



[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

FILTER BY

Object

All Stars Galaxies HII regions
Nebulae Other

Band

Radio Infrared Ultraviolet X-ray

Custom

Harvard

Year

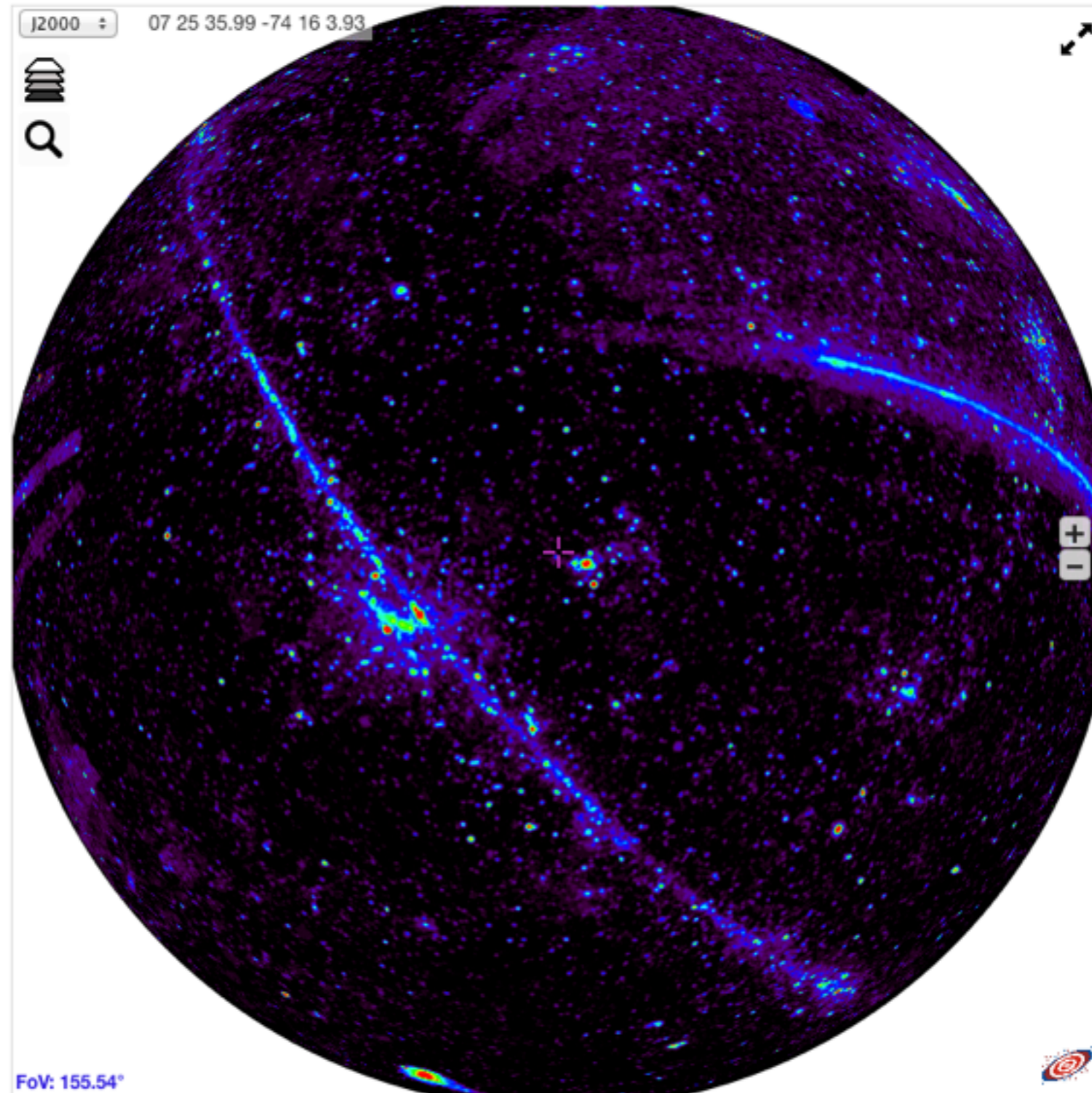


TOGGLE BASE LAYER

Optical Mellinger GALEX AIS
DSS2 Red IRIS 2MASS Halpha
VTSS

Select tool

J2000 07 25 35.99 -74 16 3.93



FoV: 155.54°



let's zoom in (on 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

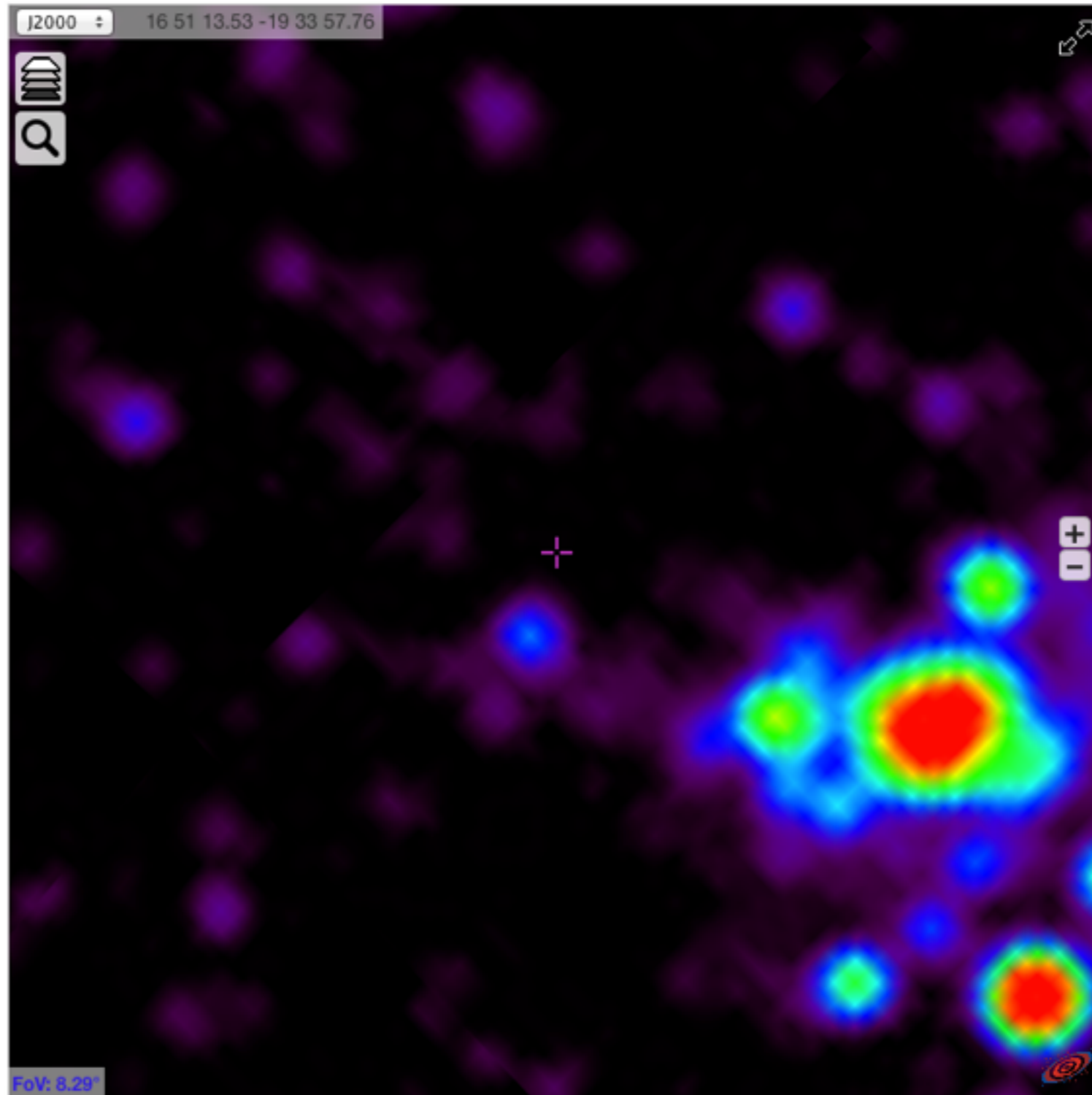
Year



TOGGLE BASE LAYER

Optical Mellinger GALEX AIS
DSS2 Red IRIS 2MASS Halpha
VTSS

Select tool



now, let's toggle on the "Mellinger" view of the Sky ...to see a nice optical image of Ophiuchus

The ADS All Sky Survey

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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 XMMSS Halpha
VTSS

Select tool



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

FILTER BY

Object

All Stars Galaxies HII regions
Nebulae Other

Band

Radio Infrared Ultraviolet X-ray

Custom

Harvard

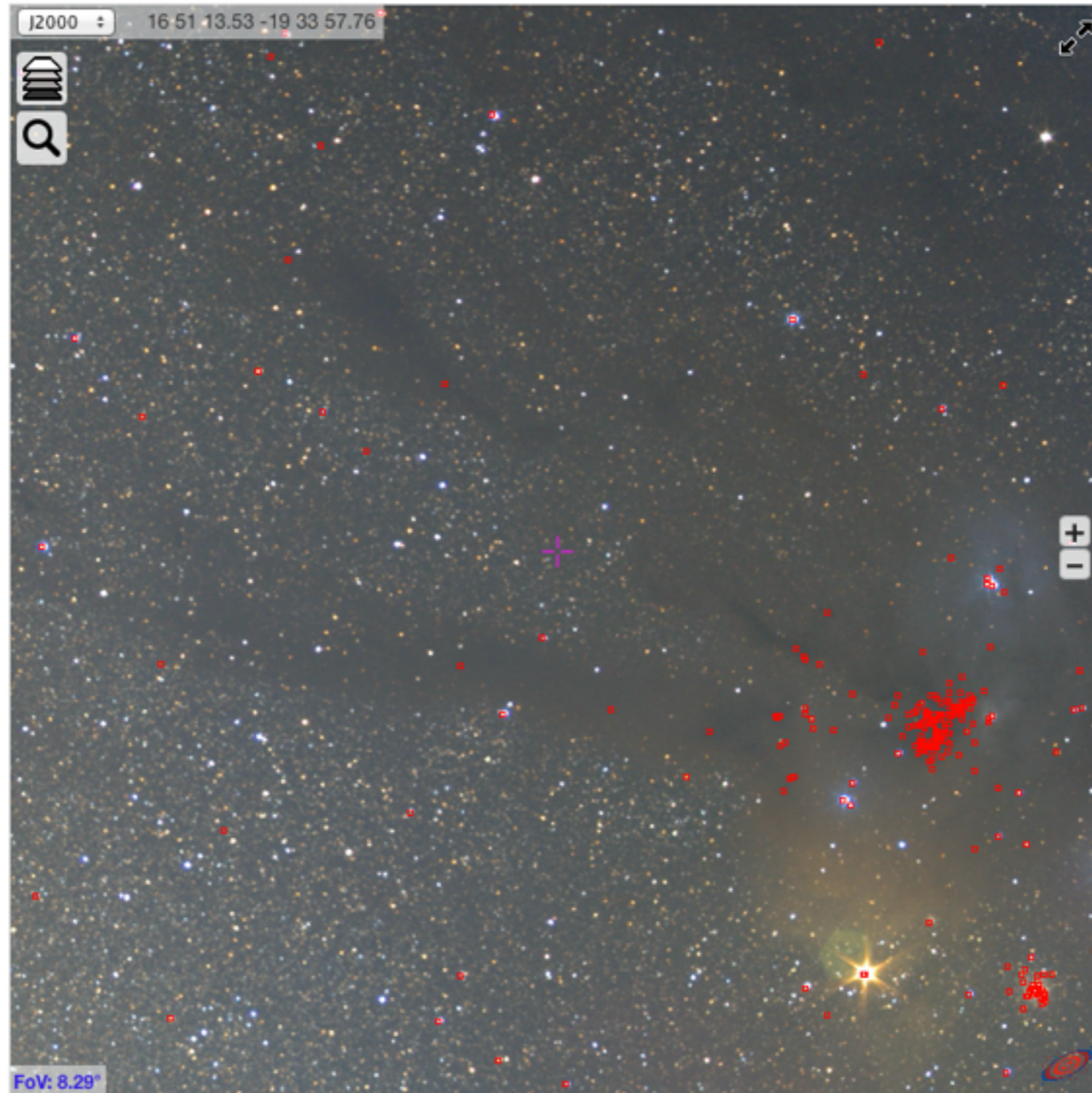
Year



TOGGLE BASE LAYER

Optical **Mellinger** GALEX AIS
DSS2 Red IRIS ZMASS Halpha
VTSS

Select tool



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

FILTER BY

Object

All Stars Galaxies HII regions
Nebulae Other

Band

Radio Infrared Ultraviolet X-ray

Custom

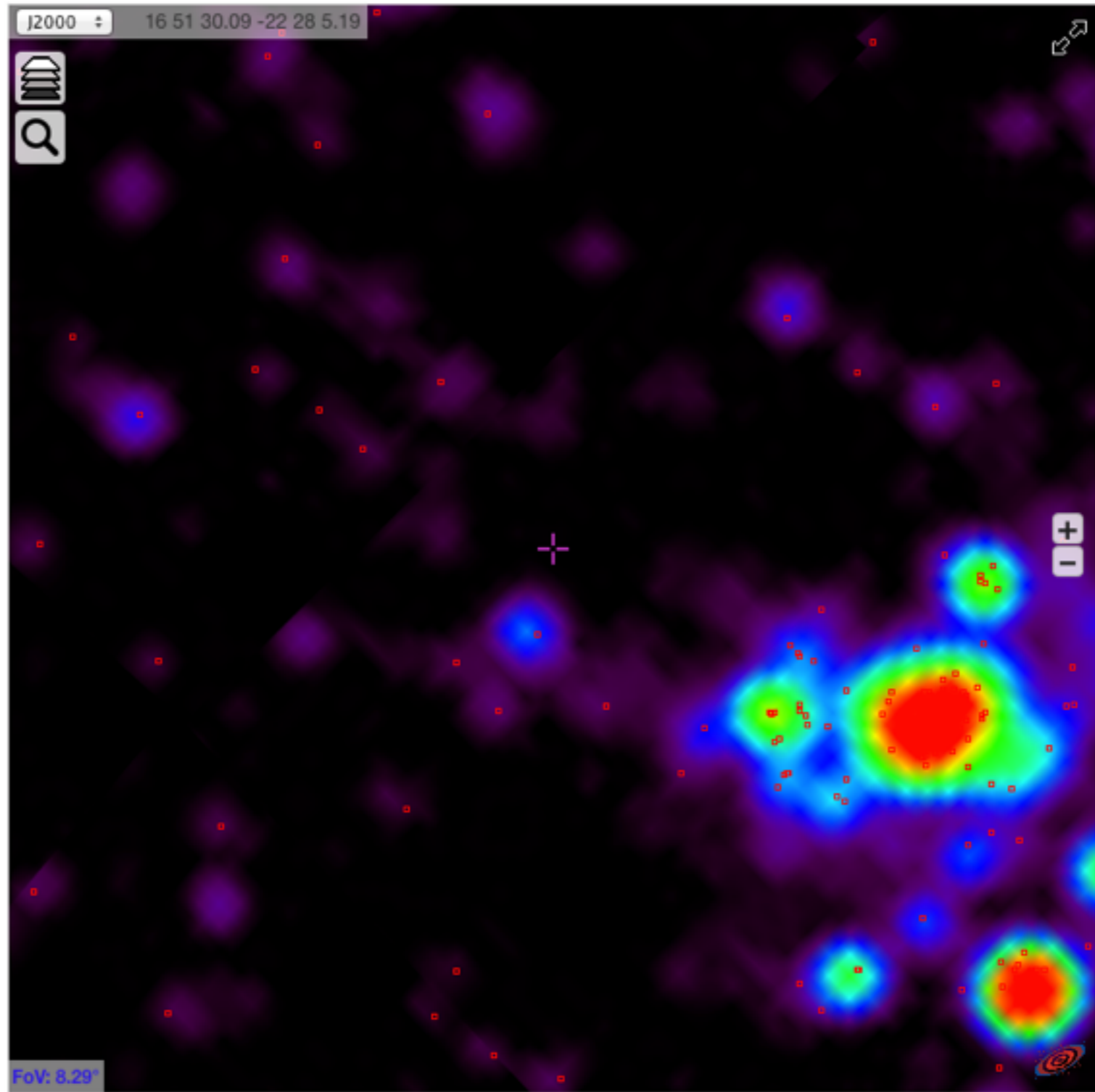
Harvard

Year

TOGGLE BASE LAYER

Optical Mellinger GALEX AIS
DSS2 Red IRIS 2MASS Halpha
VTSS

Select tool



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

The ADS All Sky Survey

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Astronomy articles. In the sky.

