as radius (R),... (L). The volumes can have any shape, and... the significance of the especially elongated features... (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.

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LETTERS

A role for self-gravity at multiple length scales in the process of star formation

Alyssa A. Goodman[1,2], Erik W. Rosolowsky[2,3], Michelle A. Borkin[1]†, Jonathan B. Foster[2], Michael Halle[1,4], Jens Kauffmann[1,2] & Jaime E. Pineda[2]

Self-gravity plays a decisive role in the final stages of star formation, where dense cores (size ~0.1 parsecs) inside molecular clouds collapse to form star-plus-disk systems[1]. But self-gravity's role at earlier times (and on larger length scales, such as ~1 parsec) is unclear; some molecular cloud simulations that do not include self-gravity suggest that 'turbulent fragmentation' alone is sufficient to create a mass distribution of dense cores that resembles, and sets, the stellar initial mass function[2]. Here we report a 'dendrogram' (hierarchical tree-diagram) analysis that reveals that self-gravity plays a significant role over the full range of possible scales traced by ^{13}CO observations in the L1448 molecular cloud, but not everywhere in the observed region. In particular, more than 90 per cent of the compact 'pre-stellar cores' traced by peaks of dust emission[3] are projected on the sky within one of the dendrogram's self-gravitating 'leaves'. As these peaks mark the loca-

overlapping features as an option, significant emission found between prominent clumps is typically either appended to the nearest clump or turned into a small, usually 'pathological', feature needed to encompass all the emission being modelled. When applied to molecular-line

Goodman et al. 2009, Nature, cf: Fluke et al. 2009

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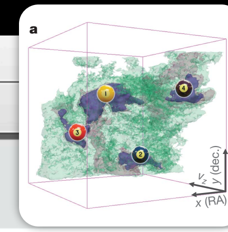

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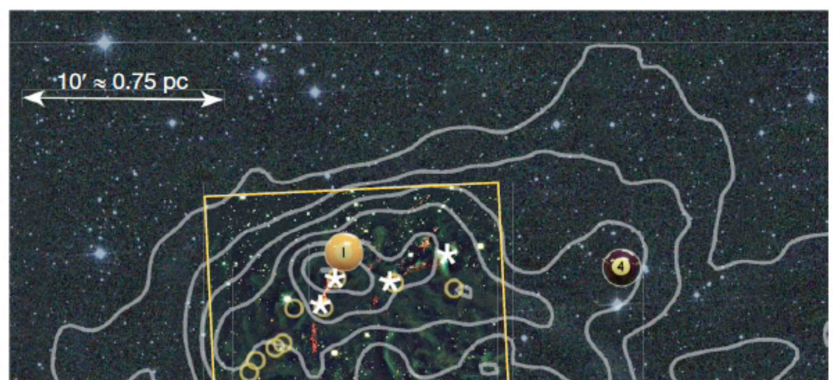

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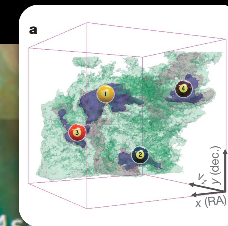
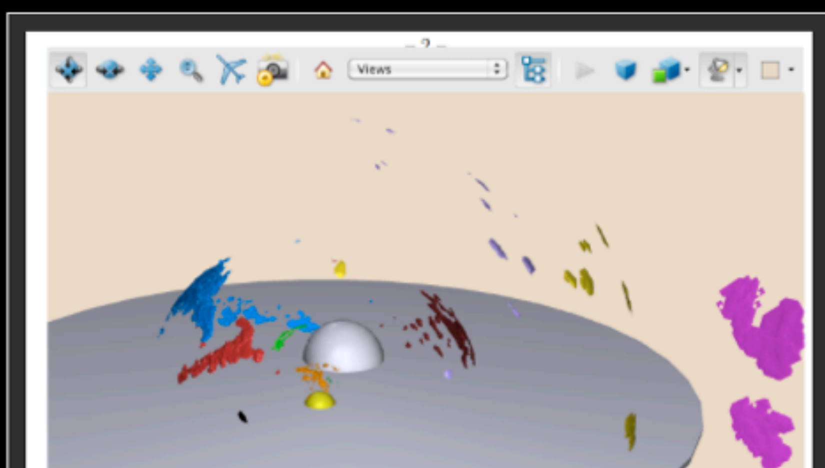


Tutorial for embedding 3D interactive graphics into PDF

by ***Guest*** *on* March 7, 2012

Josh Peek (@joshuaegpeek) is a Hubble Fellow at Columbia University, specializing in the ISM in and around disk galaxies. He has a fascination with data presentation and design.

As an astronomer studying the complex three-dimensional structures of the interstellar medium, I've been taken with the idea of presenting that information in a compelling and interactive way to readers. The major mode of communication for astronomers is the refereed journal article, as distributed through PDF, so I got interested in how one can package interactive 3D scenes with the papers we write. Interactive graphics can be embedded in PDFs that can be rotated, panned, and zoomed.



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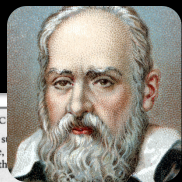

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JANUARY 1895

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PHOTOGRAPHS OF THE MILKY WAY.

By E. E. Barnard.

In my photographic survey of the Milky Way with the 6-inch Willard lens of this Observatory, I have come across many very remarkable regions. Some of these, besides being remarkable for showing the peculiar structure of the Milky Way, are singularly beautiful as simple pictures of the stars. I have selected two of these for illustration in The Astrophysical Journal.

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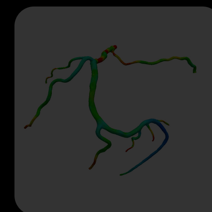

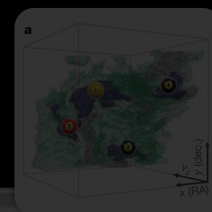

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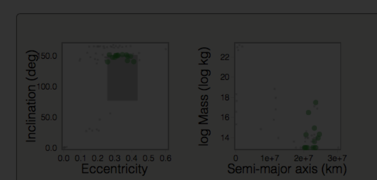
Josh Peek, Alberto Pepe, Adrian Price-Whelan, Chris Beaumont



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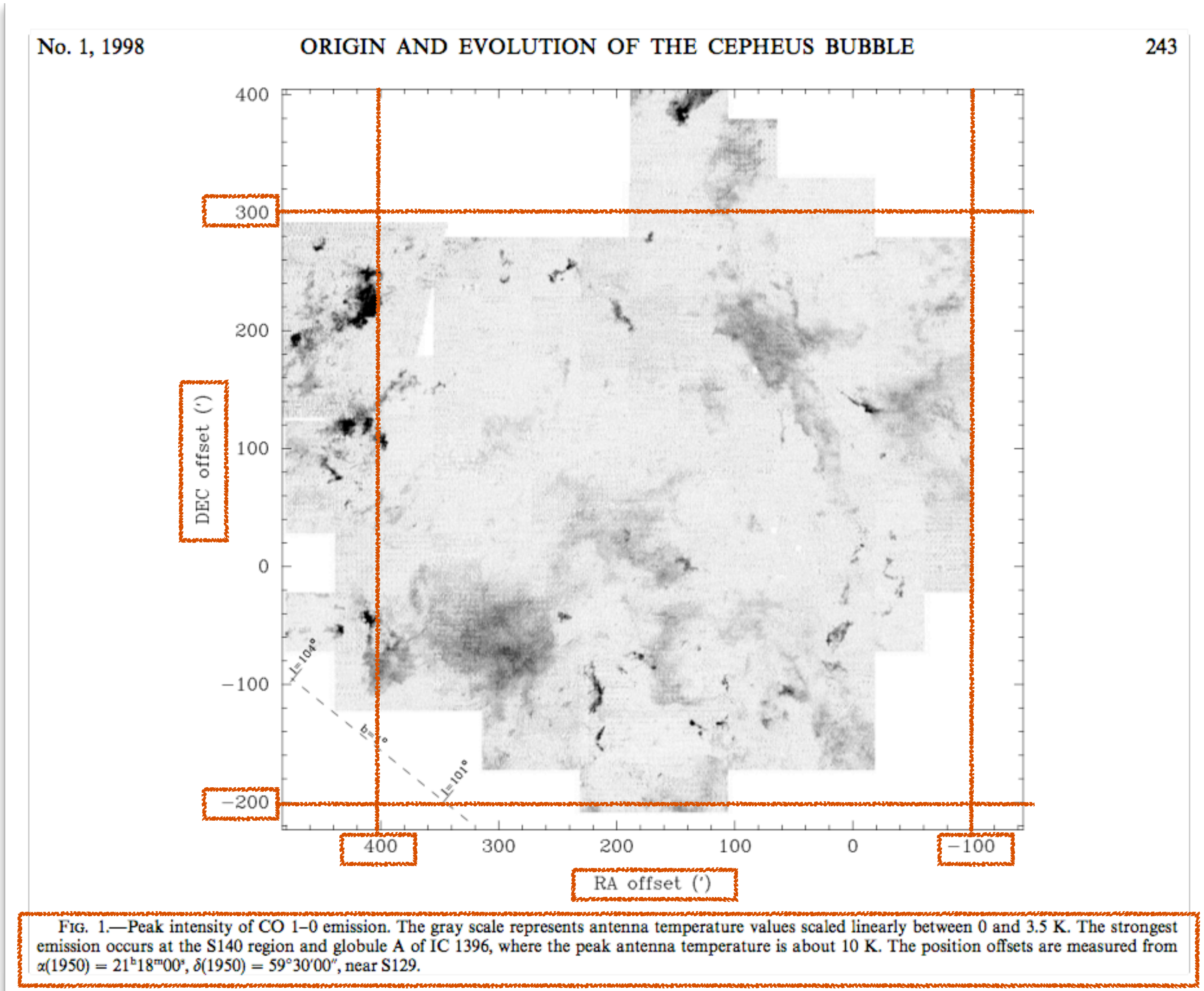
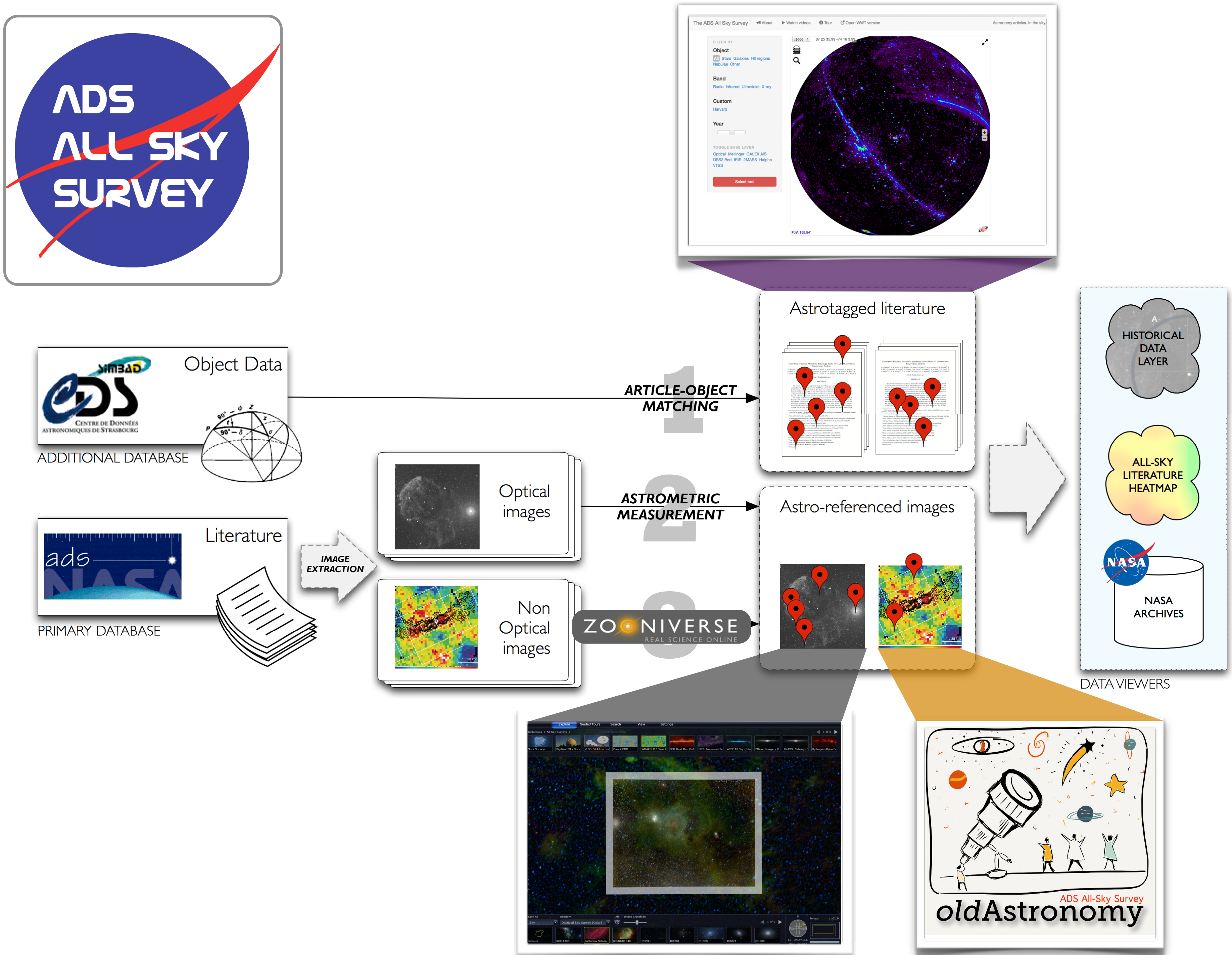


FIG. 1.—Peak intensity of CO 1–0 emission. The gray scale represents antenna temperature values scaled linearly between 0 and 3.5 K. The strongest emission occurs at the S140 region and globule A of IC 1396, where the peak antenna temperature is about 10 K. The position offsets are measured from α(1950) = 21ʰ18ᵐ00ˢ, δ(1950) = 59°30′00″, near S129.

