

2tech|, or



Not to bech?

*“Solutions for scientists: modern software tools that facilitate research”*

Alyssa Goodman

Harvard-Smithsonian Center for Astrophysics

# Relative Strengths



Pattern Recognition  
Creativity



Calculations

“Solutions for scientists:  
modern **software tools** that facilitate **research.**”

**Not** what I want  
to talk about  
today...

Microsoft  
**Research**

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Home > Events > 2011 eScience Workshop: Transforming Scholarly Communication

## 2011 eScience Workshop: Transforming Scholarly Communication

October 23-25, 2011 | Cambridge, Massachusetts

Home | **Agenda**

 Microsoft Research and Harvard University are sponsoring the invitation-only Microsoft Research eScience Workshop: Transforming Scholarly Communication from October 23 to 25, 2011, at the Microsoft Northeast Research and Development Center in Cambridge, Massachusetts. The workshop—co-sponsored in close collaboration with the Alfred P. Sloan Foundation and the Gordon and Betty Moore Foundation—will focus on discussing and describing scholarly communications to enable data-intensive research, such as collaborative authoring platforms, common data formats and identifiers, data-sharing, data citation and socio-legal issues. The ultimate aim is to provide a framework that is useful for researchers and funders in modelling a range of disciplinary and community behaviours with respect to the adoption, usage, development and exploitation of cyber-infrastructure for data-intensive research.

 Microsoft Research Northeast Research and Development Center

the adoption of new search in the st in new forms of participants transition sustainably.

**Related Website**

- tumblr Site

**Registration**

This eScience Workshop is an invitation-only event. If you have been invited:

- Register now

**Related Links**


- Jim Gray eScience Award
- eScience at Microsoft
- eScience Group
- The Fourth Paradigm


**Related Events**

- IEEE International Conference on e-Science
- 2011 eScience in Action Workshop
- eScience Workshop 2010


**Contact Us**


For more information, contact [esci@microsoft.com](mailto:esci@microsoft.com)

 UKOLN

 UNIVERSITY OF BATH

Microsoft  
**ResearchConnections**

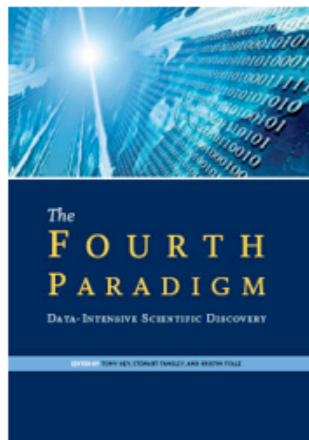


 HARVARD U

## Community Model for Data-Intensive Research

Home | Project details | About Us | Contact Us | Site Map | Member Login

### Community Capability Model for Data-Intensive Research



Microsoft Research Connections and UKOLN are working in partnership on an exciting new project to develop a Community Capability Model for Data-Intensive Research, building upon the principles described in *The Fourth Paradigm*. This second consultation workshop will focus on discussing and describing scholarly communications to enable data-intensive research, such as collaborative authoring platforms, common data formats and identifiers, data-sharing, data citation and socio-legal issues. The ultimate aim is to provide a framework that is useful for researchers and funders in modelling a range of disciplinary and community behaviours with respect to the adoption, usage, development and exploitation of cyber-infrastructure for data-intensive research.

Find out more on the [project details page](#).

#### Events

[UK e-Science All Hands Meeting, 27-29 September 2011, York, UK](#) [Sept. 28 workshop [agenda](#)]

[2011 Microsoft eScience Workshop: Transforming Scholarly Communication, 23-25 October 2011, Cambridge, MA, USA](#) [Oct. 23 workshop [agenda](#)]

[Microsoft Research eScience in Action Workshop, 4-5 December 2011, Stockholm, Sweden](#)

[7th International Digital Curation Conference, 5-7 December 2011, Bristol, UK](#)

“Solutions for scientists:  
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## Alyssa Goodman's "Desk"

Off to Oxford...