FILTER BY

Object

All Stars Galaxies HII regions
Nebulae Other

Band

Radio Infrared Ultraviolet X-ray

Custom

Harvard

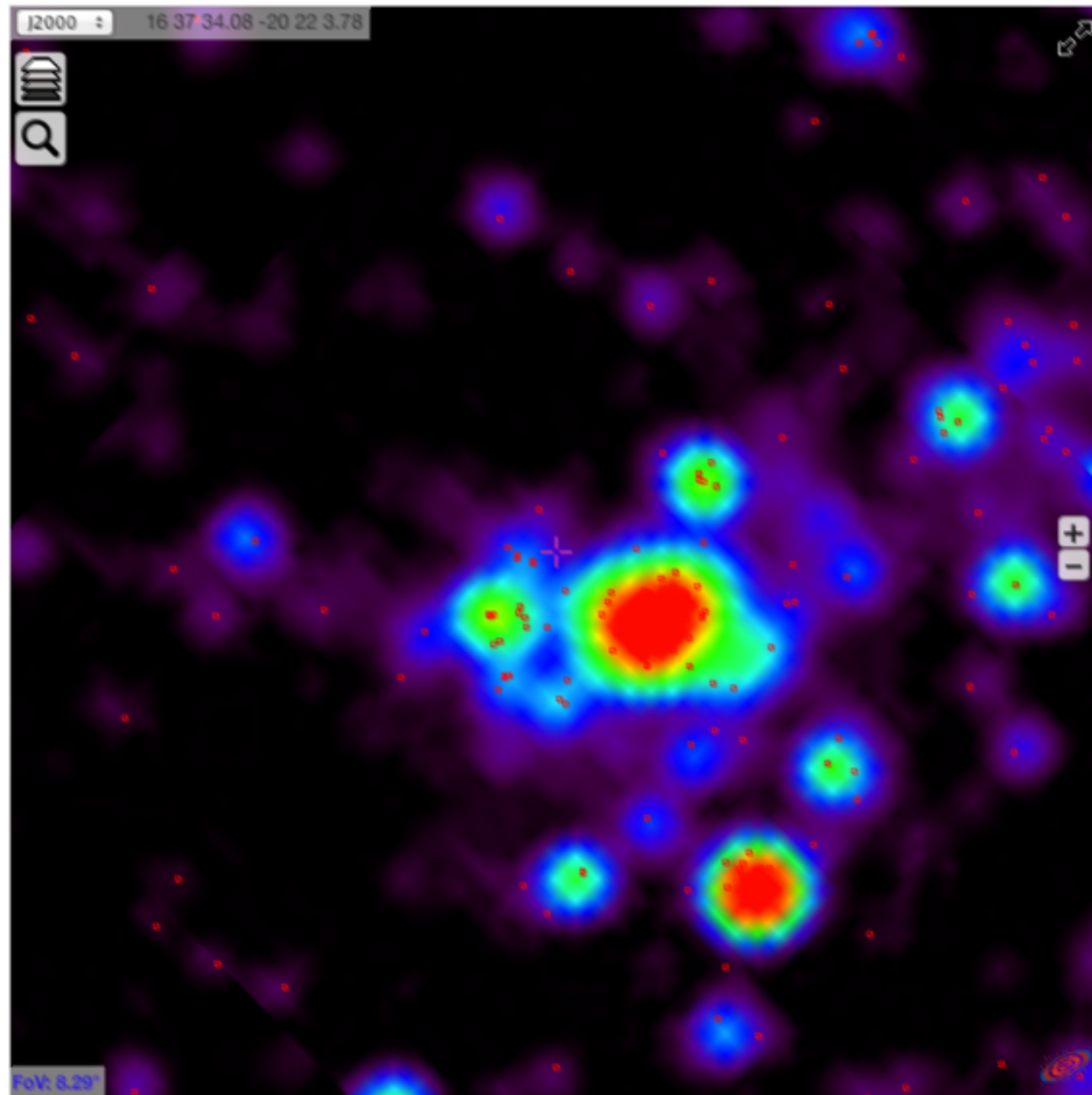
Year



TOGGLE BASE LAYER

Optical Mellinger GALEX AIS
DSS2 Red IRIS 2MASS Halpha
VTSS

Select tool



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

FILTER BY

Object

All Stars Galaxies HII regions
Nebulae Other

Band

Radio Infrared Ultraviolet X-ray

Custom

Harvard

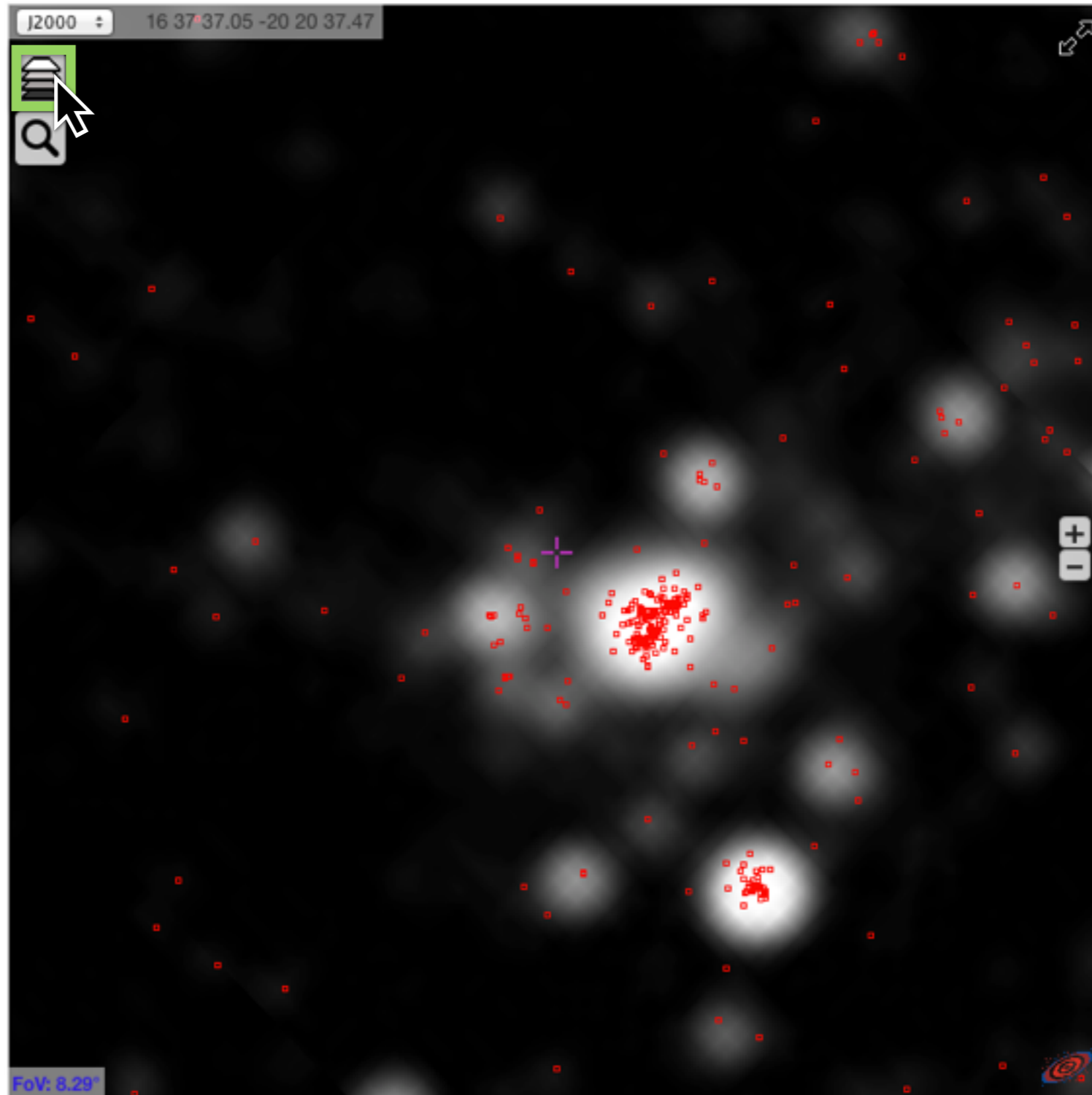
Year



TOGGLE BASE LAYER

Optical Mellinger GALEX AIS
DSS2 Red IRIS 2MASS Halpha
VTSS

Select tool



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

FILTER BY

Object
[All Stars](#) [Galaxies](#) **HII regions** [Nebulae](#) [Other](#)

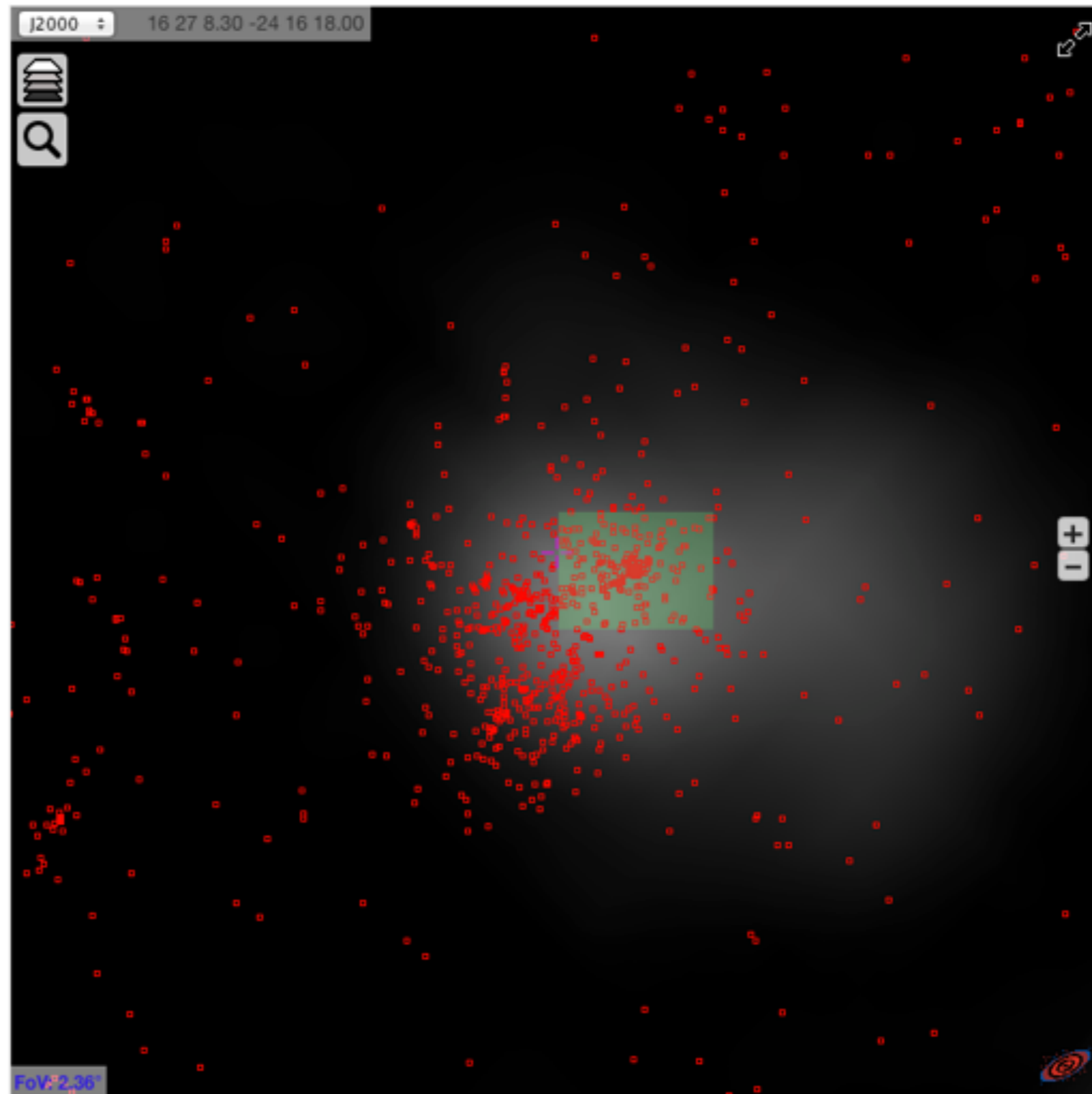
Band
[Radio](#) [Infrared](#) [Ultraviolet](#) [X-ray](#)

Custom
[Harvard](#)

Year

TOGGLE BASE LAYER
[Optical](#) [Mellinger](#) [GALEX AIS](#)
[DSS2 Red](#) [IRIS](#) [2MASS](#) [Halpha](#)
[VTSS](#)

Select tool



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

The screenshot shows the ALADIN web interface. At the top, there are navigation links: 'The ADS All Sky Survey', 'About', 'Watch videos', 'Tour', and 'Open WWT version'. On the right, it says 'Astronomy articles. In the sky.' The left sidebar contains filter options: 'FILTER BY', 'Object' (All Stars, Galaxies, HII regions, Nebulae, Other), 'Band' (Radio, Infrared, Ultraviolet, X-ray), 'Custom' (Harvard), and 'Year' (a slider). Below the filters is a 'TOGGLE BASE LAYER' section with options like 'Optical', 'Mellinger', 'GALEX', 'AIS', 'DSS2 Red', 'IRIS', '2MASS', 'Halpha', and 'VTSS'. A 'Select tool' button is at the bottom of the sidebar. The main content area is partially obscured by a pop-up window titled 'Selected papers/objects'. This window has two tabs: 'Papers' (selected) and 'Objects'. It contains a list of 30 astronomical references, truncated to 200 most recent papers. A mouse cursor is pointing at the 'Open papers in ADS' button, which is highlighted with a purple box. Another button, 'Open object list', is highlighted with an orange box. The background shows a dark sky with a red spiral galaxy and a red selection rectangle.

Selected papers/objects Open papers in ADS Open object list ×

Papers Objects

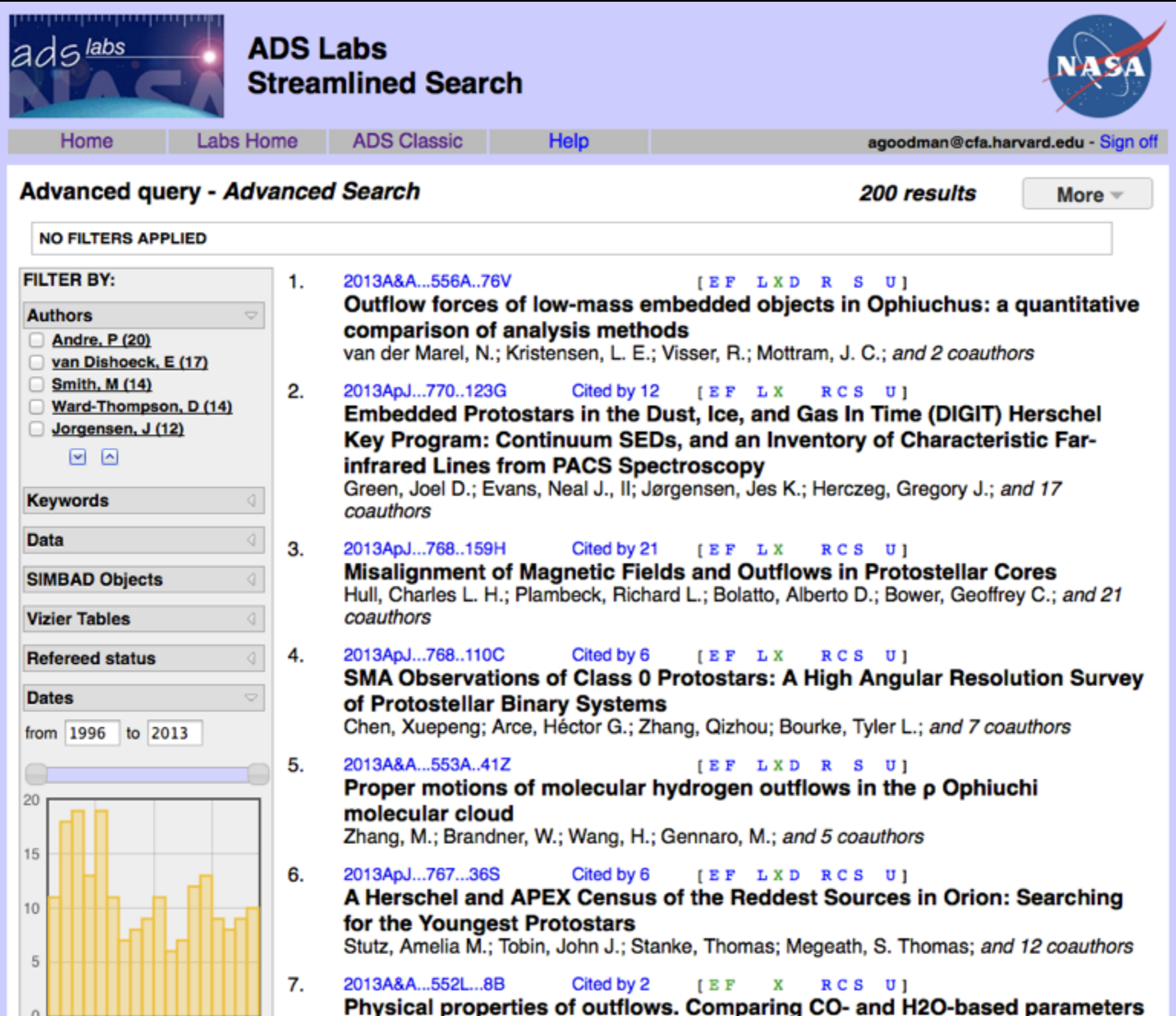
Note: List truncated to 200 most recent papers

NISINI B., et al. *Astron. Astrophys.*, 549A, 16-16 (2013)
TAFALLA M., et al. *Astron. Astrophys.*, 551A, 116-116 (2013)
BJERKELI P., et al. *Astron. Astrophys.*, 552, L8-8 (2013)
ZHANG M., et al. *Astron. Astrophys.*, 553A, 41-41 (2013)
VAN DER MAREL N., et al. *Astron. Astrophys.*, 556A, 76-76 (2013)
MURILLO N.M., et al. *Astrophys. J.*, 764, L15 (2013)
STUTZ A.M., et al. *Astrophys. J.*, 767, 36 (2013)
CHEN X., et al. *Astrophys. J.*, 768, 110 (2013)
HULL C.L.H., et al. *Astrophys. J.*, 768, 159 (2013)
GREEN J.D., et al. *Astrophys. J.*, 770, 123 (2013)
HSIEH T.-H., et al. *Astrophys. J., Suppl. Ser.*, 205, 5 (2013)
MAURY A., et al. *Astron. Astrophys.*, 539A, 130-130 (2012)
LISEAU R., et al. *Astron. Astrophys.*, 541A, 73-73 (2012)
ROBERTS J.F., et al. *Astron. Astrophys.*, 544A, 150-150 (2012)
BJERKELI P., et al. *Astron. Astrophys.*, 546A, 29-29 (2012)
PEZZUTO S., et al. *Astron. Astrophys.*, 547A, 54-54 (2012)
BOURKE T.L., et al. *Astrophys. J.*, 745, 117 (2012)
BARSONY M., et al. *Astrophys. J.*, 751, 22 (2012)
CHIANG H.-F., et al. *Astrophys. J.*, 756, 168 (2012)
NAKAMURA F., et al. *Astrophys. J.*, 758, L25 (2012)
BUSQUET G., et al. *Astron. Astrophys.*, 525A, 141-141 (2011)
BERGMAN P., et al. *Astron. Astrophys.*, 527A, 39-39 (2011)
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GIANNINI T., et al. *Astrophys. J.*, 738, 80 (2011)
VELUSAMY T., et al. *Astrophys. J.*, 741, 60 (2011)
WARD-THOMPSON D., et al. *Mon. Not. R. Astron. Soc.*, 415, 2812-2817 (2011)
SIMPSON R.J., et al. *Mon. Not. R. Astron. Soc.*, 417, 216-227 (2011)
VAN DISHOECK E.F., et al. *Publ. Astron. Soc. Pac.*, 123, 138-170 (2011)
LISEAU R., et al. *Astron. Astrophys.*, 510, A98-98 (2010)
MAURY A.J., et al. *Astron. Astrophys.*, 512, A40-40 (2010)
LAHUIS F., et al. *Astron. Astrophys.*, 519, A3-3 (2010)


ALADIN

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.)