Patel et al. 1998, page 243, Figure 1, with markup (orange) to be made by a citizen scientist using oldAstronomy tools.



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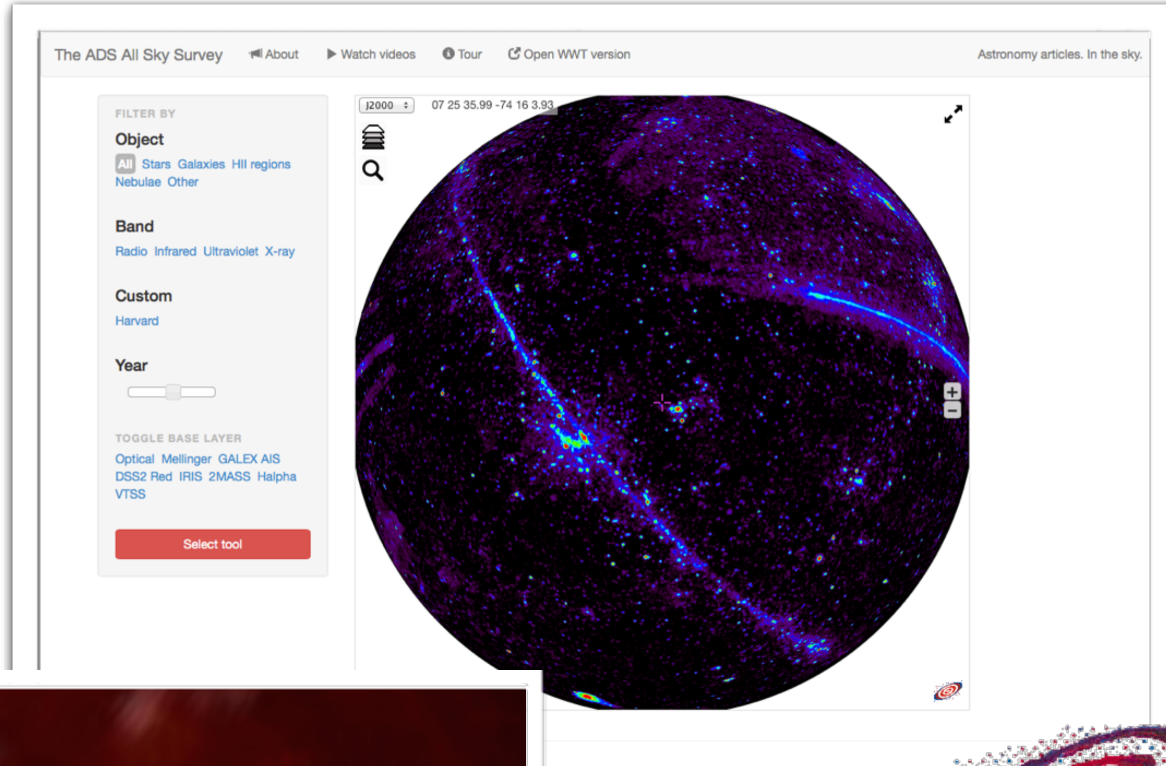

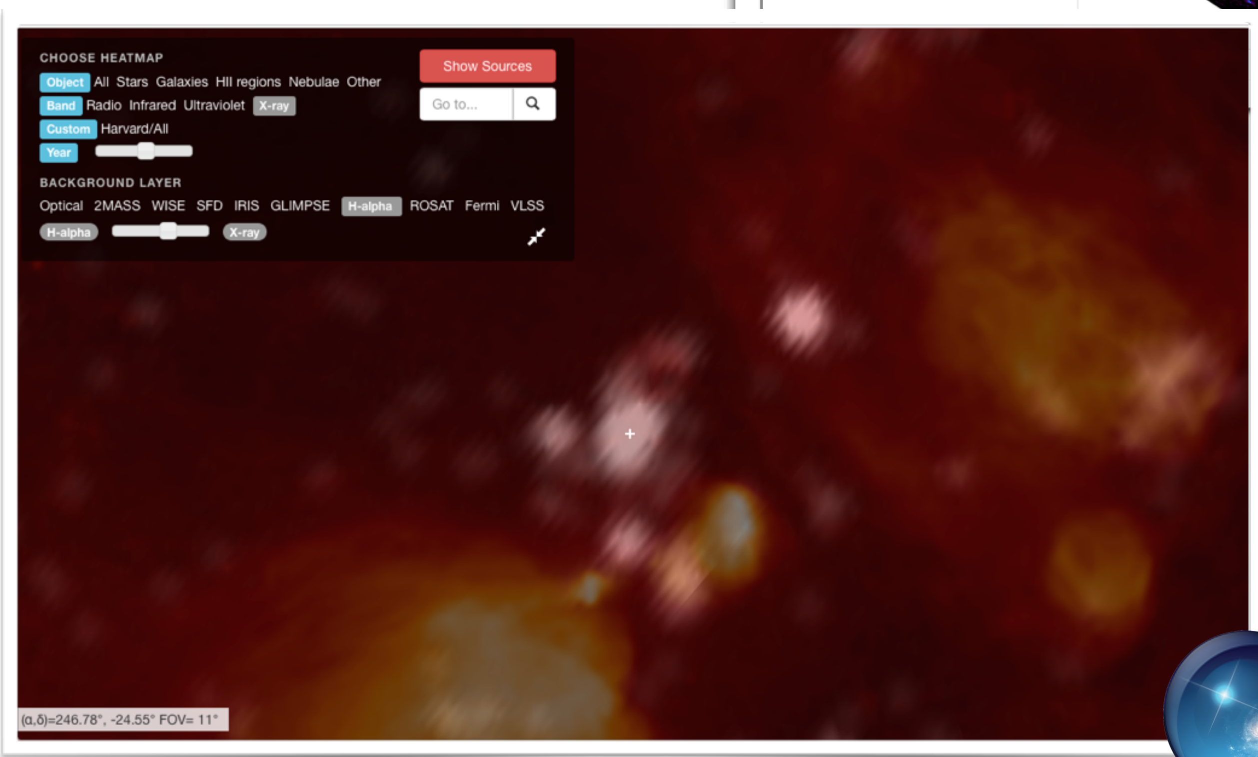

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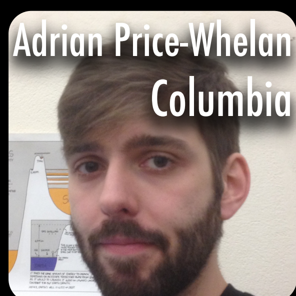