09/8/11



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software

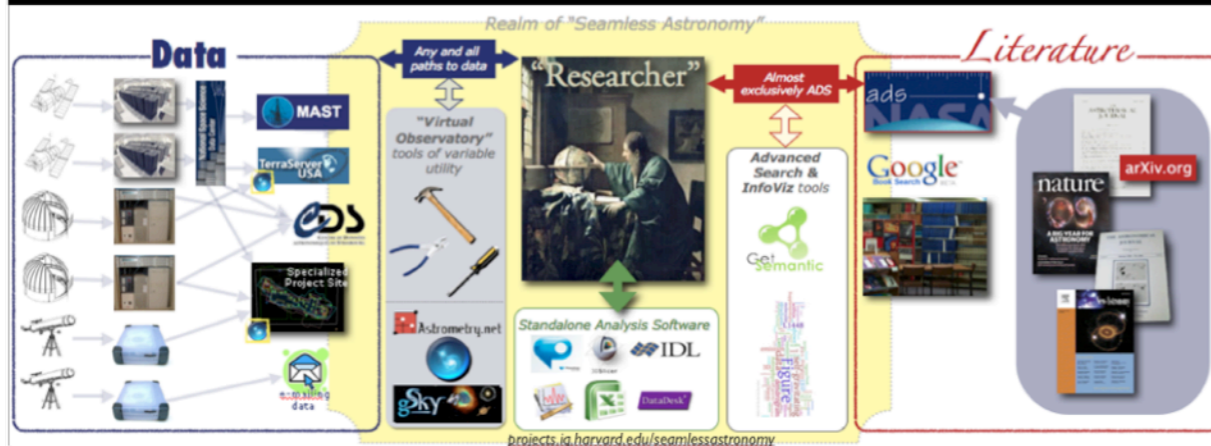
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manipulation publishing  
visualization presentation  
communication outreach media editing  
**collaboration** organization teaching  
data acquisition text-editing and formatting travel

### Seamless Astronomy

How astronomers share, explore & discover



python: The Programming Language for 2011--? - Once upon a time, I really could program. Now, I'm lucky to... <http://t.co/O6NI0dP>

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twitter.com/aagie

[alyssagoodman.tumblr.com](http://alyssagoodman.tumblr.com)

# Data

[Information, Communication]

# Career

[Time allocation, Communication]

# Science

[Analysis, Communication]

# Life

[Organization, Communication]

Offline

Online

Astronomy  
(domain-specific)

Statistics,  
Analysis

Data  
Acquisition

Image  
Manipulation

Collaboration

"Publishing"

Visualization

Communication

Text  
Editing

Outreach

Travel

Please  
remember me!

Presentation

Teaching

Organization

Custom  
Software

Media  
Editing





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Unselect Add tags Edit tags Delete Jump to month

SEPTEMBER 2011

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<b>An example of a very "real" scholarly blog (Danny... --</b> Danny Calegari's research blog is a prime example of what the "scholarly	<b>Adobe Illustrator</b> Adobe Illustrator is a very powerful inherently object-based (rather than pixel-based) image-editing program.	<b>Boxee: A Vision for Academia's Future</b> When I first saw Boxee in 2010, and installed it on a Mac Mini connected to a	<b>Skype: A+ for voice; B for interface; C+ for...</b> It's hardly necessary to explain the utility of Skype to anyone these days, but I	<b>yuuguu: The easiest way to screen share 1:many</b> -Too many places to be at once? -Too many collaborators around the country	<b>Massively Parallel (Human) Math: The Polymath...</b> This group blog, together with its associated wiki, is intended to host "polymath"
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<b>Apple's Pages is best for Graphical Snobs</b> If you're a font & graphics snob like me (or like Steve Jobs), then Apple's Pages is likely the	<b>MORE Astronomy Software --</b> There are many lists of Astronomy Software online, here's one that's meant mostly for amateur	<b>Microsoft Word is Still an Essential Tool, even...</b> Microsoft Word is the object of some derision amongst some nerd friends of mine. But, truth-	<b>WorldWide Telescope: The Universe for Everyone</b> WorldWide Telescope is a "Universe Information	<b>I NEED TripIt</b> OK, I confess that my life is kept under control through the use of technology, which is also the "cause" of much of my, and	<b>Elegant Graphics, at a Price: IGOR Pro</b> Long ago, way before the era of IDL and Python, started using
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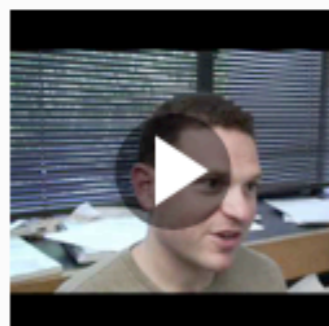
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### Watch