The screenshot displays the ADS Labs Streamlined Search interface. At the top, there is a navigation bar with links for Home, Labs Home, ADS Classic, and Help, along with a user profile for agoodman@cfa.harvard.edu and a Sign off option. The main content area shows an advanced search query with 200 results. A sidebar on the left allows filtering by Authors, Keywords, Data, SIMBAD Objects, Vizier Tables, Refereed status, and Dates. The search results list includes titles, authors, and citation counts for several papers.

ads labs **ADS Labs Streamlined Search** 

Home Labs Home ADS Classic Help agoodman@cfa.harvard.edu - Sign off

Advanced query - Advanced Search 200 results More ▾

NO FILTERS APPLIED

FILTER BY:

Authors

- Andre, P (20)
- van Dishoeck, E (17)
- Smith, M (14)
- Ward-Thompson, D (14)
- Jorgensen, J (12)

Keywords

Data

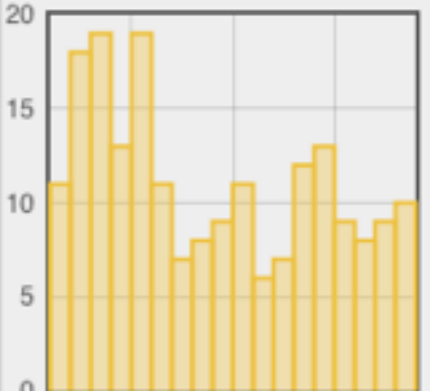
SIMBAD Objects

Vizier Tables

Refereed status

Dates

from 1996 to 2013



1. [2013A&A...556A..76V](#) [EF LXD R S U]
Outflow forces of low-mass embedded objects in Ophiuchus: a quantitative comparison of analysis methods
van der Marel, N.; Kristensen, L. E.; Visser, R.; Mottram, J. C.; and 2 coauthors

2. [2013ApJ...770..123G](#) Cited by 12 [EF LX RCS U]
Embedded Protostars in the Dust, Ice, and Gas In Time (DIGIT) Herschel Key Program: Continuum SEDs, and an Inventory of Characteristic Far-infrared Lines from PACS Spectroscopy
Green, Joel D.; Evans, Neal J., II; Jørgensen, Jes K.; Herczeg, Gregory J.; and 17 coauthors

3. [2013ApJ...768..159H](#) Cited by 21 [EF LX RCS U]
Misalignment of Magnetic Fields and Outflows in Protostellar Cores
Hull, Charles L. H.; Plambeck, Richard L.; Bolatto, Alberto D.; Bower, Geoffrey C.; and 21 coauthors

4. [2013ApJ...768..110C](#) Cited by 6 [EF LX RCS U]
SMA Observations of Class 0 Protostars: A High Angular Resolution Survey of Protostellar Binary Systems
Chen, Xuepeng; Arce, Héctor G.; Zhang, Qizhou; Bourke, Tyler L.; and 7 coauthors

5. [2013A&A...553A..41Z](#) [EF LXD R S U]
Proper motions of molecular hydrogen outflows in the ρ Ophiuchi molecular cloud
Zhang, M.; Brandner, W.; Wang, H.; Gennaro, M.; and 5 coauthors

6. [2013ApJ...767...36S](#) Cited by 6 [EF LXD RCS U]
A Herschel and APEX Census of the Reddest Sources in Orion: Searching for the Youngest Protostars
Stutz, Amelia M.; Tobin, John J.; Stanke, Thomas; Megeath, S. Thomas; and 12 coauthors

7. [2013A&A...552L...8B](#) Cited by 2 [EF X RCS U]
Physical properties of outflows. Comparing CO- and H₂O-based parameters

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

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

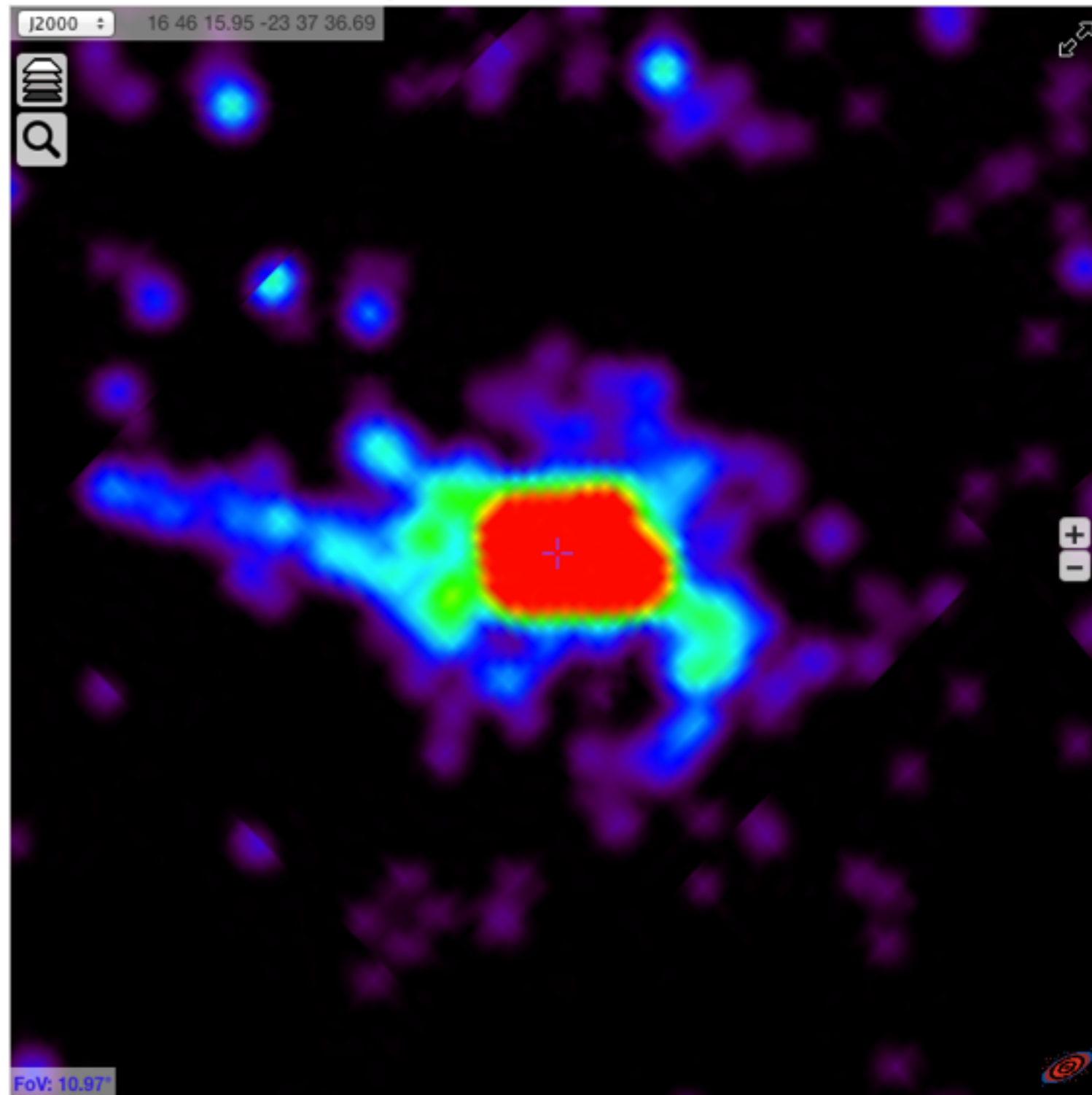
Year



TOGGLE BASE LAYER

Optical Mellinger GALEX AIS
DSS2 Red IRIS 2MASS Halpha
VTSS

Select tool



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

The ADS All Sky Survey

[Open Aladin version](#)

[Astronomy articles. In the sky.](#)

CHOOSE HEATMAP

Object All Stars Galaxies HII regions Nebulae Other

Band Radio **Infrared** Ultraviolet X-ray

Custom Harvard/All

Year

Show Sources

Go to...



BACKGROUND LAYER

Optical 2MASS **WISE** SFD IRIS GLIMPSE H-alpha ROSAT Fermi VLSS

WISE **Infrared**

position slider
move slider to
"WISE" all the way to
"infrared"

$(\alpha, \delta) = 246.78^\circ, -24.55^\circ$ FOV = 11°



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

CHOOSE HEATMAP

Object All Stars Galaxies HII regions Nebulae Other

Band Radio Infrared Ultraviolet X-ray

Custom Harvard/All

Year

Show Sources

Go to...



BACKGROUND LAYER

Optical 2MASS WISE SFD IRIS GLIMPSE H-alpha ROSAT Fermi VLSS

H-alpha X-ray



(α, δ)=246.78°, -24.55° FOV= 11°



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

CHOOSE HEATMAP

Object All Stars Galaxies HII regions Nebulae Other

Band Radio Infrared Ultraviolet **X-ray**

Custom Harvard/All

Year

Show Sources

Go to...

BACKGROUND LAYER

Optical 2MASS WISE SFD IRIS GLIMPSE **H-alpha** ROSAT Fermi VLSS

H-alpha **X-ray**



(α, δ)=246.78°, -24.55° FOV= 11°



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

CHOOSE HEATMAP

Object All Stars Galaxies HII regions Nebulae Other

Band Radio Infrared Ultraviolet **X-ray**

Custom Harvard/All

Year

Show Sources

Go to...



BACKGROUND LAYER

Optical 2MASS WISE SFD IRIS GLIMPSE **H-alpha** ROSAT Fermi VLSS

H-alpha X-ray



select an interesting source

$(\alpha, \delta) = 246.72^\circ, -23.97^\circ$ FOV = 3°



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

The ADS All Sky Survey [Open Aladin version](#) Astronomy articles. In the sky.

V* V2503 Oph [SIMBAD Entry](#) [Open papers in ADS](#)

CHOOSE HEATMAP

Object All Stars Galaxies HII regions Nebulae

Band Radio Infrared Ultraviolet X-ray

Custom Harvard/All

Year

BACKGROUND LAYER

Optical 2MASS WISE SFD IRIS GLIMPSE

H-alpha X-ray

$(\alpha, \delta) = 246.72^\circ, -23.97^\circ$ FOV = 3°

Papers

ESPAILLAT C., et al. *Astrophys. J.*, 762, 62 (2013)

BROWN J.M., et al. *Astrophys. J.*, 770, 94 (2013)

ARTEMENKO S.A., et al. *Astron. Lett.*, 38, 783-792 (2012)

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MONIN J.-L., et al. *The Messenger*, 89, 33-37 (1997)

JENSEN E.L.N., et al. *Astrophys. J.*, 459, 210-226 (1996)



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

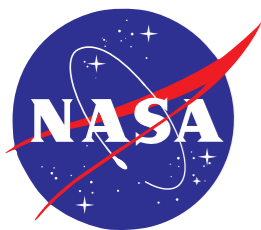
Christopher **Beaumont**, Harvard-CfA

Thomas **Boch**, CDS Strasbourg

Jonathan **Fay**, Microsoft Research

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

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



**SEAMLESS
ASTRONOMY**
Linking scientific data, publications, and communities



Stephen

all lines

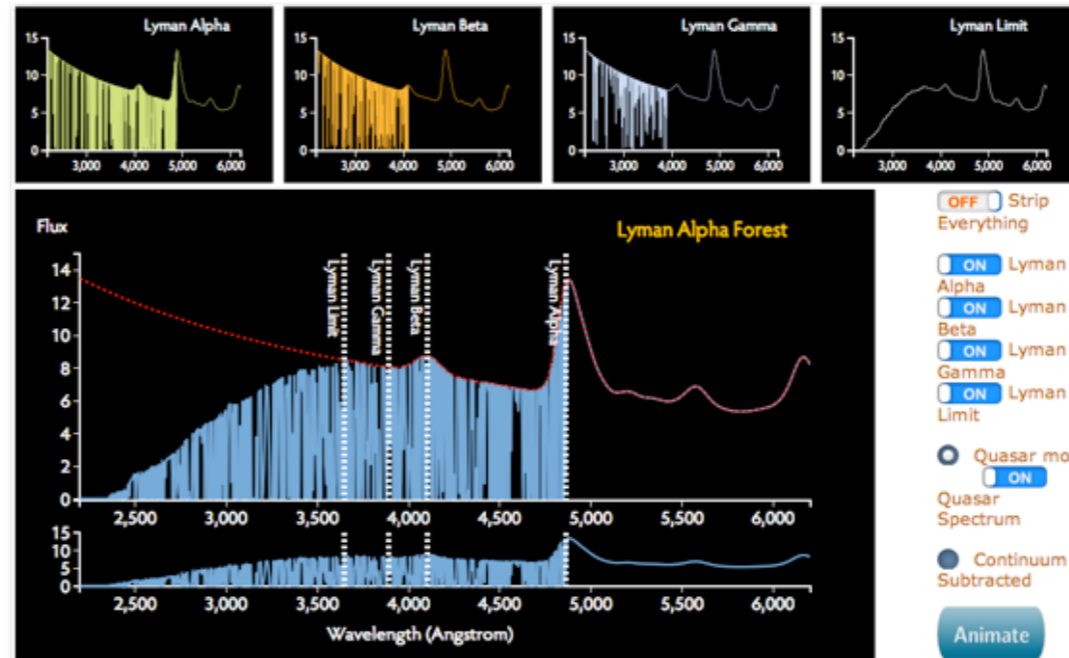
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He 6563 Å

OIII 5007 Å

Yuan-Sen
Ting

Interstellar
Absorption
and the
Lyman Alpha
Forest



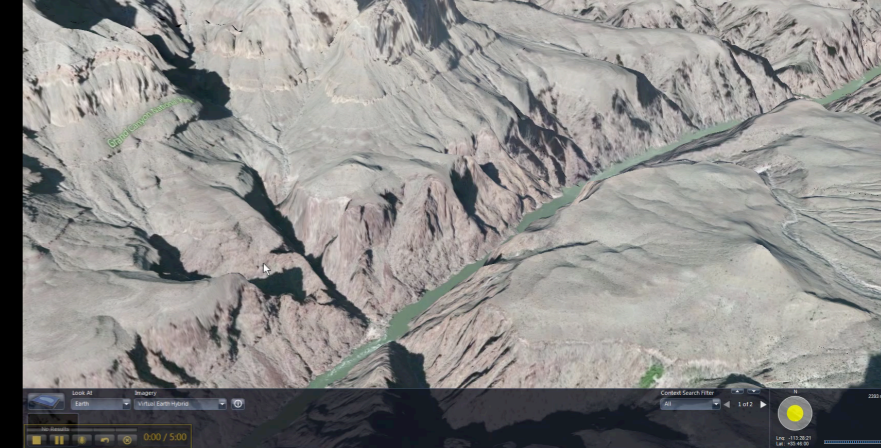
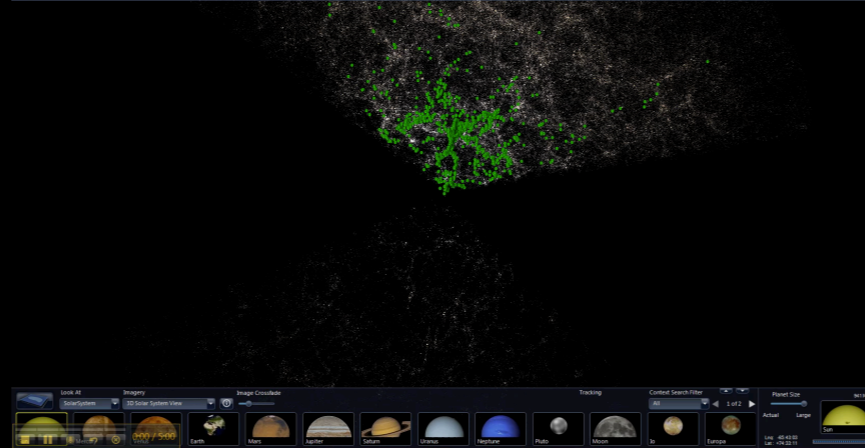
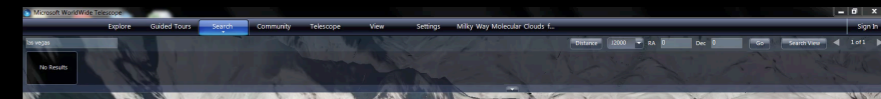
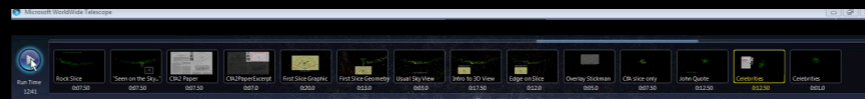
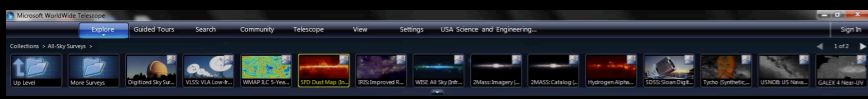
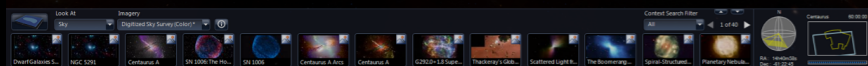
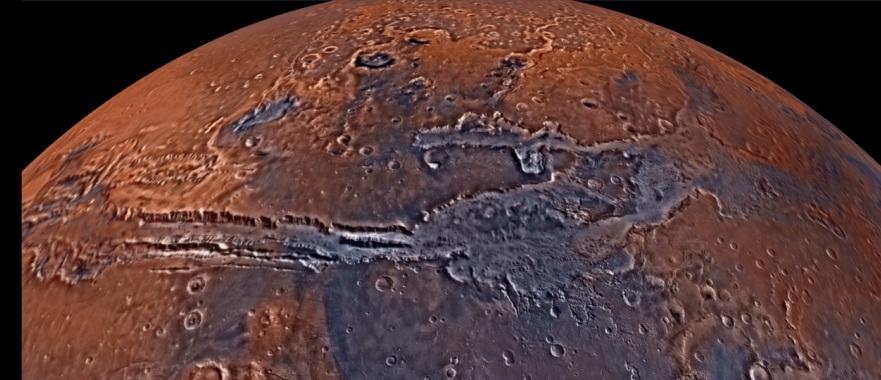
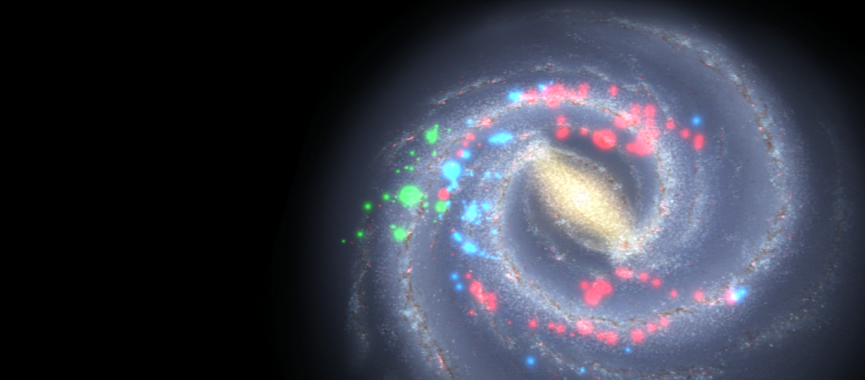
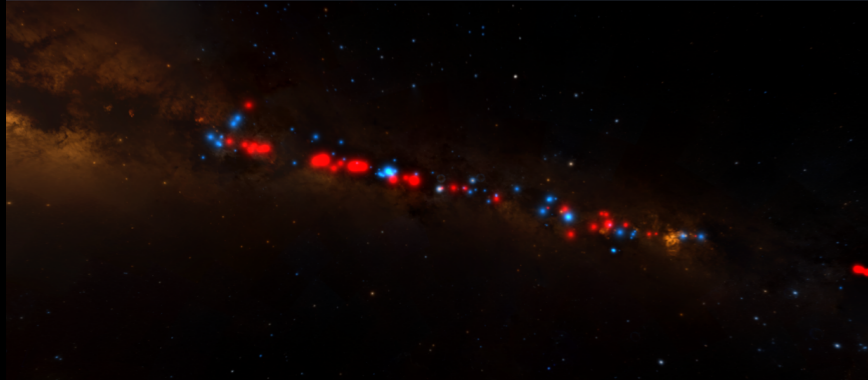
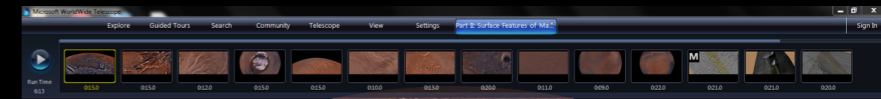
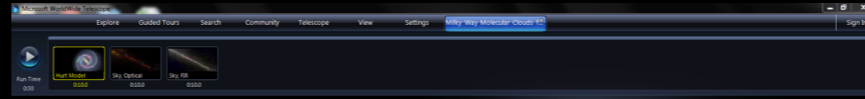
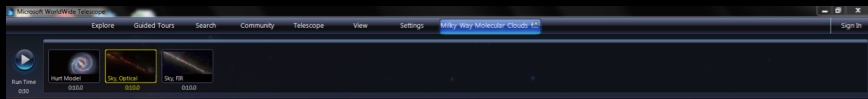
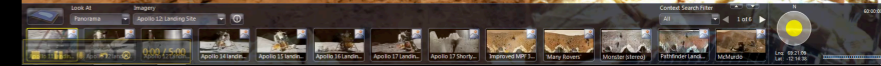
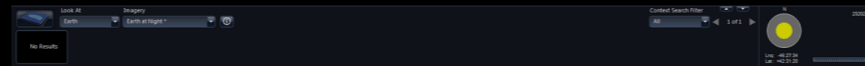
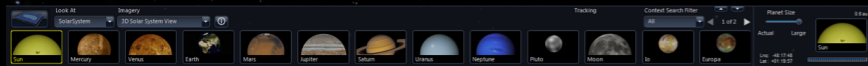
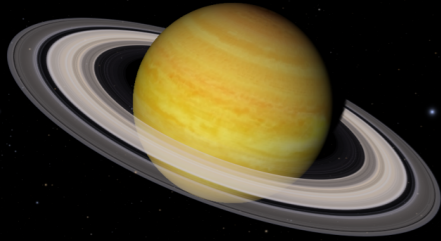
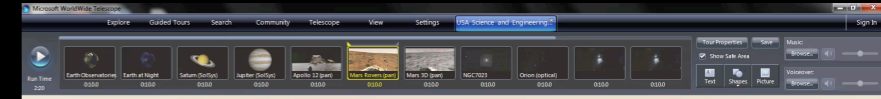
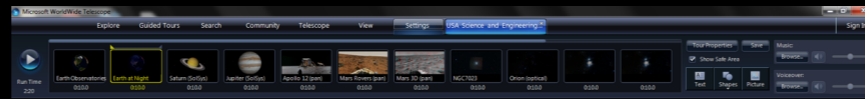
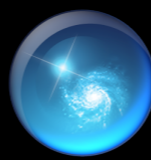
JavaScript