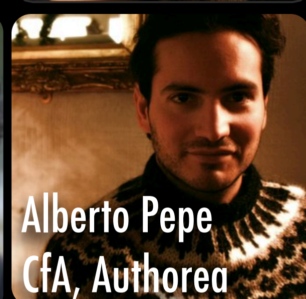

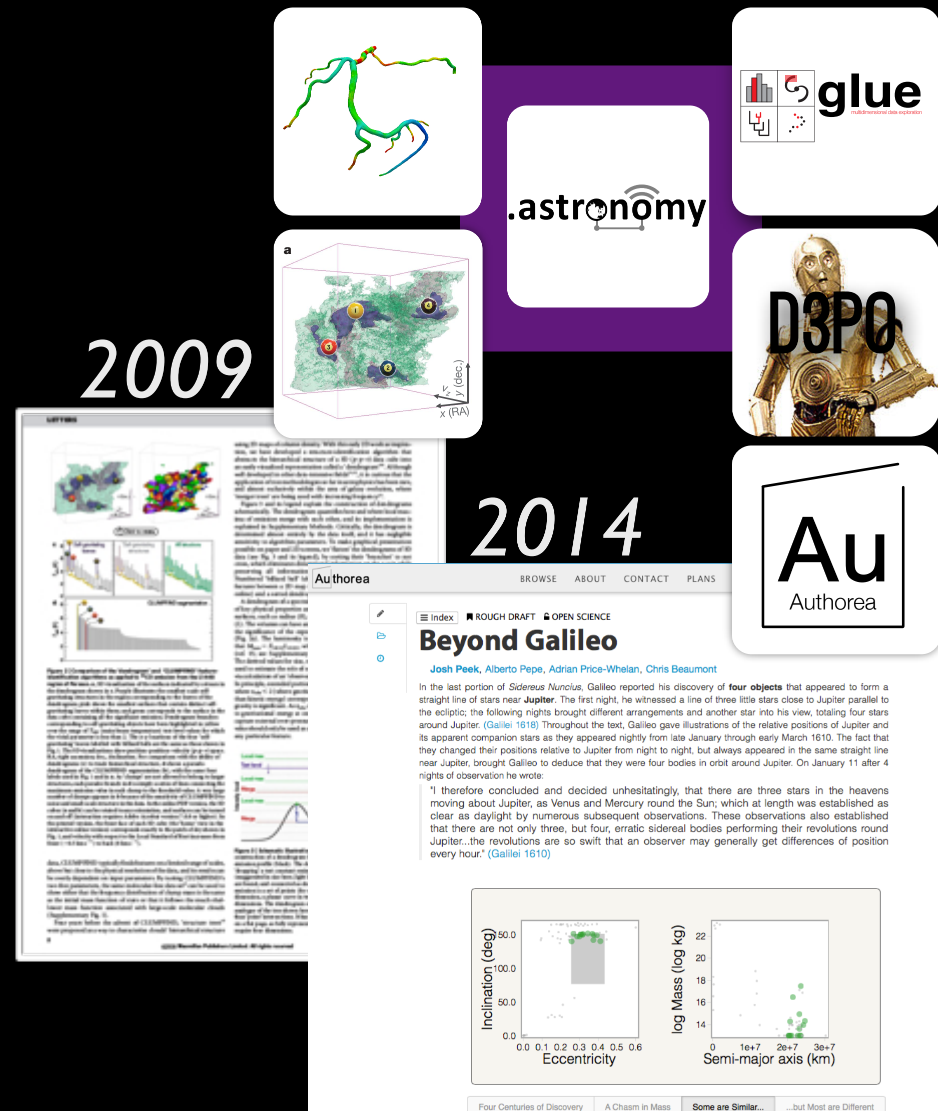

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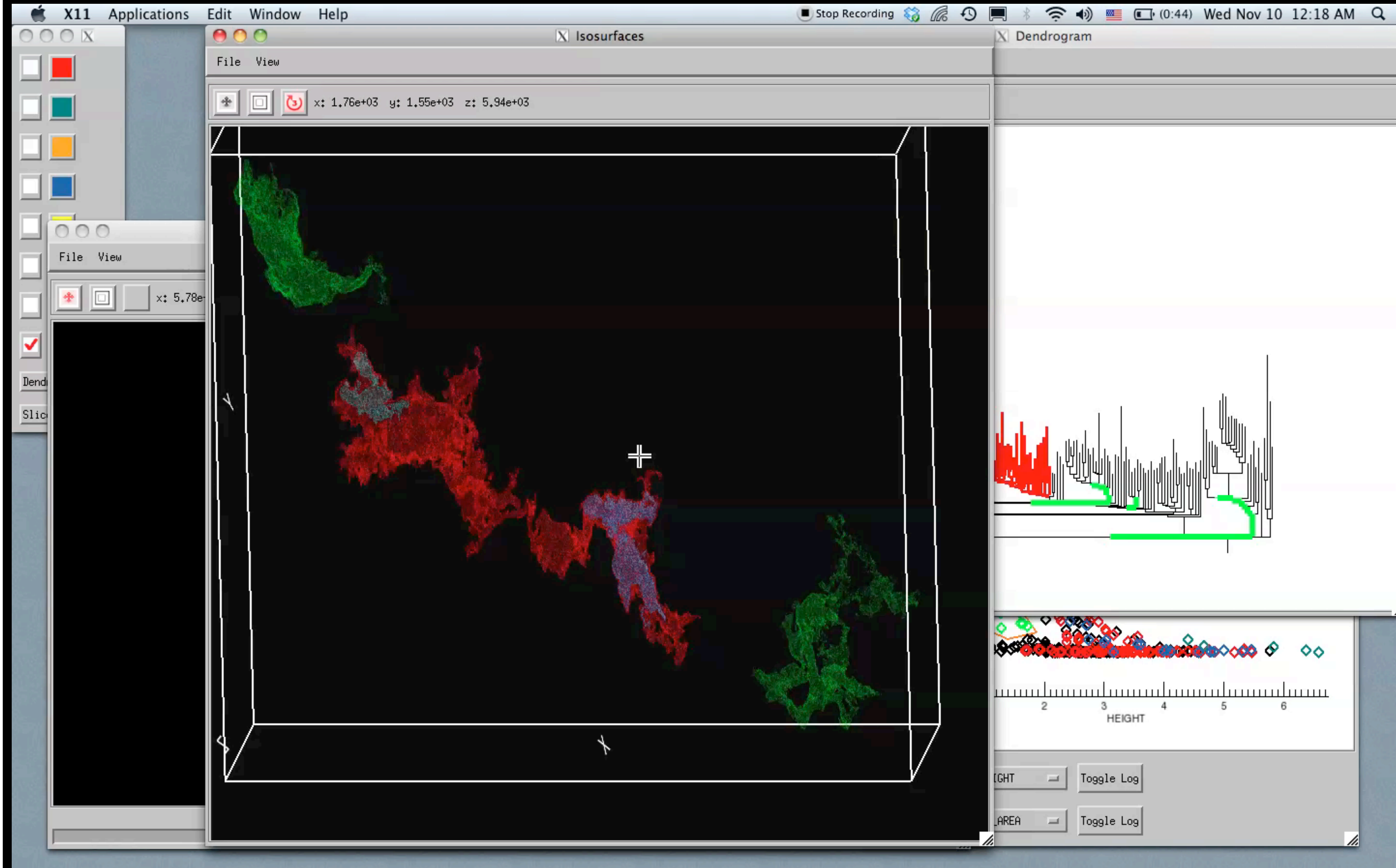

*Video & implementation: Christopher **Beaumont**, CfA;*
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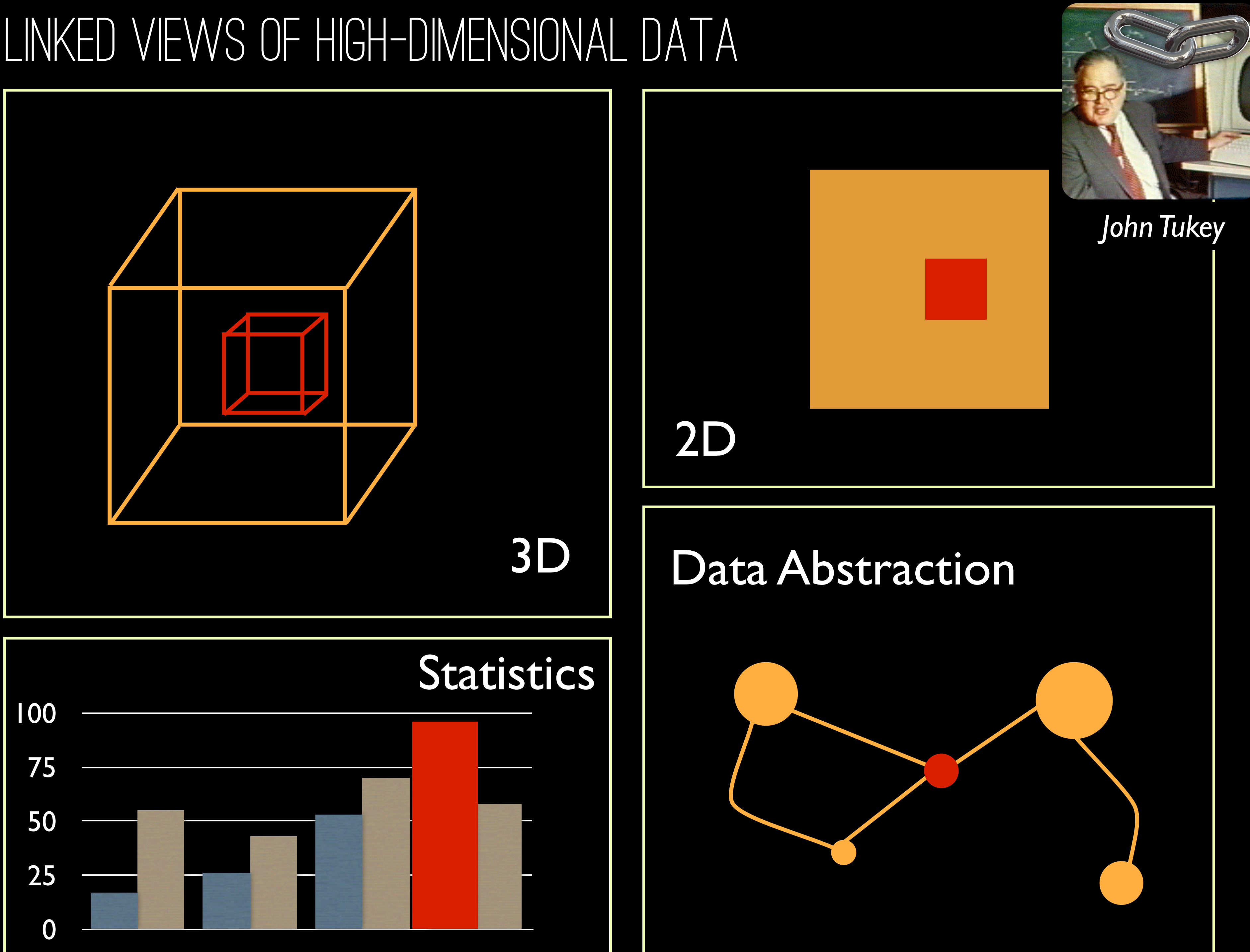

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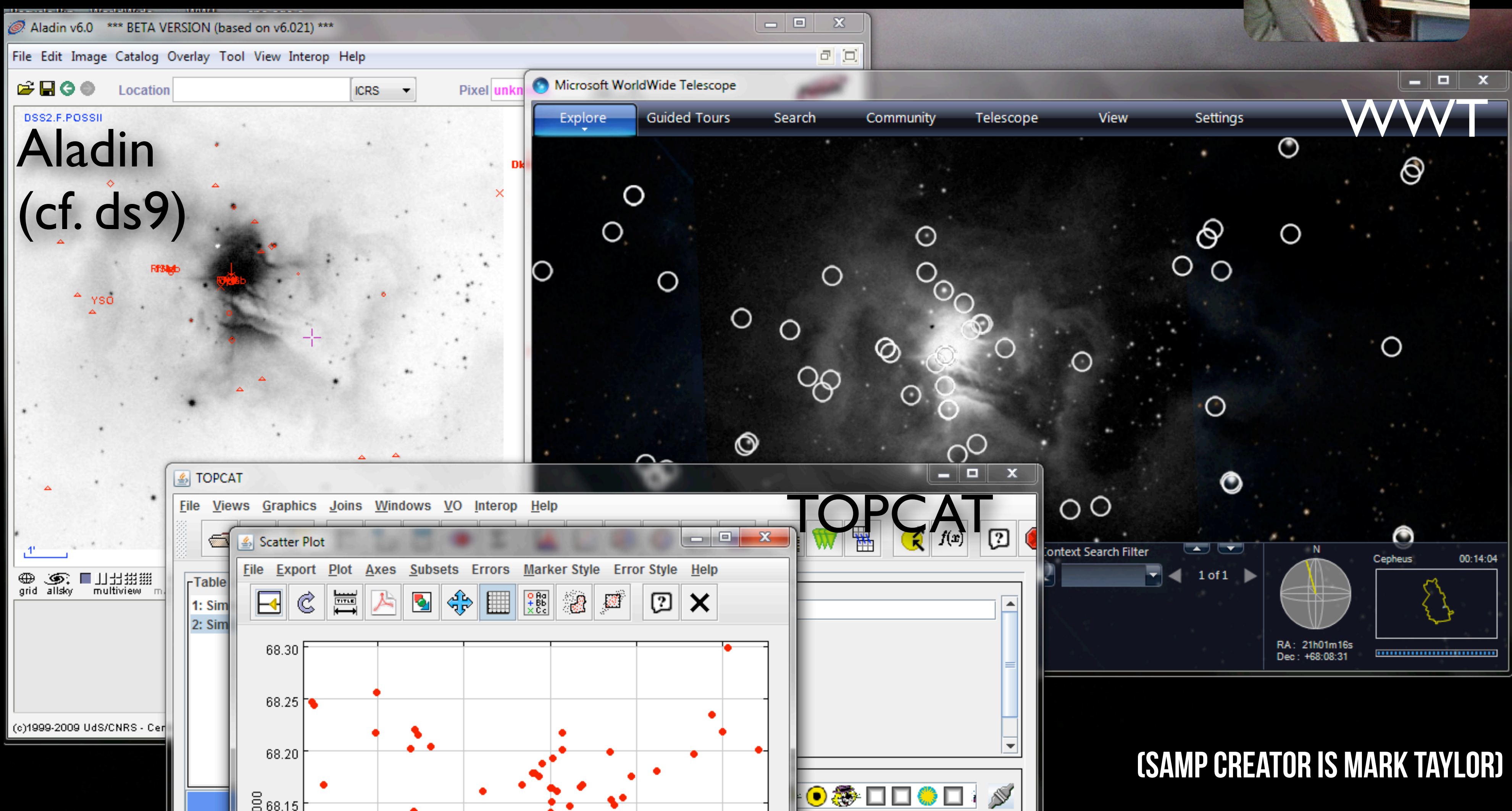

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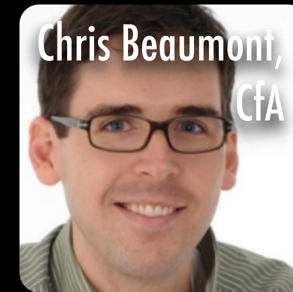