Seamless Astronomy: Keynote at Sage Bionetworks Congress (April 2011) The embedded video

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### Good old Data Desk

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### WorldWide Telescope: The Universe for Everyone

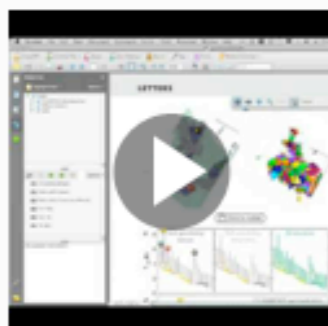
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



Information Aggregation

# Information Aggregation

+Alyssa Gmail Calendar Documents Photos Reader Web more - Alyssa Goodman 1 Share...  

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Calendar Today < > Apr 24 - 30, 2011 Day Week Month 7 Days Agenda  


**CREATE** ▼

▼ April 2011 < >  
S M T W T F S  
27 28 29 30 31 1 2  
3 4 5 6 7 8 9  
10 11 12 13 14 15 16  
17 18 19 20 21 22 23  
24 25 26 27 28 29 30  
1 2 3 4 5 6 7

▶ My calendars   
▶ Other calendars

	Sun 4/24	Mon 4/25	Tue 4/26	Wed 4/27	Thu 4/28	Fri 4/29	Sat 4/30
	Easter	Cleaning	PS 4 Due	Last Day of Spring	Spring Reading Period	Change fish water ALMA NOI Due	
GMT-05							
8am				8 - 9 DSS meeting (confirmed)			
9am		9 - 10 DSS conference call	9 - 2p AY201b prep- last class	9:30 - 10:30 Kerry	9 - 10 EPS Breakfast	9 - 11 Jeff Correia	
10am		10 - 11 WWTA weekly coffee	10 - 12p April 2011 CfA Grou meet	10 - 11 Roman Shcher	9:30 - 1 kids to work day		
11am		11 - 12p Besla Public Talk	11 - SM &	11 - 12 Roman Shcher	11 - 12 Ingrid Stairs: Dileas and	11 - AG travel to	
12pm		12p - 1p SF Lunch (you)	12:30p - 1 Sourav Chatterjee	12p - 1p Postdoc Search	12p - 1:30p AstroViz Lunch Meeting	11:30 - Gilberto	
1pm		1:30p - Chris Far		12:30p COMP LETE Lunch	12:30p ITC lunch	12p - 5p AY95 Presi tions	12:30 Ashley Zaidara
2pm		2p - 3p Besla Defense	2p - 3:30p AY201b(Tuesda y)	2:30p - 3:30p Mocz Dr	1:30p - 5:30p finish taxes if not done		
3pm		3p - 5p Data Management meeting at the Forum Room at Lamont	3:30p - Li Zeng	3p - 4p Shmuli			
4pm		5p - 6p Skype Jonathan Williams_Chris	4p - 5p Coffee w/Lincoln (HR)	4p - 5p Chris' Thesis Meeting	4p - 5: Mukre min Killic:		
5pm							
6pm							
7pm			7:30p - 9p dss update	7p - 8p WW Lexington			
8pm							


# Information Aggregation



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✓ Everything looks good, but TripIt Pro will keep monitoring this trip. 5 alerts ▼ Update




## Oxford-Heidelberg-Rome

Sep 11 - Sep 24, 2011 - Rome, Italy  
Heidelberg, Germany; London, United Kingdom; Rome, Italy

Crazy! trip to give talk in Oxford, then Rome, then Heidelberg...

