

Astronomy as I "See" It

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Professor of Astronomy
& Founding Director of the
Initiative in Innovative Computing,
Harvard University

Scholar-in-Residence,
WGBH Boston



~~VVVA/1111 the iiic based on a research...~~

Astronomical Medicine

3D PDF (& Touch & Taste)
(a.k.a. "coming to our senses")

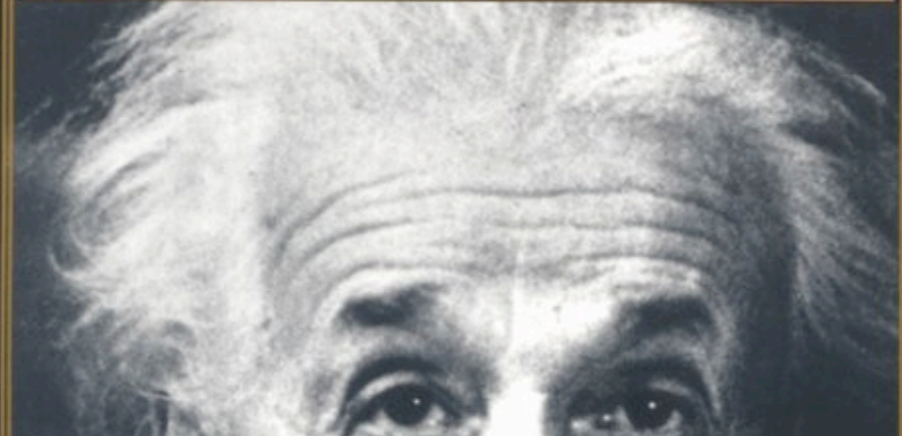
WorldWide Telescope

"Seamless Astronomy"

and someday..Generalized Interoperable Viz Tools

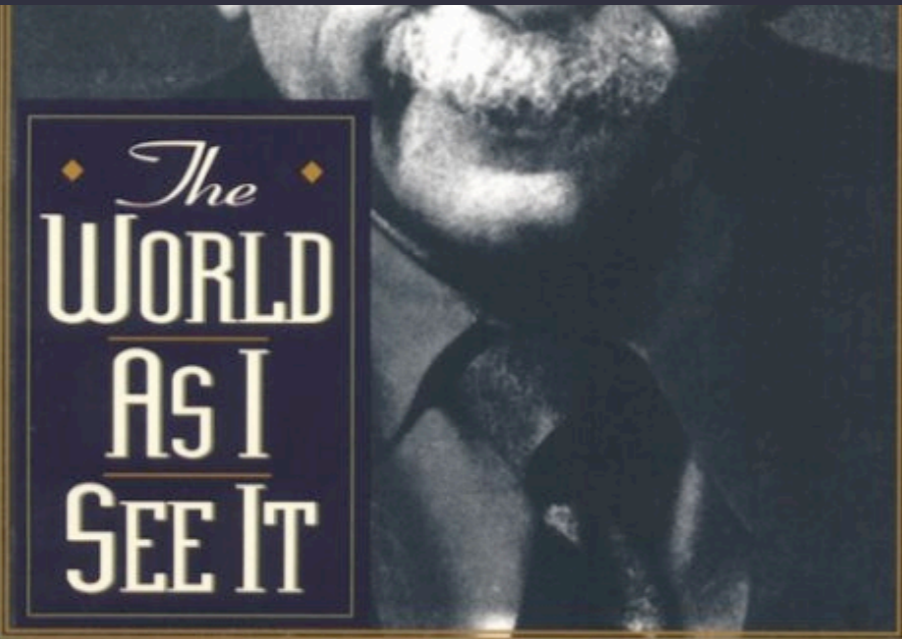


ALBERT EINSTEIN



The most incomprehensible

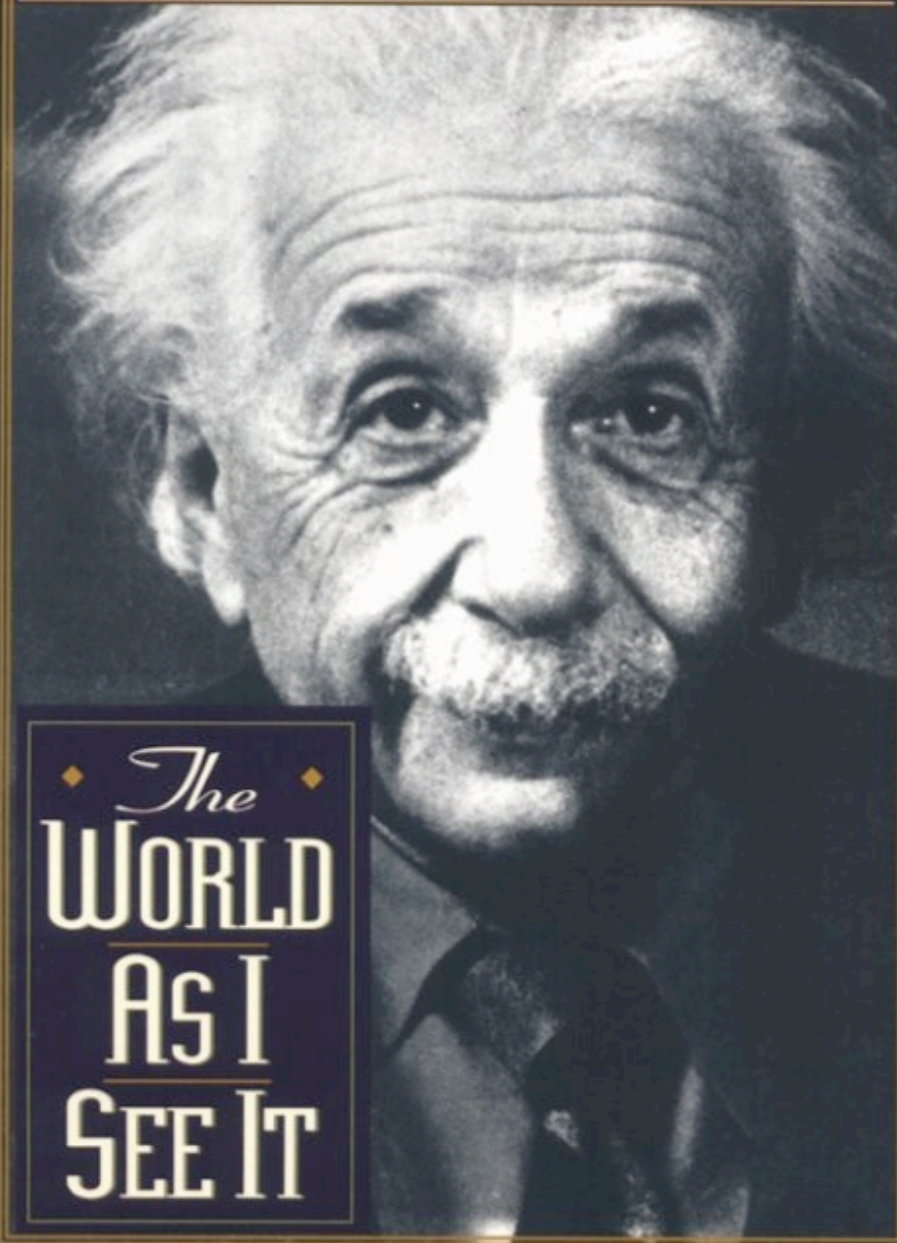
“Astronomy as I See It”



- Albert Einstein

“Astronomy as  It”

ALBERT EINSTEIN



*The most incomprehensible
thing about the universe is
that it is **comprehensible**.*

- Albert Einstein

Relative Strengths



Pattern Recognition
Creativity



Calculations



“Interocularity”

(see work of John Tukey)

“Image and Meaning”

(see work of Felice Frankel,
and imageandmeaning.org)

Data • Dimensions • Display (DDD)

What about DDD...

...is easier now than before?

fast computation, animation, 3D

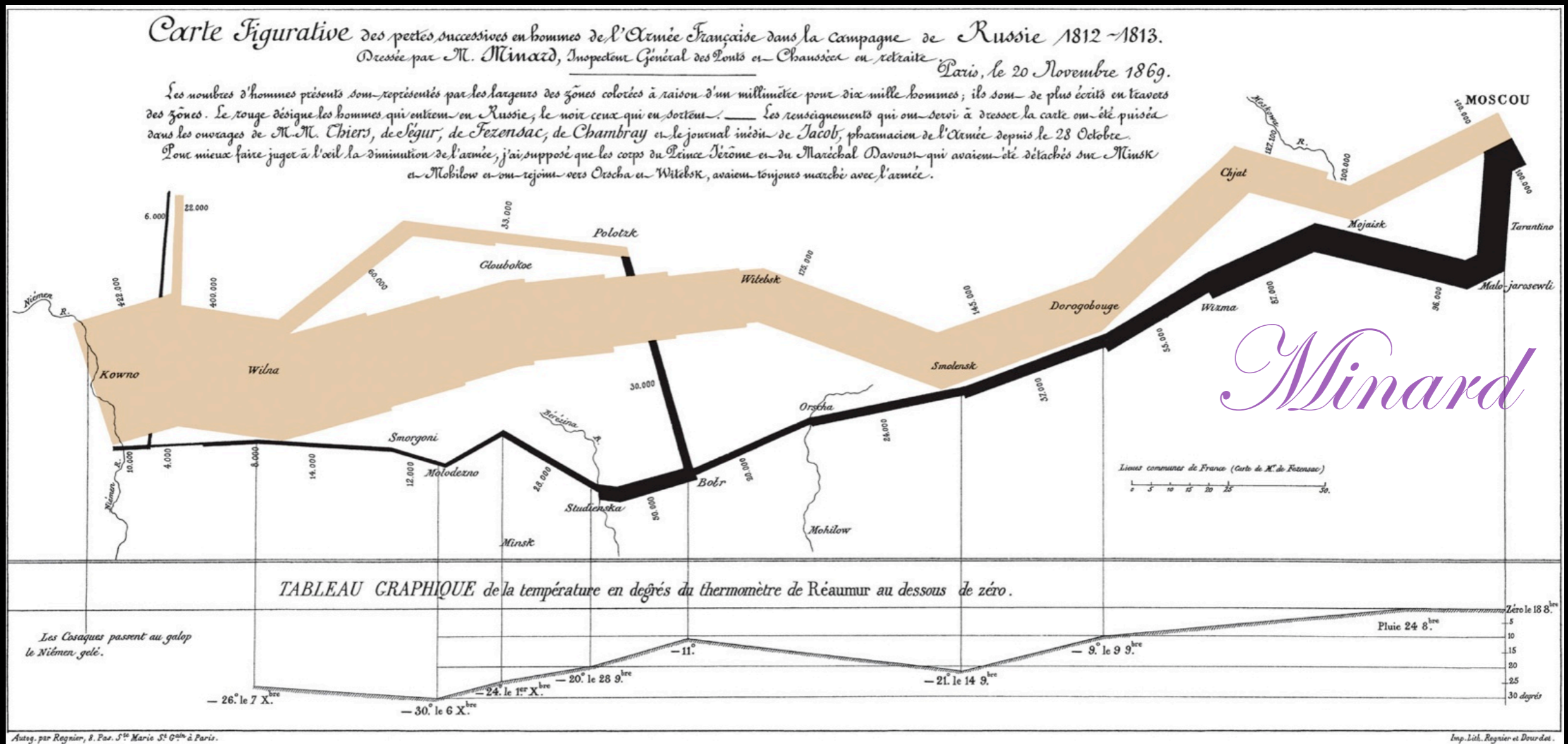
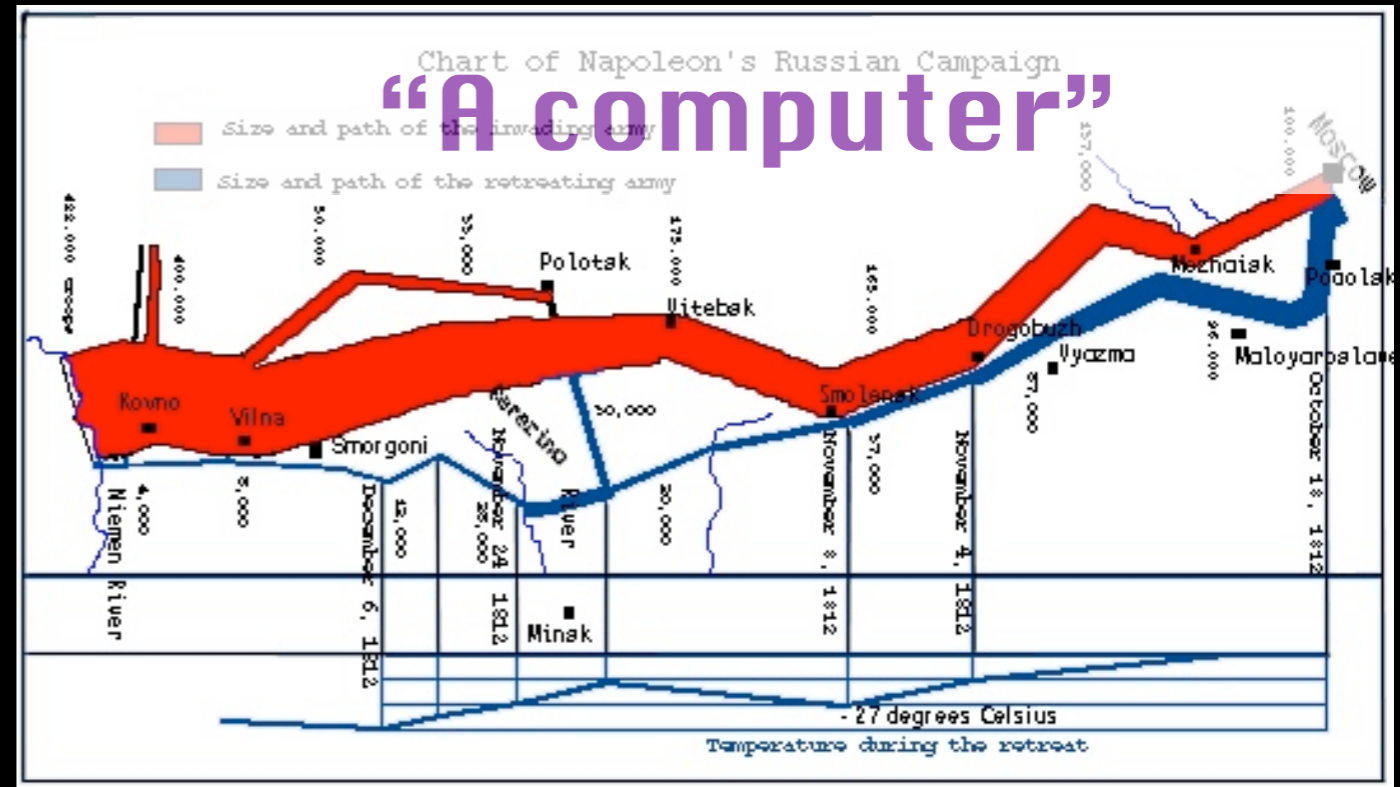
...was easier before than now?

craftsmanship

...should be easier in the future?

modular craftsmanship

Are we held back by confining tools?



Galileo (1564-1642)

Sex^{mo} Principe.

Galileo Galilei, Humilis^s Servus della Ser.^a V.^a inuigilanti
 do assiduam, et de ogni spirito se essere no solo satisfatto
 alvario che non della stessa di Mathematico nelle sue
 Dio di Padova,

Inuere diuere determinate di presentare al Sex^{mo} Principe
 l'Orbicle et il p. essere di giuamento inestimabile p. ogni
 negozio et in irea marittima o terreste stimo di tenere per
 ste nuovi artificio ne l'ingegno segreto et solam a disposizione
 di u. ser. l'Orbicle auato dalle piu u. d. ite speculazioni di
 prop. botina na l'uantaggio di scoprire Legni et Vele dell' inimici
 p. Val hore et piu di tempo prima di essi suspra noi et distinguend
 il numero et la qualita dei Vasselli giudicare le sue forze
 ballastarsi alla caccia al combattimento o alla fuga, o pure essi
 nella campagna aperta uedere et particolarly distinguere ogni suo
 moto et propriamento.

Adi 7. di gennaio
 Giove si uide u. 10. 11.
 Adi 8. u. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30.
 4. ora d'uy diretto et no retrogrado
 Adi 12. si uide in tale uisione * * * * *
 N. 13. si uide u. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30.
 Adi 14. è angelo * * * * *
 N. 15. * * * * * la pressi a 4. ora in mig. la 4. ora di =
 stante dalla 3. a. d. d. p. p. la terra
 Lo spazio delle 3. meridionali no om
 maggiore del diametro di 7. et c.
 in area retta.