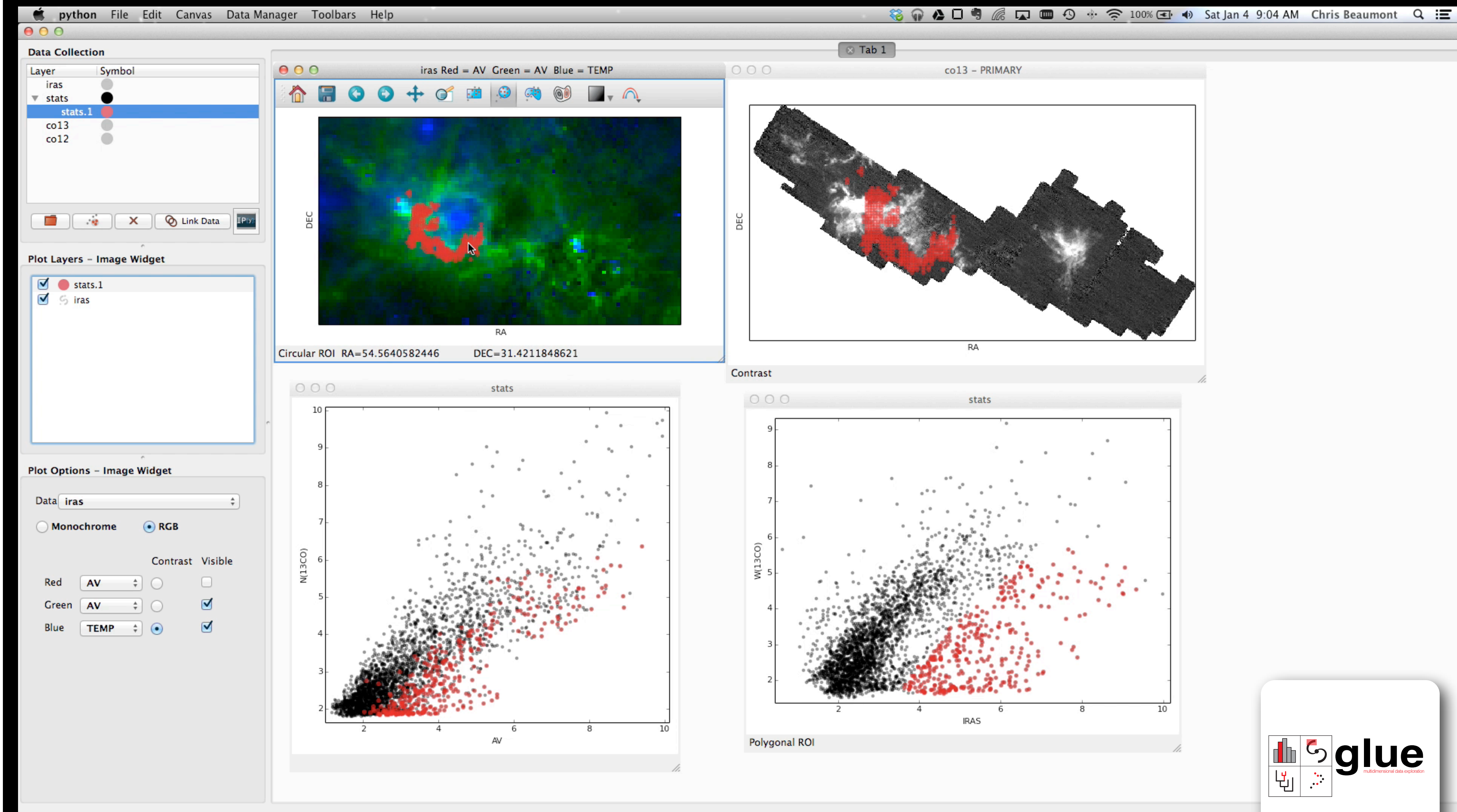

Beaumont, w/Goodman, Robitaille & Borkin

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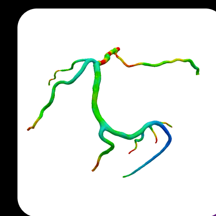

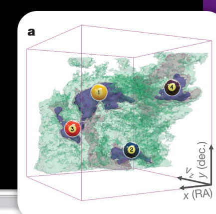

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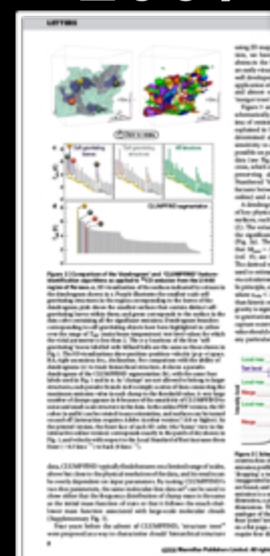

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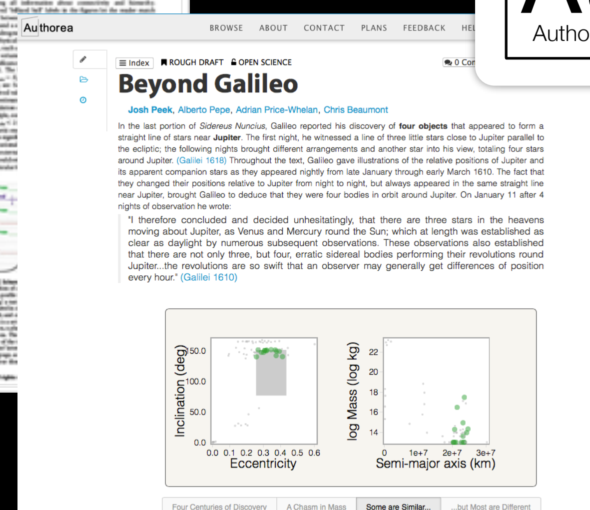
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Index ROUGH DRAFT OPEN SCIENCE

Beyond Galileo

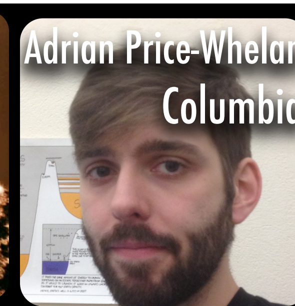
Josh Peek, Alberto Pepe, Adrian Price-Whelan, Chris Beaumont

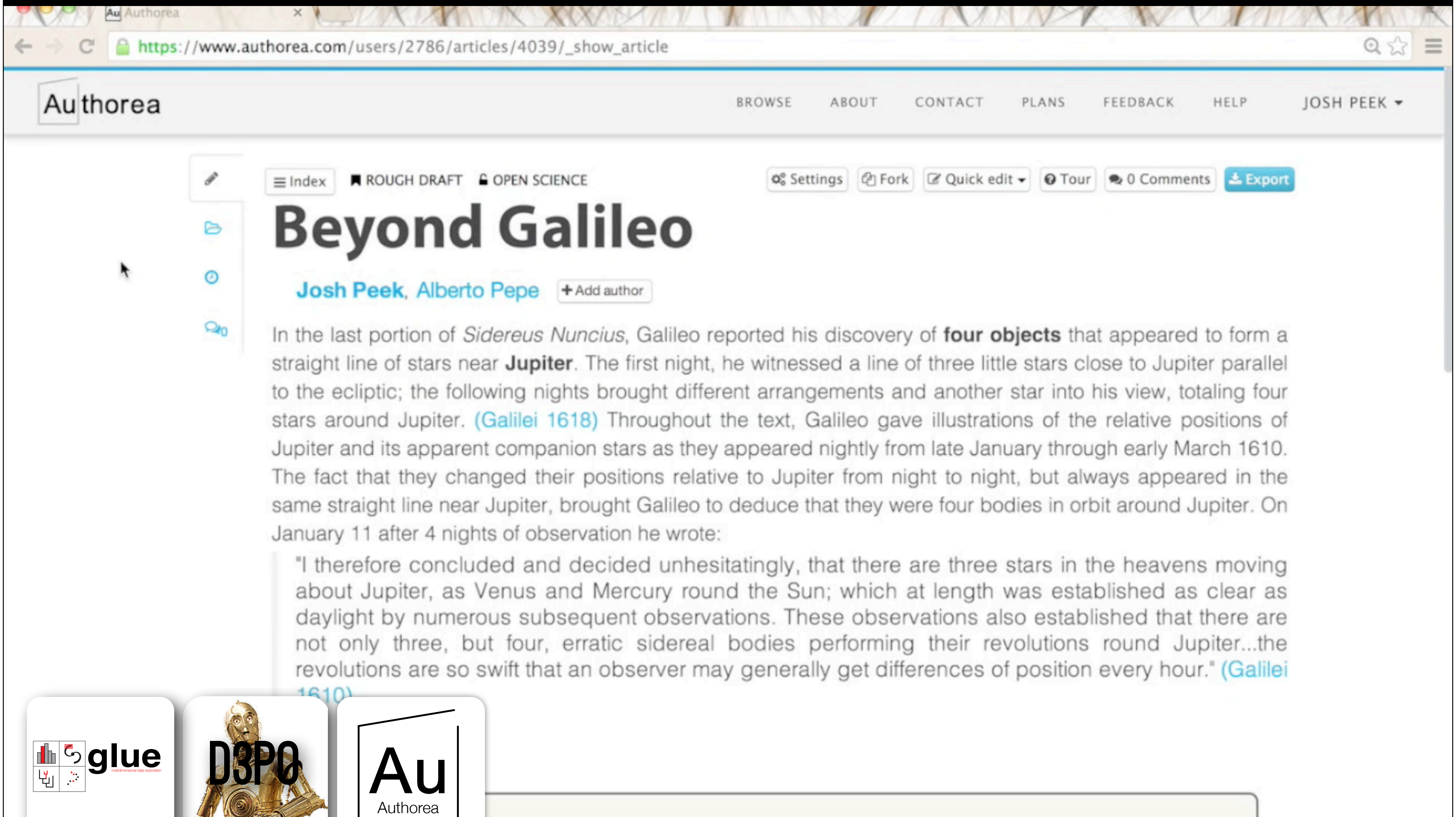
In the last portion of *Sidereus Nuncius*, Galileo reported his discovery of **four objects** that appeared to form a straight line of stars near **Jupiter**. The first night, he witnessed a line of three little stars close to Jupiter parallel to the ecliptic; the following nights brought different arrangements and another star into his view, totaling four stars around Jupiter. (Galilei 1618) Throughout the text, Galileo gave illustrations of the relative positions of Jupiter and its apparent companion stars as they appeared nightly from late January through early March 1610. The fact that they changed their positions relative to Jupiter from night to night, but always appeared in the same straight line near Jupiter, brought Galileo to deduce that they were four bodies in orbit around Jupiter. On January 11 after 4 nights of observation he wrote:

> "I therefore concluded and decided unhesitatingly, that there are three stars in the heavens moving about Jupiter, as Venus and Mercury round the Sun; which at length was established as clear as daylight by numerous subsequent observations. These observations also established that there are not only three, but four, erratic sidereal bodies performing their revolutions round Jupiter...the revolutions are so swift that an observer may generally get differences of position every hour." (Galilei 1610)

"THE STORY & THE SANDBOX"

(GLUE:D3PO:AUTHOREA)





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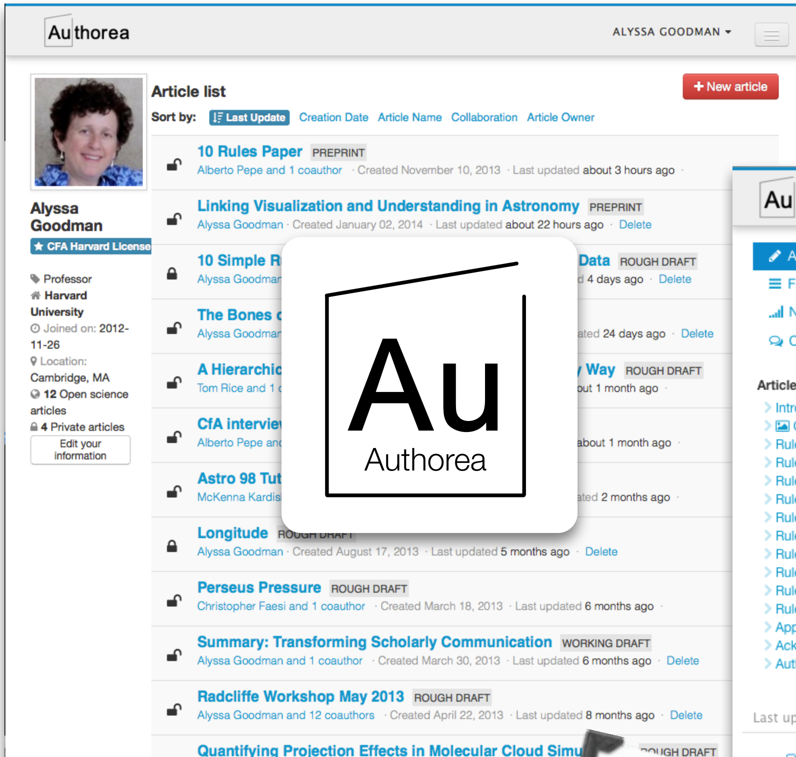
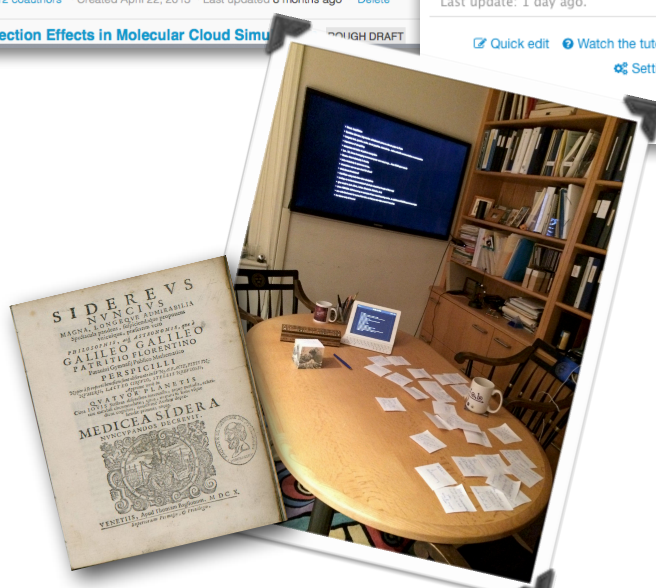
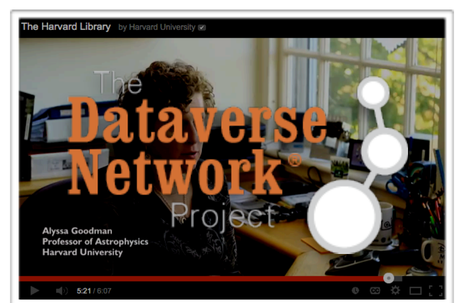


BUT WE DO NEED TO FIGURE OUT HOW NOT TO LOSE IT.