Itinerary: [Expand](#) | [Collapse](#)

**Sun, Sep 11** London, United Kingdom - Avg: Hi 68°F / Lo 55°F + Add Plans

 **7:45** PM EDT Options ▼

**Boston (BOS) to London (LHR) -**

**Virgin Atlantic Airways 12 - Conf # FFG9GV seats are IN**

Aircraft Airbus A340-600  
nonstop 6h, 35m 3,255 mi Premium Economy seat ag added - [Get seating advice](#)

**Depart:** Boston (BOS), 7:45pm EDT, terminal E  
**Arrive:** London (LHR), 7:20am BST(+1 day), terminal 3

<b>Passenger</b> Alyssa Goodman FF#00661973464	<b>Booking Information</b> Booked on Virgin Atlantic <a href="http://www.virgin-atlantic.com/">http://www.virgin-atlantic.com/</a>
---	--

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**People and sharing** Update

Who's close  
Jaime E Pineda, ebressert (+2 others)

People  
Travelers: [Alyssa A Goodman](#)  
Non-travelers: [Sarah Block](#), [Jaime E Pineda](#), [Katherine Blundell](#), [Abby Schwartz](#), [Edward P Schwartz](#)

Social networks  
[TripIt Contacts and Facebook](#)

This trip is not private. [Change](#)

# Information Aggregation

## Calendar & Map

### Visit to Heidelberg 2011

Today ◀ ▶ Tuesday, September 6 Print Week Month Agenda

#### Thursday, September 15

10:30pm AG check in to Qube hotel in Heidelberg

#### Friday, September 16

9:00am Meet with Ralf, Rahul, Chris, et al. (all day)