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



JavaScript

<http://portillo.ca/nebula/>



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Alyssa A. Goodman

Harvard-Smithsonian Center for Astrophysics

3500 years of Astronomy

Stonehenge, 1500 BC



Ptolemy in Alexandria, 100 AD



Observatory Tower, Lincolnshire, UK, c. 1300



Galileo, 1600



The "Scientific Revolution"

Reber's Radio Telescope, 1937



NASA/Explorer 7
(Space-based
Observing)
1959

"The Internet"



Long-distance
remote-control/
"robotic"
telescopes
1990s



"Virtual
Observatories"
21st century

"Seamless Astronomy"

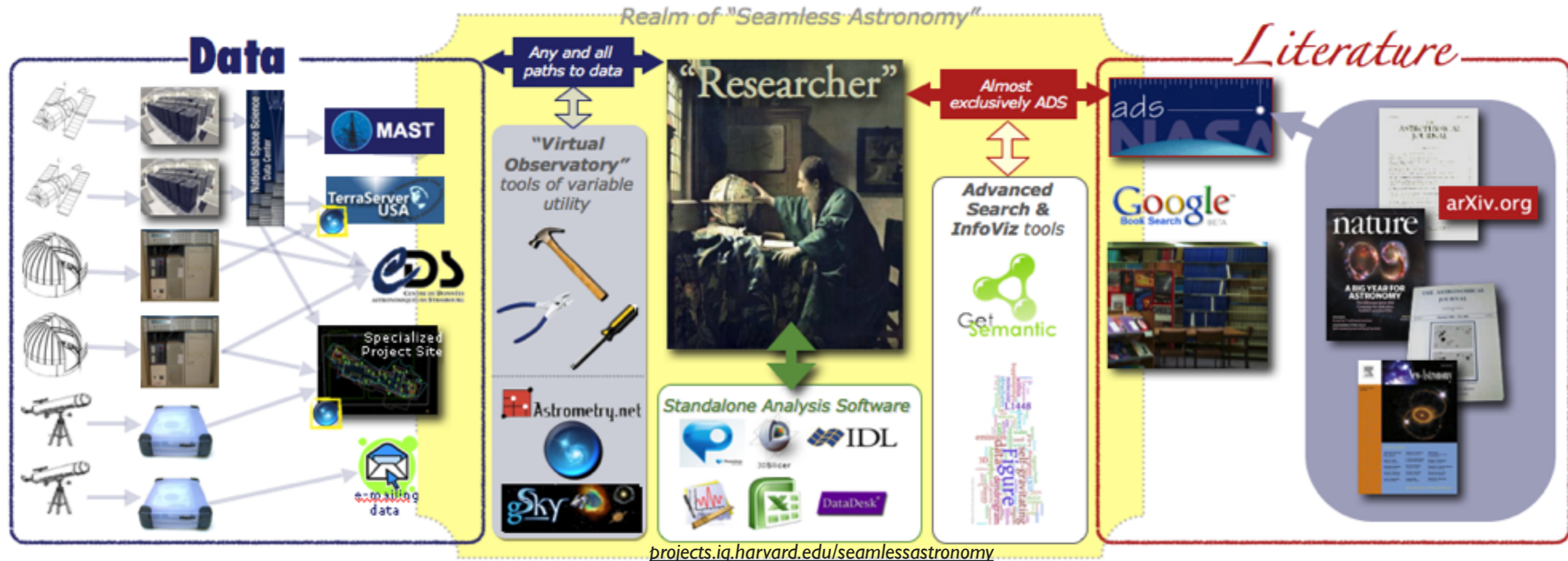
3500 Years of Writing





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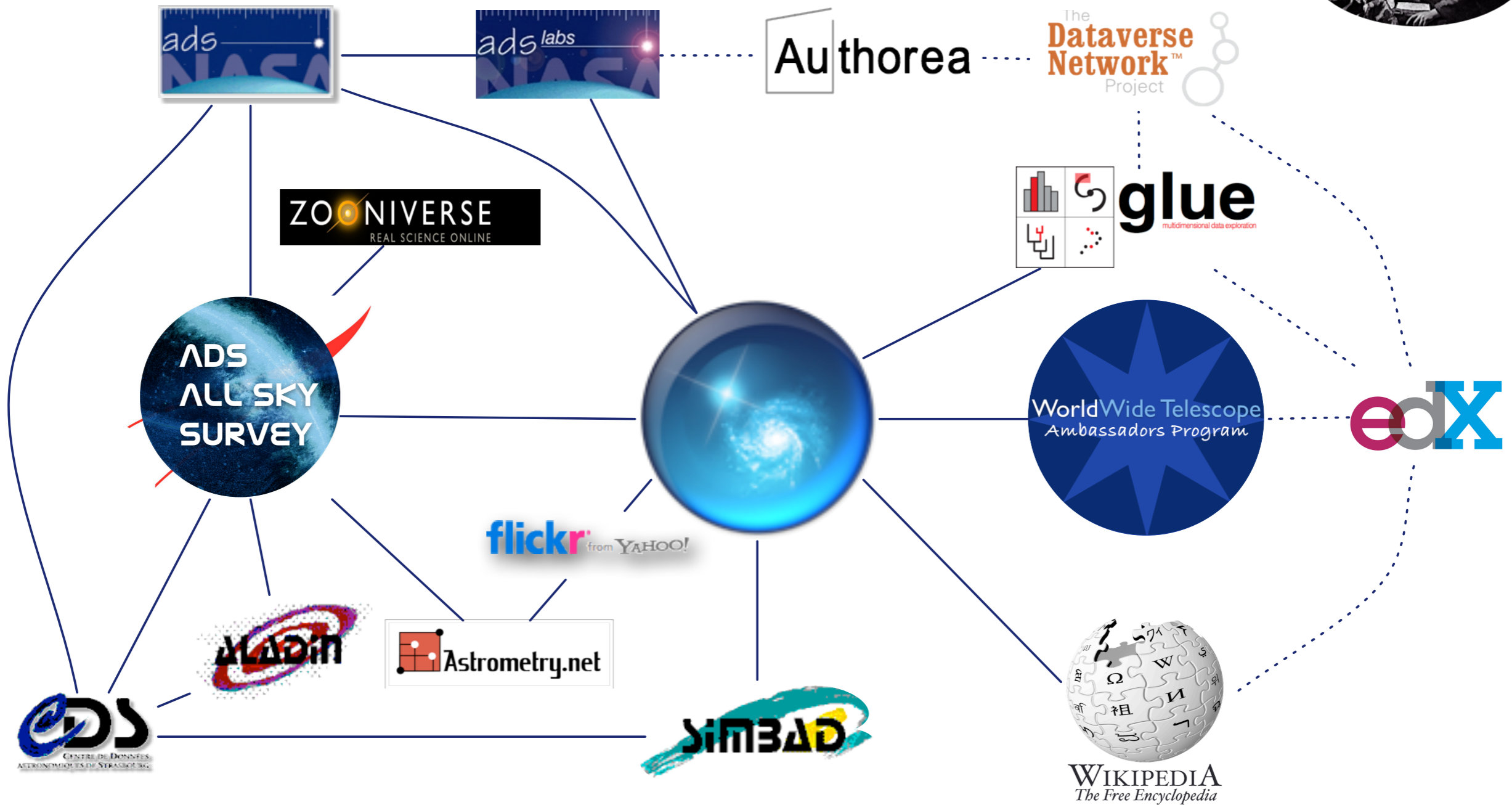
Alberto Accomazzi, Christopher Beaumont, Douglas Burke, Raffaele D’Abrusco, Rahul Davé, Christopher Erdmann, Pepi Fabbiano, Alyssa Goodman, Edwin Henneken, Jay Luker, Gus Muench, Michael Kurtz, Max Lu, Victoria Mittelbach, Alberto Pepe, Arnold Rots, Patricia Udomprasert (Harvard-Smithsonian CfA); Mercé Crosas (Harvard Institute for Quantitative Social Science); Christine Borgman (UCLA); Jonathan Fay & Curtis Wong (Microsoft Research); Alberto Conti (Space Telescope Science Institute)





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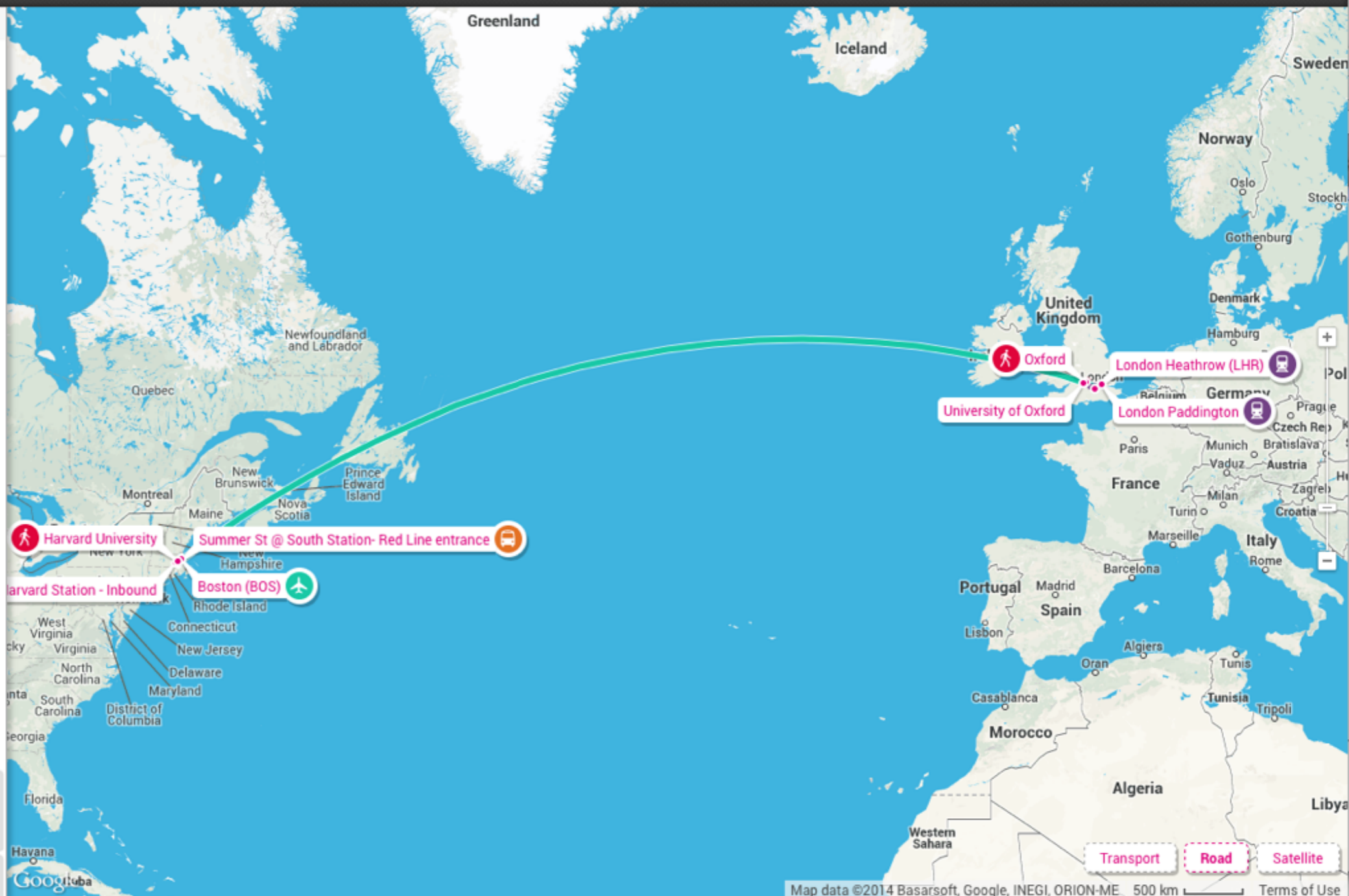
1 Fly to London Heathrow, train \$539

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- Harvard Station - Inbound 15min - every 5 minutes \$2
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- London Paddington 58min - every 20 minutes \$30
- Oxford 33min - 1.4 miles
- University of Oxford 58 hotels

2 Fly to Bristol, train \$605 14hrs 08min

3 Fly to Manchester, train \$492





Galileo Galilei (1564–1642)



Scipio Principe.

Galileo Galilei, Familiari. Seruo della Ser. V. inuigilato
 do assiduam, et de ogni spirito de bene no solo satisfas
 aluano che non della lettera di Madonati, nelle sua
 Dio di Padova,

Inuere d'auere determinato di presentare al Scipio Principe
 l'occhio et il p. essere di giuamenti inestimabile di ogni
 negozio et in breua marittima o terrestre stimo di tenere que
 sto nuovo artificio nel maggior segreto et solap a disposizione
 di V. Ser. L. Galileo conato dalle piu u. di te speculationi di
 pros, pettina in l'uantaggio di scoprire Legni et Vele dell' inimici
 di due hore et piu di tempo prima di gli scopri noi et distinguend
 il numero et la qualita de i Vasselli, giudicare le sue forze
 balloptirsi alla caccia et combattimento o alla fuga, o pure uenire
 nella campagna aperta uedere et particolarly distinguere ogni sua
 posto et propriamento.

Adi 7. di gennaio
 Giove si uede u. 4 * ucci: 10. 11.

Adi 8. u. 4 * ucci: 10. 11.

Adi 12. si uede in tale uisione * * * *

Adi 13. si uede in uisione a Giove 4 stelle * * * *

Adi 14. si uede * * * *

Adi 15. si uede * * * *

Adi 16. si uede * * * *

Adi 17. si uede * * * *

7	* * ○ *	17	* ○
8	○ * * *	18	* ○ *
10	* * ○	19	* ○ * *
11	* * ○	19	* ○ * *
12	* ○ *	20	○ * ○ ○ ○
13	* ○ * *	21	... ○ *
15	○ * * *	22	* ○ * *
15	○ * * *	22	* ○ * *
16	○ * *	23	* ○ *
16	○ * *	23	* ○ *
17	* ○ *	24	* ○ *
17	* ○ *	24	* ○ *

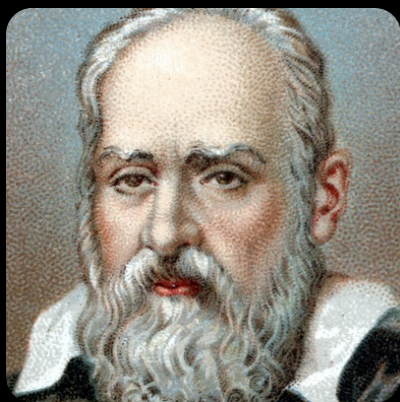
On the third, at the seventh hour, the stars were arranged in this
 sequence. The eastern one was 1 minute, 30 seconds from Jupiter
 the closest western one 2 minutes; and the other western one was
 3 minutes removed from this one. They were absolutely on the same
 straight line and of equal magnitude.