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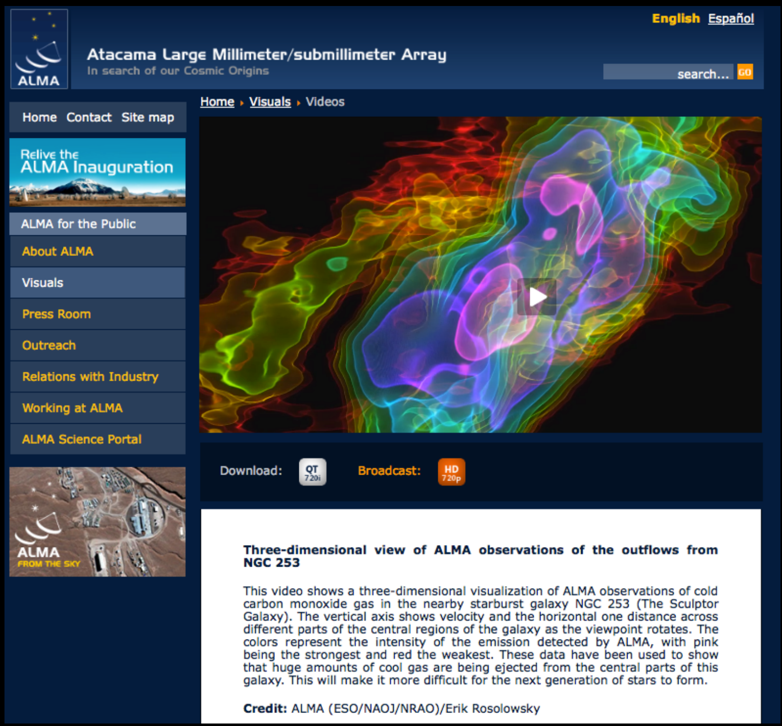
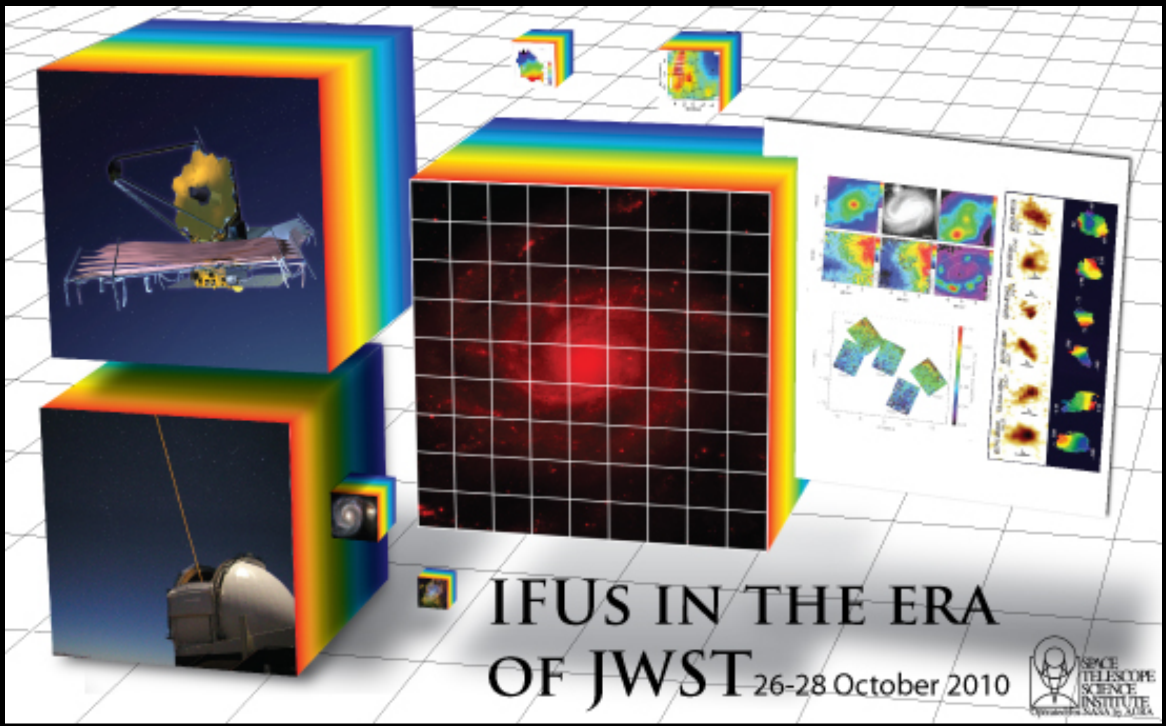
THE FUTURE IS IN 3D



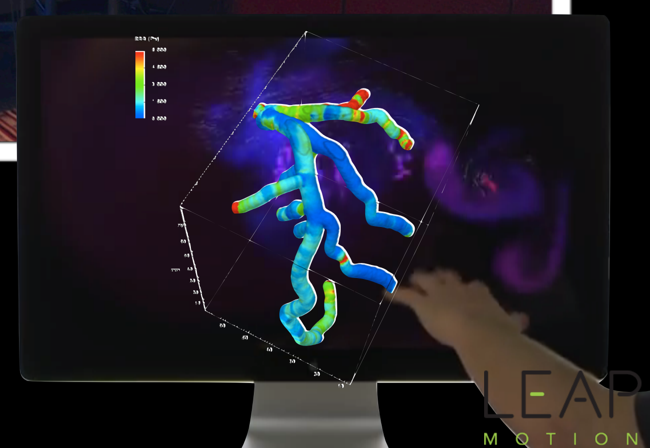


yt viz from ALMA data
(Turk, Rosolowsky)

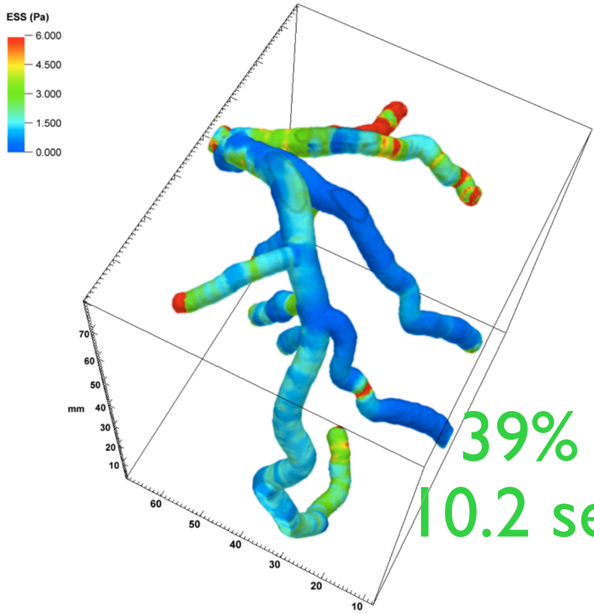
IFUs on JWST...with Glue!
(Beaumont et al., coming soon)