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

SIDERIUS 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
 e closest western one 2 minutes; and the other western one wa

East * ○ * * West

o 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 precise

East * * ○ * * West

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

East ** ○ * * West

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

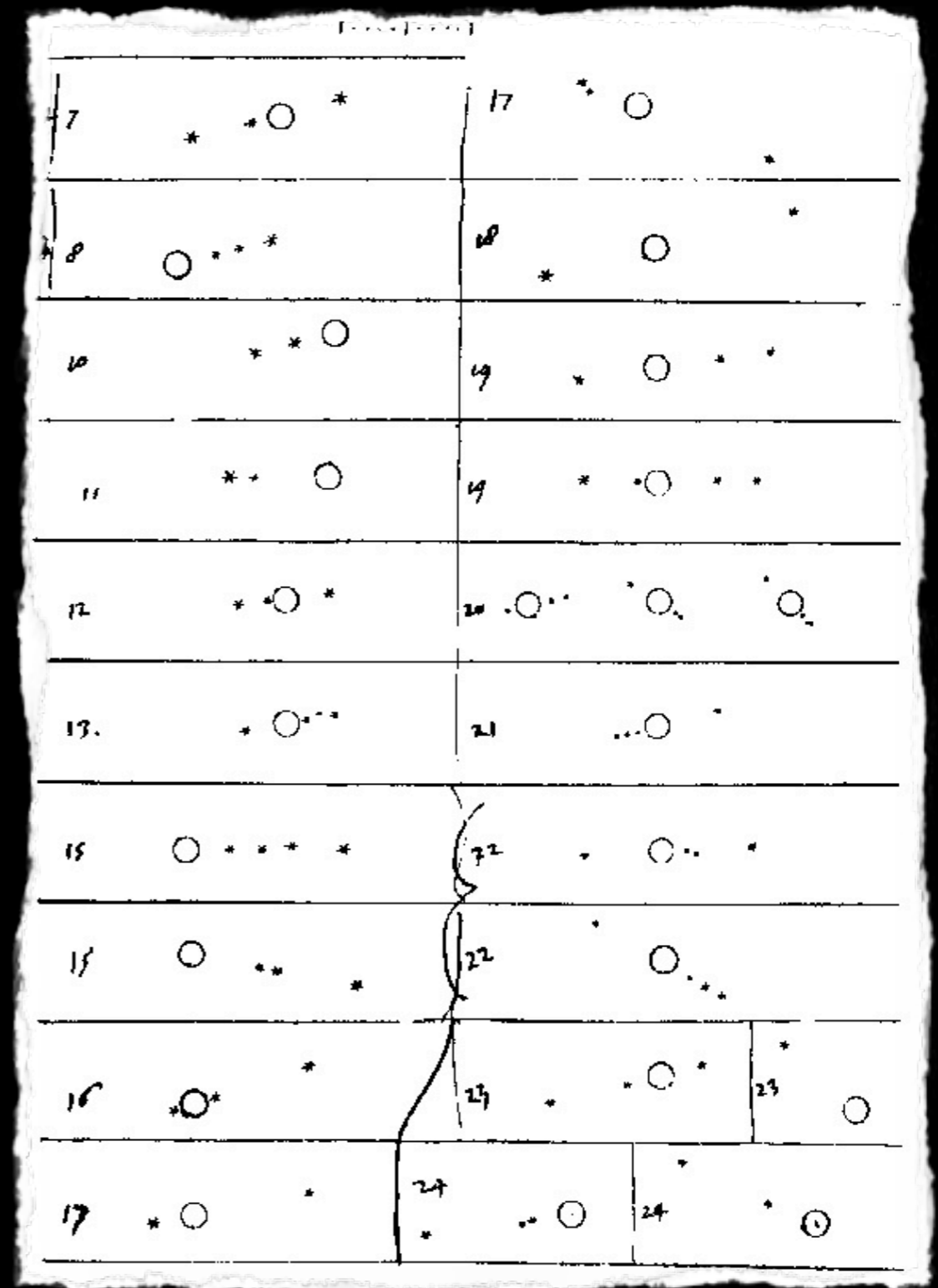
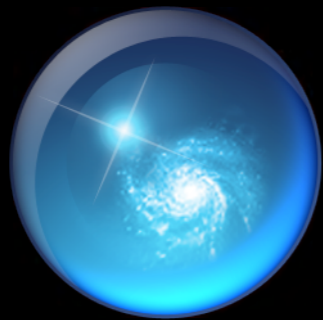
East * ○ * West

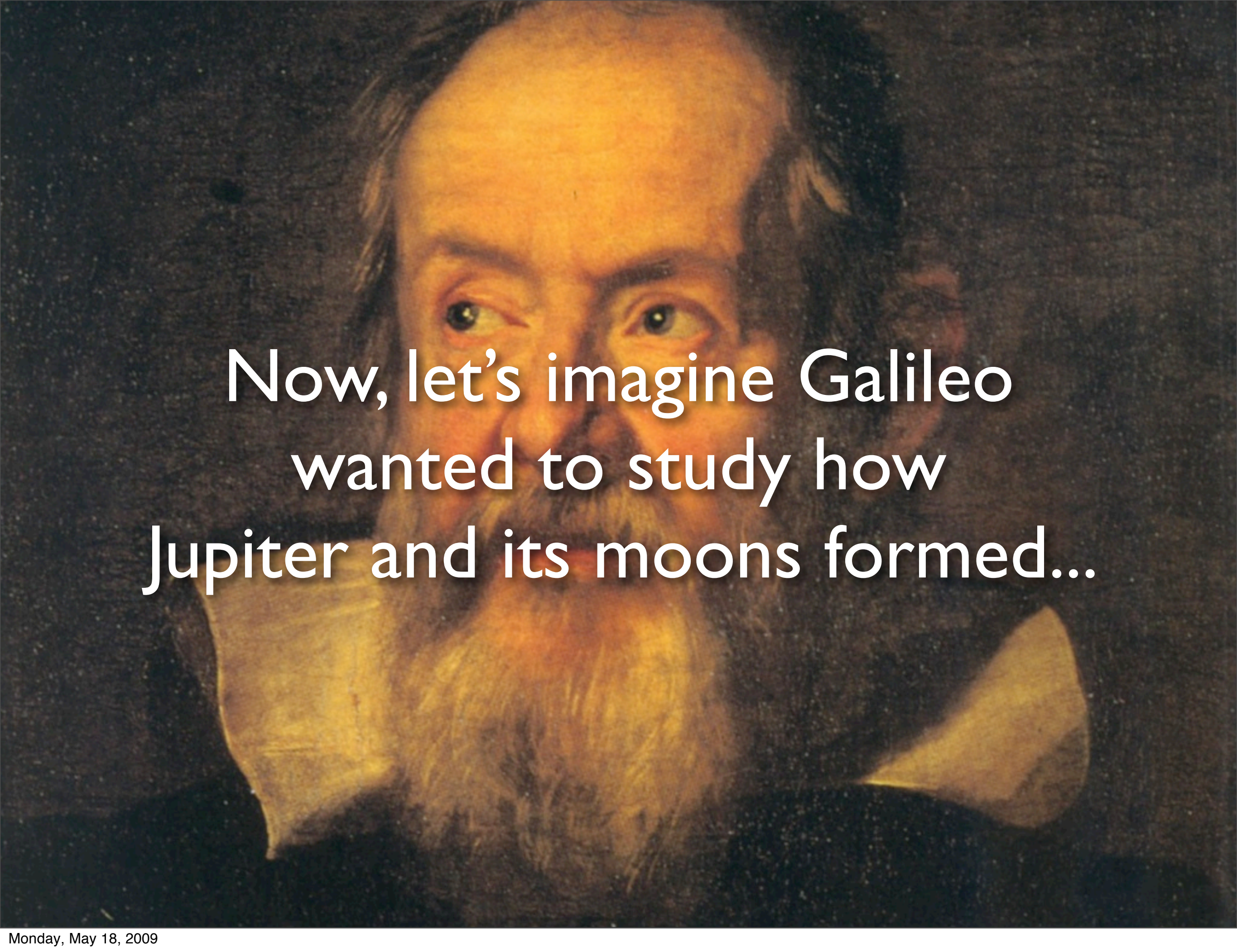
in the adjoining figure. The eastern one was 2 minutes and the
 western one 3 minutes from Jupiter. They were on the same straight
 line with Jupiter and equal in magnitude.

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

Notes for & re-productions of Siderius Nunciuss

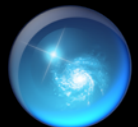
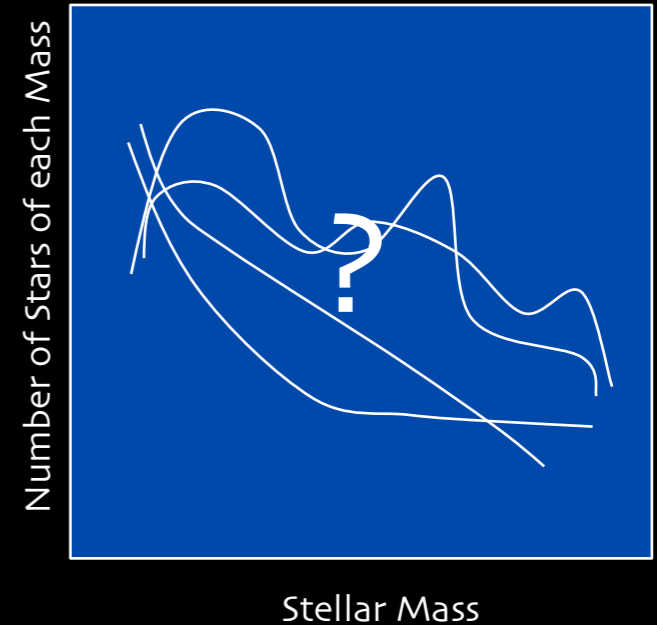
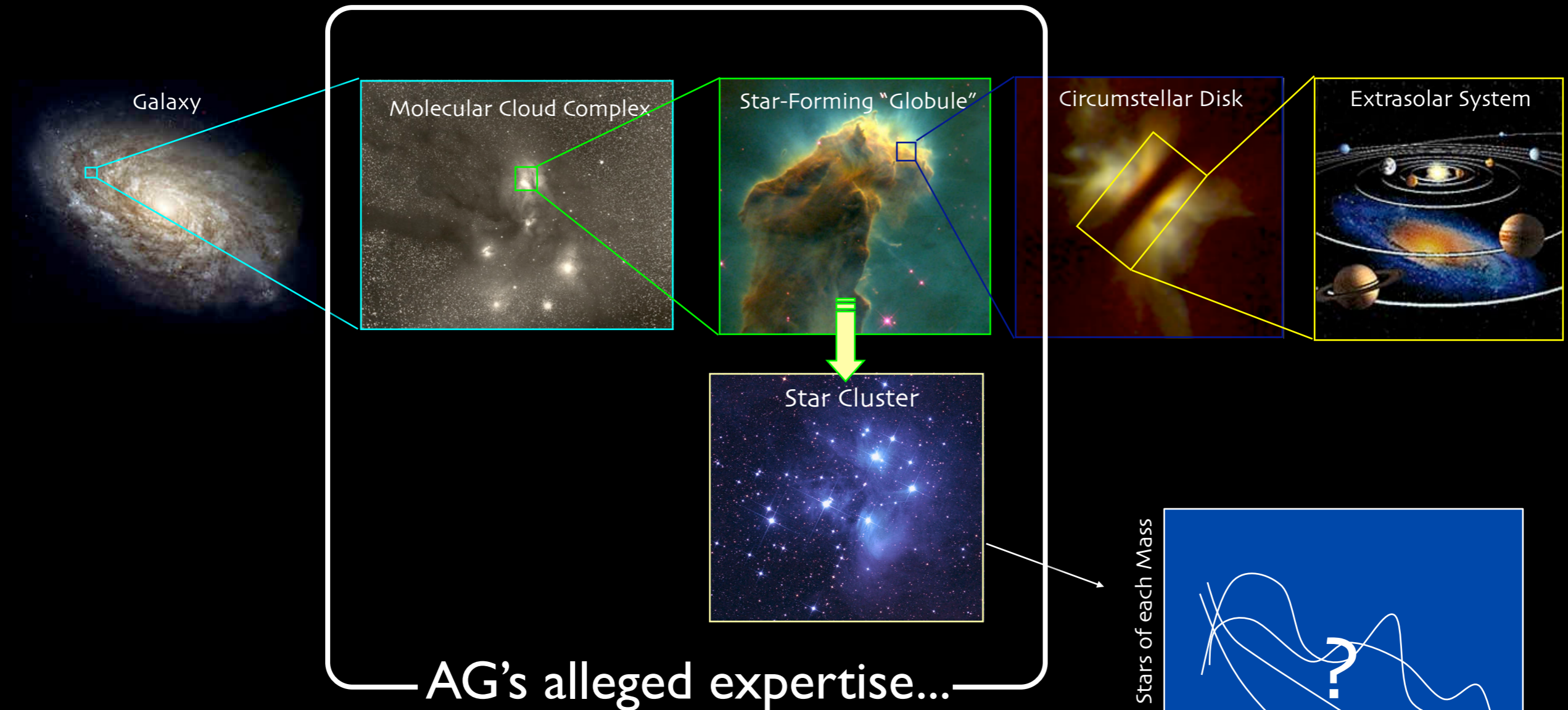
How could Galileo study Jupiter and its moons *now*?



A close-up portrait of Galileo Galilei, showing his face and a full, dark beard. He is looking slightly to the left of the viewer. The background is dark and textured.

Now, let's imagine Galileo
wanted to study how
Jupiter and its moons formed...

Star (and Planet, and Moon) Formation 101





Astronomical Medicine

Alyssa Goodman (IIC/CfA/FAS)

Michael Halle (IIC/SPL/HMS)

Ron Kikinis (SPL/HMS)

Douglas Alan (IIC)

Michelle Borkin (FAS/IIC)

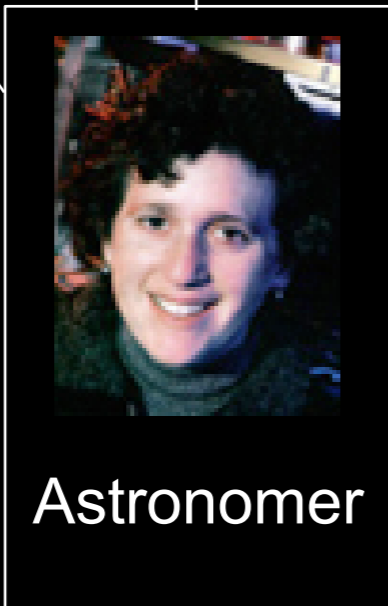
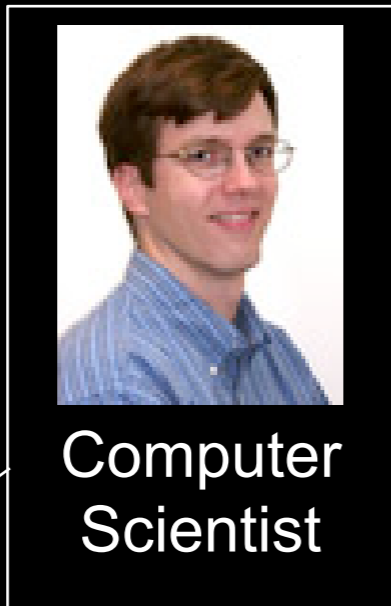
Jens Kauffmann (CfA/IIC)

Erik Rosolowsky (CfA/UBC Okanagan)

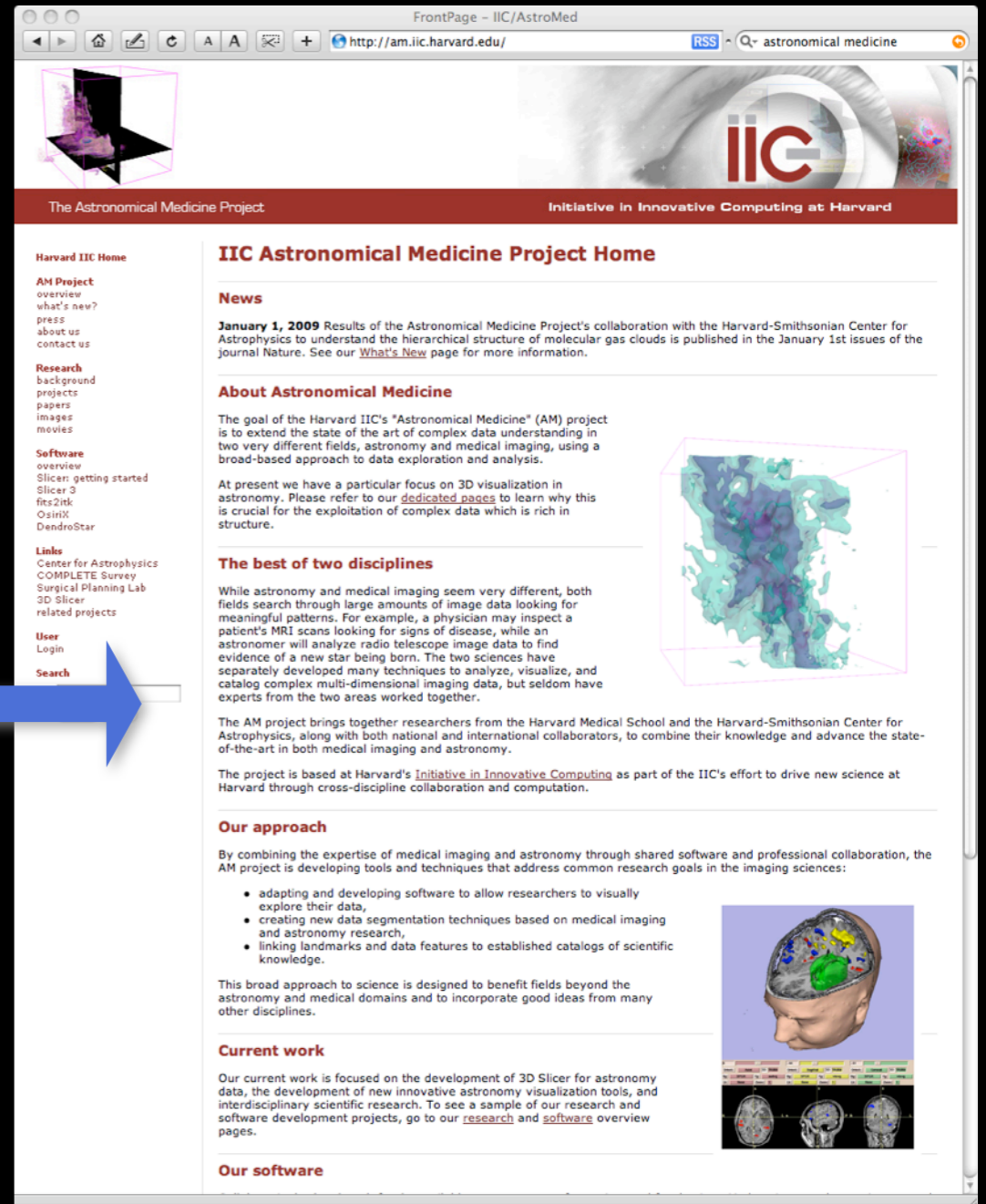
Nick Holliman (U. Durham)



The Astronomical Medicine Story



“Viz has failed the scientific community...”



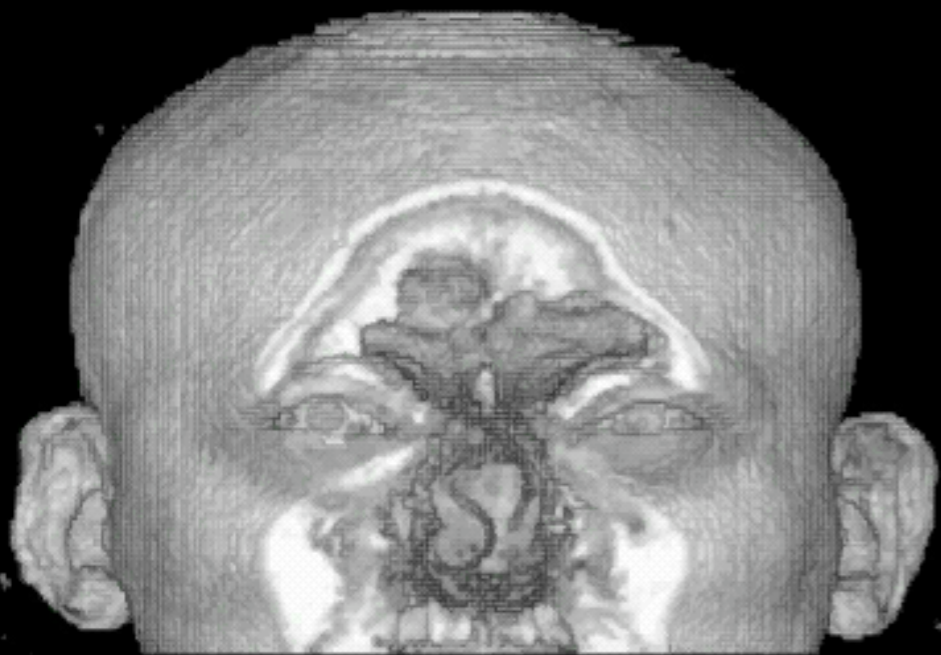
- +Nick Holliman (CS, 3D expert)
- +Doug Alan (S/W Engineer)
- +Jens Kauffmann (postdoc)
- +Erik Rosolowsky (postdoc) + ...



The “DDD” issue Mike saw in his mind...