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
 in 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 magnitude
 were nearly equal; the one closest to Jupiter appeared a little smaller
 than the rest. But at the seventh hour the eastern stars were only
 30 seconds apart. Jupiter was 2 minutes from the nearer eastern
 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

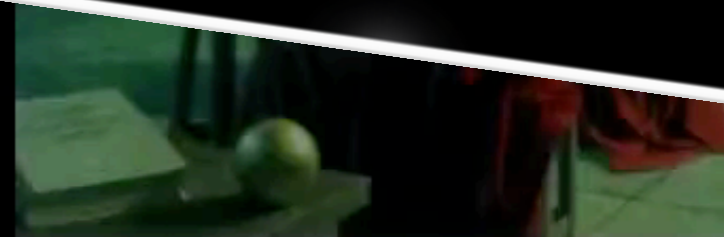


Galileo Galilei



GALILEO'S "NEW ORDER"

Created by Alyssa Goodman, Curtis Wong
with advice from Owen Gingerich and Dan

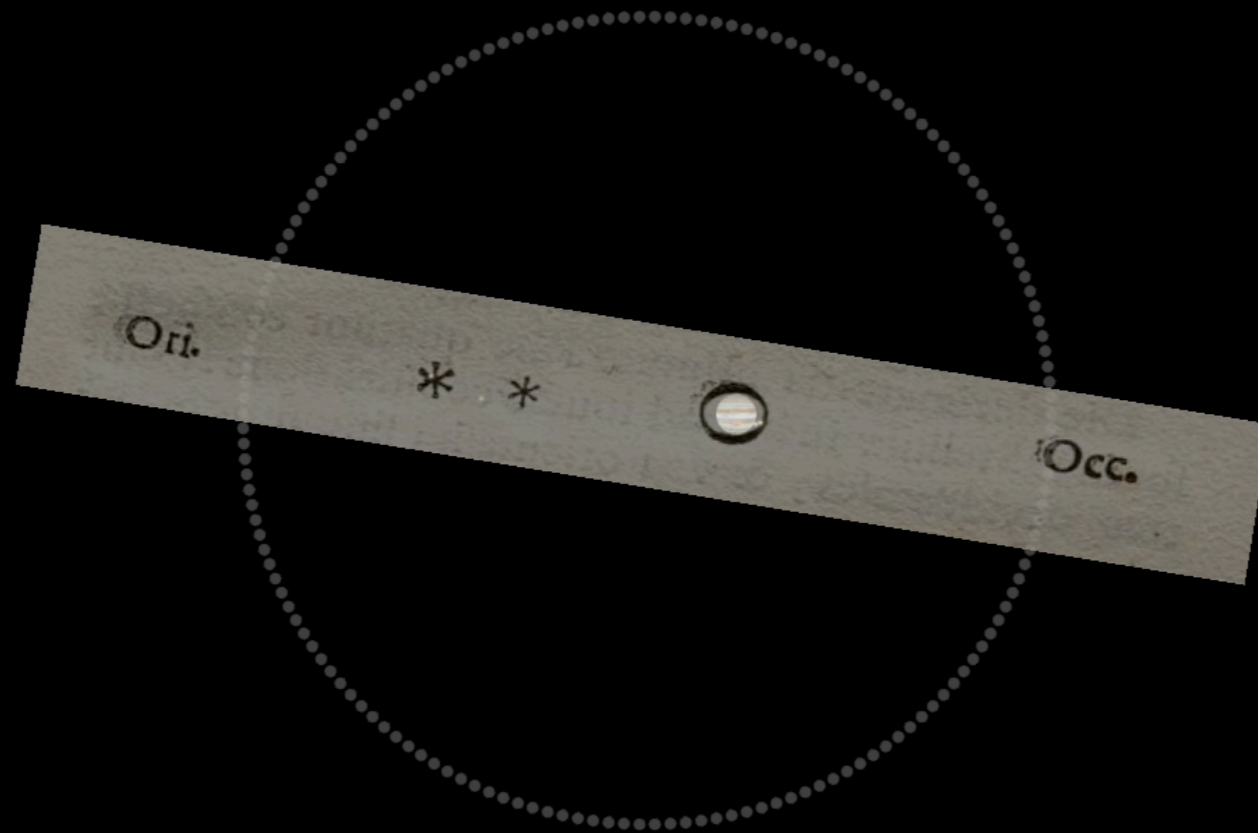




Galileo Galilei



January 11, 1610



1610



SIDEREUS NUNCIUS

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

East * ○ * 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 * ○ * * 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 a little smaller than the rest. But at the seventh hour the eastern star was 30 seconds apart. Jupiter was 2 minutes from the

East ** ○ * *

one, while he was 4 minutes from the next western one was 3 minutes from the westernmost one. They 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

East * ○ *

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

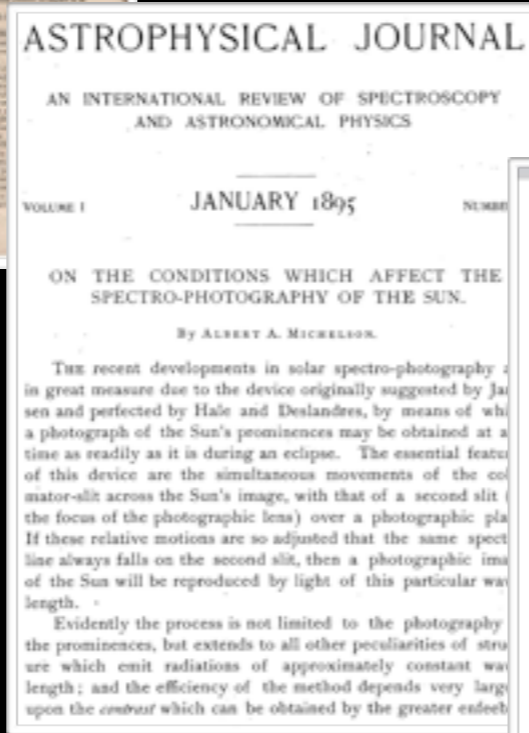
On the seventh, two stars stood near Jupiter, but not arranged in this manner.

what do we publish?

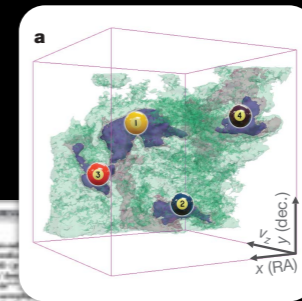
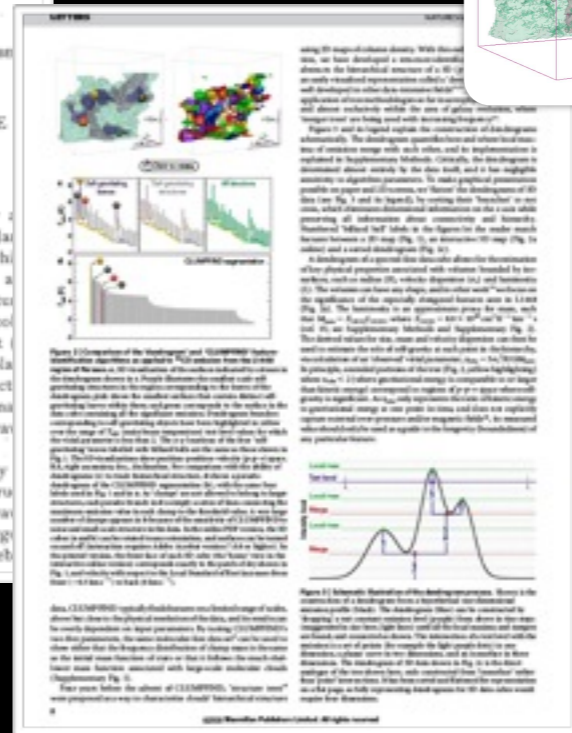
1665



1895



2009



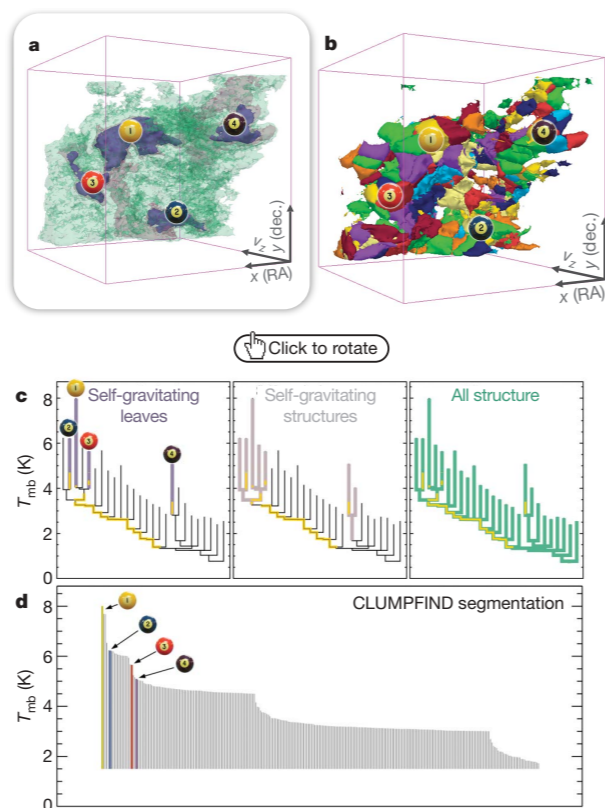


Figure 2 | Comparison of the 'dendrogram' and 'CLUMPFIND' feature-identification algorithms as applied to ^{13}CO emission from the L1448 region of Perseus. **a**, 3D visualization of the surfaces indicated by colours in the dendrogram shown in **c**. Purple illustrates the smallest scale self-gravitating 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 set⁸ 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 the help of the 2D work as inspiration, we have developed a structure-identification algorithm that abstracts the hierarchical structure of a data set into an easily visualized representation called a dendrogram. This method, well developed in other data-intensive applications such as image segmentation and almost exclusively within the area of computer vision, 'merger trees' are being used with increasing frequency.

Figure 3 and its legend explain the dendrogram process schematically. The dendrogram was constructed from the data set determined almost entirely by the sensitivity to algorithm parameters. The dendrogram is possible on paper and 2D screen, and is a 1D representation of the data (see Fig. 3 and its legend). The dendrogram is a cross, which eliminates dimensions, but preserves all information. Numbered 'billiard ball' labels are used to track features between a 2D map (see Fig. 1) and a sorted dendrogram (see Fig. 2).

A dendrogram of a spectral line emission cube, such as the L1448 region, surfaces, such as radius (R), luminosity (L). The volumes can have any shape, and are defined by the significance of the especially elongated features (Fig. 2a). The luminosity is an approximate proxy for mass, such that $M_{\text{lum}} = X_{13\text{CO}} L_{13\text{CO}}$, where $X_{13\text{CO}} = 8.0 \times 10^{20} \text{ cm}^{-2} \text{ K}^{-1} \text{ s}$ (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, $\alpha_{\text{obs}} = 5\sigma_v^2 R / GM_{\text{lum}}$. In principle, extended portions of the tree (Fig. 2, yellow highlighting) where $\alpha_{\text{obs}} < 2$ (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 fields¹⁶, its measured value should only be used as a guide to the longevity (boundedness) of any particular feature.

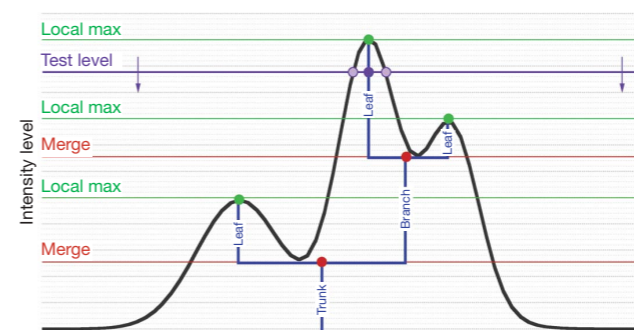


Figure 3 | Schematic illustration of the dendrogram process. Shown is the construction of a dendrogram from a hypothetical one-dimensional emission profile (black). The dendrogram (blue) can be constructed by 'dropping' a test constant emission level (purple) from above in tiny steps (exaggerated in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

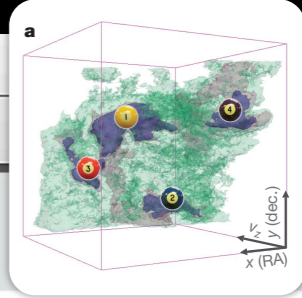
A role for self-gravity at multiple length scales in the process of star formation

Alyssa A. Goodman^{1,2}, Erik W. Rosolowsky^{2,3}, Michelle A. Borkin^{1†}, Jonathan B. Foster², Michael Halle^{1,4}, Jens Kauffmann^{1,2} & Jaime E. Pineda²

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'. 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 the stellar initial mass function'. Here we report a 'dendrogram' (hierarchical tree-diagram) analysis that reveals 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' 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



LETTERS

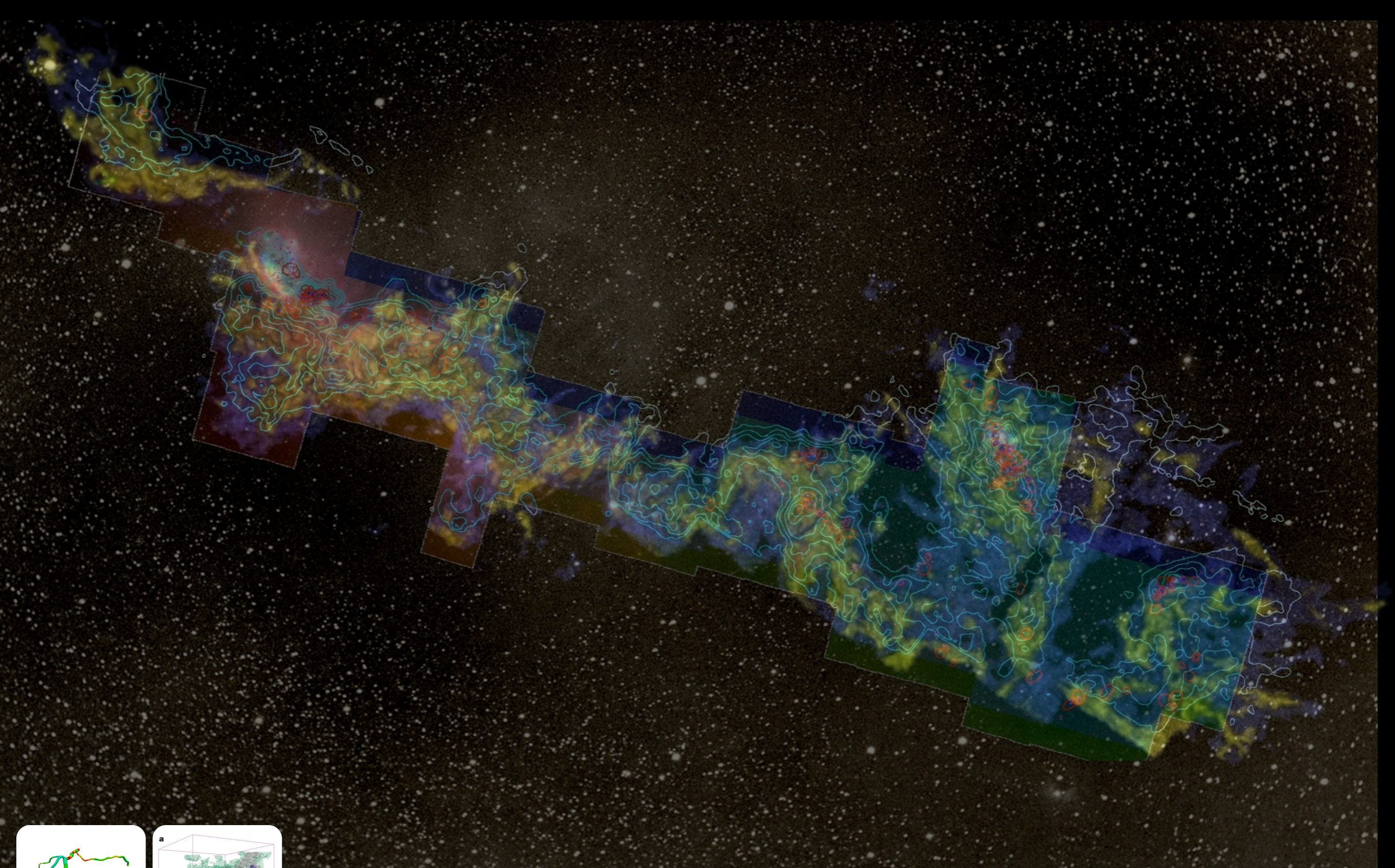
A role for self-gravity at multiple length scales in the process of star formation

Alyssa A. Goodman^{1,2}, Erik W. Rosolowsky^{2,3}, Michelle A. Borkin^{1†}, Jonathan B. Foster², Michael Halle^{1,4}, Jens Kauffmann^{1,2} & Jaime E. Pineda²

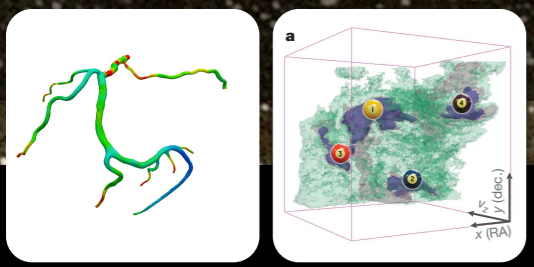
Self-gravity plays a decisive role in the final stages of star formation, where dense cores (size ~ 0.1 parsecs) inside molecular clouds collapse to form star-plus-disk systems¹. But self-gravity's role at earlier times (and on larger length scales, such as ~ 1 parsec) is unclear; some molecular cloud 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 function². 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 ¹³CO 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 emission³ are projected on the sky within one of the dendrogram's self-gravitating 'leaves'. As these peaks mark the locations of already-forming stars, or of those probably about to form, a self-gravitating cocoon seems a critical condition for their exist-