THE FUTURE IS MODULAR, OPEN-SOURCE, AND NOT (JUST) ON THE DESKTOP

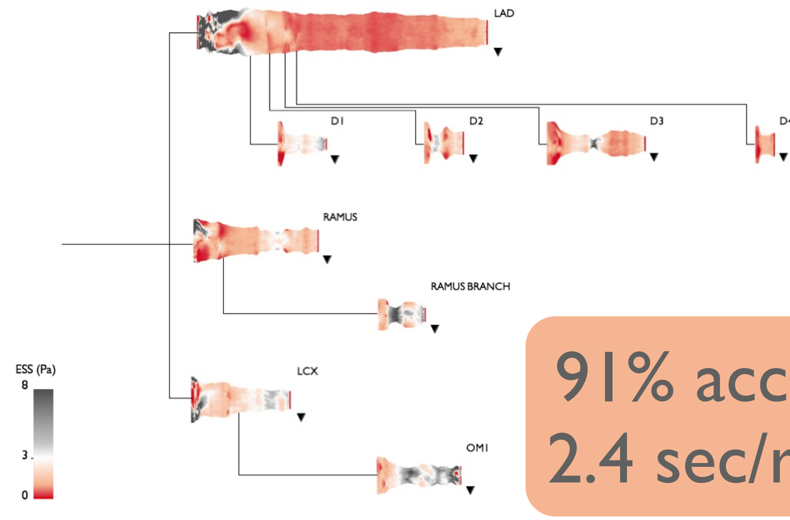
HACK TO THE FUTURE



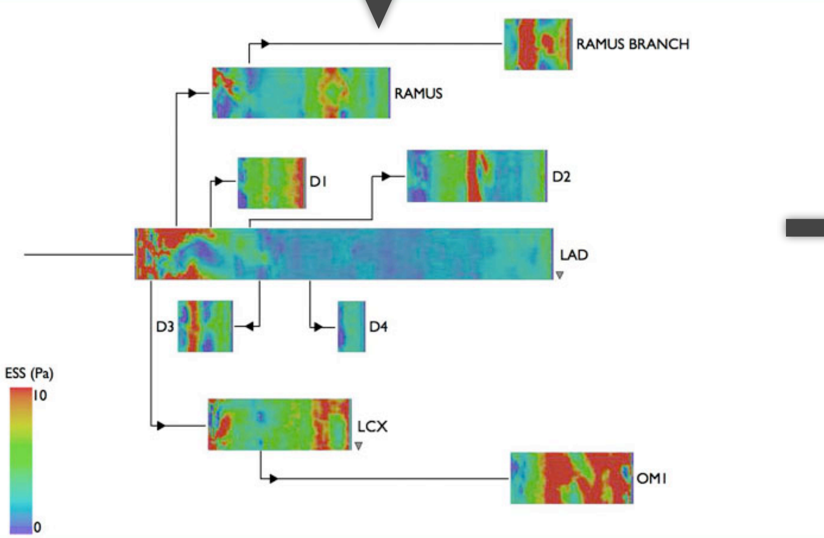
DIMENSIONALITY AND COLOR

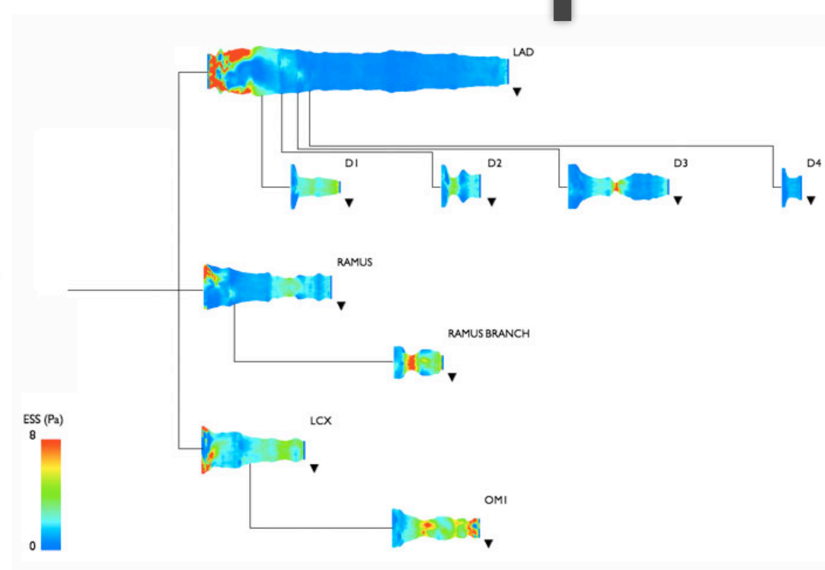


39% accurate
10.2 sec/region



91% accurate
2.4 sec/region

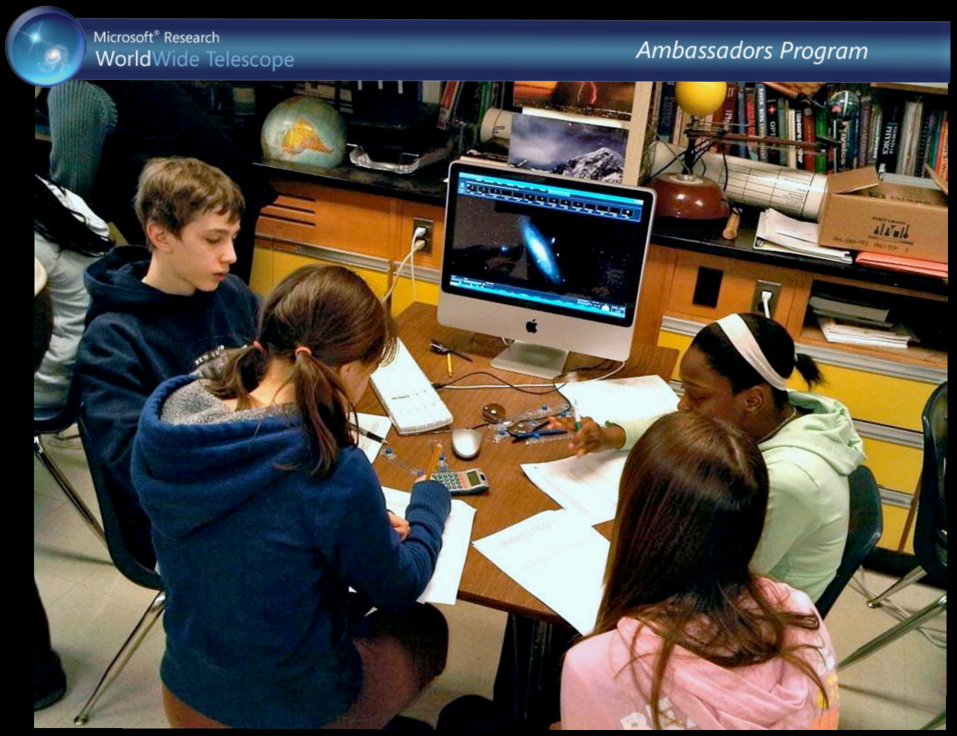




Borkin et al. 2011
cf. colorbrewer2.org

THE FUTURE OFFERS NEW WAYS TO LEARN

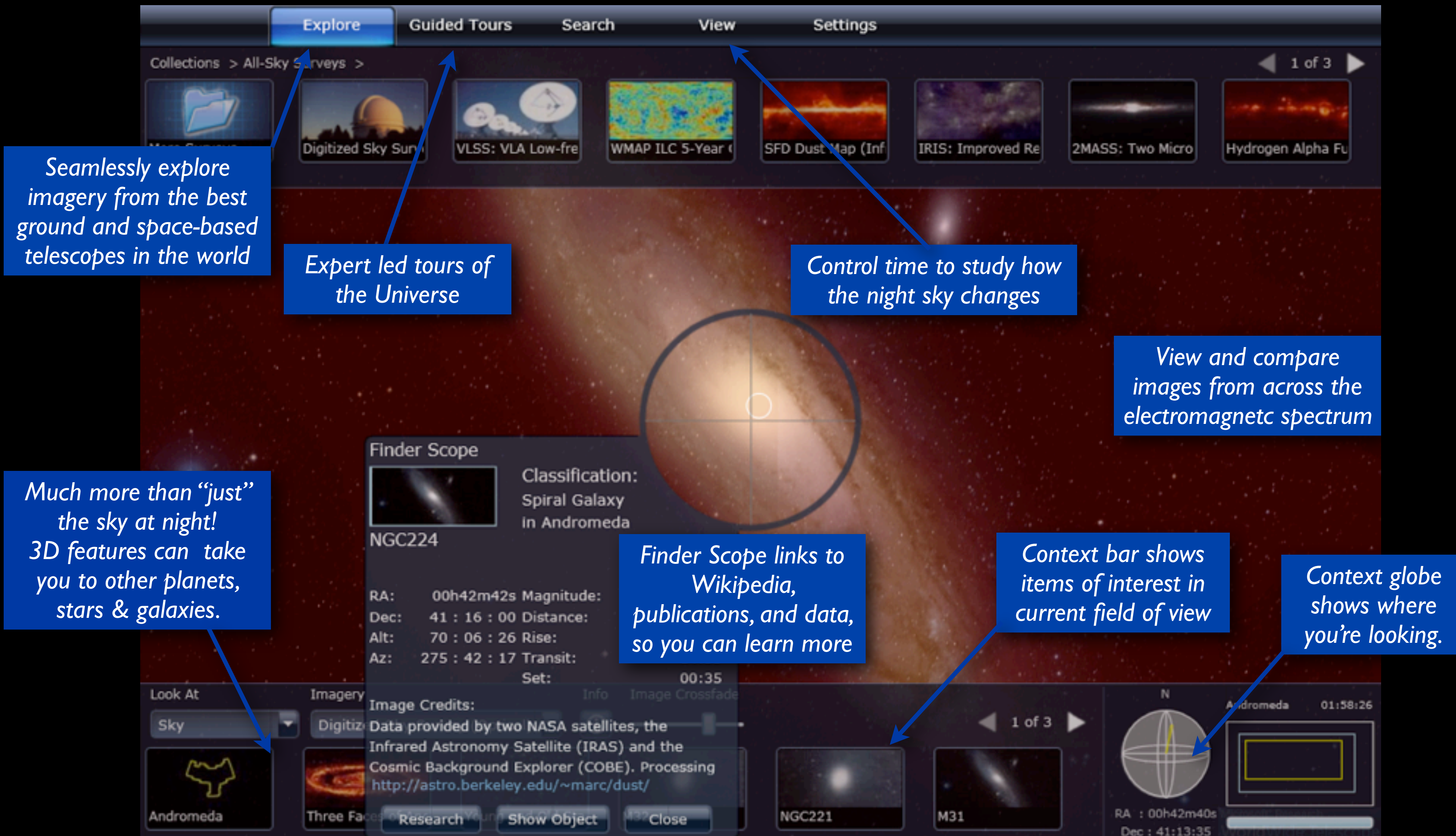
WorldWide Telescope Ambassadors



Higher Ed

Microsoft® Research
WorldWide Telescope

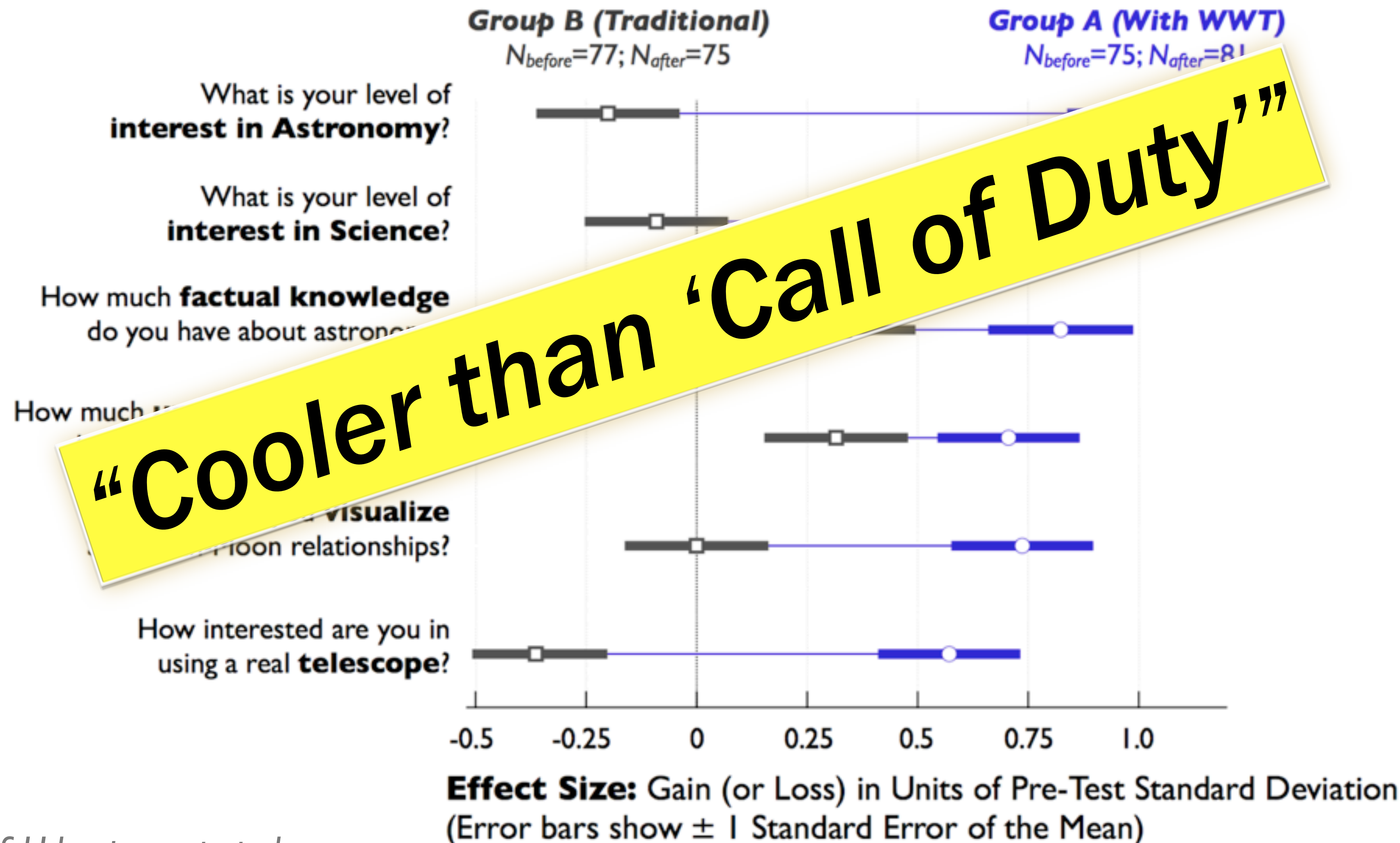
Experience WWT at **worldwidetelescope.org**