“Astronomical Medicine”

“KEITH”



“z” is depth into head

“PERSEUS”

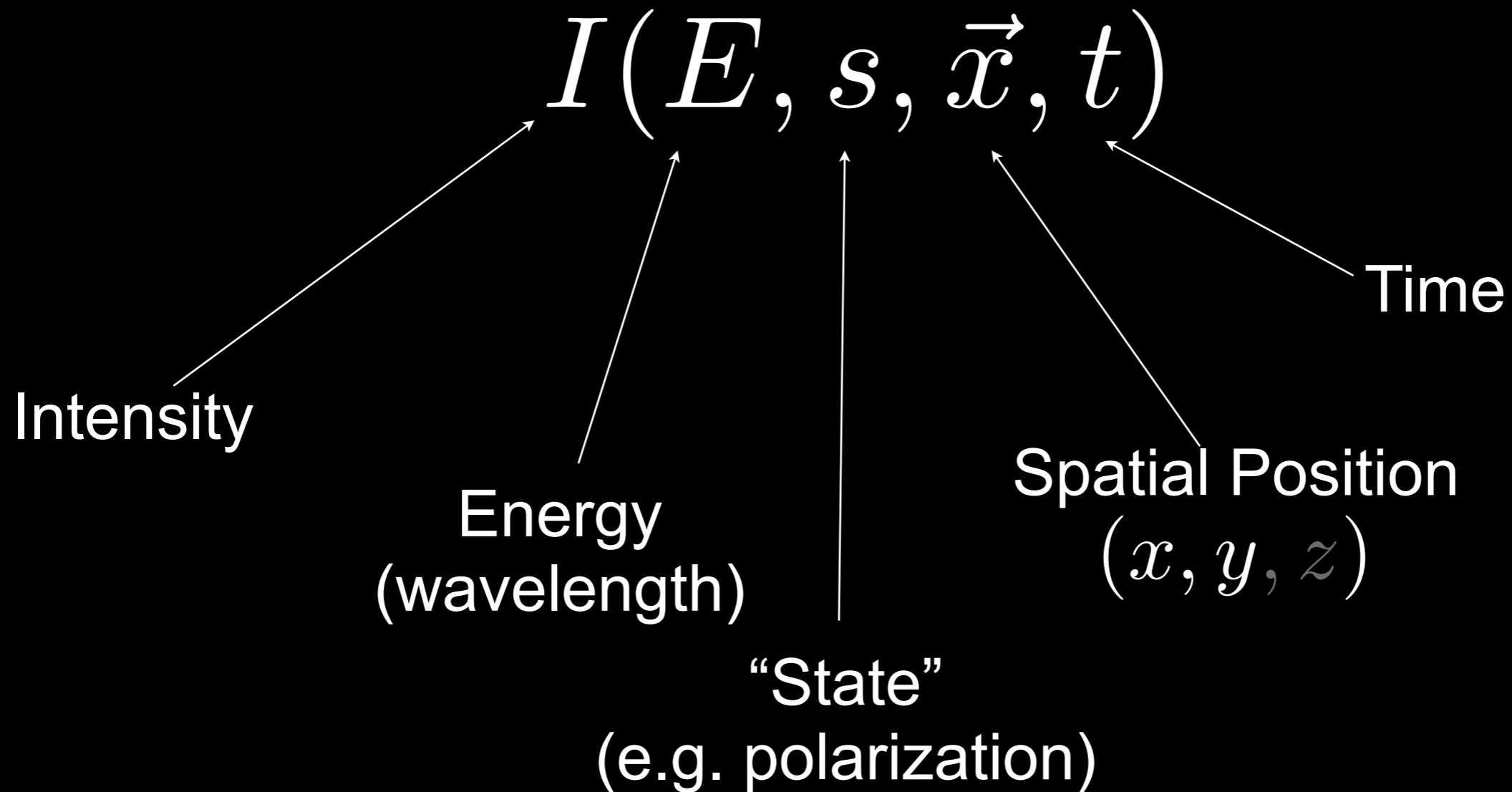


“z” is line-of-sight velocity

(This kind of “series of 2D slices view” is known in the Viz as “the grand tour”)

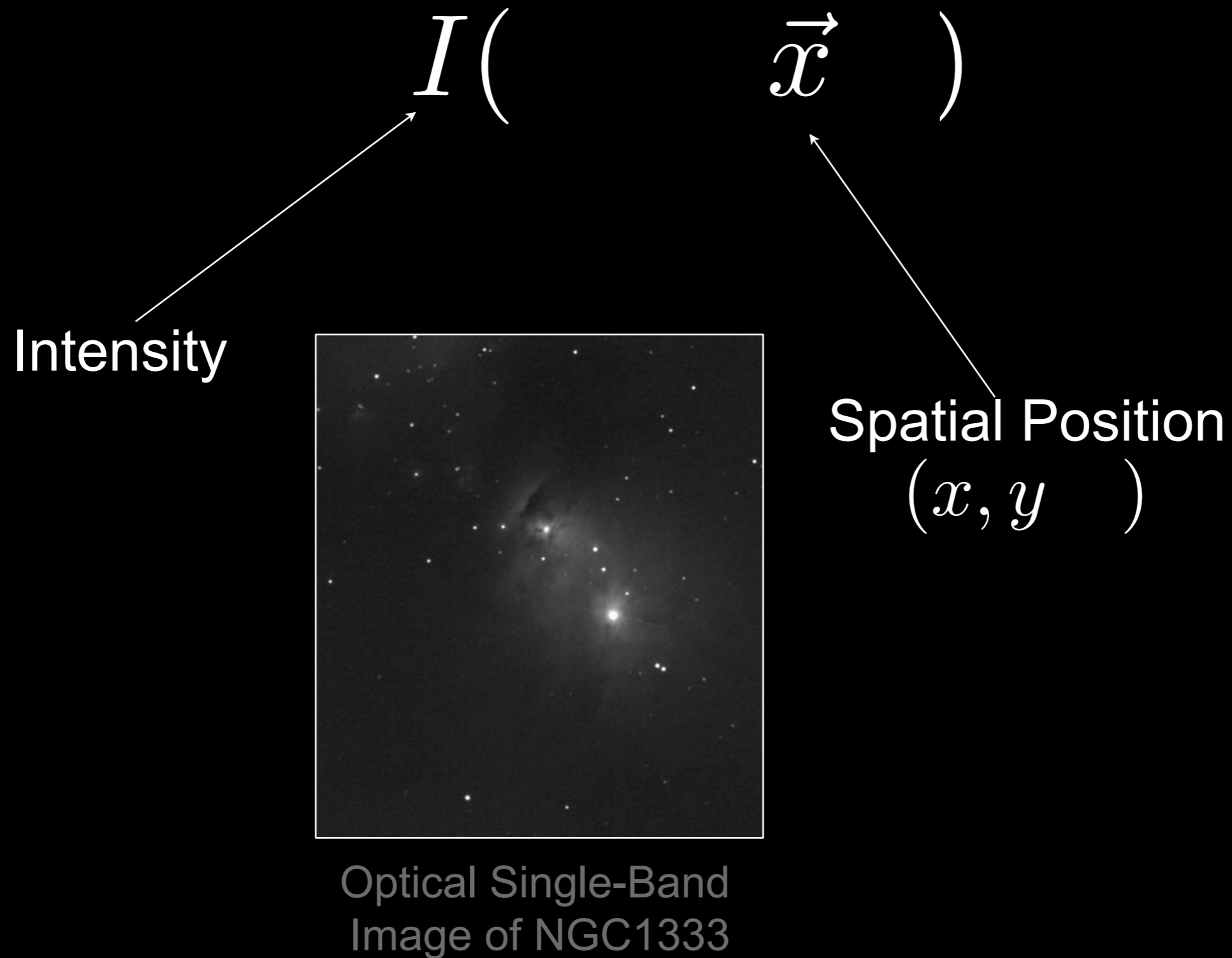
Data • Dimensions • Display

What can we observe?



...and the science is in the interpretation of these measurements into physical quantities & processes.

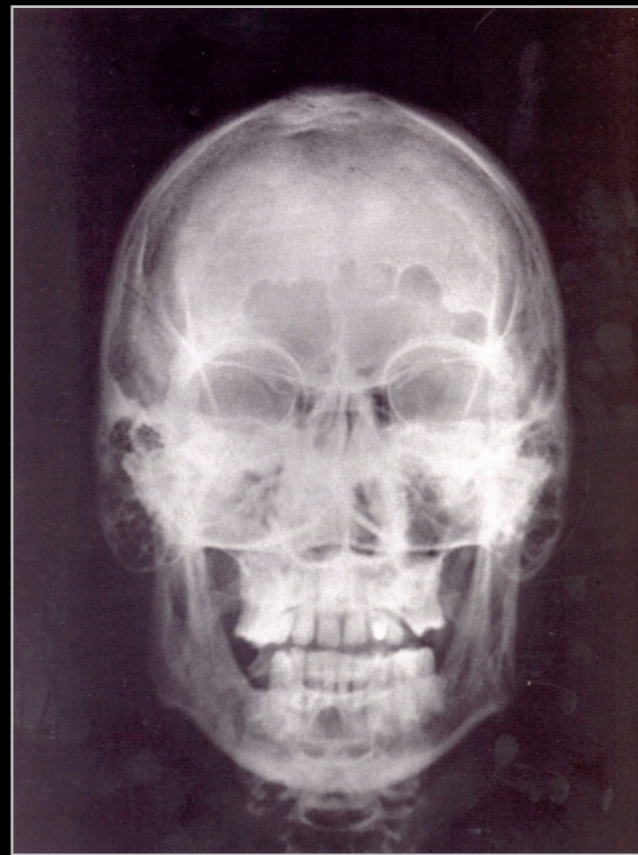
What can we observe?



What can we observe?

$$I(\vec{x})$$

Intensity



Spatial Position
(x, y)

X-Ray of Human Skull, c. 1920

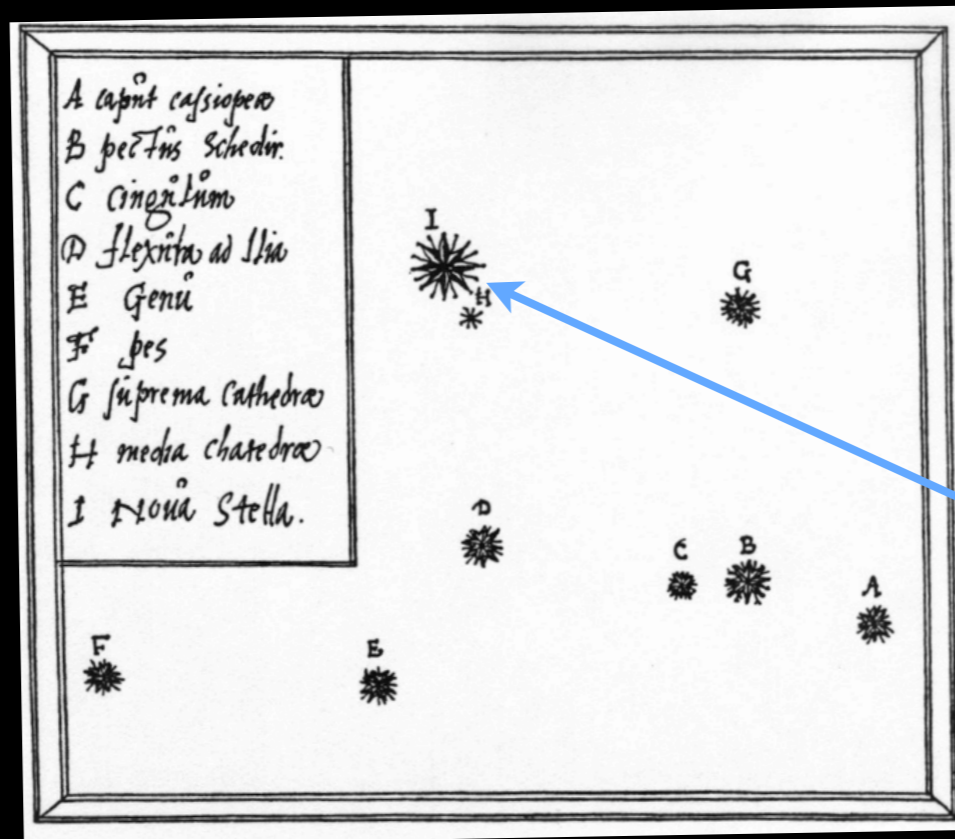
What can we observe?

$$I(\vec{x}, t)$$

Intensity

Time

Spatial Position
(x, y, z)



“Nova Stella”
of Tycho, 1572

What can we observe?

$$I(\vec{x}, t)$$

Intensity

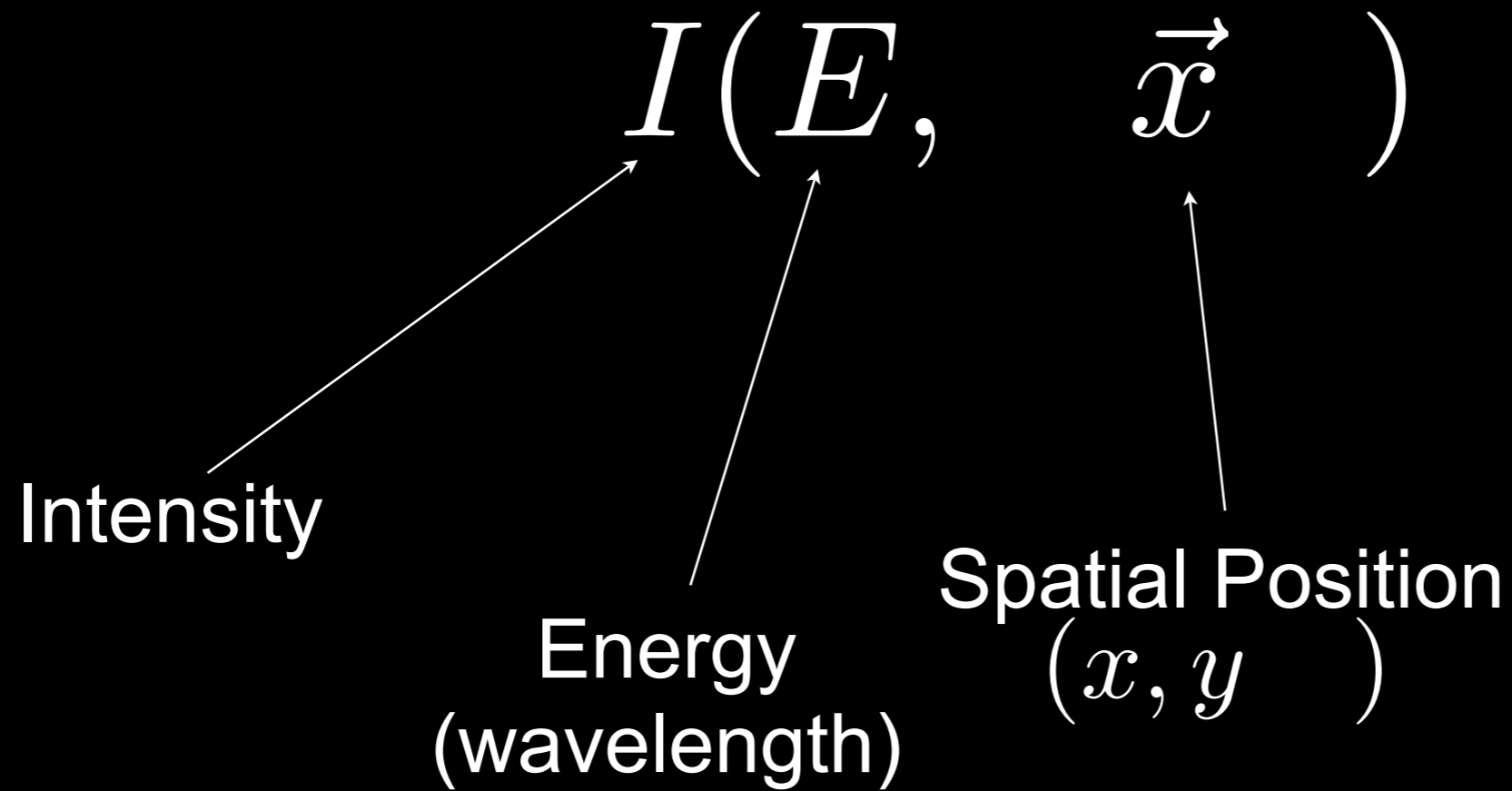
Time

Spatial Position
(x, y, z)



Cardiac Motion

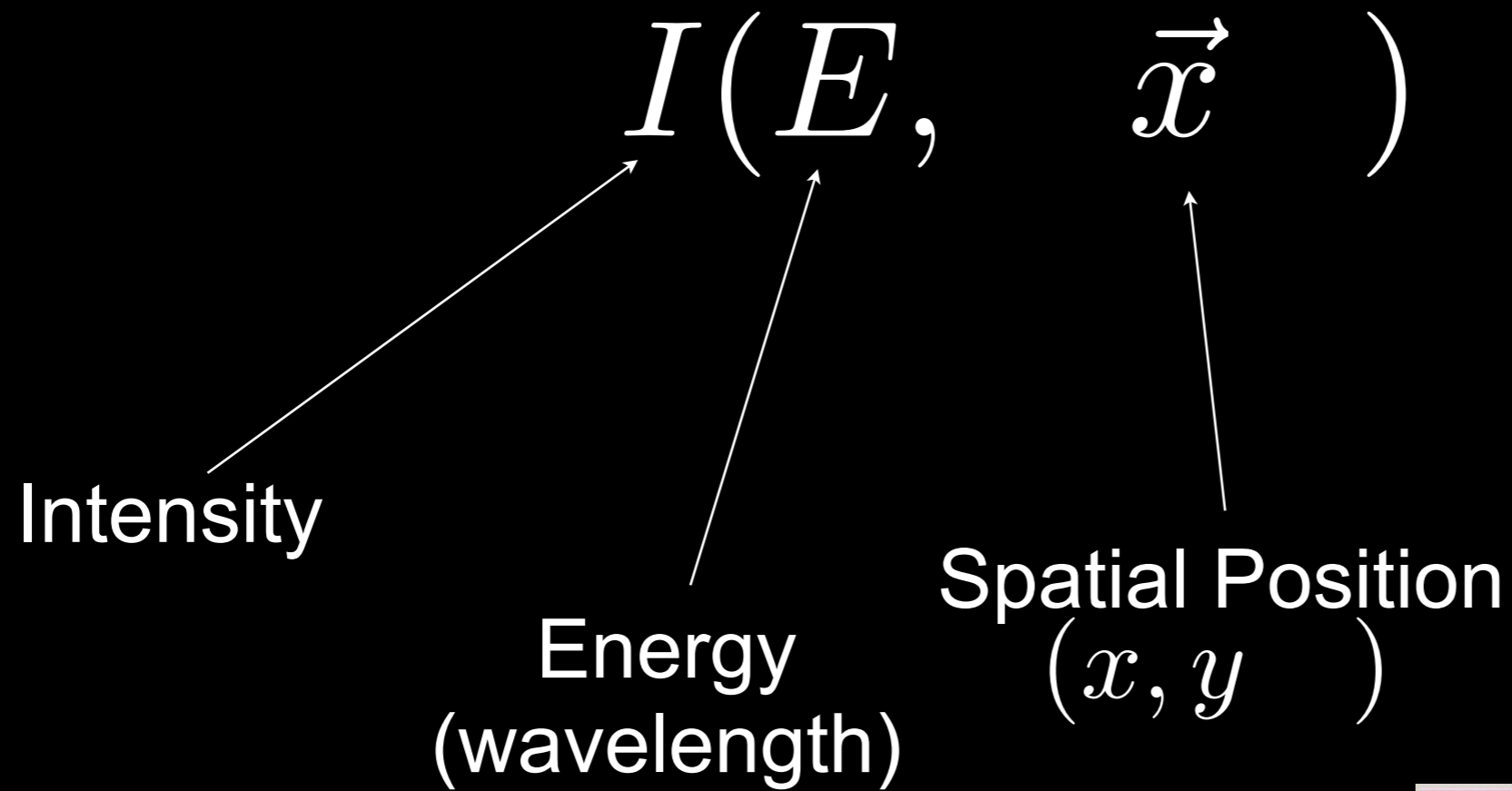
What can we observe?