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





3D Viz made with VolView








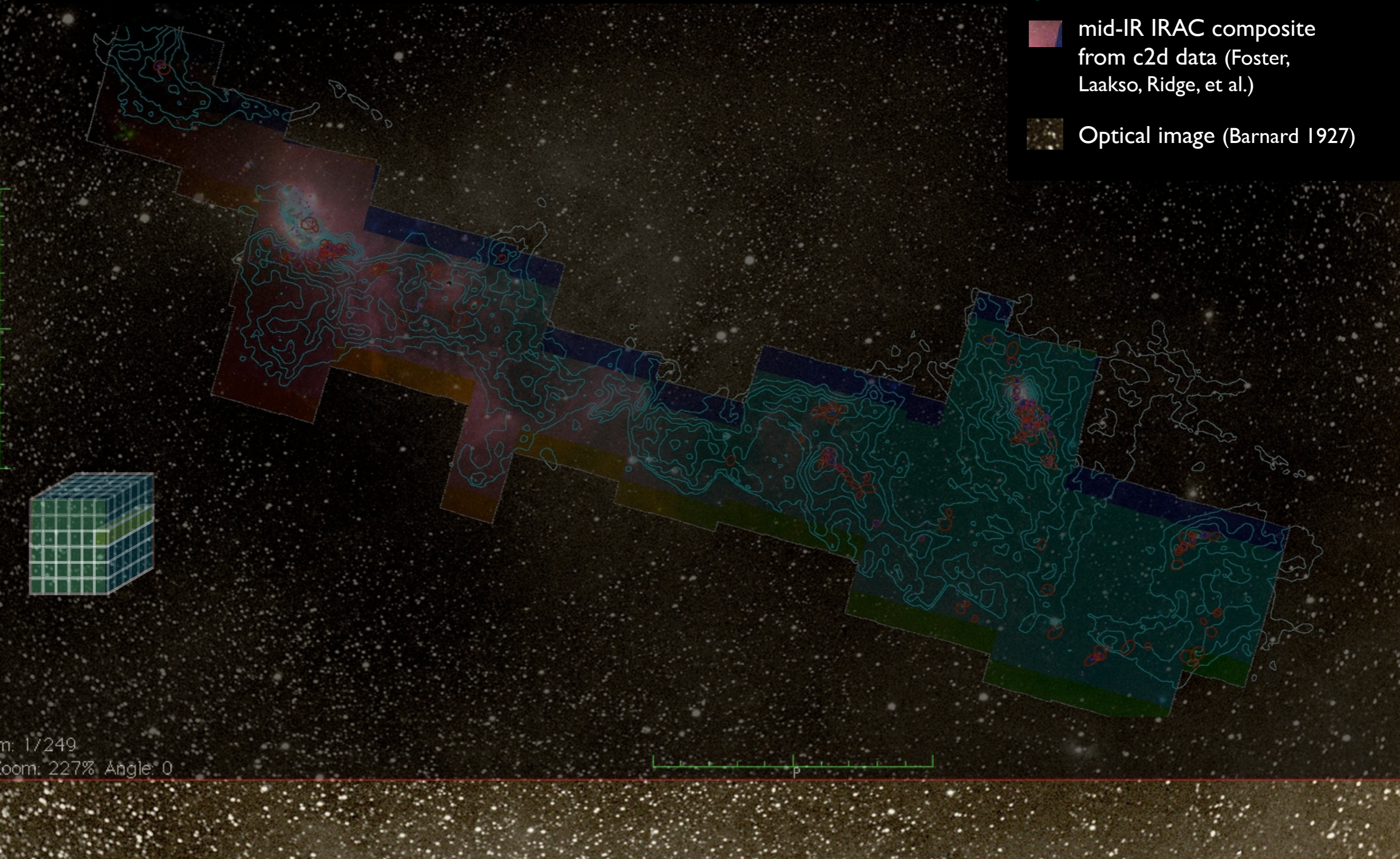
AstronomicalMedicine@



COMPLETE

The “old” way

-  mm peak (Enoch et al. 2006)
-  sub-mm peak (Hatchell et al. 2005, Kirk et al. 2006)
-  ^{13}CO (Ridge et al. 2006)
-  mid-IR IRAC composite from c2d data (Foster, Laakso, Ridge, et al.)
-  Optical image (Barnard 1927)



PRIVATE ROUGH DRAFT

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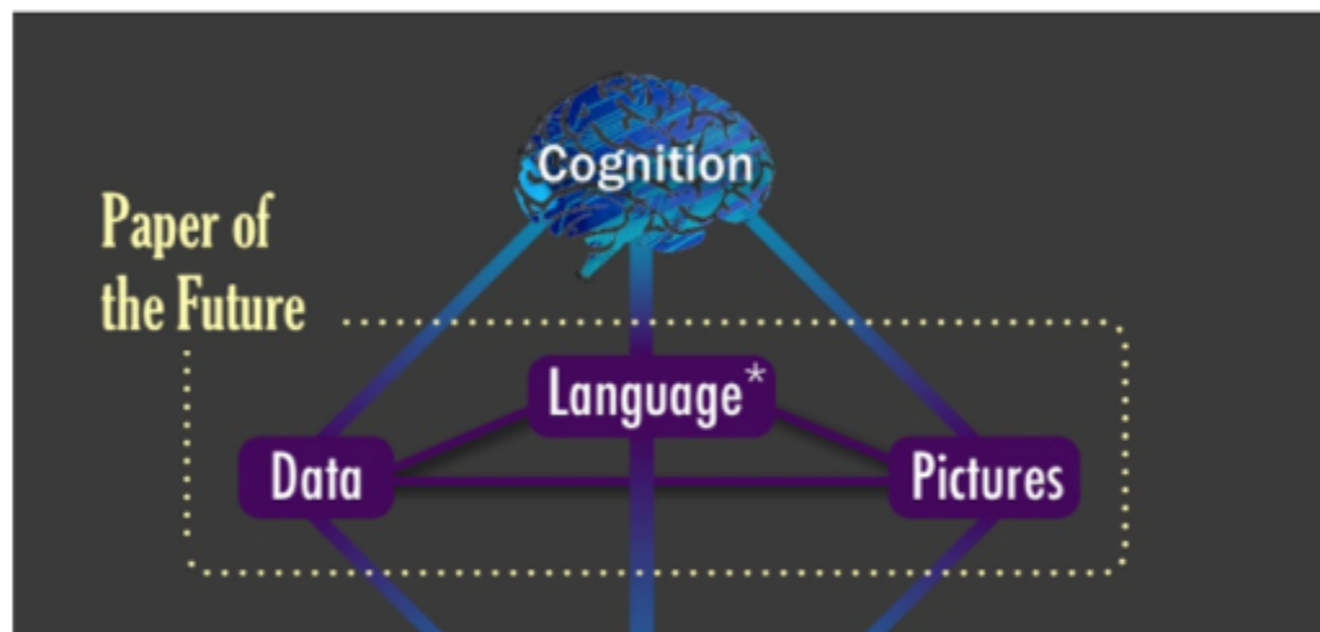
The "Paper" of the Future

[Alyssa Goodman](#), [Josh Peek](#), [How-Huan Hope Chen](#), [Nathan Jenkins](#), [August Muench](#), [Chris Beaumont](#), [Christine L. Borgman](#), [Alberto Pepe](#), [Alberto Accomazzi](#), [Christopher Erdmann](#), [Curtis Wong](#) [+ Add author](#)

1 Preamble

A variety of research on human cognition demonstrates that humans learn and communicate best when more than one processing system (e.g. visual, auditory, touch) is used. And, related research also shows that, no matter how technical the material, most humans also retain and process information best when they can put a narrative "story" to it. Thus, when considering the future of scholarly communication, we should be careful not to blithely do away with the linear narrative format that articles and books have followed for centuries: instead, we should enrich it.

Much more than text is used to communicate in Science. "Figures," which include images, diagrams, graphs, charts, and more, have enriched scholarly articles since the time of Galileo, and ever-growing volumes of data underpin most scientific papers. When scientists communicate face-to-face, as in talks or small discussions, these figures are often the focus of the conversation. In the best discussions, scientists have the ability to manipulate the figures, and to access underlying data, in real-time, so as to test out various what-if scenarios, and to explain findings more clearly. **This short article explains--and shows with demonstrations--how scholarly "publications" can morph into long-lasting rich records of scientific discourse**, enriched with deep data and code linkages, interactive figures, audio, video, and commenting.



The Present

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7.2 km s⁻¹ (see, respectively, As its position explains in detail, Figure 10.10, colored lines are associated with the near part of the Scutum-Centaurus Arm. The versions of the Sky view shown, one pointing to the Sun, and the other also accounting for the tilt of the Galactic coordinate system caused by the Galactic rotation (see Figure 10.10).

The dashed lines in Figure 10.10, indicating the predicted position of the Galactic Plane on the Sky when viewed from the Sun, pass directly through Nessie, regardless of whether or not color-coded lines "tilt" the coordinate system caused by SgrA's offset. Solid colored lines show 20 pc above and below the Plane at the distance to the Scutum-Centaurus Arm, so Figure 10.10 (colored lines) makes it very clear that Nessie lies within just a few pc of the Plane, along its entire length. This is either an extremely fortuitous coincidence, or an indication that Nessie is tracing a significant feature that effectively marks the mean location of the Galactic Plane. Given the waviness of the plane on 10 pc scales (see above, [Lalor&Mahotra1994](#)), the location at even less than 10 pc from the mean plane may be fortuitous—but the location so close to the mean is not.

`\begin{figure}[htbp]`
`\begin{center}`
`\includegraphics[width=0.8\columnwidth]{`
`Knessie_Latlon_both_final.pdf}`
`\caption{Figure 10.10: For the fourth quadrant of the Milky Way, contours of constant LSR velocity of 30, 40, and 60 km s-1 (see McClure&Griffiths2007) are superimposed on a cartoon model of the Milky Way. CO and dense gas observations (see below) give LSR velocities associated with Nessie (shown here as rainbow curve) near -40 km s-1, placing Nessie in the Scutum-Centaurus arm (highlighted in black), about 3.1 kpc from the Sun. Yellow-highlighted curves show positions in the Galaxy that would have the labeled value of Galactic Latitude (B) when viewed from the Sun. In the \text{top} panel, \text{Nessie} (only) is considered in drawing the iso-b curves, and in the \text{bottom} panel, \text{Nessie} (only) is considered in drawing the iso-b curves, and in the \text{bottom} panel, a 7 pc offset of the Galactic Center (see \text{text}), which causes an overall tilt of 0.12° (see \text{text}) is also taken into account.`

Life On Earth.lba

In terms of total mass, there is about 1,000 times more phytomass (photosynthetic plants, phytoplankton, and so on) on the planet than animals. Yet animals consume almost 20% of the total phytomass produced each year by nibbling, scraping, and filter-feeding through the microbial pastures of the ocean. Who owns the planet, plants or animals?

Plants paint a record of climate conditions on the face of the earth. In response to extended warming trends, plant hardiness zones move north. The Carolina perennial becomes a Maryland perennial.

Readers of *Life on Earth* will understand how environmental factors like temperature and precipitation act like control handles that govern the functioning of the ecosystem and determine the regional viability of plants and animals.

As the keystone species of the Earth, proprietors of an industrial civilization, we have choices to make. Education now is the key to wisdom later.

Interactive Global Temperature 1884-2010
 This map compares temperature readings against five year averages. Blue is cooler than average, red is hotter.

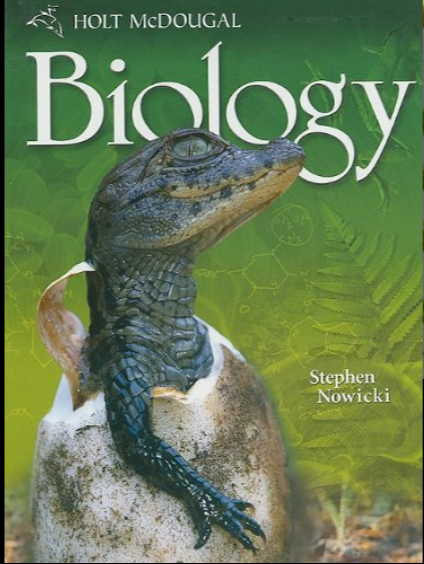


Fig. 4— For the fourth quadrant of the Milky Way, contours of constant LSR velocity of 30, 40, and 60 km s⁻¹ (using a rotation curve from McClure-Griffiths & Diskin 2007,) superimposed on a cartoon model of the Milky Way. CO and dense gas observations (see below) give LSR velocities associated with Nessie (shown here as rainbow curve) near -40 km s⁻¹, placing Nessie in the Scutum-Centaurus arm (highlighted in black), about 3.1 kpc from the Sun. Yellow-highlighted curves show positions in the Galaxy that would have the labeled value of Galactic Latitude (B) when viewed from the Sun. In the top panel, only height of the Sun off the plane (taken to be 25 pc in this example) is considered in drawing the iso-b curves, and in the bottom panel, a 7 pc offset of the Galactic Center (see `\text{text}`), which causes an overall tilt of 0.12° is also taken into account.

Figure 10.10: Comparison of the background and foreground features... The dashed lines in Figure 10.10, indicating the predicted position of the Galactic Plane on the Sky when viewed from the Sun, pass directly through Nessie, regardless of whether or not color-coded lines "tilt" the coordinate system caused by SgrA's offset. Solid colored lines show 20 pc above and below the Plane at the distance to the Scutum-Centaurus Arm, so Figure 10.10 (colored lines) makes it very clear that Nessie lies within just a few pc of the Plane, along its entire length. This is either an extremely fortuitous coincidence, or an indication that Nessie is tracing a significant feature that effectively marks the mean location of the Galactic Plane. Given the waviness of the plane on 10 pc scales (see above, Lalor&Mahotra1994), the location at even less than 10 pc from the mean plane may be fortuitous—but the location so close to the mean is not.

Figure 10.10: For the fourth quadrant of the Milky Way, contours of constant LSR velocity of 30, 40, and 60 km s⁻¹ (see McClure&Griffiths2007) are superimposed on a cartoon model of the Milky Way. CO and dense gas observations (see below) give LSR velocities associated with Nessie (shown here as rainbow curve) near -40 km s⁻¹, placing Nessie in the Scutum-Centaurus arm (highlighted in black), about 3.1 kpc from the Sun. Yellow-highlighted curves show positions in the Galaxy that would have the labeled value of Galactic Latitude (B) when viewed from the Sun. In the top panel, only height of the Sun off the plane (taken to be 25 pc in this example) is considered in drawing the iso-b curves, and in the bottom panel, a 7 pc offset of the Galactic Center (see text), which causes an overall tilt of 0.12° is also taken into account.



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Real Life

2000

"Science"

The screenshot shows the KAYAK website interface for a flight search. The search parameters are London, United Kingdom to Boston, MA, United States, from 06/03/2013 to 13/03/2013. The results show 55 of 1327 flights, sorted by Price - Low to High. The first result is a Delta flight for £420, with a layover in Boston. Other results include Virgin Atlantic (£445) and British Airways (£449). The interface includes a 'Check Fares' section with a promotional offer for up to 10% off flights and 15% off hotels in Boston. There are also filters for stops, times, and airports.

The screenshot shows the VAO Data Discovery Tool interface. The search query is 'ngc1333' with a radius of 1. The results table lists various data sources and their titles. The table has columns for Type, Short Name, and Title. The results include ADS (Astrophysics Data System), CADC (CADC Image Search), SIMBAD (The SIMBAD astronomical database), NOMAD (NOMAD Catalogue), ZMASS QL (ZMASS All-Sky Quicklook Image Service), MAST-Scrapbook (The MAST Image Scrapbook), IRAS (The IRAS Sky Survey Atlas), UKIDSS DR5 SPAP (UKIDSS DR5 SPAP Service), UKIDSS DR7 SPAP (UKIDSS DR7 SPAP Service), UKIDSS DR8 SPAP (UKIDSS DR8 SPAP Service), UKIDSS DR4 SPAP (UKIDSS DR4 SPAP Service), UKIDSS DR3 SPAP (UKIDSS DR3 SPAP Service), HLA (Hubble Legacy Archive), NED/sources (The NASA/IPAC Extragalactic Database), NED/SED (The NASA/IPAC Extragalactic Database SED), and NED/images (The NASA/IPAC Extragalactic Database Images). On the right side, there is a 'AstroView' window showing a galaxy image with coordinates [RA] 03:29:47.279 [DEC] +31:42:02.539.