WWT created by Curtis Wong & Jonathan Fay

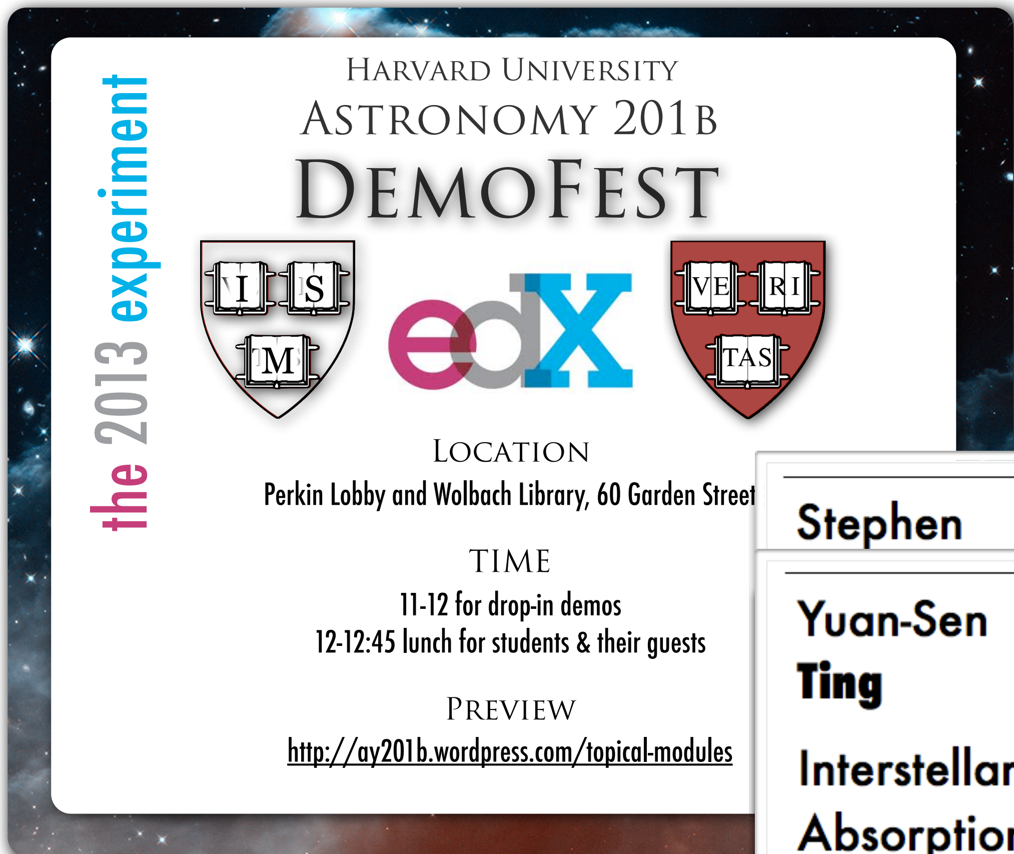
GAINS IN STUDENT INTEREST AND UNDERSTANDING

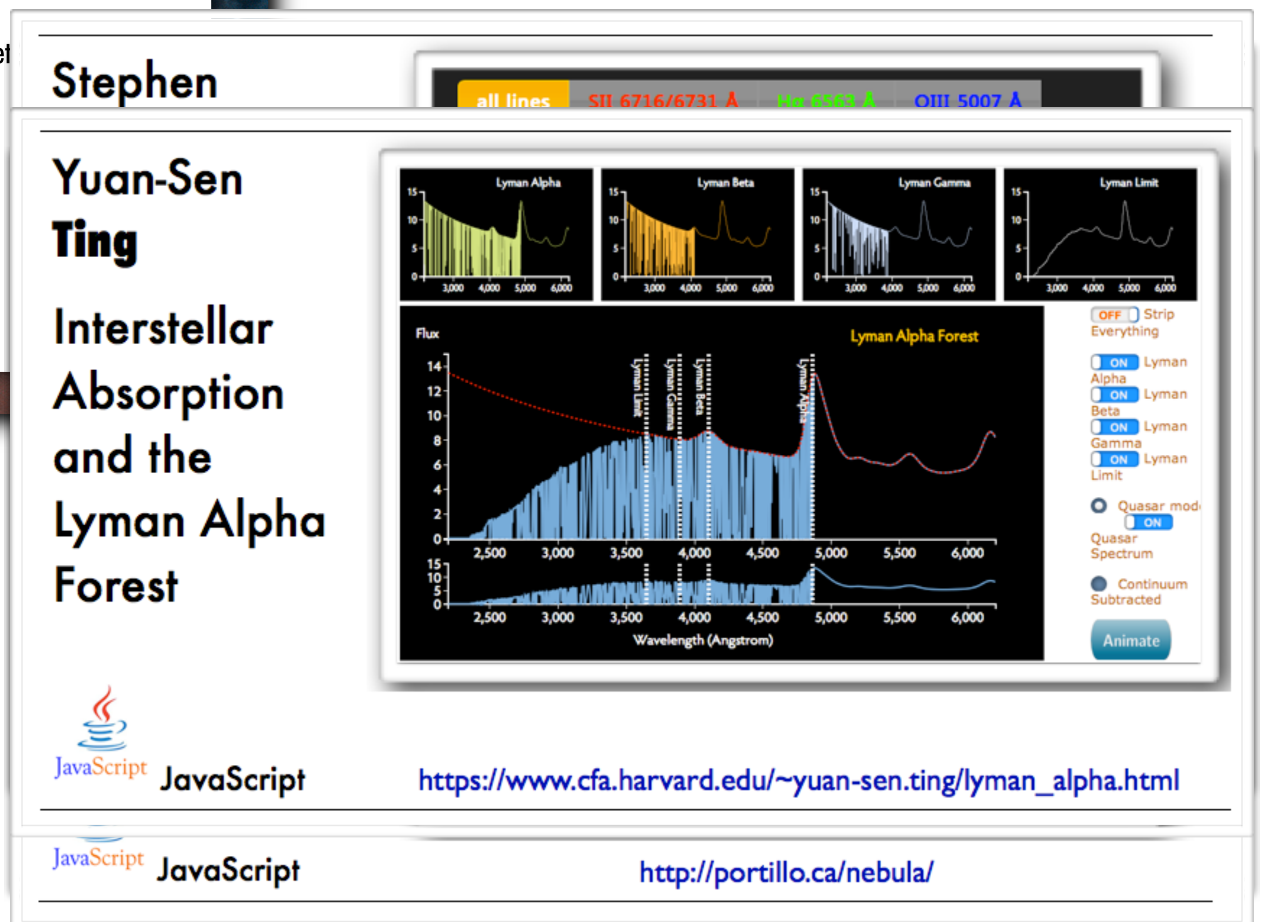
("Traditional Way" vs "WWT Way")



cf. Udomprasert et al.

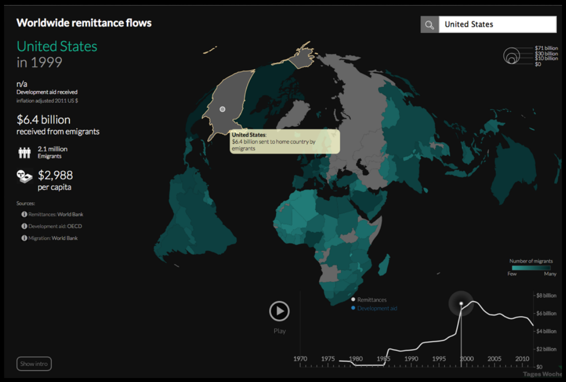
VIZ IN HIGHER-ED

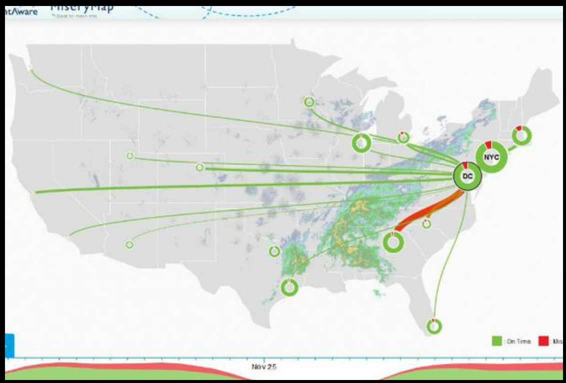


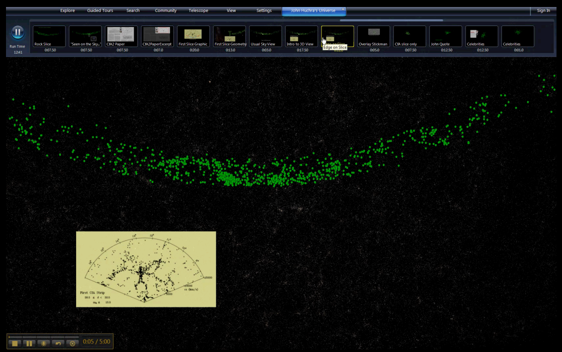


see: A New Approach to Developing Interactive Software Modules through Graduate Education, Sanders, Faesi & Goodman 2013

CHALLENGES







What can we afford?

What do we teach?

Is visualization, and computation more generally, the new “instrumentation”?

How do we value visualization specialists?

How much customization?

Will tools be preserved?

How much organization (orchestration) is too much?

LINKING VISUALIZATION & UNDERSTANDING IN ASTRONOMY

[redacted]

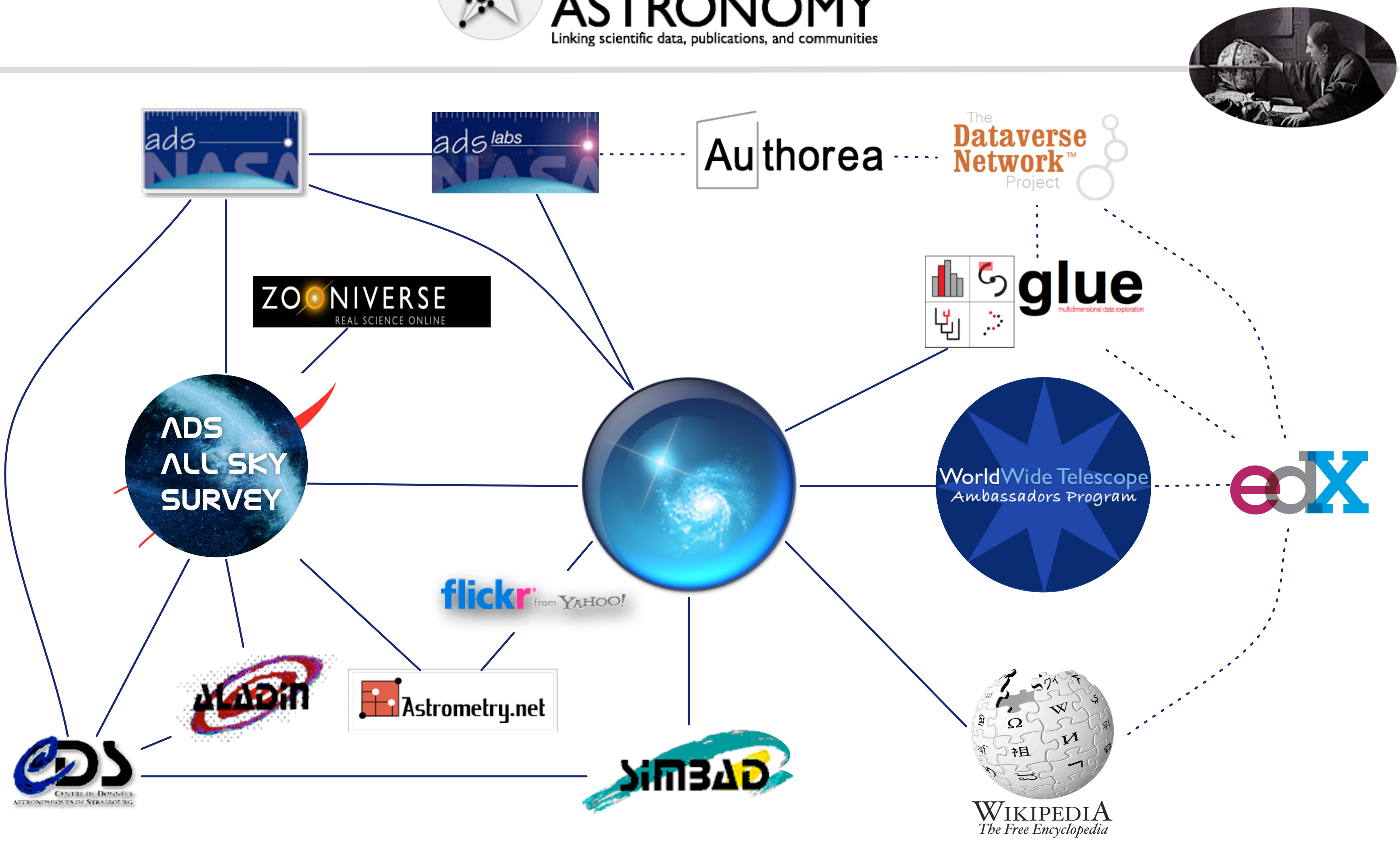
extra slides (not shown)