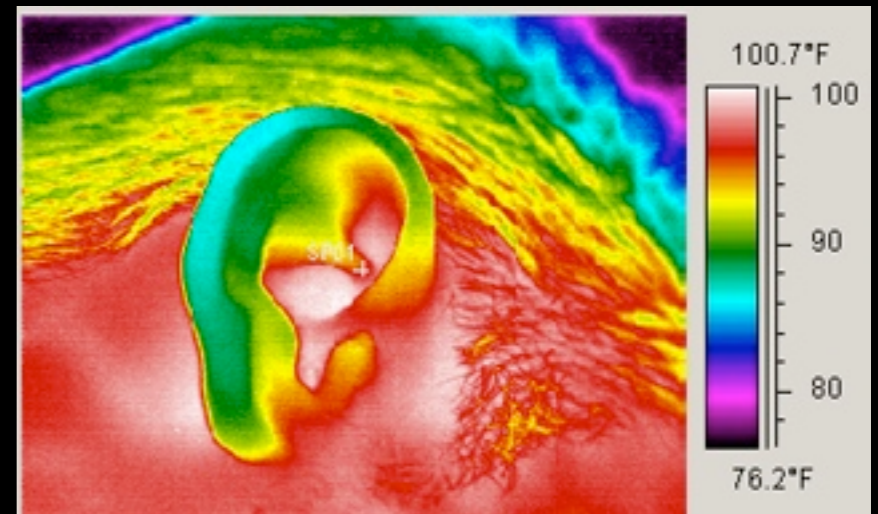
Optical (B,V,R) image
of NGC1333



What can we observe?



Human Ear,
Thermal Infrared



What can we observe?

$$I(s, \vec{x})$$

Intensity

Spatial Position
(x, y)

“State”
(e.g. polarization)

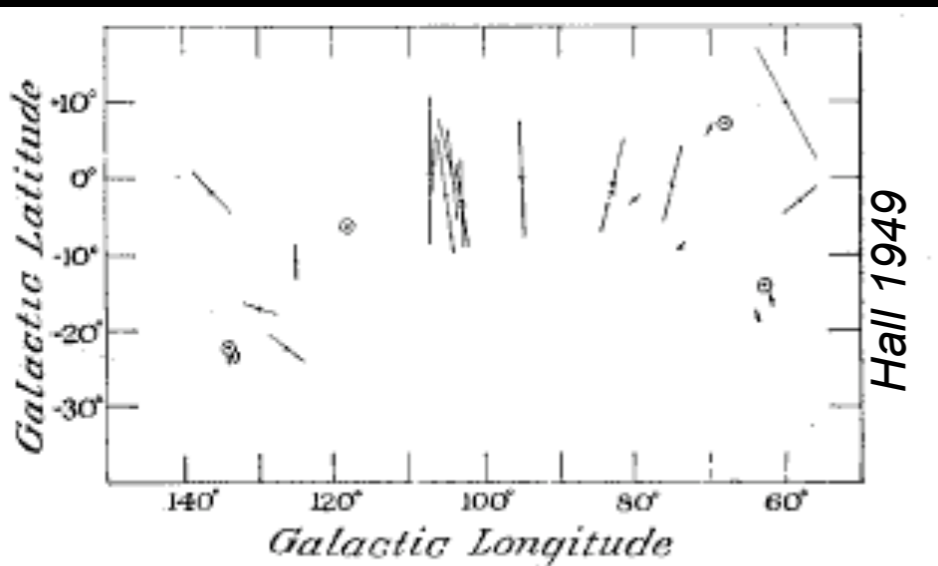


FIG. 4. Observational evidence that there is no one preferential orientation of the plane of polarization. Stars showing no polarization are represented by circles.

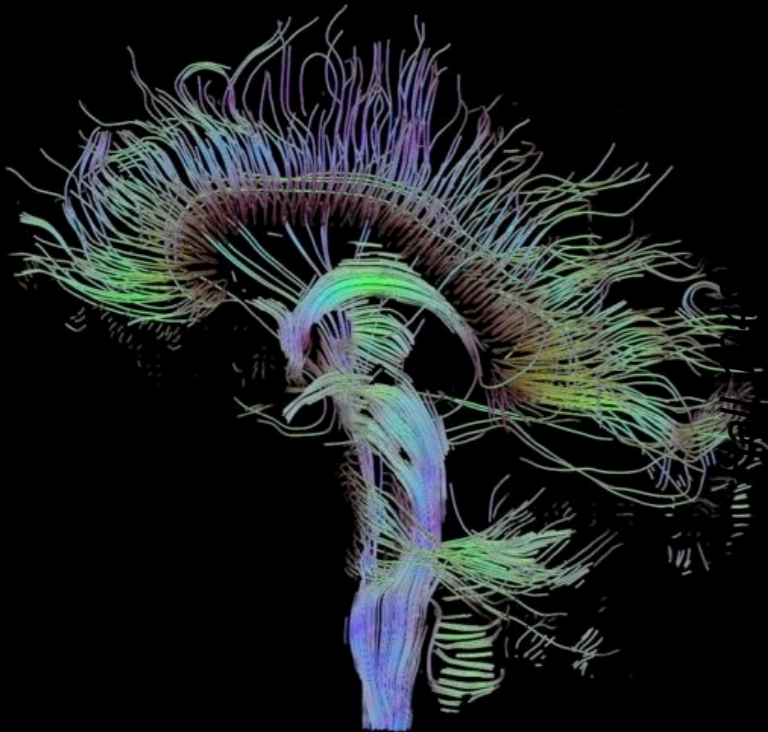
What can we observe?

$$I(s, \vec{x})$$

Intensity

Spatial Position
(x, y, z)

“State”
(~diffusivity)



Our current interest in $I(E, s, \vec{x}, t)$



COMPLETE Home Page

http://www.cfa.harvard.edu/COMPLETE/

Google

COMPLETE

The COordinated Molecular Probe Line Extinction Thermal Emission Survey of Star Forming Regions

- Data
- Results
- Projects
- People
- Learn
- Restricted

Project Description

The COordinated Molecular Probe Line Extinction Thermal Emission Survey of Star Forming Regions (COMPLETE) provides a range of data complementary to the Spitzer Legacy Program "[From Molecular Cores to Planet Forming Disks](#)" (c2d) for the Perseus, Ophiuchus and Serpens regions. In combination with the Spitzer observations, COMPLETE will allow for detailed analysis and understanding of the physics of star formation on scales from 500 A.U. to 10 pc.

Phase I, which is now complete, provides fully sampled, arcminute resolution observations of the density and velocity structure of the three regions, comprising: extinction maps derived from the Two Micron All Sky Survey (2MASS) near-infrared data using the NICER algorithm; extinction and temperature maps derived from IRAS 60 and 100um emission; HI maps of atomic gas; 12CO and 13CO maps of molecular gas; and submillimeter continuum images of emission from dust in dense cores.

Click on the "Data" button to the left to access this data.

Phase II (which is still ongoing) uses targeted source lists based on the Phase I data, as it is (still) not feasible to cover every dense star-forming peak at high resolution. Phase II includes high-sensitivity near-IR imaging (for high resolution extinction mapping), mm-continuum imaging with MAMBO on IRAM and high-resolution observations of dense gas tracers such as N2H+. These data are being released as they are validated.

COMPLETE Movies: Check-out our [movies](#) page for animations of the COMPLETE data cubes in 3D.

Referencing Data from the COMPLETE Survey


COMPLETE data are non-proprietary. Please reference **Ridge, N.A. et al., "The COMPLETE Survey of Star Forming Regions: Phase 1 Data", 2006, AJ, 131, 2921** as the data source. However, we would like to keep a record of work that is using COMPLETE data, so please send us an [email](#) (with a reference if possible) if you make use of any data provided here.

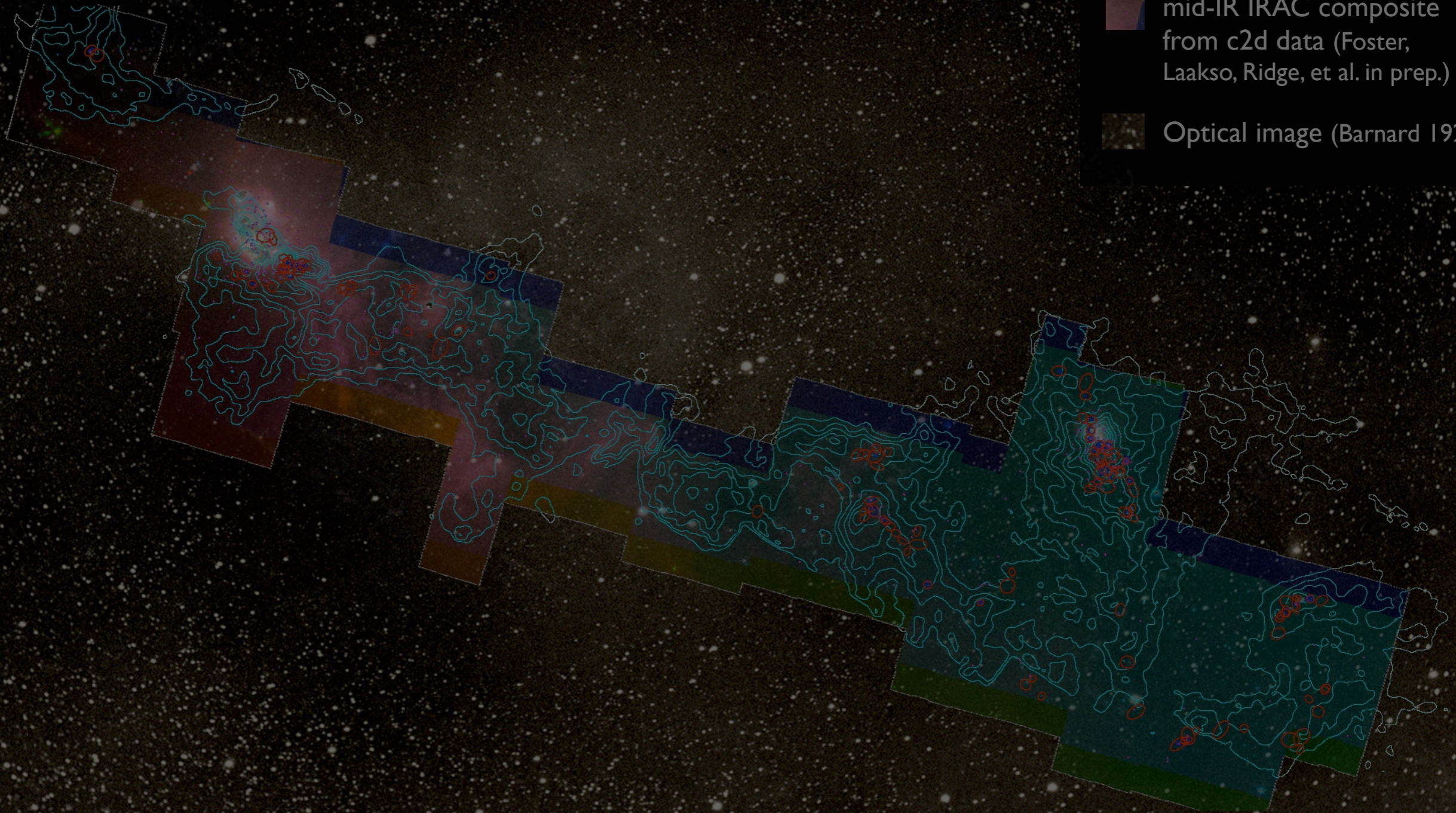
Recent COMPLETE Publications

- NEW** Rahul Shetty, Jens Kauffmann, Scott Schnee, Alyssa A. Goodman, Barbara Ercolano *The Effect of Line of Sight Temperature Variation and Noise on Dust Continuum Observations*, Accepted to ApJ. ([Local](#) | [astro-ph](#))
- NEW** Rahul Shetty, Jens Kauffmann, Scott Schnee, Alyssa A. Goodman, *The Effect of Noise on the Dust Temperature - Spectral Index Correlation*, Accepted to ApJ. ([Local](#) | [astro-ph](#))
- NEW** Jonathan B. Foster, E.R. Rosolowsky, J. Kauffman, J.E. Pineda, M.A. Borkin, P. Caselli, P.C. Myers, A.A. Goodman, *Dense Cores in Perseus: The Influence of Stellar Content and Cluster Environment*, Accepted to ApJ. ([Local](#) | [astro-ph](#))
- NEW** A.A. Goodman, E.W. Rosolowsky, M.A. Borkin, J.B. Foster, M. Halle, J. Kauffmann & J.E. Pineda, 2009, *A role for self-gravity at multiple length scales in the process of star formation*, Nature, 2009, 457, 63-66 ([doi:10.1038/nature07609](#)) ([Nature](#) | [ADS](#))

COMPLETE Perseus

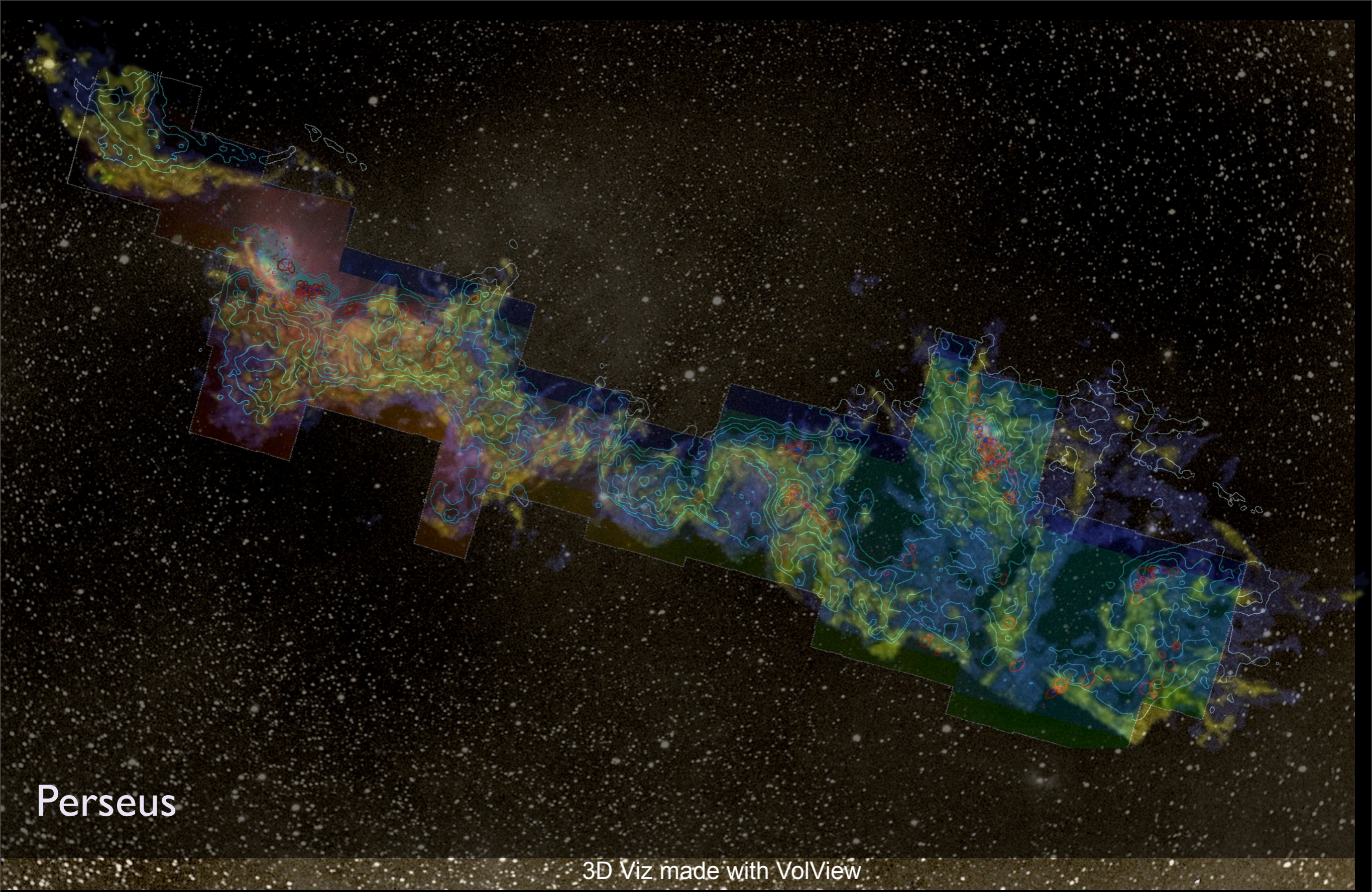
Image size: 1305 x 733
VL: 63 WW: 127

-  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. in prep.)
-  Optical image (Barnard 1927)



m: 17249
Zoom: 227% Angle: 0





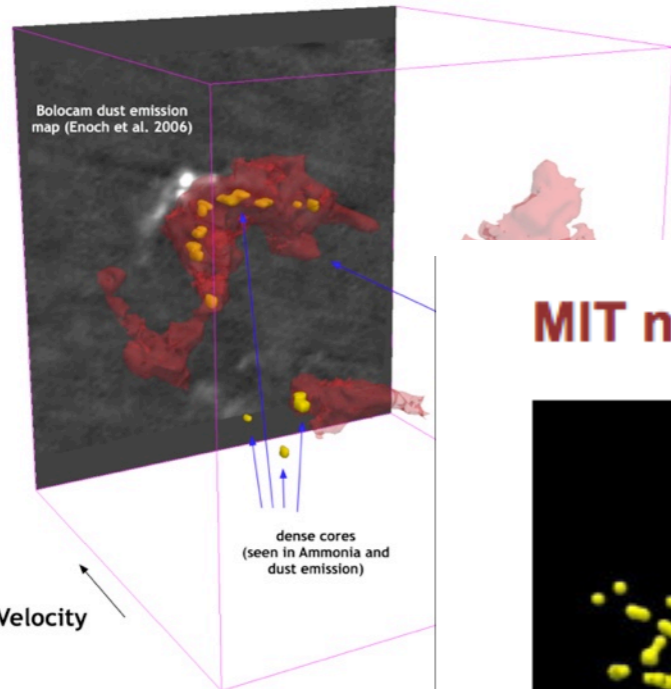
Perseus

3D Viz made with VolView

AstronomicalMedicine@iig

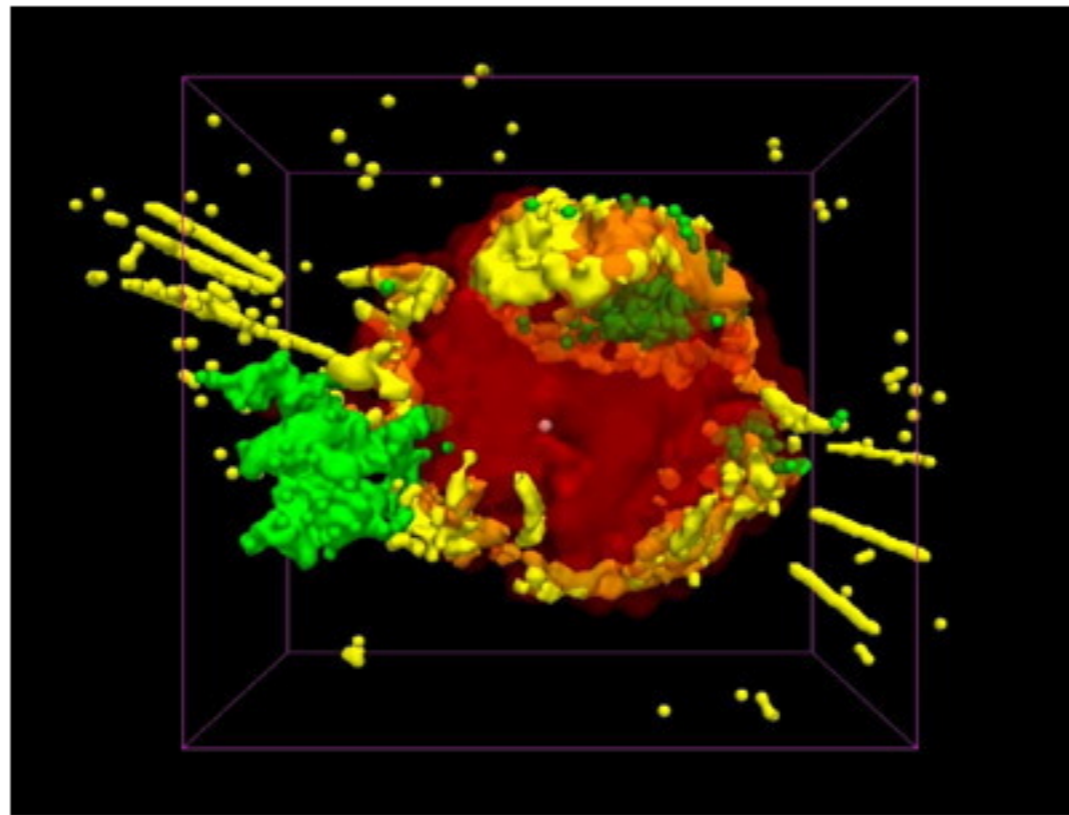
COMPLETE

Some of What We've Learned...