#### Saturday, September 17

9:00am Meet with Ralf, Rahul, Chris, et al. again Saturday if weekend is OK

#### Sunday, September 18

9:30am AG leaves for Rome

#### Wednesday, September 21

7:00pm Dinner of Astronomische Gesellschaft

#### Thursday, September 22

9:30am Visit ITA or MPI, depending on availability/timing

1:00pm Visit HdA, begin at 1 PM local time

4:00pm Meet with Andreas Reuter (+Volker Springel?) at HdA

6:00pm Dinner hosted by Andreas Reuter

#### Friday, September 23

9:00am Attend as much of AG meeting as feasible

12:25pm AG give Viz talk at AG meeting

2:00pm Conclude collaboration at ITA

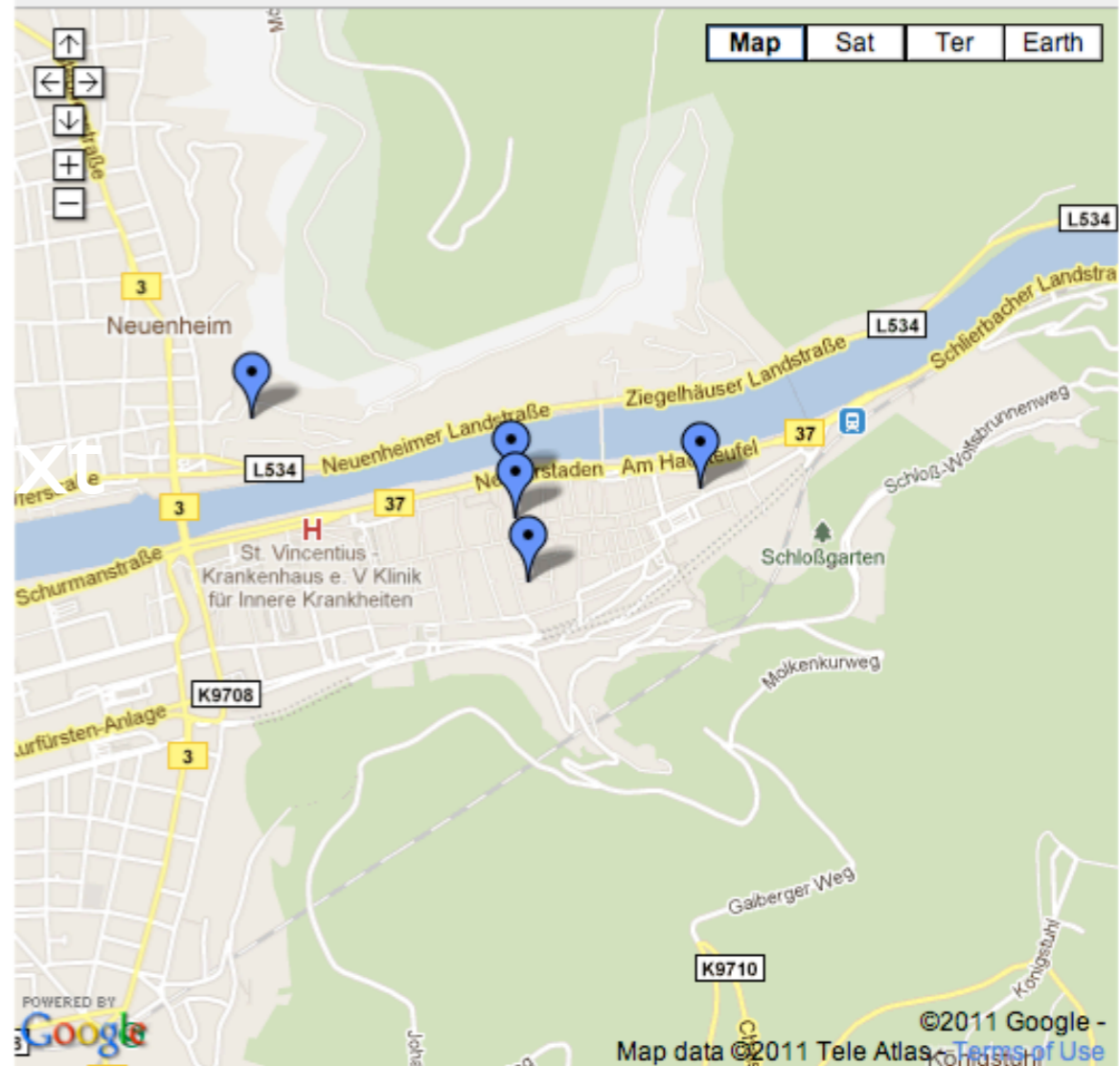
#### Saturday, September 24

8:30am AG leaves Heidelberg for Frankfurt/Home

Events shown in time zone: Berlin



### Heidelberg Locations



Send email to Alyssa? [agoodman@cfa.harvard.edu](mailto:agoodman@cfa.harvard.edu)

SMS or call her? +16172307080

<https://sites.google.com/site/agheidelberg2011/>

# Information Aggregation

The image shows a screenshot of an email client interface. On the left, an email window is open, displaying the header and body of an email from Alberto Bolatto. The email subject is "Re: [Anasaonly] next telecon: Friday Sep 16 2pm EDT". The body text explains that the sender will be in Heidelberg next week and has another telecon at the same time, so they cannot attend. They request information on "teleporting" and provide contact details for the telecon, including a URL for the agenda and contact information for the ANASAC chair. The email is signed by Alberto.

On the right, a calendar window is open for Friday, September 16, 2011. The calendar shows a schedule of events, including "Oxford-Heidelberg-Rome", "Note", "Randall Wayth", "MSR Call", "[Anasaonly] next telecon: Friday Sep 16 2pm EDT", and "NASAC chair". The "Anasaonly" telecon is highlighted with a green dashed border.

At the bottom of the screenshot, a green bar indicates a "Panel Discuss" session from 5:10 - 6:00 PM, with the name "Konigl/Rodriguez/Ho" listed below it.





NGC 7027

WWT/Seamless Astronomy Core Collaboration  
J. Fay (MSR), A. Goodman (CfA), G. Muench (CfA), A. Pepe (CfA), C. Wong (MSR)

# Information Aggregation



**Finder Scope**



Classification:  
Planetary Nebula  
in Cygnus

NGC7027

RA:	21h07m01s	Magnitude:	10.5
Dec:	42 : 14 : 10	Distance:	n/a
Alt:	-02 : 33 : 41	Rise:	23:50
Az:	342 : 18 : 46	Transit:	09:40
		Set:	19:35

Image Credits:  
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Info  
<http://gsss.stsci.edu/Acknowledgements/DataCo>