LINKING VISUALIZATION & UNDERSTANDING IN ASTRONOMY

ALYSSA A. GOODMAN
HARVARD-SMITHSONIAN
CENTER FOR ASTROPHYSICS

SEAMLESS ASTRONOMY

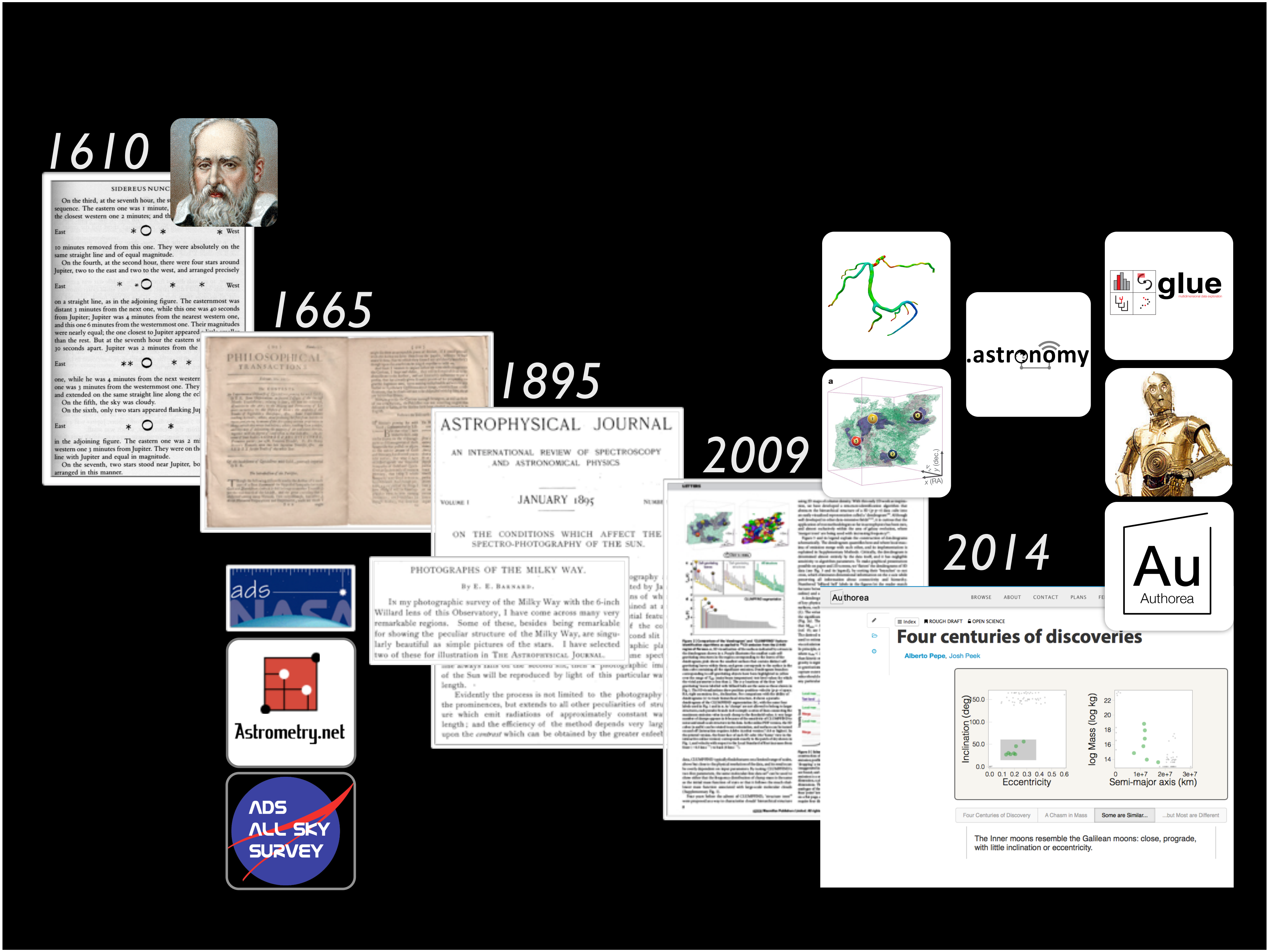
Linking scientific data, publications, and communities



https://www.cfa.harvard.edu/~agoodman/seamless/

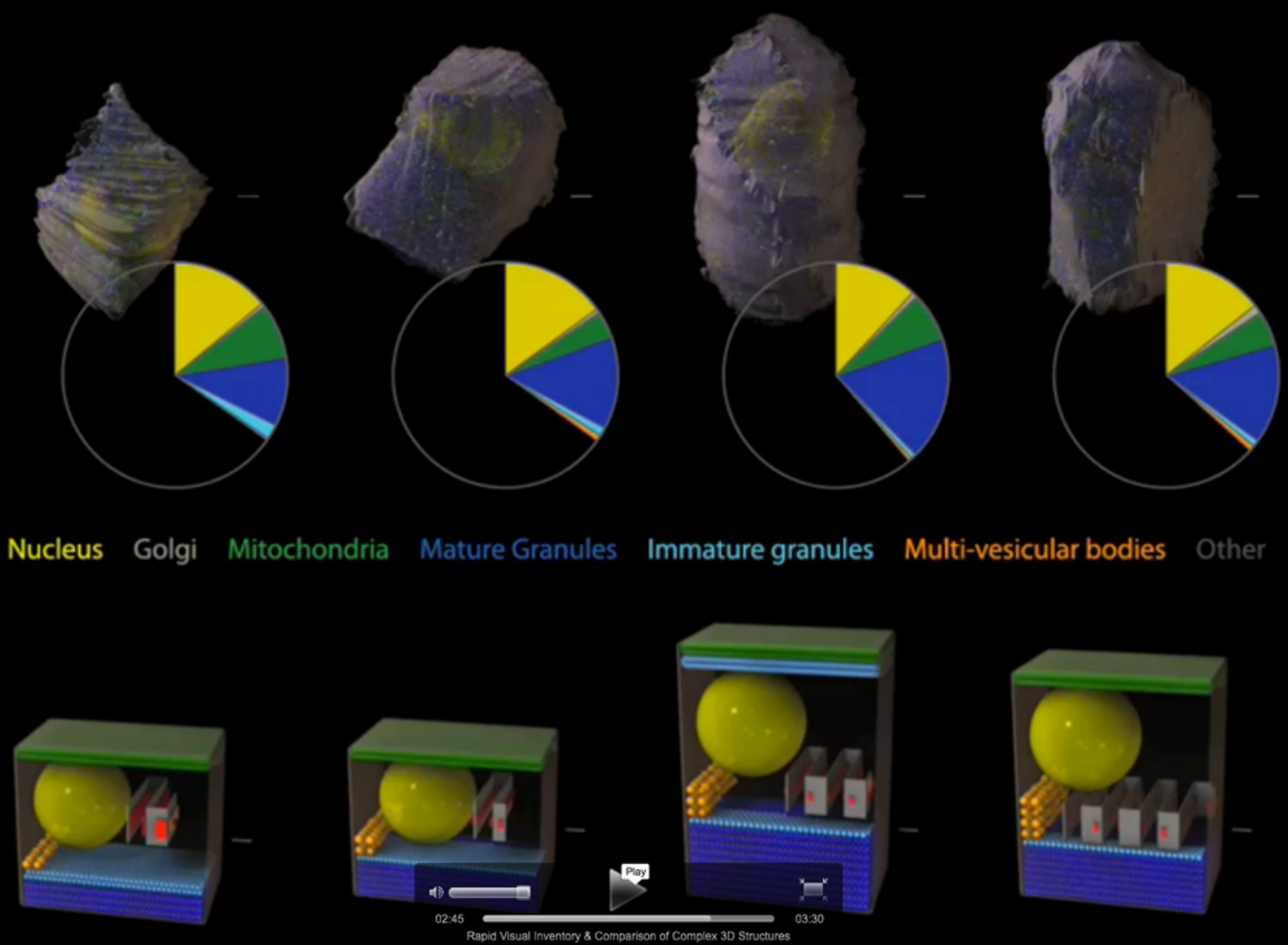
Supported by Microsoft Research, NSF, NASA, Smithsonian

Made possible by MANY collaborators, listed at projects.iq.harvard.edu/seamlessastronomy



1610
SIDEREUS NUNC
1665
PHILOSOPHICAL TRANSACTIONS
1895
ASTROPHYSICAL JOURNAL
AN INTERNATIONAL REVIEW OF SPECTROSCOPY AND ASTRONOMICAL PHYSICS
JANUARY 1895
ON THE CONDITIONS WHICH AFFECT THE SPECTRO-PHOTOGRAPHY OF THE SUN.
PHOTOGRAPHS OF THE MILKY WAY.
By E. E. Barnard.
2009
2014
ads NASA
Astrometry.net
ADS ALL SKY SURVEY
.astronomy
glue
Au Authorea
Authorea
Four centuries of discoveries
Alberto Pepe, Josh Peek
Inclination (deg)
Eccentricity
log Mass (log kg)
Semi-major axis (km)
Four Centuries of Discovery
A Chasm in Mass
Some are Similar...
...but Most are Different
The Inner moons resemble the Galilean moons: close, prograde, with little inclination or eccentricity.

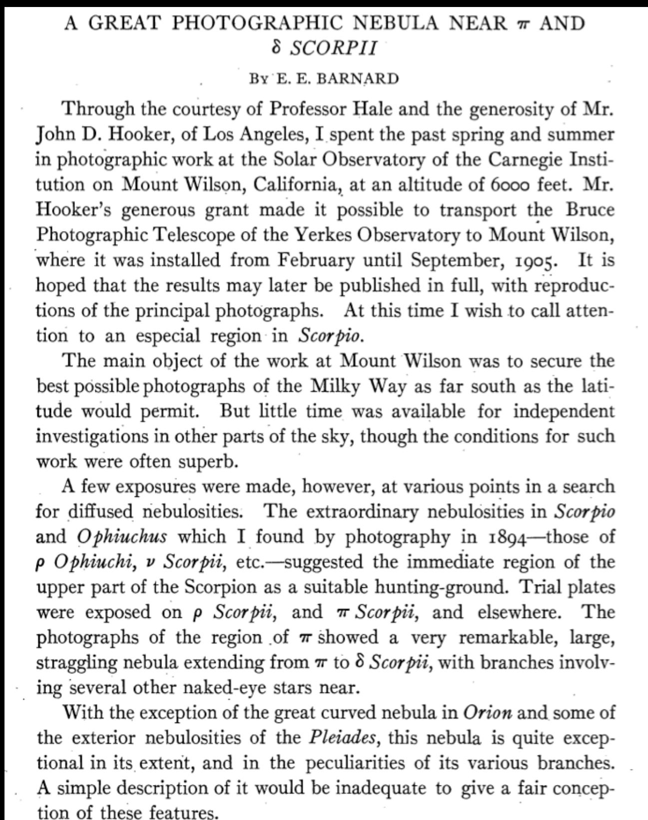
MEANINGFUL ABSTRACTION IS OFTEN BETTER THAN REALISM.



G. Johnson et al. 2011: http://video.sciencemag.org/VideoLab/1423692130001/1

A great photographic nebula near pi and delta Scorpii.

Barnard, E. E.
Astrophysical Journal, 23, 144-147 (1906)
Published in Mar 1906
DOI: 10.1086/141311



A GREAT PHOTOGRAPHIC NEBULA NEAR π AND δ *SCORPII*

BY E. E. BARNARD

Through the courtesy of Professor Hale and the generosity of Mr. John D. Hooker, of Los Angeles, I spent the past spring and summer in photographic work at the Solar Observatory of the Carnegie Institution on Mount Wilson, California, at an altitude of 6000 feet. Mr. Hooker's generous grant made it possible to transport the Bruce Photographic Telescope of the Yerkes Observatory to Mount Wilson, where it was installed from February until September, 1905. It is hoped that the results may later be published in full, with reproductions of the principal photographs. At this time I wish to call attention to an especial region in *Scorpio*.

The main object of the work at Mount Wilson was to secure the best possible photographs of the Milky Way as far south as the latitude would permit. But little time was available for independent investigations in other parts of the sky, though the conditions for such work were often superb.

A few exposures were made, however, at various points in a search for diffused nebulosities. The extraordinary nebulosities in *Scorpio* and *Ophiuchus* which I found by photography in 1894—those of ρ *Ophiuchi*, ν *Scorpii*, etc.—suggested the immediate region of the upper part of the Scorpion as a suitable hunting-ground. Trial plates were exposed on ρ *Scorpii*, and π *Scorpii*, and elsewhere. The photographs of the region of π showed a very remarkable, large, straggling nebula extending from π to δ *Scorpii*, with branches involving several other naked-eye stars near.

With the exception of the great curved nebula in *Orion* and some of the exterior nebulosities of the *Pleiades*, this nebula is quite exceptional in its extent, and in the peculiarities of its various branches. A simple description of it would be inadequate to give a fair conception of these features.

http://www.worldwidetelescope.org/webclient/default.aspx?wtml=http%3a%2f%2fwww.worldwidetelescope.org%2fwwtweb%2fShowImage.aspx%3freverseparity%3dTrue%26scale%3d13.4575%26name%3d1906ApJ....23
%2b(Page%3a%2b2%3b%2bImage%3a%2b1)%26imageurl%3dhttp%3a%2f%2fwww.adsass.org%2foldastro%2fdata%2f1906ApJ....23..144B-002-001.png%26credits%3dADS%2bAll%2bSky%2bSurvey%26creditsUrl%3dhttp%
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