Cores nest in clouds
(Kauffmann et al. 2008)

MIT news and we share...



Outflows
(Arce et al. 2008,9)

Vol 457 | January 2009 | doi:10.1038/nature07609

A role for self-gravity at multiple stages of the process of star formation

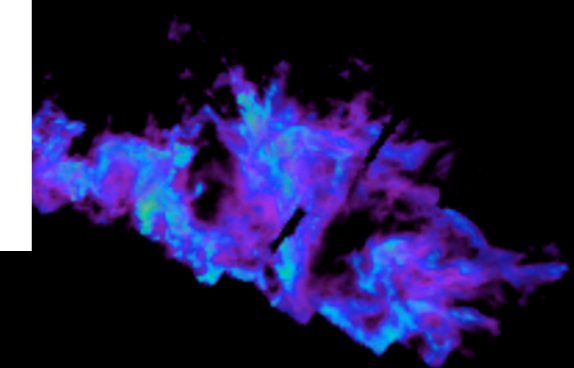
Alyssa A. Goodman^{1,2}, Erik W. Rosolowsky^{2,3}, Michelle A. Borkin^{1,†}, Jon Brice¹, Jens Kauffmann^{1,2} & Jaime E. Pineda²

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, and sets, the stellar initial mass function. 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 emission are projected on the sky within one of the densest 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

10'' = 0.75 pc

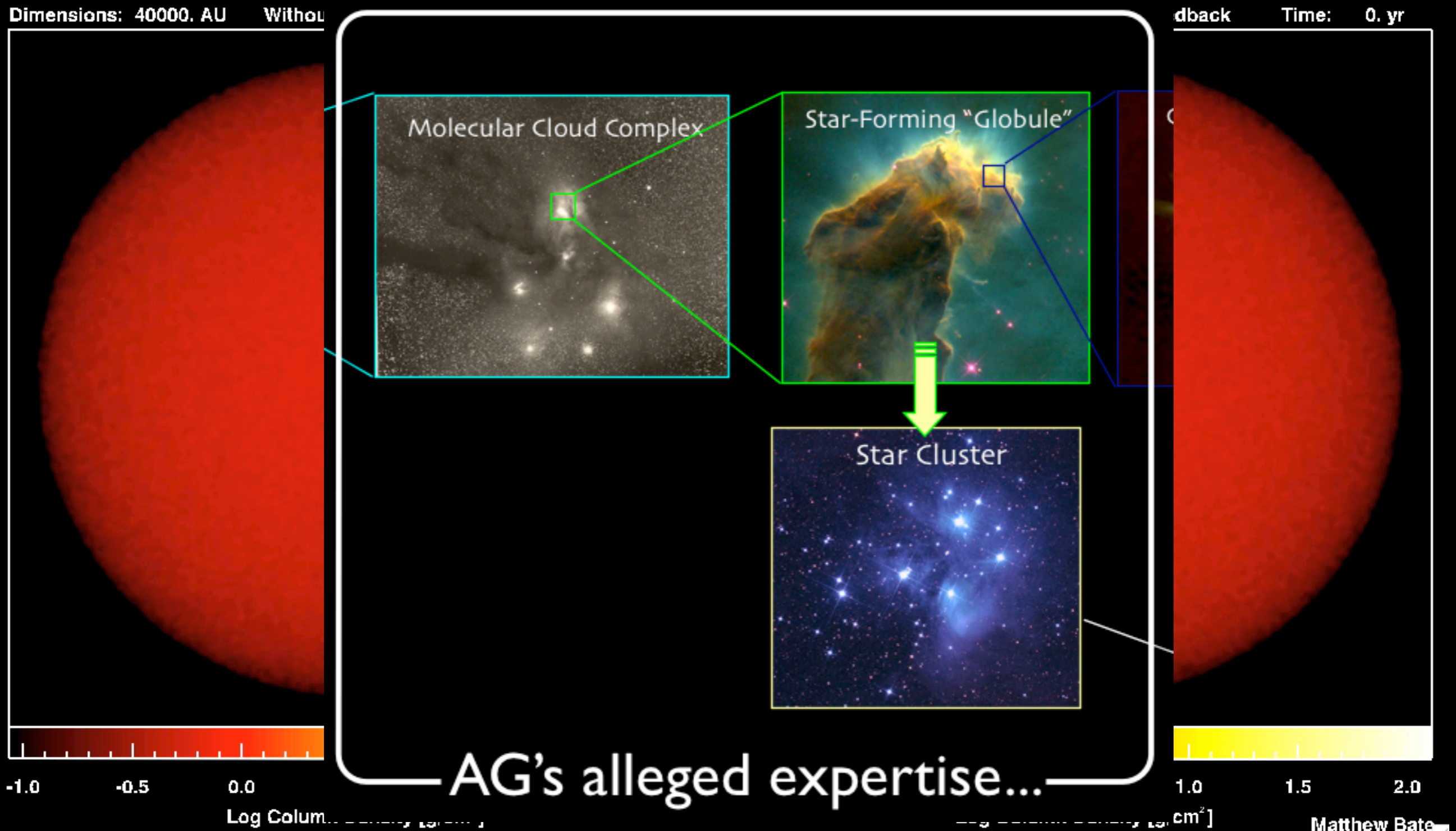
The screenshot shows a Nature journal article. The title is 'A role for self-gravity at multiple stages of the process of star formation'. The authors are Alyssa A. Goodman, Erik W. Rosolowsky, Michelle A. Borkin, Jon Brice, Jens Kauffmann, and Jaime E. Pineda. The article discusses the role of self-gravity in star formation. A diagram at the bottom shows a dendrogram analysis of a molecular cloud, with a scale bar indicating 10'' = 0.75 pc.

Gravity Matters
(Goodman et al. 2009)



Shells Rule
(Arce et al. 2009)

Physics: "Taste-Testing" Data & Simulations



Simulations of Bate 2009

Social Tasting of

$$I(E, s, \vec{x}, t)$$



Star Formation Taste Tests > Overview

https://iig.grouphub.com/projects/700257/project/log

Back to Dashboard | Switch to a different project

Project Settings | My info | Log-out HELP


Star Formation Taste Tests CFA

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Project overview & activity [New message](#) [New to-do list](#) [New milestone](#) [New file](#)

Welcome to the Tasting Room



This is the collaborative space for those who do simulations of star forming regions, and those who observe them. It was inspired, in the Fall of 2006, by the NSF proposal entitled "Star Formation Taste Tests," by A. Goodman & E. Rosolowsky. Today, it is used to host conversations about and short descriptions of simulatons, along with links to longer descriptions (e.g. Journal articles & web sites). In the future, we are planning to connect more enhanced descriptions of those simulations directly to online code bases and sample outputs, via the new [CADAC](#) site. So, stay tuned.

MONDAY, 13 APRIL 2009

Message [Relevant References relating to Bayesian Methods](#) Posted by Rahul S.

TUESDAY, 7 APRIL 2009

File [dustfit_slides.pdf](#) Uploaded by Rahul S.

WEDNESDAY, 18 FEBRUARY 2009

Writeboard [Taste Tests we Plan \(COMPLETE Group\)](#) Updated by Alyssa G.

To-do ~~Compare PPP and PPV dendrograms to determine the correct "paradigm" for mapping between the two. (Dendrograms and Simulations)~~ Completed by Alyssa G.

To-do ~~Taste Testing delivery to CADAC prior to Ringberg Meeting (Dendrograms and Simulations)~~ Completed by Alyssa G.

To-do ~~link to http://www1.astrophysik.uni-kiel.de/asd/ (Dendrograms and Simulations)~~ Assigned to Sarah B.

Writeboard [Re: Heitsch et al: Colliding Flows](#) Comment by Alyssa G.


WEDNESDAY, 21 JANUARY 2009

Message [Decadal Survey](#) Posted by Alyssa G.

THURSDAY, 20 NOVEMBER 2008

Comment [Re: "Toward a Prescriptive Understanding of Kennicutt-Schmidt Relations"](#) Posted by Alex L.

Comment [Re: "Toward a Prescriptive Understanding of Kennicutt-Schmidt Relations"](#) Posted by Alex L.



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[Subscribe to your project RSS feed](#) and be notified when someone posts a message, comment or file, or adds or completes a to-do item or milestone in this project. [What's RSS?](#)

People on this project

HCO

Alyssa Goodman
You are logged in right now

Sarah Block
Latest activity 25 days ago

Rahul Shetty
Latest activity 28 days ago

August Muench
Latest activity 28 days ago

Douglas Alan
Latest activity 28 days ago

Jens Kauffmann
Hasn't logged in recently

Michelle Borkin
Hasn't logged in recently

Michael Halle
Hasn't logged in recently

Felice Frankel
Hasn't logged in recently

Tim Kaxiras
Hasn't logged in recently

Tim Clark
Hasn't logged in recently

American Museum of Natural History

Mordecai-Mark Mac Low
Hasn't logged in recently

Héctor Arce
Hasn't logged in recently

Cal State Stanislaus

Christopher De Vries
Hasn't logged in recently

Calar Alto/MPI

Joao Alves
Hasn't logged in recently

Caltech

Scott Schnee
Hasn't logged in recently

A sample of what we've learned, and shared (3D PDF)

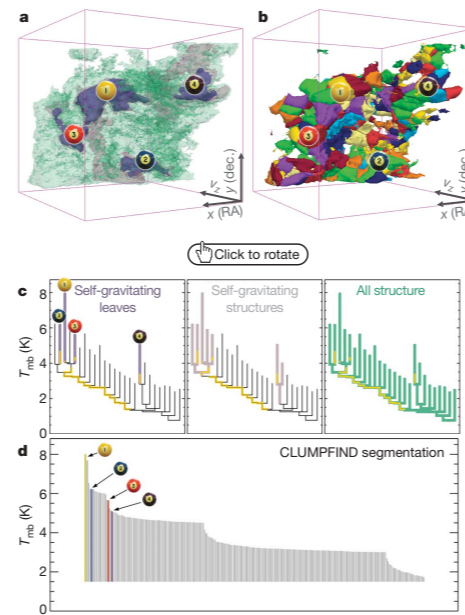


Figure 2 | Comparison of the 'dendrogram' and 'CLUMPFIND' feature-identification algorithms as applied to ^{13}CO emission from the L1448 region of Perseus. **a**, 3D visualization of the surfaces indicated by colours in the dendrogram shown in **c**. Purple illustrates the smallest scale self-gravitating 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 this early 2D work as inspiration, we have developed a structure-identification algorithm that abstracts the hierarchical structure of a 3D (p - p - v) data cube into an easily visualized representation called a 'dendrogram'¹⁰. Although well developed in other data-intensive fields^{11,12}, it is curious that the application of tree methodologies so far in astrophysics has been rare, and almost exclusively within the area of galaxy evolution, where 'merger trees' are being used with increasing frequency¹³.

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

A dendrogram of a spectral-line data cube allows for the estimation of key physical properties associated with volumes bounded by isosurfaces, such as radius (R), velocity dispersion (σ_v) and luminosity (L). The volumes can have any shape, and in other work¹⁴ we focus on the significance of the especially elongated features seen in L1448 (Fig. 2a). The luminosity is an approximate proxy for mass, such that $M_{\text{lum}} = X_{13\text{CO}} L_{13\text{CO}}$, where $X_{13\text{CO}} = 8.0 \times 10^{20} \text{ cm}^{-2} \text{ K}^{-1} \text{ km}^{-1} \text{ s}$ (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.

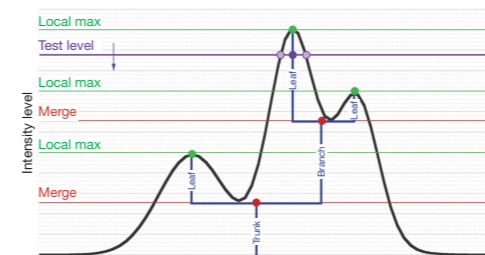
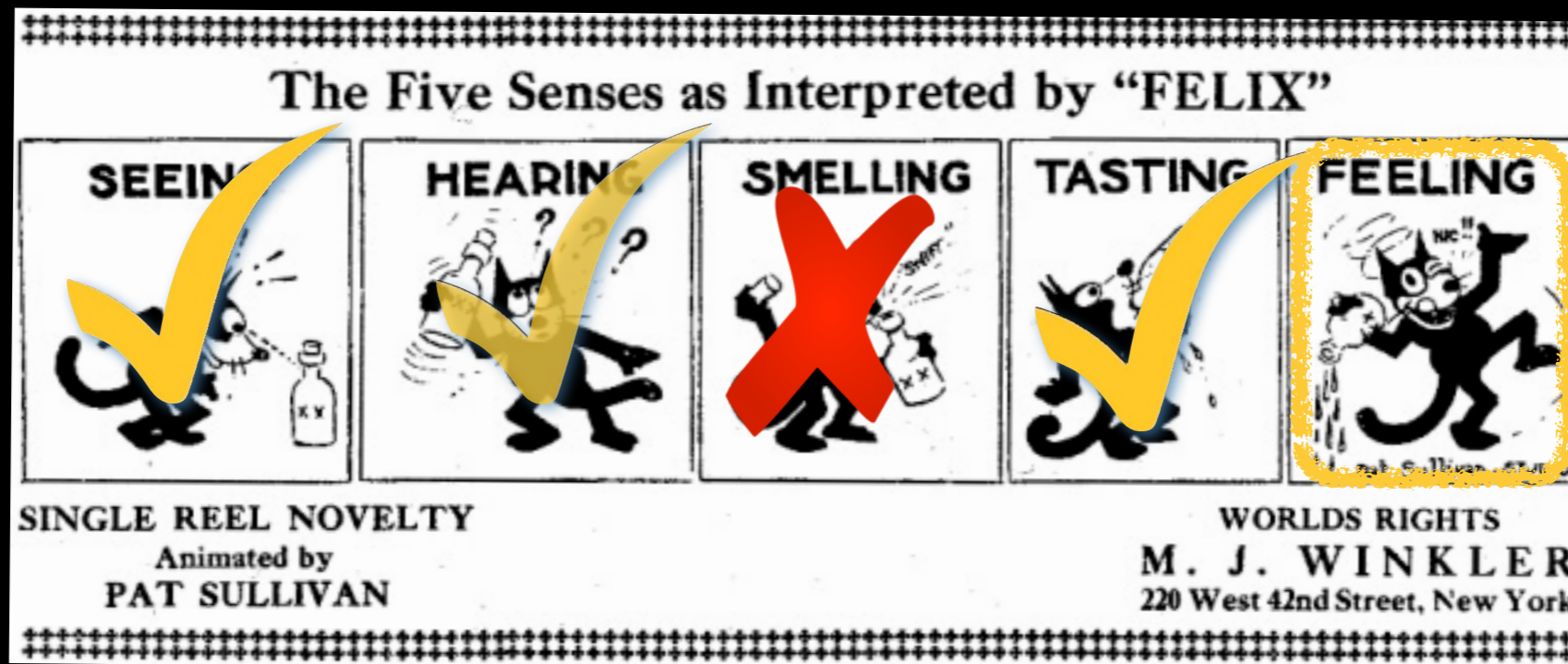


Figure 3 | Schematic illustration of the dendrogram process. Shown is the construction of a dendrogram from a hypothetical one-dimensional emission profile (black). The dendrogram (blue) can be constructed by 'dropping' a test constant emission level (purple) from above in tiny steps (exaggerated in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



Data • Dimensions • Display



Astronomy as I Touch it?

home
about the iic
research
education
people
events
employment
reaching the iic

INITIATIVE IN INNOVATIVE COMPUTING (IIC) NEWSLETTER
Stay informed on our latest news!
E-mail: *

 Subscribe
 Unsubscribe

Previous issues

IIC Member login

IIC

Initiative in Innovative Computing at Harvard

home > research


scientists' discovery room lab (sdr lab)

Lead investigators
Chia Shen (IIC) and Hanspeter Pfister (SEAS/IIC)

Project staff
Michael Horn, Meekal Bajaj, Matthew Tobiasz and Matthias Lee

Description

The Scientists' Discovery Room (SDR) is a next-generation visual digital laboratory for science discovery, collaborative learning and education. Our research focuses on experimenting with new modalities of human-computer interaction and visualization, to create a new genre of navigation, exploration and detailed analyses in multi-dimensional information spaces. All projects in SDR are in close collaboration with domain scientists and educators.



INVOLV is a generalizable multi-user interactive visualization framework for large hierarchical data sets. In this project, we address the visual layout of both the primary data representation and the overlay of alternate structures of the same data. Our first case study is the visualization of life on earth based on the Encyclopedia of Life (www.eol.org) and Tree of Life (www.tolweb.org). The user interface provides free-form exploration of more than 1.2 million named species while communicating issues of biodiversity and phylogeny. The current visualization combines a Voronoi Treemap tessellation with innovative human-computer interaction designs to support collaborative exploration and learning. Please visit www.involvweb.org for more information on this project.

CThru, a collaborative endeavor with Molecular and Cellular Biology faculty, aims to develop a self-guided learning environment. In CThru, we examine methods for constructing interactive video-based educational modules. Using the animation "The Inner Life of the Cell" as a testbed, CThru addresses research issues of embedding interactive visible objects, extensive multimedia information and manipulatable 3D models within a video flow, replacing sequential video viewing with the experience of exploring and manipulating in a multi-dimensional information space.