Research Show Object Close

Look At: Sky

Imagery: Digitized Sky Survey (Color)



Cygnus



NGC7027



# Seamless Astronomy

## How astronomers share, explore & discover



Alyssa A. Goodman  
Harvard-Smithsonian Center for Astrophysics

with

Alberto Accomazzi, Douglas Burke, Raffaele D'Abrusco, Rahul Davé, Christopher Erdmann, Pepi Fabbiano, Jay Luker, Gus Muench, Michael Kurtz & Alberto Pepe (Harvard-Smithsonian CfA); Eli Bressert (U. Exeter); Tim Clark (Massachusetts General Hospital/Harvard Medical School); Mercé Crosas (Harvard Institute for Quantitative Social Science); Chris Borgman (UCLA); Jonathan Fay & Curtis Wong (Microsoft Research)



From: Abstract Service <ads@cfa.harvard.edu>  
 Subject: myADS Notification (Astronomy database)  
 Date: March 23, 2010 12:19:23 AM EDT  
 To: Alyssa Goodman



myADS Personal Notification Service  
 for Alyssa Goodman  
 Tue Mar 23 00:19:23 2010  
 Astronomy database

ADS Main Queries

- [Astronomy](#)
- [Physics](#)
- [arXiv e-prints](#)
- [FAQ](#)
- [What's new](#)

GOODMAN, ALYSSA -

Citations: 3310 (total 4002)

2010NewA...15..444K: Karatas,+ : New intrinsic-colour calibration for uvby-beta photometry

2010MNRAS.403.1054D: Dabringhausen,+ : Mass loss and expansion of ultra compact dwarf galaxies through gas exp

2010ApJ...713..269F: Federrath Collapse and Accretion in Turb

2010ApJ...712.1403P: Pech,+ : Sink Particles in AMR and SPH

2010ApJ...712.1137K: Kauffma a Recent Bipolar Ejection in the Hierarchical Multiple System IP

2422

2010ApJ...712.1137K: Kauffma

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PROPER MOTION, etc - Recent Papers

2010A&A...511A..90B: Breddels,+ : Distance determination for RAVE stars using stellar

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- [Astronomy & Astrophysics Supplements](#)
- [Astrophysical Journal](#)

From: Kayak Alert <alert@kayak.com>  
 Subject: Your KAYAK Fare Alert: Boston (BOS) > Munich (MUC)  
 Date: March 26, 2010 3:52:30 AM EDT  
 To: Alyssa Goodman  
 Reply-To: Kayak Alert <alert@kayak.com>



Fare Alert

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Boston (BOS) to Munich (MUC), round trip  
 Saturday, Jun 12 to Saturday, Jun 19

**\$1649** \$0 since yesterday  
 per person, economy, nonstop

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Today's best fares - cheapest 3 of 3 airlines (Mar 26, 3:51a EDT)

	All Results	Lufthansa	United	Multiple Airlines
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  - \$146+ [Washington](#)
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Imagine  
 astronomy research  
 as seamless as  
 travel research...



*How?*

# Literature



WIKIPEDIA  
The Free Encyclopedia



Blogs, Wikis, etc.

# Data



“Registries”



DataScope

**Disclaimer:** This slide shows key excerpts from within the astronomy community & excludes more general s/w that is used, such as Papers, Zotero, Mendeley, EndNote, graphing & statistics packages, data handling software, search engines, etc.

# Literature

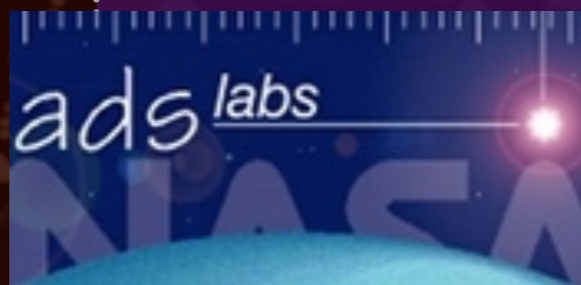


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# "Seamless Astronomy" (Tools)



WorldWide Telescope



TOPCAT



ds9



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ds9



# Data



"Registries"



DataScope

**Disclaimer:** This slide shows key excerpts from within the astronomy community & excludes more general s/w that is used, such as Papers, Zotero, Mendeley, EndNote, graphing & statistics packages, data handling software, search engines, etc.