KAYAK

<http://www.rome2rio.com>

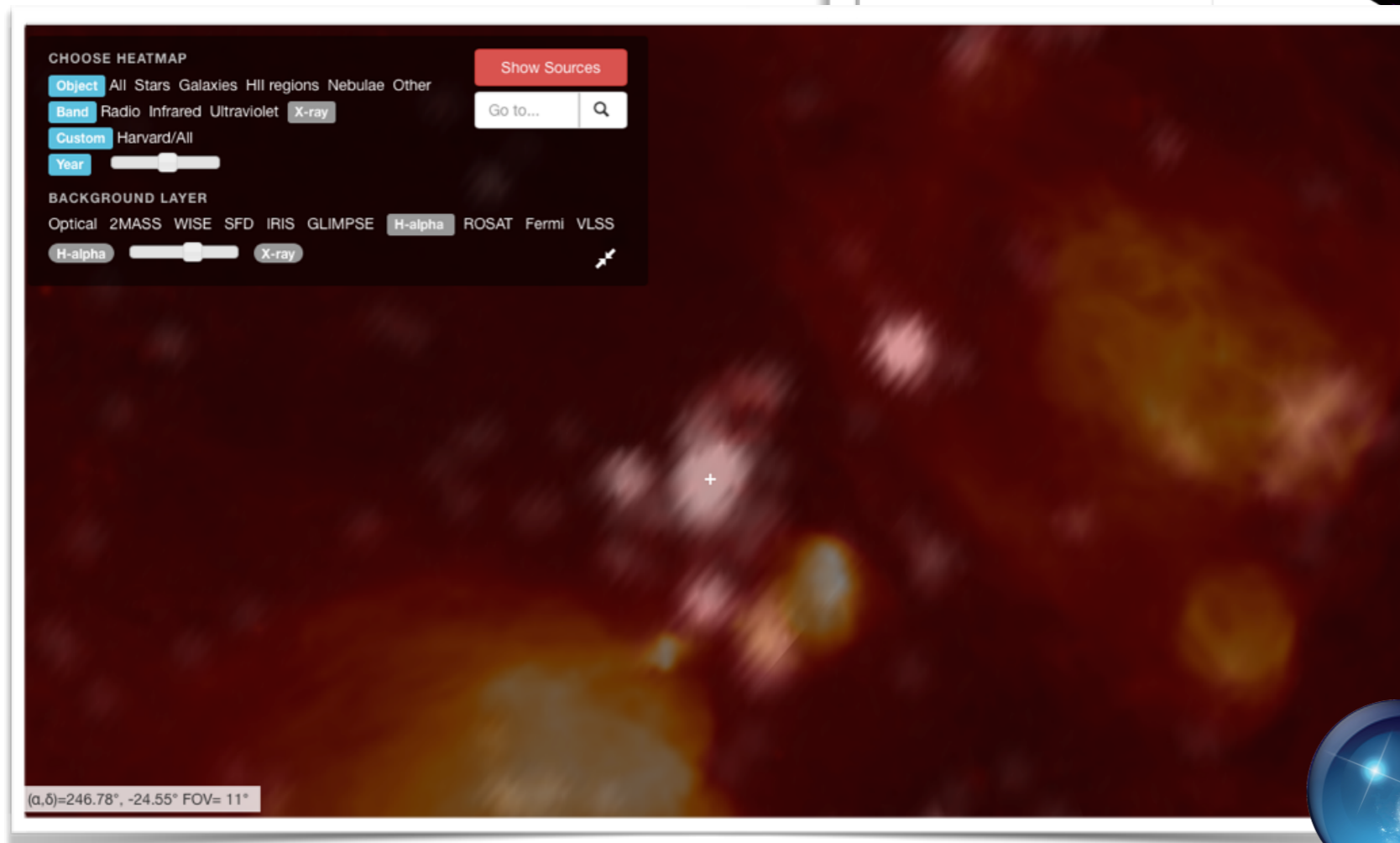
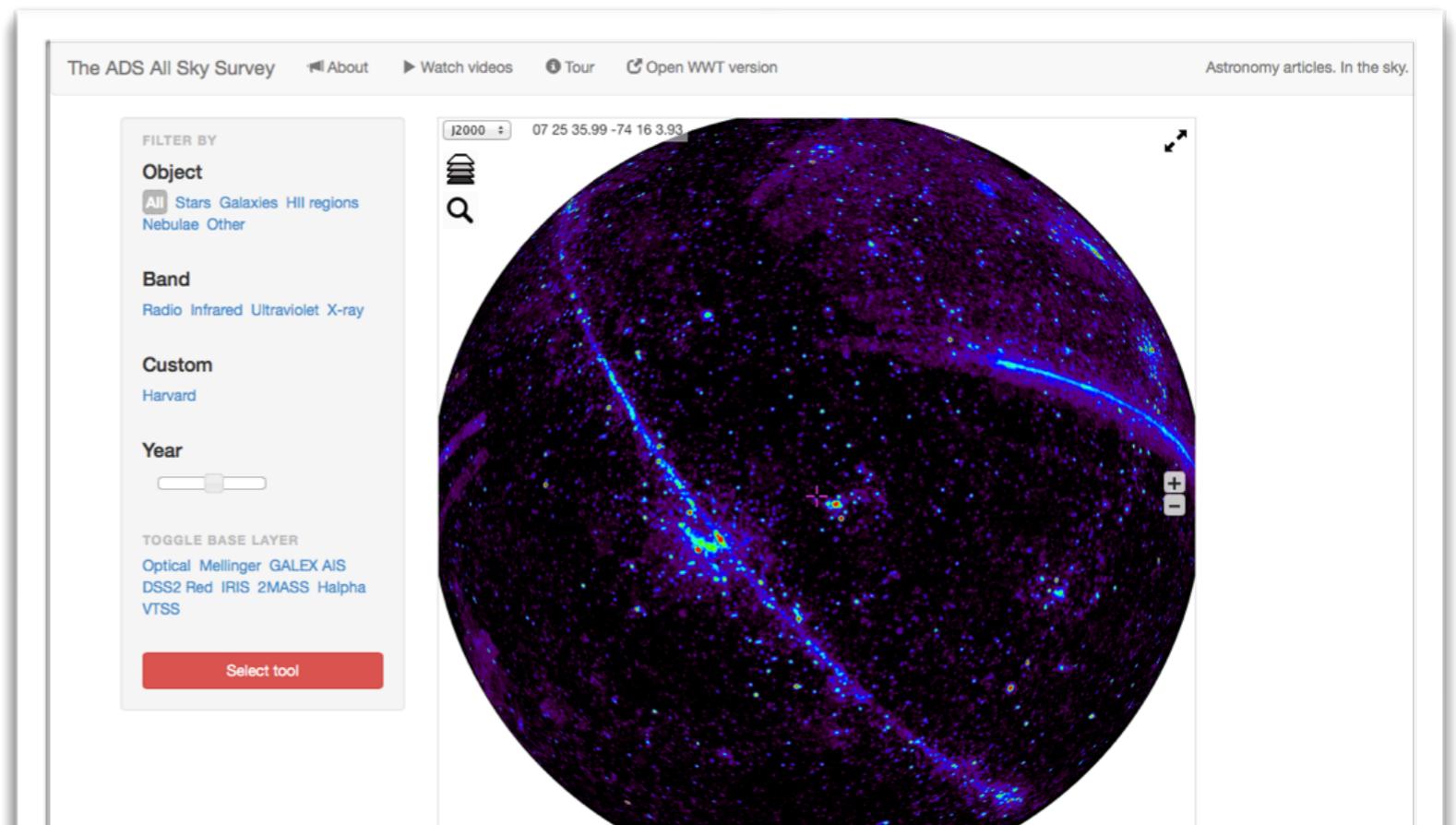
VAO Data Discovery Tool

The Present

A screenshot of a Facebook group page for 'Astronomers'. The page header shows the group name and a search bar. The profile picture is a vibrant, colorful nebula. The left sidebar contains navigation options like 'News Feed', 'Messages', 'Events', 'Photos', 'Browse', and 'Saved'. Below that are 'PAGES' and 'APPS' sections. The main content area features a post by 'JoEllen McBride via Julie Lauffenburger' with the text 'This is an interesting breakdown by topic of ArXiv paper authorship.' and an image of three stylized figures.

A screenshot of a Twitter search results page for the query 'bicep2'. The page shows a list of tweets related to the topic. The top tweet is from 'Dark Matter Hunters' (@DMHunters) discussing 'Neutrinos and dark energy after Planck and BICEP2: data consistency tests and cosmological parameter'. Other tweets include a link to a Washington Post article, a tweet in Spanish from Antonio Herrera, and tweets from arXiver, Dr. Michael Reidinger, and Lindsworth Deer. The left sidebar shows search filters like 'Everything', 'All people', and 'Everywhere', along with a 'Who to follow' section.

The Present



try it at
adsass.org



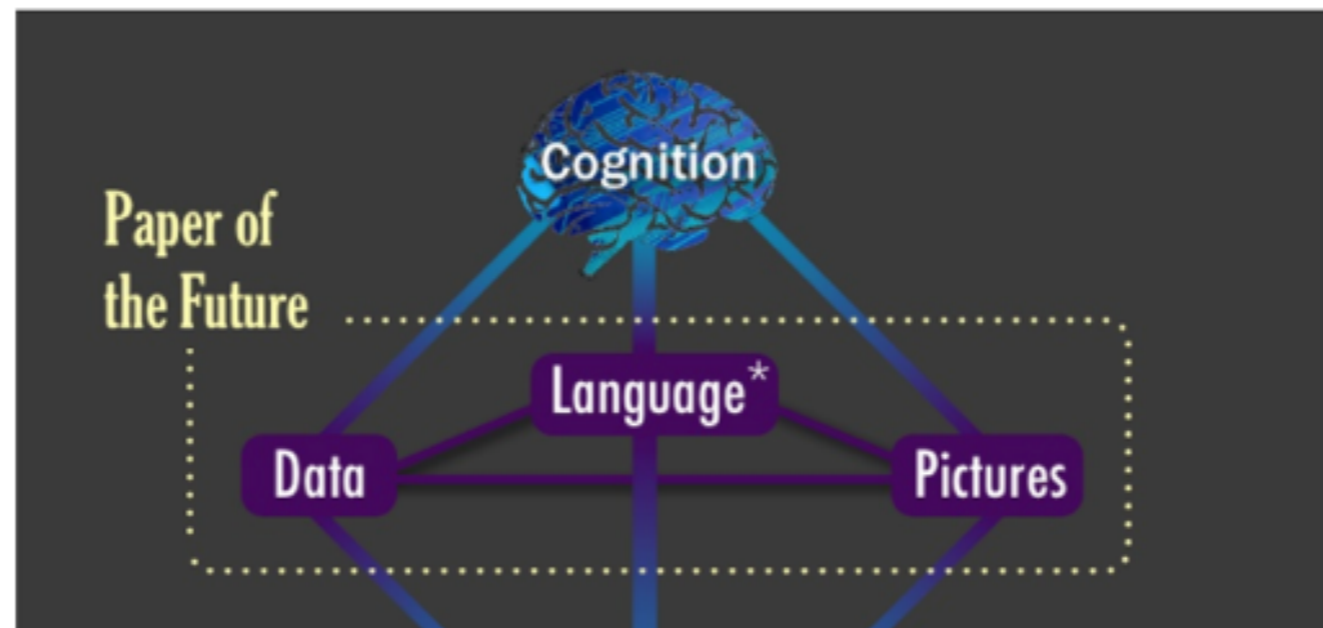
The "Paper" of the Future

[Alyssa Goodman](#), [Josh Peek](#), [How-Huan Hope Chen](#), [Nathan Jenkins](#), [August Muench](#), [Chris Beaumont](#), [Christine L. Borgman](#), [Alberto Pepe](#), [Alberto Accomazzi](#), [Christopher Erdmann](#), [Curtis Wong](#) [+ Add author](#)

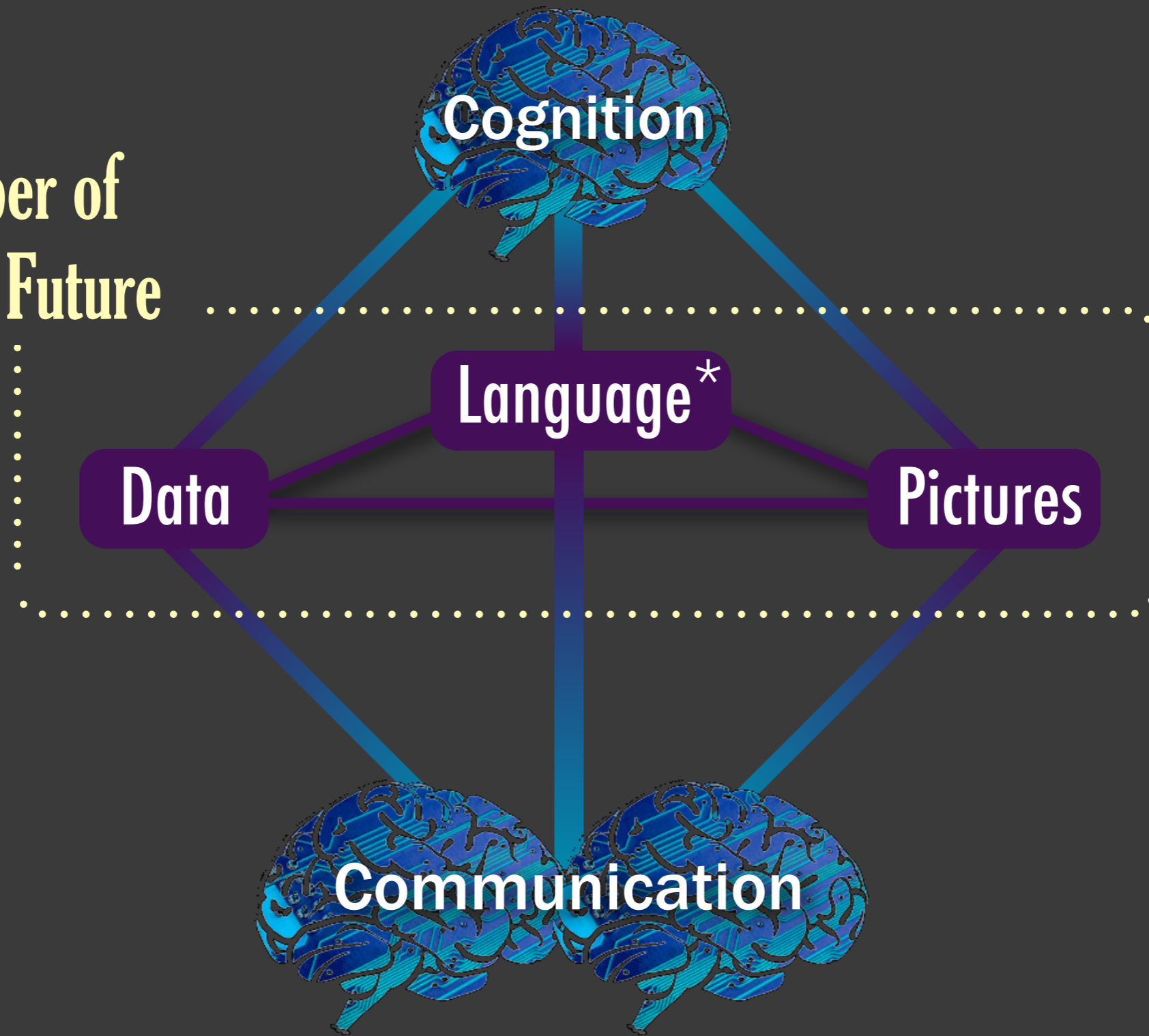
1 Preamble

A variety of research on human cognition demonstrates that humans learn and communicate best when more than one processing system (e.g. visual, auditory, touch) is used. And, related research also shows that, no matter how technical the material, most humans also retain and process information best when they can put a narrative "story" to it. Thus, when considering the future of scholarly communication, we should be careful not to blithely do away with the linear narrative format that articles and books have followed for centuries: instead, we should enrich it.

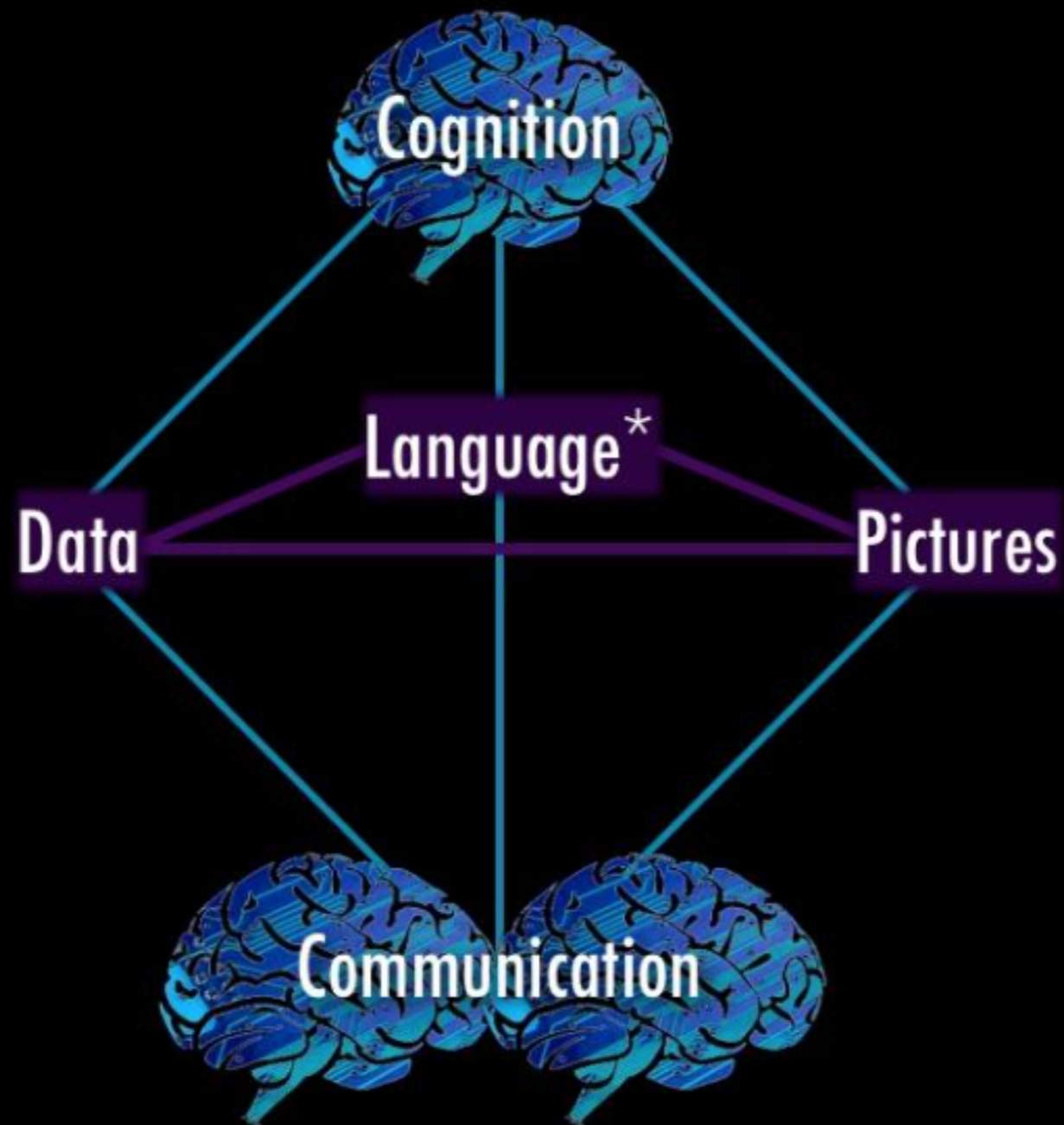
Much more than text is used to communicate in Science. "Figures," which include images, diagrams, graphs, charts, and more, have enriched scholarly articles since the time of Galileo, and ever-growing volumes of data underpin most scientific papers. When scientists communicate face-to-face, as in talks or small discussions, these figures are often the focus of the conversation. In the best discussions, scientists have the ability to manipulate the figures, and to access underlying data, in real-time, so as to test out various what-if scenarios, and to explain findings more clearly. **This short article explains--and shows with demonstrations--how scholarly "publications" can morph into long-lasting rich records of scientific discourse**, enriched with deep data and code linkages, interactive figures, audio, video, and commenting.



Paper of the Future



*"Language" includes words & math



*"Language" includes words & math



55 Alyssa Goodman @aagie · 11s

Seen these relationships between data:words:pictures re:cognition & communication before? If so, where?