WeSpace is a collaborative work space that integrates a large data wall with a multi-user multi-touch table. WeSpace has been developed for a population of scientists who frequently meet in small groups for data exploration and visualization. It provides a low overhead walk-up and share environment for users with their own personal applications and laptops.

LivOlay is an interactive image overlay tool that enables the rapid visual overlay of live data rendered in different applications. Our tool addresses datasets in which visual registration of the information is necessary in order to allow for thorough understanding and visual analysis.

Slideshow: Tabletop Computers *Continued* By Meredith Ringel Morris

First Published December 2008

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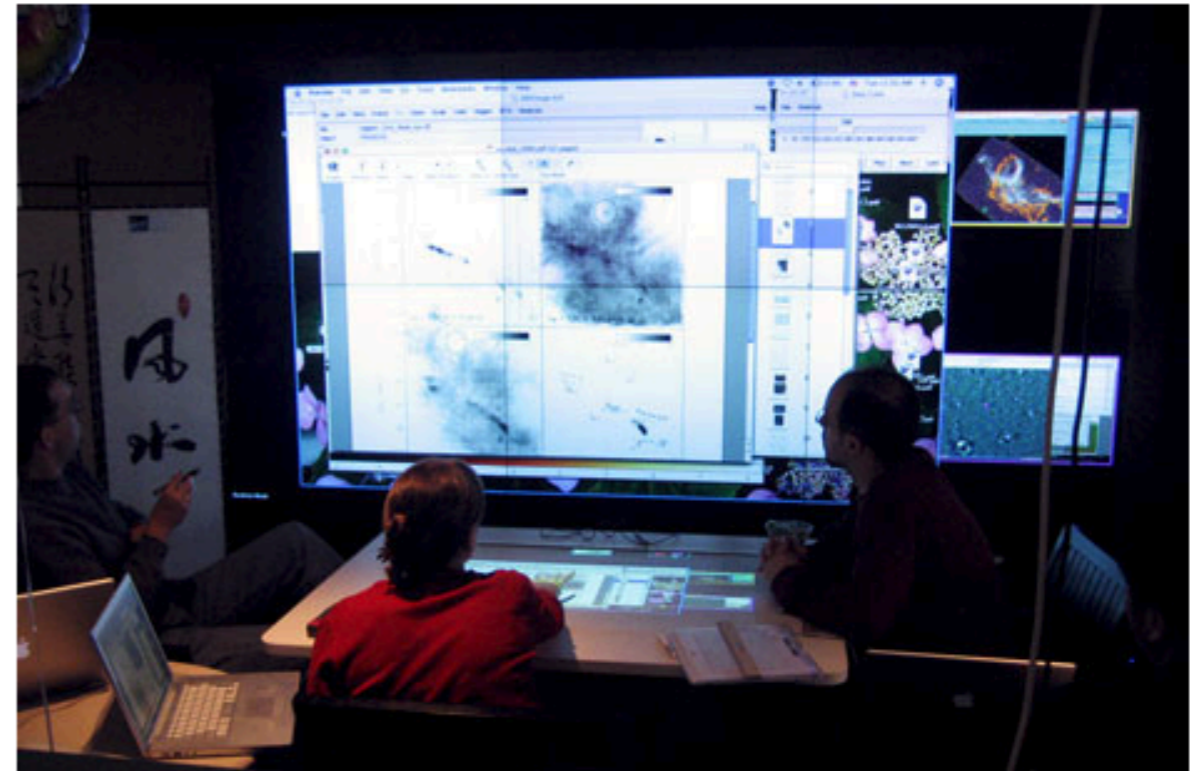


PHOTO: HAO JIANG, DANIEL WIGDOR, CLIFTON FORLINES, AND CHIA SHEN

UBITABLE: Users can interact with surface computers through auxiliary devices, such as laptops, phones, and PDAs. The display on the auxiliary device can convey private or sensitive content to a single user, while group-appropriate content can appear on the tabletop display. Chia Shen and her colleagues at Mitsubishi Electric Research Laboratories, in Cambridge, Mass., have explored auxiliary interactions with surface computers in their UbiTable project, in which two people with laptops collaborate over a tabletop display. Recently, Shen expanded the UbiTable into an interactive room called the WeSpace. People can share data on their laptops with other people in the room, using both a table and a large display wall. Here, three Harvard University astrophysicists discuss radio and IR spectrum images using the WeSpace.

The Scientists' Discovery Room (Shen & Pfister)



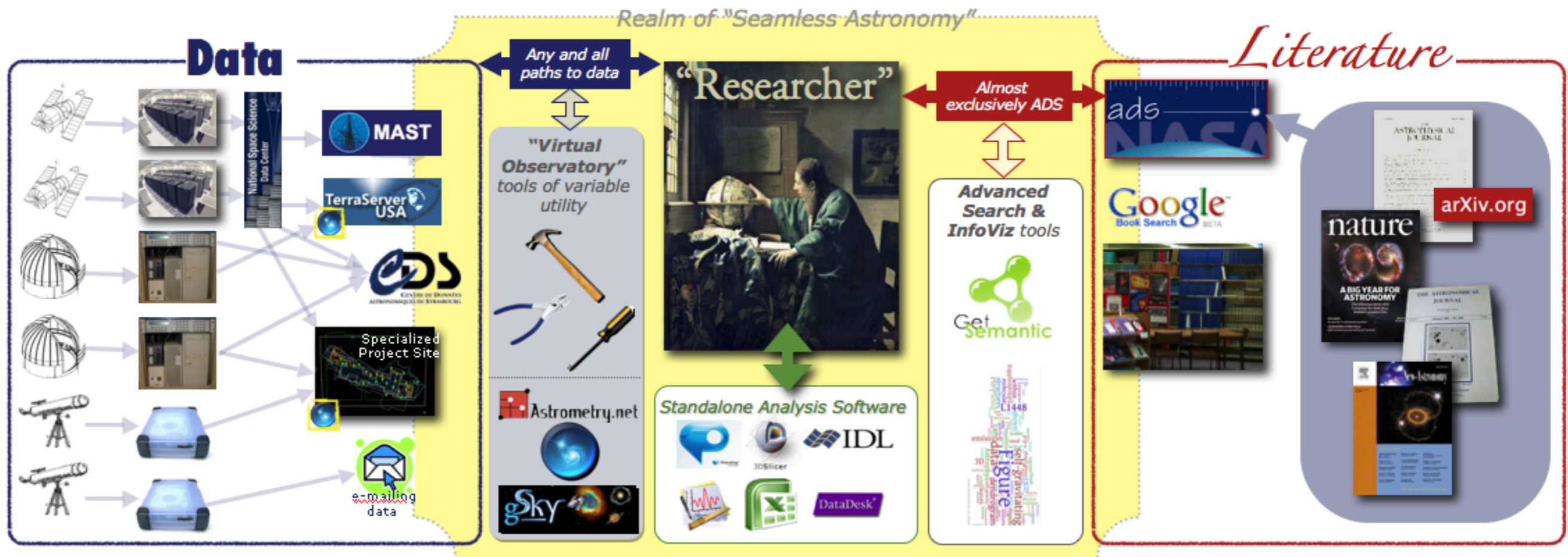
movie courtesy Daniel Wigdor, equipment now in Chia Shen's SDR lab at SEAS



The Big Picture:
Seamless Astronomy
...and the future of DDD

Seamless Astronomy

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



**Today, “Virtual Observatory” should really just mean
“Facilitated Online Astronomy Research”**

Seamless Astronomy includes a collaboration amongst researchers from CfA/WWT (Goodman, Muench) MSR/WWT (Wong), RPI (Hendler, McGuinness), STScI (Conti, Christian), ADS (Accomazzi, Kurtz), Chandra (Bressert, Rots, Burke) and UCLA (Borgman)

astrobitz?

terabitz every bit on real estate

Getting Started | Sign In

Enter Location

Street: optional

City, State or Zip: Ocala, FL

Go

filter listings

Drag and Drop icon to workspace below

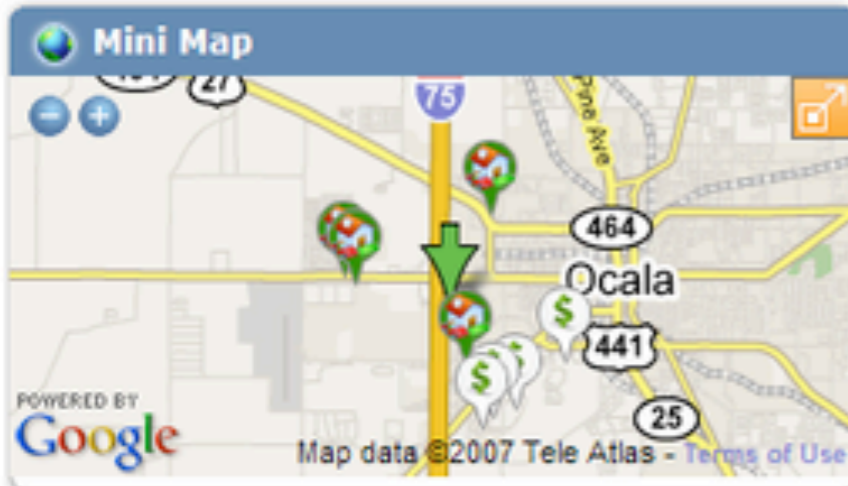
Navigation tabs: Listings, Local, Market, Education, Safety, Financing, Professional, Misc

Icons: Google Local Search, Local Photos, Airports, Banks, Cafes, Cinemas, Fast Food, Gas Stations, Grocery Stores, Health Care, Libr

Take Snapshot

Dashboard

Map



For Sale Listings

2-Br 1-Ba	\$ 49,900
3116 Nw 17th St, Ocala, FL 34475	
3-Br 2-Ba	\$ 109,900
375 Nw 55th Ave, Ocala, FL 34482	
3-Br 2-Ba	\$ 124,900
280 Nw 53rd Ct, Ocala, FL 34482	
2-Br 2-Ba	\$ 150,000
3459 Sw 18th Pl, Ocala, FL 34474	

[filter listings](#) [Map](#) | 90 results

Banks

Regions Bank	352-291-2965
3101 Sw College Rd, Ocala, FL	
Regions Bank	352-861-2342
2811 Sw 27th Ave, Ocala, FL	
Wachovia Bank	352-873-5010
3201 Sw College Rd, Ocala, FL	
Community Bank & Trust of ...	352-369-1000
1603 Sw 19th Ave, Ocala, FL	

[Map](#) | 20 results

Seamless Astronomy?

The mockup is titled "AstroNavigator" and features a navigation bar with "Project 1", "Project 2", "Project 3", and "Edit" buttons. The main content area is divided into four panels:

- Panel A (Semantic Search):** Displays search results for "QSO MgII absorption lines observed". It includes fields for "Authors" (listing "Drinkwater" and "Webster R.L., Th...") and a "Description" (starting with "The results of a large R-band").
- Panel B (Literature Viewer):** Shows a list of search results from "SAO/NASA ADS Astronomy Abstracts". It includes links for "Find Similar Abstracts", "Electronic Refereed Journal Article", "Full Refereed Journal Article (PDF/P...)", and "Xiv e-print (arXiv:astro-ph/0004386)". A "FIND IT @ HARVARD" button is also present.
- Panel C (Info Viz for Search Results):** A visualization showing a network of search results. A central node is labeled "STARS WITH Nebula" and is connected to other nodes like "ST Grains".
- Panel D (Data Viewer (e.g. WWT)):** A screenshot of the Microsoft WorldWide Telescope (WWT) interface. It shows a large astronomical image of a nebula with a smaller, more detailed view overlaid. The interface includes various controls like "Look At", "Imagery", "Image Crossfade", and "Context Search Filter".

Semantic Search

Literature Viewer

Info Viz for Search Results

Archive Browser

Data Viewer (e.g. WWT)

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

“GIS/Layering”

“Ontology”

“Search”

What's needed?

“Progressive Resolve”

“Registration”

“Selection”

**“Side-by-Side
Comparison”**

“Readable Labels”

“Highlighting”

“Zoom”

“Custom Site”

“Measurement”

“Off-the-Desktop”

“Inference”





Monday, May 18, 2009

From: Yan Xu
 Subject: RE: (non WWT) press conference attendance for AG or Tuesday AM
 Date: December 31, 2008 2:56:23 AM EST
 To: Yan Xu , Alyssa Goodman , Megan Watzke
 Cc: Becki Culbert (Swift Group) , Curtis G. G. Wong <curtisgwong@msn.com> , Jens Kauffmann , Rosalind Reid

Email with Room Numbers
 (result of search)

I just found Megan's earlier email, which mentioned that the press will be in room 204 of Convention Center. It is probably not too far from our room 308.

Our setup and presentation will be in the same room: #308 (Exhibition Hall C).

Thanks,
 Yan

Requires "Ontology"

Interior Map on Long Beach CC Web Site

Requires "GIS/Layering"



Area Map, with Photos & Street Names from Google Maps

Ballroom & Meeting Room

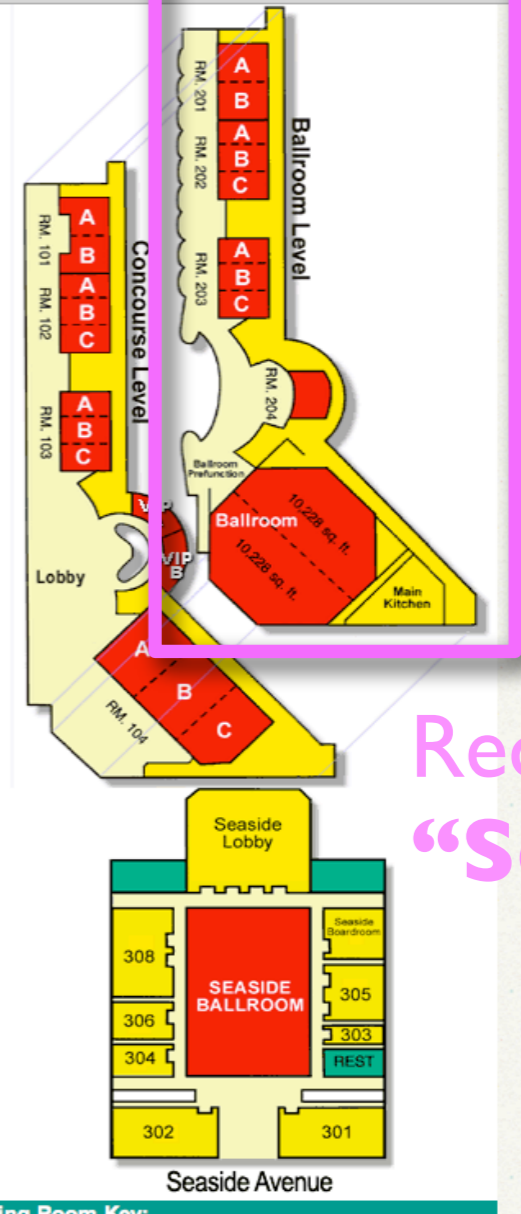
http://www.longbeachcc.com/meeting.h

SPECIAL SERVICES INCLUDED:

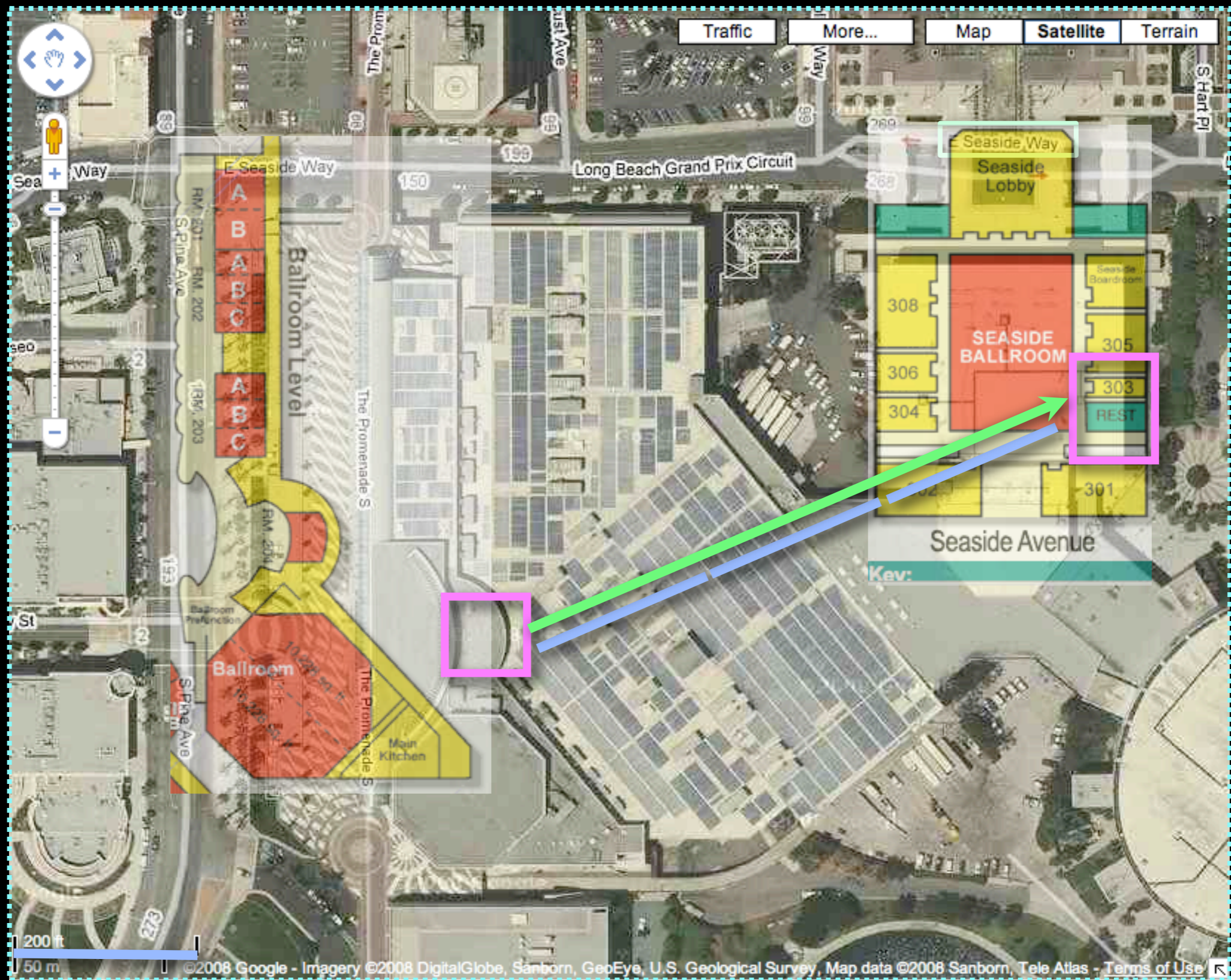
- House lighting, ventilation, heat or air conditioning as required during open times. Energy conservation is of prime concern to the Convention Center and minimal light and comfort levels will be maintained during move-in and move-out periods. Rehearsals and similar pre-event activities will be maintained accordingly
- Housekeeping services during open hours in aisles, corridors, lobby, open spaces and restrooms, plus one rough cleaning of these same areas during non-openers. Meeting rooms will be cleaned between 12 AM and 11 PM nightly unless prior arrangements are made with the Event Manager.
- Water service will be supplied to head tables and rooms only. All other water service needs must be ordered through your Catering Sales Manager.
- Basic set up is included with the daily rental. Additional set ups are charged based upon half of the daily rental.
- Real-time basic room set per rented event day. Meeting rooms included with an Exhibit Hall rental include a one-basic room set for the run of the event.
- Fully equipped first-aid facilities. Does not include a first-aid kit. An Emergency Medical Technician will be scheduled through your Event Manager.
- Use of the outdoor marquee, as available. The marquee is subject to information directly related to Licensee's activities within the Convention Center. All messages must be pre-approved by Convention Center staff. (Please see the marketing kit for all in-house Marketing and Public Relations details pertaining to your event).

SPECIAL SERVICES NOT INCLUDED:

- First aid staffing with Emergency Medical Technician will be provided at current rates.
- Licensee is responsible for removal of bulk trash, crates, pallets, packing materials, lumber, etc. prior to show start-up and following move-out.
- Event staff, ticket takers, ushers, security, stagehands, and event operations shall be provided by the Convention Center and billed to Licensee.
- Performance stages, exhibit tables and dance floors.



Requires "Search"

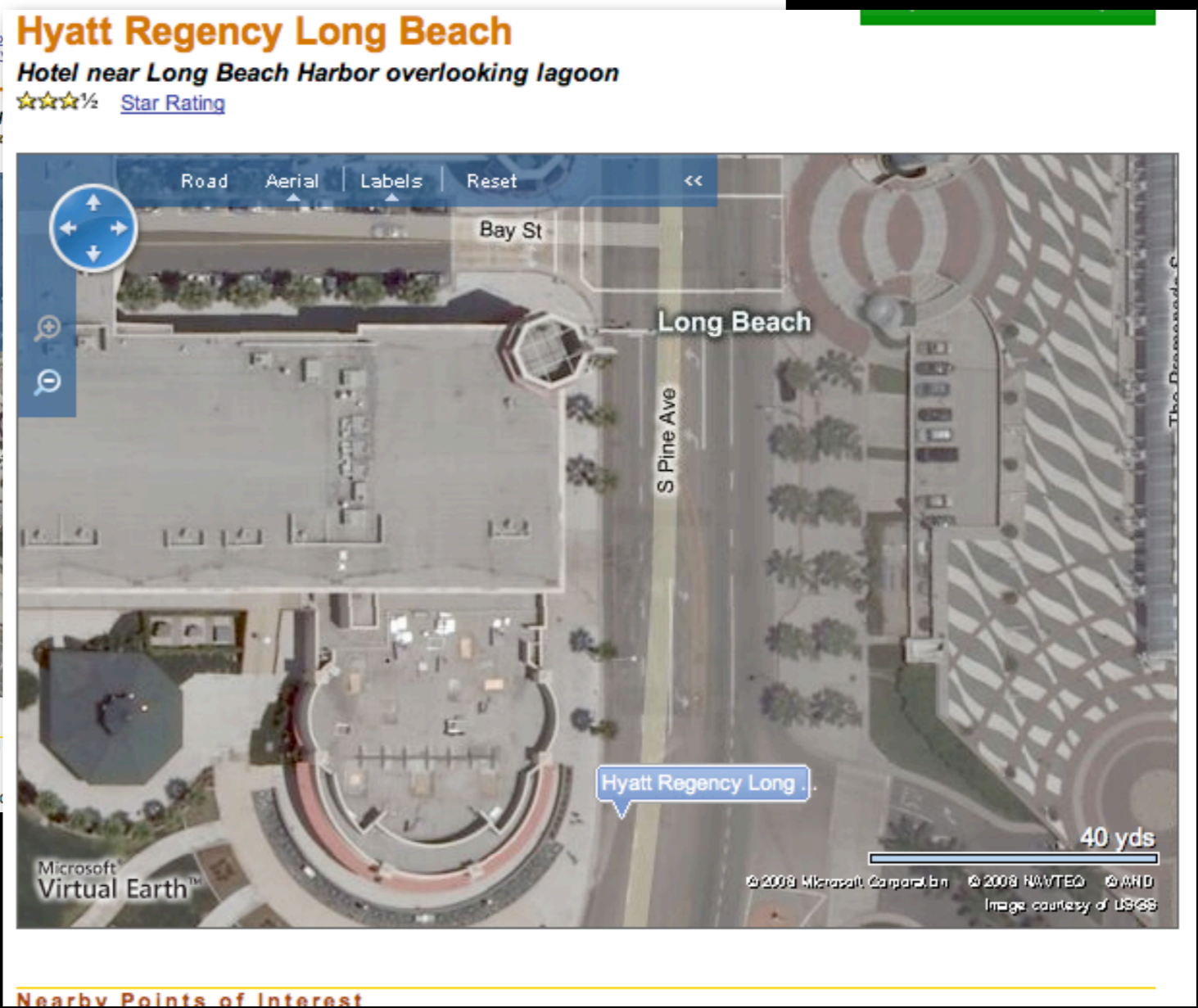
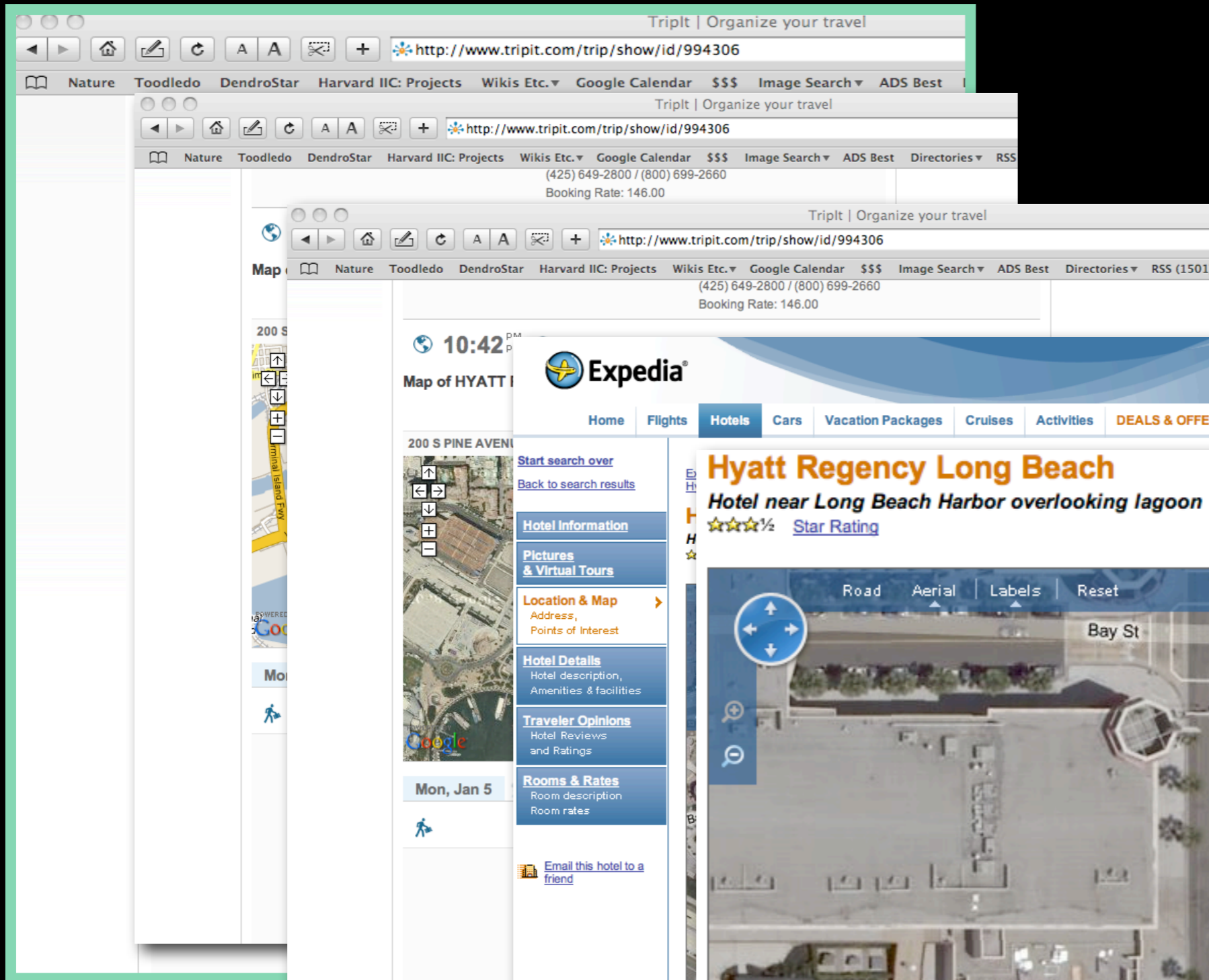


...requires: **“Selection”** ; **“Registration”**;

“Readable Labels” ; **“Highlighting”** ; & **“Measurement”**

in order to yield: **“Inference”**: ...Wow, that’s about 600 feet, hope we can change the room!

And, what about that “custom Triplt site” I made to organize all this? What about the hotel & its location?



Nearby Points of Interest



Hyatt Regency Long Beach
Hotel near Long Beach Harbor overlooking lagoon
☆☆☆½ Star Rating

Road Aerial Labels Reset <<

Bay St
Long Beach
S Pine Ave

Hyatt Regency Long

40 yds

©2008 Microsoft Corporation ©2008 NAVTEQ ©AHD
Image courtesy of USGS

“Side-by-Side Comparison”

Click

“Zoom”

“Progressive Resolve”

“Inference”: ...Oh, that building with the funky paths outside is the Hyatt.. what if I..



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Over 20 million traveler reviews & opinions of hotels, vacations & more

Hyatt Regency Long Beach Hotel

Home Destinations Fun & Games Free Travel Guides Vacation Ideas International Sites

Home → United States → California (CA) → Long Beach → Long Beach Hotels

Search

Search input field with 'Go' button

- Long Beach Overview
- Long Beach Hotels
 - Hyatt Regency Long Beach
- Flights to Long Beach
- Long Beach Deals
- More On Long Beach
 - Before You Go
 - Things to Do
 - Restaurants
 - Map
 - Traveler Photos
 - Forum
- Long Beach Deals
 - Discount Hotels
 - Hotel & Air
 - All Travel Offers

Hyatt Regency Long Beach



Hotel class: ★★★★★

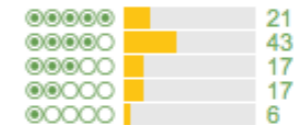
Rooms: 510

COMPARE PRICES

- Hotel photos
- Map this hotel
- Hotel amenities
- Virtual tour

TripAdvisor Traveler Rating: ?

104 Reviews



Write a review

TripAdvisor Popularity Index: ?

#14 of 38 hotels in Long Beach

Call now to book: 1-800-45-HOTEL from hotels.com

200 South Pine Avenue, Long Beach, CA 90802

Property Type: Hotel ?

Full service hotel with water views from rooms. Walking distance to 100 shops and restaurants, Aquarium of the Pacific. Centrally located for easy...

+ more »



Check Rates and Availability: \$236 Avg. Price

Check-in: 10/2/2009 Check-out: 10/9/2009 Adults: 1

- | | |
|---|--|
| <input checked="" type="checkbox"/> Expedia.com | <input checked="" type="checkbox"/> Orbitz.com |
| <input checked="" type="checkbox"/> LongBeach.Hyatt.com | <input checked="" type="checkbox"/> hotels.com |
| <input checked="" type="checkbox"/> Travelocity | <input type="checkbox"/> HotelClub.com |
| <input checked="" type="checkbox"/> Priceline.com | <input type="checkbox"/> Gtahotels.com |

CHECK RATES! Opens one window for each offer. Please disable pop-up blockers.

Click here for best prices for Hyatt Regency Long Beach

- Hyatt Regency Long Beach: Great rooms from \$115 Smart Deal
Expedia.com Photos, Reviews and the Guaranteed Lowest Prices
- Hyatt Regency Long Beach: Save Up To 50% On Hotels Smart Deal
Orbitz.com View Hotel Photos, Reviews & More Compare & Save on Hotels at Orbitz
- Hyatt Regency Long Beach: Official Site Smart Deal
LongBeach.Hyatt.com Best Rates Guaranteed. Book Direct.
- Hyatt Regency Long Beach: Official Site Smart Deal

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TripAdvisor Traveler Reviews

TripAdvisor Traveler Rating:

What's possible now?

“Progressive Resolve”

“Zoom”

“Search”

“Selection”

“GIS/Layering”

“Registration”

**“Side-by-Side
Comparison”**

“Readable Labels”

“Highlighting”

“Custom Site”

“Inference”

“Off-the-Desktop”

“Ontology”

“Measurement”

WWT Silverlight “Alpha”

The screenshot displays the Microsoft WorldWide Telescope Web Client interface. The browser window title is "Microsoft WorldWide Telescope Web Client" and the address bar shows the URL "http://www.worldwidetelescope.org/webclient/default.aspx?wtml=http%3a%2f%2fwww.worldwidetel...". The navigation menu includes "Explore", "Guided Tours", "Search", "Community", "View", and "Settings". The breadcrumb trail reads "Collections > Open Collections > HH4647 >". A thumbnail of the current view is shown in the top left corner, labeled "HH4647". The main view is a star field with a central nebula. A white box highlights a region of the star field, and a smaller inset window shows a zoomed-in view of that region. The bottom control panel includes "Look At" (Sky), "Imagery" (Digitized Sky Survey (Optical)), "Image Crossfade", "Vela" (with a map icon), "Bubbly Little Star" (with a thumbnail), "RA : 08h25m38s", "Dec : -51:01:43", and a "Done" button. The interface also features a compass and a "Vela" label with a timer "00:07:32".

“Side-by-Side Comparison”

“Readable Labels”

“Highlighting”

“Custom Site”

“Inference”

“Off-the-Desktop”

“Progressive Resolve”

“Zoom”

“Search”

“Selection”

“GIS/Layering”

“Registration”



Spitzer Space Telescope

• Jet Propulsion Laboratory
• California Institute of Technology
• Vision for Space Exploration

[Home](#)
[Images](#)
[Newsroom](#)
[Podcasts](#)
[Features](#)
[About Spitzer](#)
[Search / Site Info](#)

NEWSROOM

Press Releases

- Chronological
- By Subject
- Outside Institutions

What's Happening Archive

Visuals

- Image Use Policy

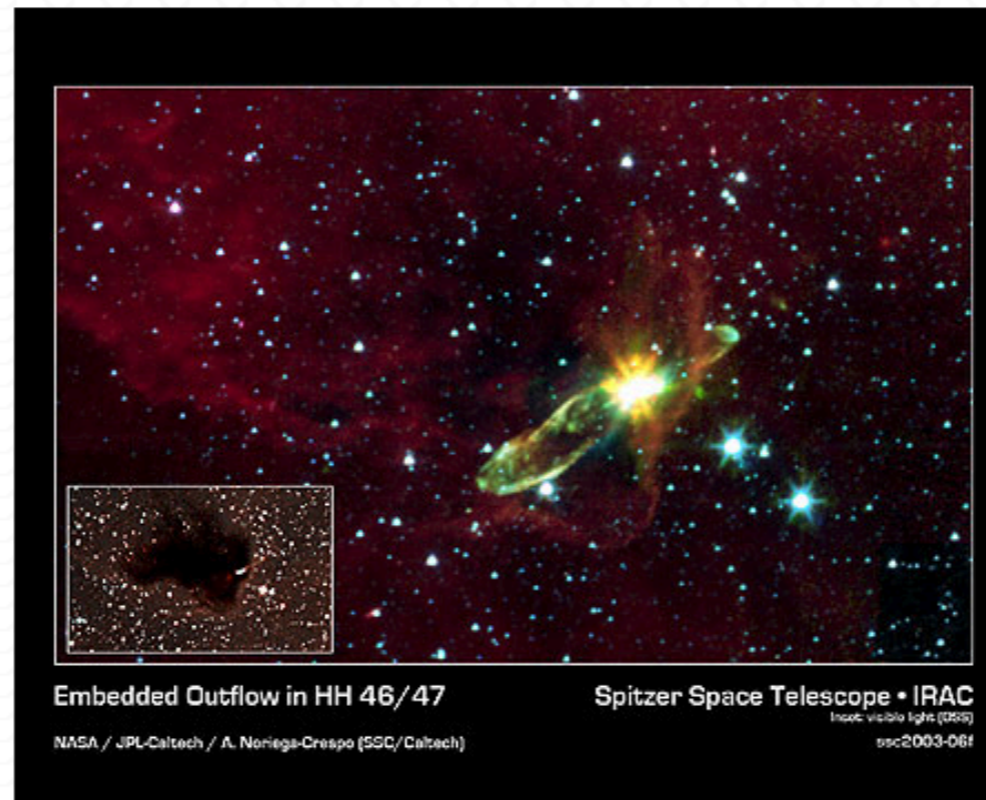
Update Notifications

- Mailing List
- RSS Feed (XML)

References

- Fast Facts
- Press Kit (.pdf)
- Fact Sheet (.pdf)
- Field Guides
- Glossary

Media Contacts



Embedded Outflow in HH 46/47

Spitzer Space Telescope • IRAC

NASA / JPL-Caltech / A. Noriega-Crespo (SSC/Caltech)

Inset: visible light (DSS)
ssc2003-06f

Credit: NASA/JPL-Caltech/A. Noriega-Crespo (SSC/Caltech), Digital Sky Survey

HH46/47

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

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

HH 46/47 is a striking example of a low-mass protostar ejecting a jet and creating a bipolar, or two-sided, outflow. The central

HH4647

ADD NOTE SEND TO GROUP ADD TO SET BLOG THIS ALL SIZES ORDER PRINTS ROTATE EDIT PHOTO DELETE



Embedded Outflow in HH 46/47 Spitzer Space Telescope • IRAC
NASA / JPL-Caltech / A. Noriega-Crespo (SSC/Caltech) ssc2003-06f

“Search”
“Custom Site”
“Registration”
“Readable Labels”

Uploaded on January 6, 2009 by Alyssa Goodman

Alyssa_Goodman's photostream
16 uploads
browse

This photo also belongs to:

astrometry (Pool)

Tags

- Astrometrydotnet:version=10146
- Astrometrydotnet:id=alpha-200901-20629873
- Astrometrydotnet:status=solved

Add a tag

Additional Information

- All rights reserved
- Anyone can see this photo
- Add to your map
- Taken on December 12, 2003
- Photo stats
- Viewed 7 times (Not including you)
- Edit title, description, and tags

Flag your photo

To go really “seamless”...

“Progressive Resolve”

“Zoom”

“Search”

“Selection”

“GIS/Layering”

“Registration”

**“Side-by-Side
Comparison”**

“Readable Labels”

“Highlighting”

“Custom Site”

“Inference”

“Off-the-Desktop”

“Ontology”

“Measurement”

“Ontology”

“Measurement”

Seamless Astronomy: “Configure This”

The screenshot shows the AstroNavigator interface with several panels:

- Project 1, Project 2, Project 3, Edit** buttons at the top right.
- Panel A:** "QSO MgII absorption lines observed" with a search bar and a "Find Similar" button.
- Panel B:** "SAO/NASA ADS Astronomy Abstracts" with links for "Find Similar Abstracts", "Electronic Refereed Journal Article", "Full Refereed Journal Article (PDF/PPT)", and "Xiv e-print".
- Panel C:** A diagram showing a blue arrow pointing up and a yellow circle labeled "STARS WITH Nebula age".
- Panel D:** "IC 348 Example Requires" with a satellite icon and buttons for "Inventory", "Images", and "Footprints".
- Central Image Viewer:** A large image of a nebula with a blue sphere and arrows indicating a search or zoom function.