@SciTechProf pic.twitter.com/VTjjCzDZYc

Reply Delete Favorite

Flag media

PRIVATE ROUGH DRAFT

Index

Settings

Fork

Quickedit

13 Comments

Export

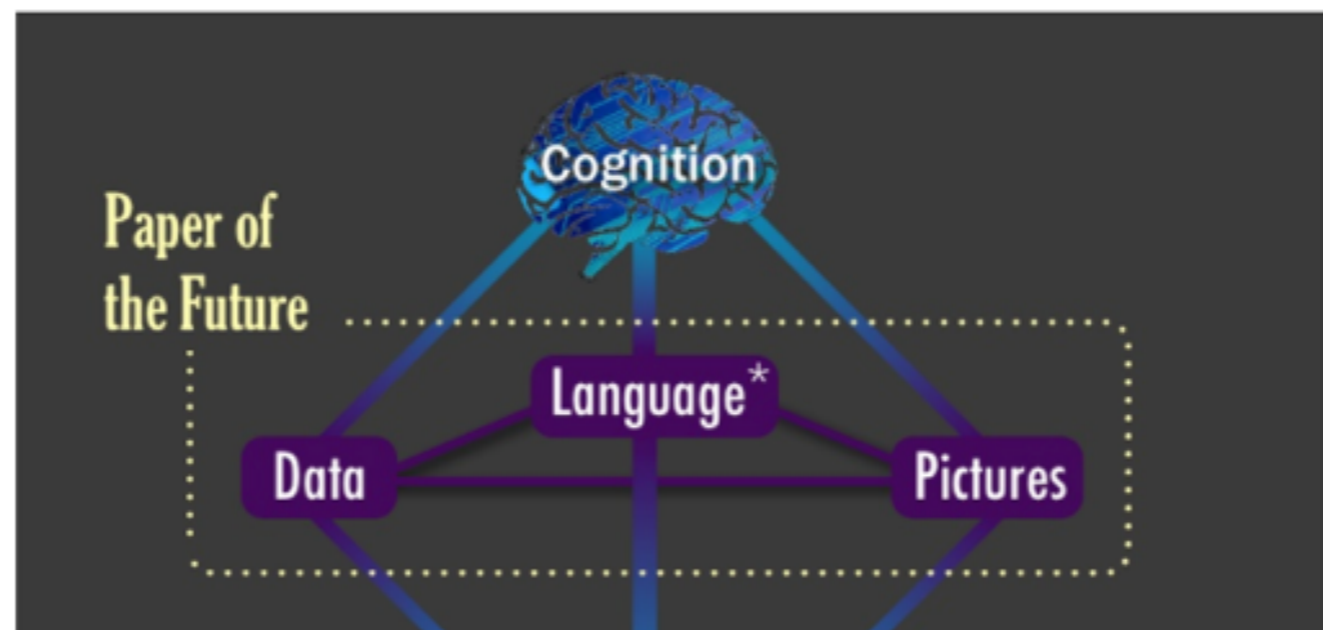
The "Paper" of the Future

[Alyssa Goodman](#), [Josh Peek](#), [How-Huan Hope Chen](#), [Nathan Jenkins](#), [August Muench](#), [Chris Beaumont](#), [Christine L. Borgman](#), [Alberto Pepe](#), [Alberto Accomazzi](#), [Christopher Erdmann](#), [Curtis Wong](#) [+ Add author](#)

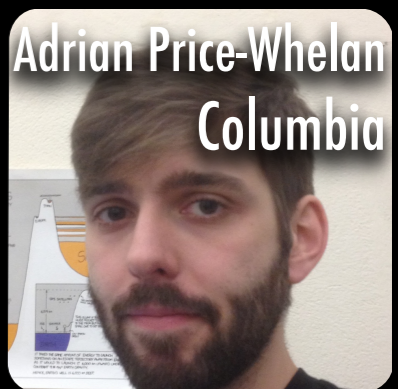
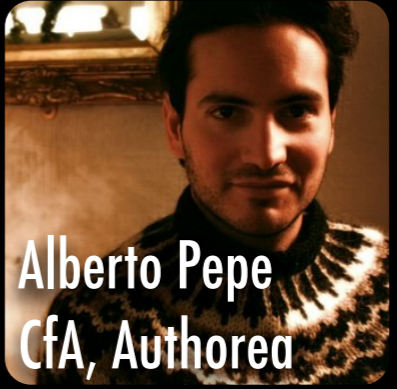
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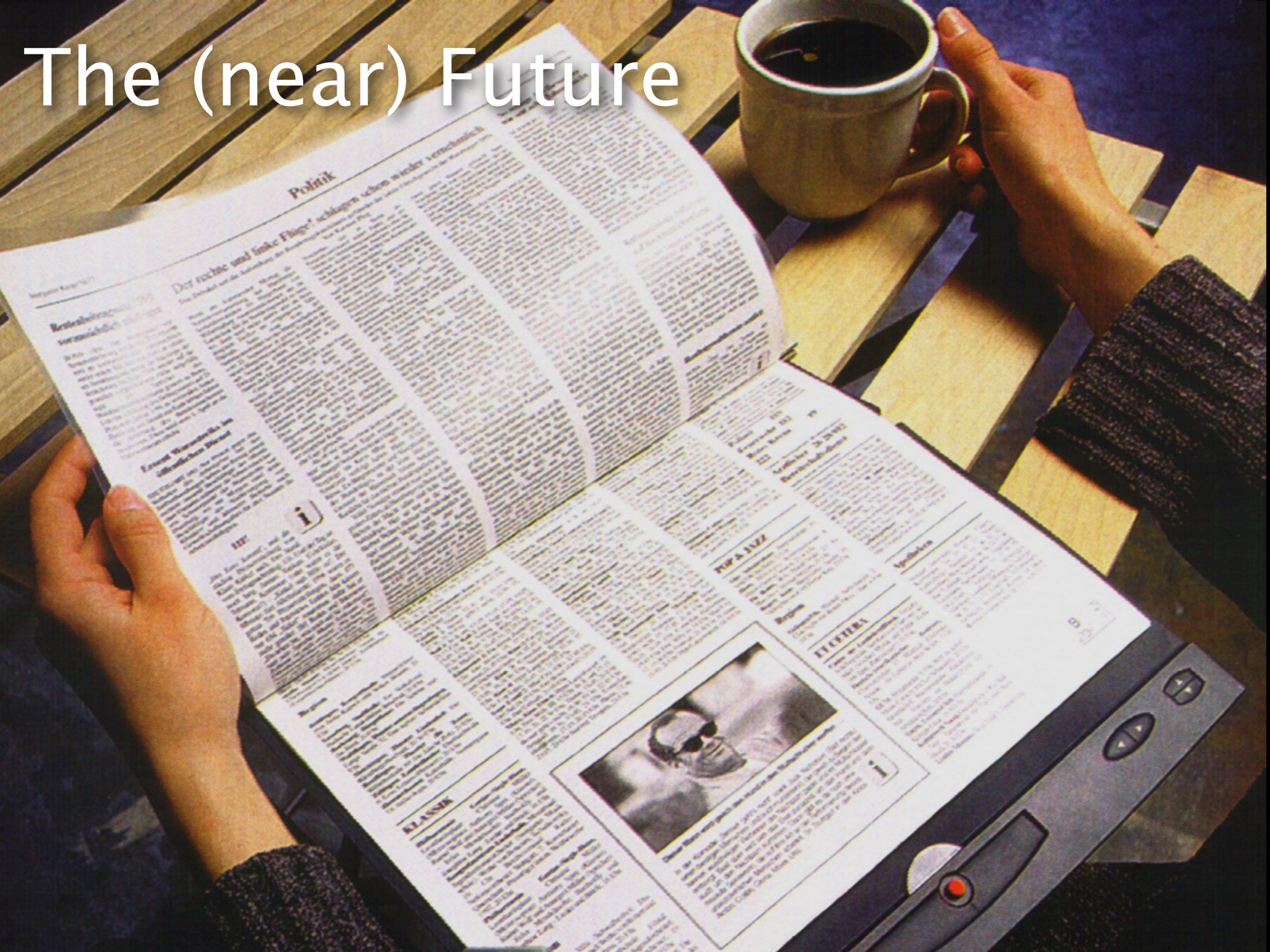
“The Story & the Sandbox” (Glue:D3PO:Authorea)



The screenshot shows a web browser displaying an Authorea article. The URL is https://www.authorea.com/users/2786/articles/4039/_show_article. The page features a navigation bar with links for BROWSE, ABOUT, CONTACT, PLANS, FEEDBACK, HELP, and a user profile for JOSH PEEK. The article title is "Beyond Galileo" by Josh Peek and Alberto Pepe. The article text discusses Galileo's discovery of four objects near Jupiter in 1610. A quote from Galileo's *Sidereus Nuncius* is included: "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 (near) Future



2002 Patent Application for e-Scroll

Patents

Application

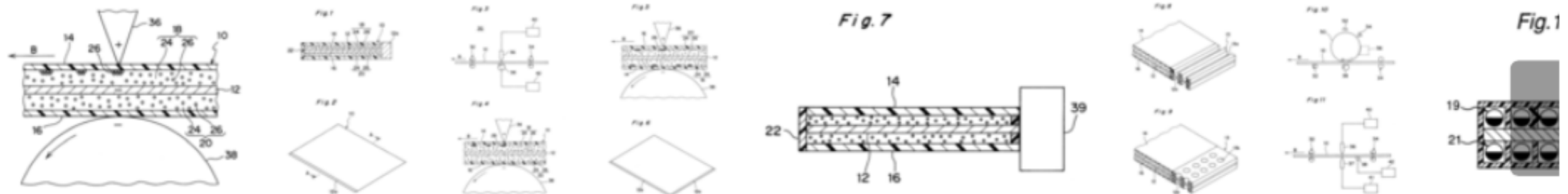
Grant

Rewritable display sheet, image forming apparatus for displaying image on rewritable display sheet, and image displaying method US 6618188 B2

ABSTRACT

Provided is a rewritable display sheet capable of displaying different images on both surfaces. The rewritable display sheet **10** of the present invention is provided with a conductive substrate **12** that has a voltage applying section **12 a** at an end portion, transparent sheets **14** and **16** provided on both sides of the conductive substrate **12**, and display layers **18** and **20** which are provided between the conductive substrate **12** and the transparent sheets **14** and **16** and in which an image is written with an electric field applied.

IMAGES (8)



Publication number	US6618188 B2
Publication type	Grant
Application number	US 10/097,273
Publication date	Sep 9, 2003
Filing date	Mar 15, 2002
Priority date	Mar 23, 2001
Fee status	Paid

Also published as [US20020135859](#)

Inventors [Masayasu Haga](#)

Original Assignee [Minolta Co., Ltd.](#)

Export Citation [BiBTeX](#), [EndNote](#), [RefMan](#)

[Patent Citations](#) (12), [Classifications](#) (8), [Legal Events](#) (3)

External Links: [USPTO](#), [USPTO Assignment](#), [Espacenet](#)

Future Learning

WorldWide Telescope Ambassadors



Higher Ed

the 2013 experiment

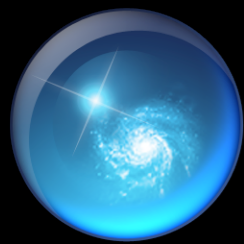
HARVARD UNIVERSITY
ASTRONOMY 201B
DEMOFEST

edX

LOCATION
Perkin Lobby and Wolbach Library, 60 Garden Street

TIME
11-12 for drop-in demos
12-12:45 lunch for students & their guests

PREVIEW
<http://ay201b.wordpress.com/topical-modules>



Microsoft World



Experience WWT at worldwidetelescope.org

The screenshot displays the WWT interface with a top navigation bar containing 'Explore', 'Guided Tours', 'Search', 'View', and 'Settings'. Below this is a 'Collections > All-Sky Surveys >' section with a row of image thumbnails: 'Digitized Sky Survey', 'VLSS: VLA Low-frequency Sky Survey', 'WMAP ILC 5-Year Cosmic Microwave Background', 'SFD Dust Map (Infrared)', 'IRIS: Improved Resolution', '2MASS: Two Micron All Sky Survey', and 'Hydrogen Alpha Filter'. A central circular field of view shows a galaxy with a crosshair. A 'Finder Scope' window is open, displaying 'NGC224' with its classification as a 'Spiral Galaxy in Andromeda' and various astronomical coordinates (RA, Dec, Alt, Az, Rise, Transit, Set). Below the main view is a 'Look At' dropdown set to 'Sky', an 'Imagery' section with 'Digitized Sky Survey' and 'Three Faces of Andromeda', and a 'Context bar' showing 'NGC221' and 'M31'. A 'Context globe' on the right shows the current field of view on a celestial sphere. A 'Context bar' at the bottom right shows 'Andromeda' and coordinates (RA: 00h42m40s, Dec: 41:13:35).

Seamlessly explore imagery from the best ground and space-based telescopes in the world

Expert led tours of the Universe

Control time to study how the night sky changes

View and compare images from across the electromagnetic spectrum

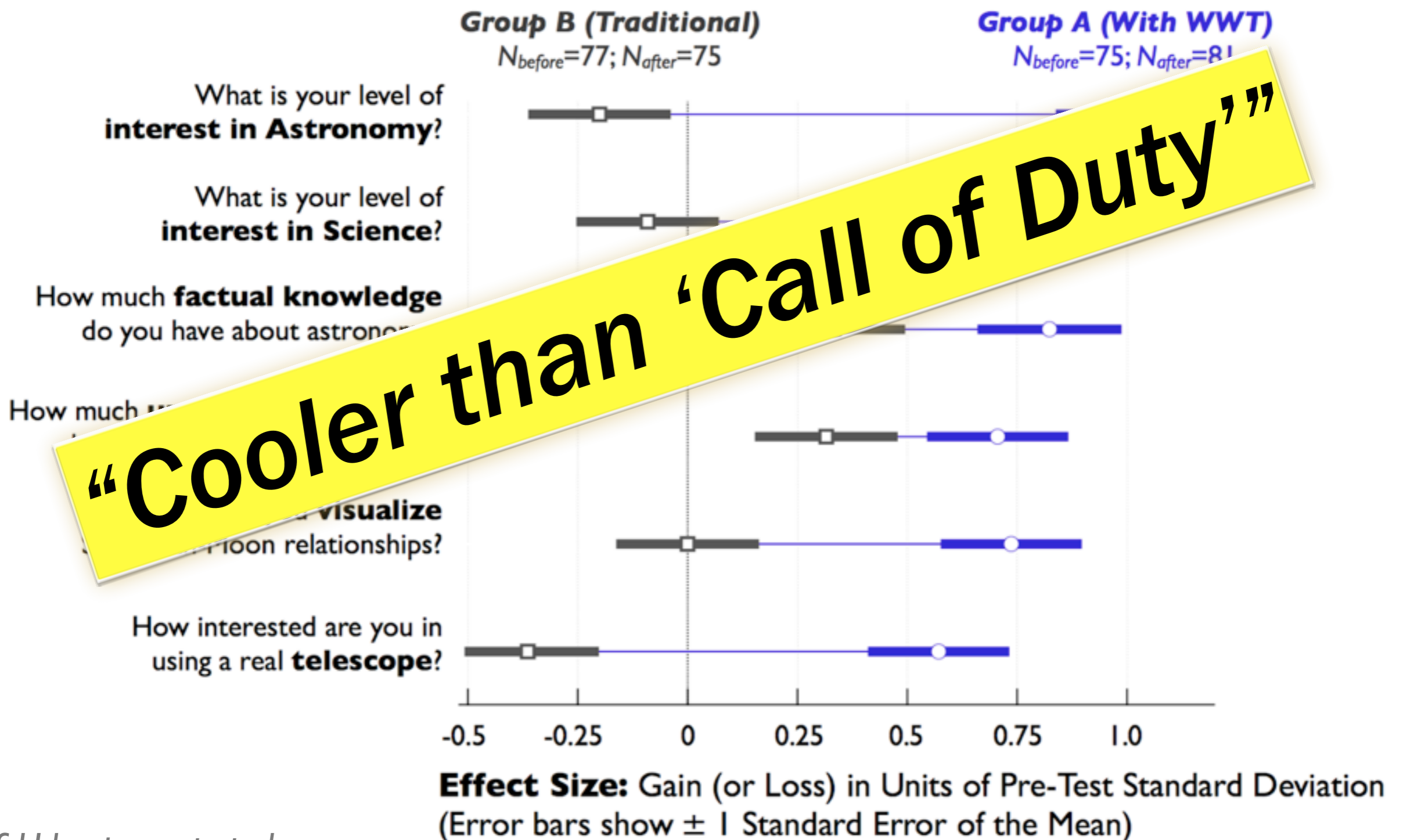
Much more than "just" the sky at night! 3D features can take you to other planets, stars & galaxies.

Finder Scope links to Wikipedia, publications, and data, so you can learn more

Context bar shows items of interest in current field of view

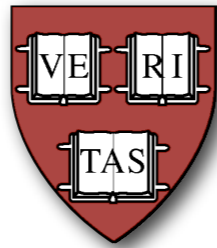
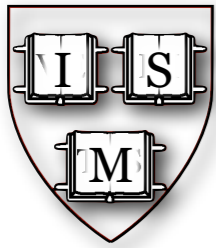
Context globe shows where you're looking.

Gains in Student Interest and Understanding



the 2013 experiment

HARVARD UNIVERSITY ASTRONOMY 201B DEMOFEST



LOCATION

Perkin Lobby and Wolbach Library, 60 Garden Street

TIME

11-12 for drop-in demos
12-12:45 lunch for students & their guests

PREVIEW

<http://ay201b.wordpress.com/topical-modules>



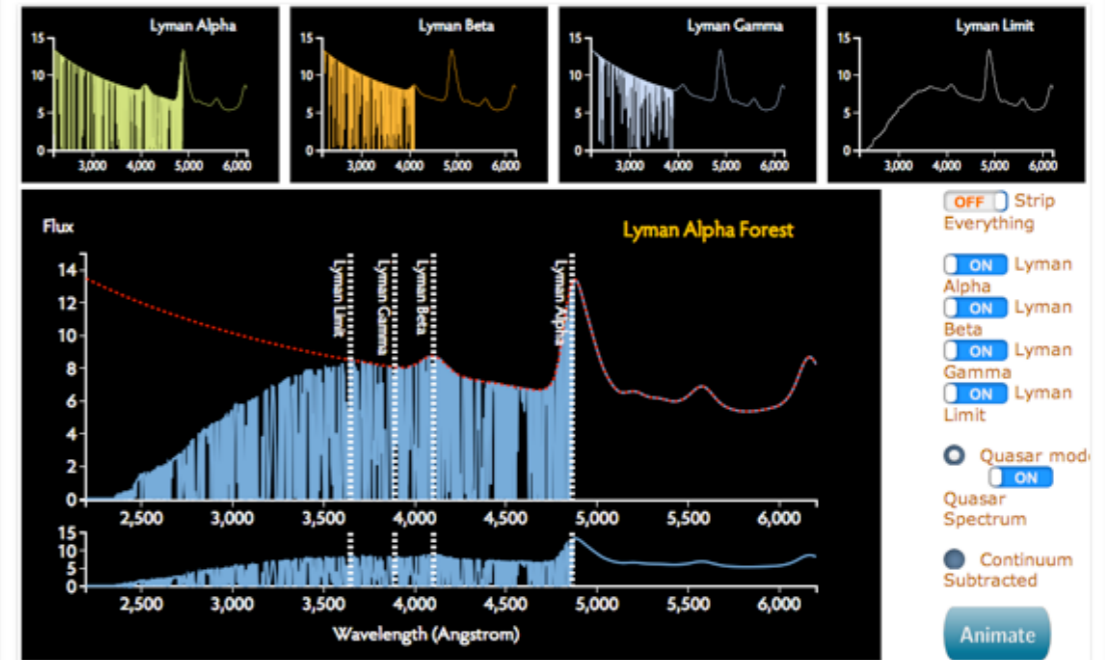
Viz in Higher-Ed

Stephen

all lines SII 6716/6731 A He 6683 A OIII 5007 A

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/>

The Future

bendable paper

everything is a screen

data are everywhere

everyone's data are shared

new data are community efforts, and community property

software is modular, seamless, and largely invisible