Demo:
WWT to
ADS, VO
(SAMP),
TSC,
DASCH

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

“Modular Craftsmanship”

Semantic Search

AstroNavigator

Project 1 Project 2 Project 3 Edit

QSO MgII absorption lines observed

Authors
Drinkwater, Webster R.L., Th...

Description
The results of a large R-band

SAO/NASA ADS Astronomy Abs...

Find Similar Abstracts (with default...
Electronic Refereed Journal Article (...
Full Refereed Journal Article (PDF/P...
FIND IT @ HARVARD
eXiv e-print (arXiv:astro-ph/0004386)

STARS WITH NEBULAR AGN

ST Grains

Microsoft WorldWide Telescope

IC 348
Example Requires...

Inventory Images Footprint

IC 348 RA = 56.141667 De

results 1-20 of 907

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

Prototype “Faceted” Browsing

(using very lightweight “**Ontology**”)

Faceted browsing of the IVOA Registry

Start search

2 filter criteria [\(remove all\)](#)

- Wavelength coverage: Infrared [\(remove\)](#) [\[add more\]](#)
- Text Search: "quasar" [\(remove\)](#)

Order

40 items
sorted by Citation [A to Z]

1(28) 2(12)

« previous 1 2 3 4 next »

QSO MgII absorption line systems (Drinkwater+, 1993) - Quasars observed

Authors Drinkwater M.J., Webster R.L., Thomas P.A.	Type Catalog
Description The results of a large R-band imaging survey of 71 bright ($m(V) < 18$) quasars are presented. The quasars were chosen from published samples which have intermediate resolution optical spectroscopy available, so the presence of low redshift Mg II absorption lines can be determined. We have searched our data for galaxies close to the line-of-sight to the quasars, which we might be able to identify with the absorption systems. We find a high coincidence between galaxies very near the line-of-sight and quasars showing absorption systems in their spectra, a result consistent with other studies. These galaxies have a mean luminosity of $0.5L_{\text{star}}$ (assuming they lie at the absorption redshift). The distribution of impact parameters between the galaxies and the quasars extends with a flat distribution to large radii ($> 30h^{-1} \text{kpc}$). This suggests that the absorption systems may not be gravitationally bound to the observed galaxies, but may be part of larger extended systems. We also find a significant number of galaxies near the line-of-sight to the	Content Level Research
	VizieR collection Tables from Astronomical Journal
	Bibliographic Code 1993AJ....106..848D
	Original data [external link]

Type here to search

^ VizieR keyword

Type here to filter

- QSOs (35)
- Redshifts (9)
- Wide-band photometry (9)
- Spectroscopy (6)
- Galaxies (4)
- Photometry (3)
- White Dwarf stars (3)

^ Wavelength coverage

Type here to filter

- Radio (16)
- Optical (15)
- UV (13)
- X-ray (13)

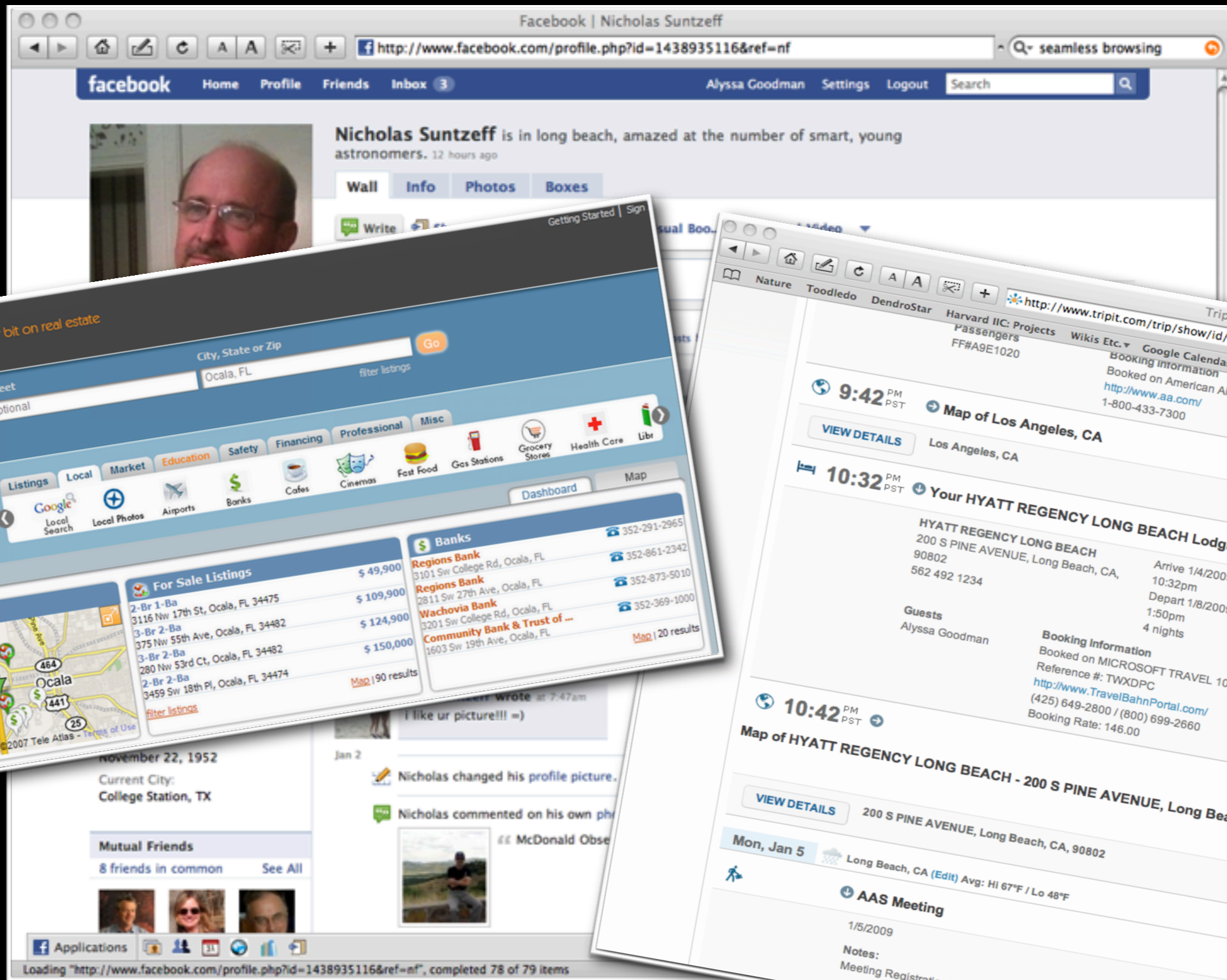
^ VizieR catalog collection

Type here to filter

- Tables from Astronomical Journal (16)
- Tables from Astrophysical Journal Supplement Series (13)
- Tables from Astronomy and Astrophysics Supplement Series (3)

courtesy Douglas Burke, CfA/IIC

We need to catch up to this & go beyond...



iiC = Opportunity to Generalize...

Loading "SWAN Hypothesis Browser"

http://hypothesis.alzforum.org/swan/dolgetHome.action

SWAN Alzheimer Knowledge Base beta

Semantic Web Applications in Neuromedicine

Home About

Welcome to the SWAN Alzheimer Knowledge Base

SWAN is the participatory knowledge base of Alzheimer Disease that YOU can help develop. SWAN is all about how you interpret, debate, ask questions and advance the science.

Log in now to browse the SWAN Alzheimer Knowledgebase!

Login Now!

Or Contact us if you are interested in participating to our Beta Program!

» Featured Contributions

- H** Aβ Plaques Lead to Aberrant Regulation of Calcium Homeostasis In Vivo Resulting in Structural and Functional Disruption of Neuronal Networks. Kuchibhotla Kishore V et Al.
- H** Amyloid-β protein dimers isolated directly from Alzheimer's brains impair synaptic plasticity and memory. Shankar Ganesh M et Al.
- H** Transglutaminase induces proteolytic amyloid-β-protein assemblies that are resistant and inhibit long-term potentiation. Hartley Dean M et Al.

click on the title to browse the full content and use the arrows to scroll the list

» Hot Topics (browse all hypotheses)

- Aβ accumulation in the brain is the primary event in Alzheimer Disease pathogenesis
- Soluble oligomeric aggregates of Aβ are toxic to neurons and cause AD pathology
- Insoluble fibrillar Aβ leads to AD
- Defective mechanisms of Aβ clearance contribute to AD
- Tau dysfunction mediates neurodegeneration
- ApoE contributes to AD through multiple mechanisms
- Changes in calcium homeostasis may provide a common pathway for the neuropathological changes in AD
- Changes in presenilin function lead to dementia and neurodegeneration in Alzheimer Disease
- Misfolded proteins accumulated into protein aggregates characterizes the pathologic lesions of AD
- The molecular mechanisms of neuronal cell death are involved in the dysfunction and death of neurons in AD
- Synaptic loss appears to be the most powerful and ubiquitous proximate factor leading to the dementia of AD
- Failure of axonal transport might be the underlying basis for neurodegeneration in AD
- Cell membrane properties play a key role in AD Pathophysiology

» Mechanisms

- Energetics
- Functional Changes of Proteins
- Structural Changes of Proteins

» How to Contribute

- Build a hypothesis
- Critique a hypothesis
- Nominate a key paper
- Help find connections
- Propose new features
- Add supporting evidence

Contact us!

» Knowledge Base

Statements
1438 Research Statements

- » 128 Hypotheses
- » 26 with Extended annotation
- » 102 with Simple annotation
- » 1310 Claims

35 Research Questions
29 Comments

Publications
1201 Journal Articles
6 Journal Comments
2 Journal News
30 Web Comments

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Ectoderm specification and differentiation | Germ cell and somatic stem cell biology in reproduction | Stem cell immunology

Endoderm specification and differentiation | Mesoderm specification and differentiation | Therapeutic prospects

Epigenetics | Niche biology, homing, and migration | Tissue engineering

News

National Institutes of Health Guidelines for Human Stem Cell Research

News, NIH 16 April 2009

The National Institutes of Health (NIH) is requesting public comment on draft guidelines entitled "National Institutes of Health Guidelines for Human Stem Cell Research. To read more, [click here](#)

[Login or register](#) to post comments

Commentaries

July 31, 2008
Random versus deterministic input into stem cell lineage choice

June 26, 2008
Stem cell maintenance factors represent potential therapeutic targets for cancer

May 30, 2008
Genomic approaches provide insights into the molecular basis of pluripotency

[more](#)

The Science Collaboration Framework is a project of the Initiative in Innovative Computing at Harvard University in collaboration with the Harvard Stem Cell Institute, based on the Drupal open source content management system.
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...from, e.g. "Semantic"
Life Science Success (e.g.
work of Clark, Das et al.)

Seamless AstroLife?

The mockup displays the AstroNavigator interface with several key components:

- Literature Viewer:** Located at the top, it includes tabs for "Project 1", "Project 2", "Project 3", and "Edit". Below it, a search result for "SAO/NASA ADS Astronomy Abs" is shown with options to "Find Similar", "Electronic Ref", "Full Reference", and "Xiv e-print".
- Semantic Search:** On the left, it shows a search result for "QSO MgII absorption line observed" with fields for "Authors", "Description", and a "Description" field containing "The results of a large R-band".
- Info Viz for Search Results:** On the right, it features a circular visualization of search results, with one result labeled "STARS WITH Nebula".
- Data Viewer (e.g. WWT):** At the bottom left, it shows a screenshot of the Microsoft WorldWide Telescope (WWT) interface displaying a large, detailed image of a nebula.
- Archive Browser:** On the bottom right, it shows a search result for "IC 348" with fields for "Inventory", "Images", and "Footprint". It also displays coordinates "C 348 RA = 56.141667 De" and "results 1-20 of 907".

A central globe icon is positioned between the Semantic Search and Data Viewer components, with arrows pointing to both, indicating a seamless transition between search and data visualization.

Semantic Search

Literature Viewer

Info Viz for Search Results

Data Viewer (e.g. WWT)

Archive Browser

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

What about DDD...

...is easier now than before?

fast computation, animation, 3D

...was easier before than now?

craftsmanship

...should be easier in the future?

modular craftsmanship

What...

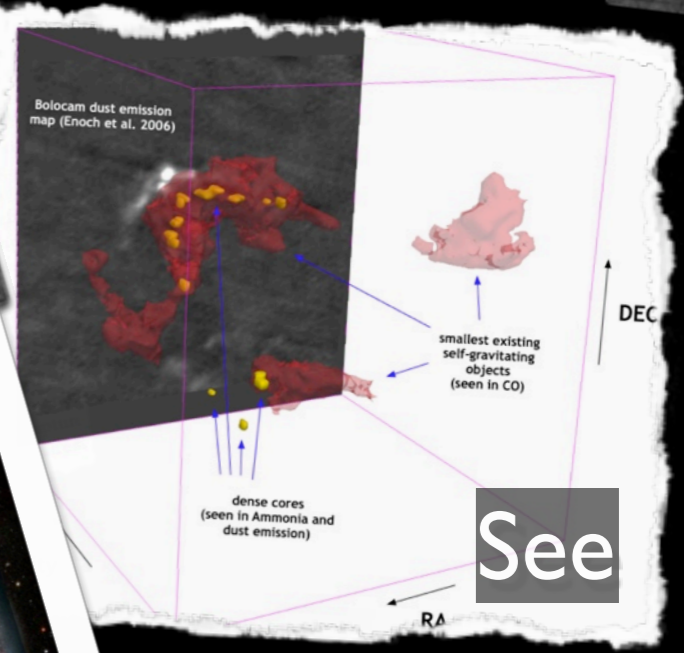
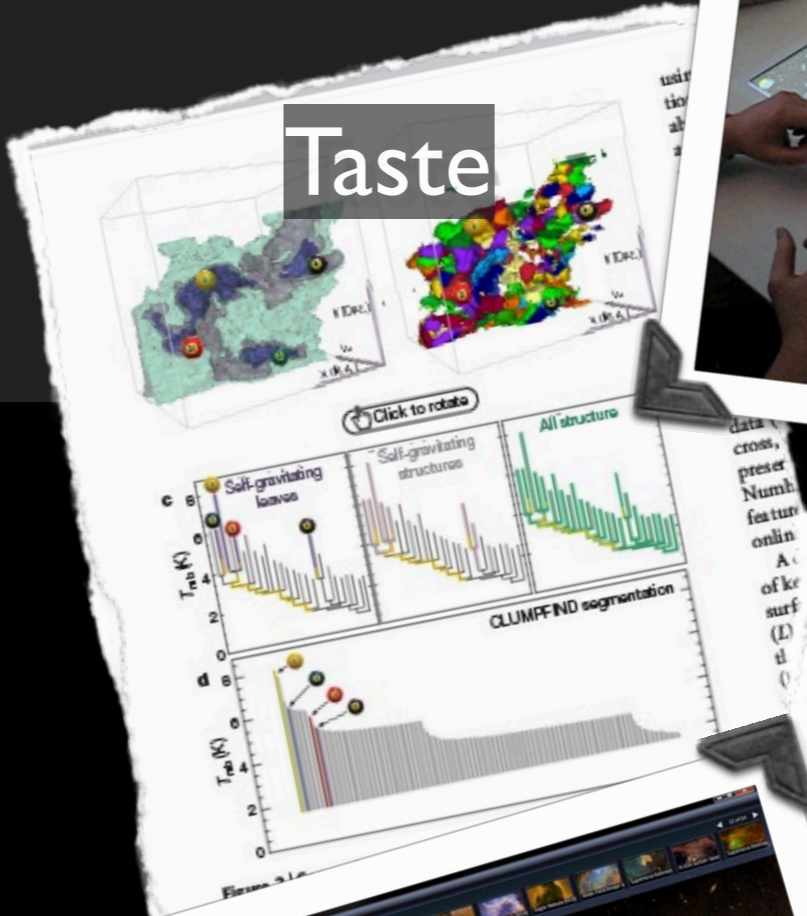
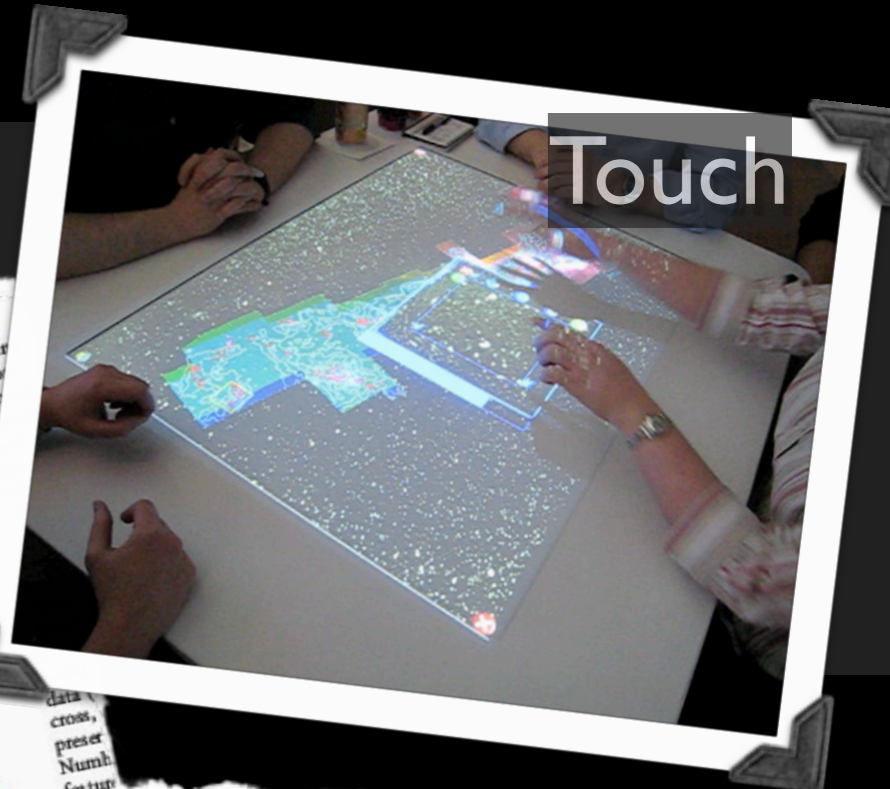
I think we can aim for general, interoperable, (viz) tools with a “modular craftsmanship” approach.



...should be easier in the future?

modular craftsmanship

Astronomy as I See, Touch, Taste, and Hear It



So many thanks, to...

Astronomical Medicine & 3D PDF: Mike Halle, Michelle Borkin, Jens Kauffmann, Doug Alan, Ron Kikinis, Erik Rosolowsky, Nick Holliman, Jonathan Foster, Jaime Pineda, Héctor Arce, Dave Kennedy, Mark Thomas, Timo Hannay & Phil Campbell

Touch: Chia Shen & Hanspeter Pfister

Taste: Erik Rosolowsky & Rahul Shetty

WorldWide Telescope: Curtis Wong, Jonathan Fay & Gus Muench + MSR supporters

Seamless Astronomy: Gus Muench, Eli Bressert, Doug Burke, Alberto Accomazzi, Michael Kurtz, Jim Hendler, Deborah McGuinness, Curtis Wong & Jonathan Fay + MSR supporters

and

IICers: Tim **Clark**, Felice Frankel, Hanspeter Pfister, Ros Reid, Helene Tingle, Lincoln Greenhill, Pavlos Protopapas, Tim Kaxiras ... +so many others!+

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...and my family, for putting up with all this.