# Literature

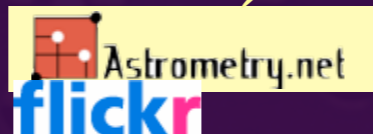


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Blogs, Wikis, etc.

# "Seamless Astronomy" (Tools)



# Data



"Registries"



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# Literature

# "Seamless Astronomy" (Tools)

# Data



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SAMP



Registries"



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# SAMP

(Simple Application Messaging Protocol)

The image displays a screenshot of the SAMP (Simple Application Messaging Protocol) interface, which is a collection of overlapping windows from various astronomical software packages. The windows are:

- Aladin v6.0** (\*\*\* BETA VERSION (based on v6.021) \*\*\*): A window showing a grayscale astronomical image of a star cluster or nebula. It includes a menu bar (File, Edit, Image, Catalog, Overlay, Tool, View, Interop, Help) and a toolbar. A French flag is overlaid on the top right corner.
- Microsoft WorldWide Telescope**: A window showing a dark astronomical image with numerous white circles highlighting specific stars. It features a menu bar (Explore, Guided Tours, Search, Community, View, Settings) and a Microsoft logo. An American flag is overlaid on the top right corner.
- TOPCAT**: A window showing a scatter plot of data points. The plot has a y-axis ranging from 68.15 to 68.30 and an x-axis ranging from 2000 to 2000. The data points are red circles. It includes a menu bar (File, Views, Graphics, Joins, Windows, VO, Interop) and a toolbar. A British flag is overlaid on the top right corner.
- Scatter Plot**: A smaller window showing a scatter plot of data points, similar to the TOPCAT window. It includes a menu bar (File, Export, Plot, Axes, Subsets, Errors, Marker Style, Error Style, Help) and a toolbar.
- Context Search Filter**: A window showing a search filter interface with a dropdown menu and a "1 of 1" indicator.
- Cepheus**: A window showing a map of the Cepheus constellation with a yellow outline. It includes a globe icon and coordinates: RA: 21h01m16s, Dec: +68:08:31. A timer shows 00:14:04.

[link](#) to I2/2010 IVOA recommendation

# Literature

# "Seamless Astronomy" (Tools)

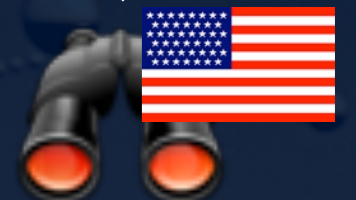
# Data



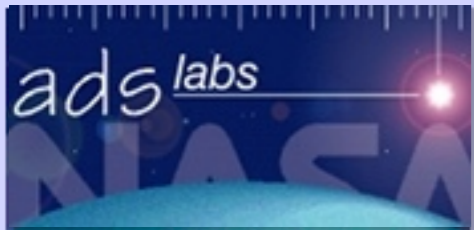
Blogs, Wikis, etc.



SAMP



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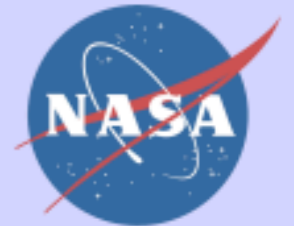
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**A. Accomazzi, A. Goodman, M. Kurtz, R. Davé, J. Luker, G. Muench, A. Pepe**



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1 of 1



NGC 7027

“shift-click”  
on object



**Finder Scope**



Classification:  
Planetary Nebula  
in Cygnus

NGC7027

RA:	21h07m01s	Magnitude:	10.5
Dec:	42 : 14 : 10	Distance:	n/a
Alt:	-02 : 33 : 41	Rise:	23:50
Az:	342 : 18 : 46	Transit:	09:40
		Set:	19:35

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<http://gsss.stsci.edu/Acknowledgements/DataCo>

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Imagery

Sky

Digitized Sky Survey (Color)

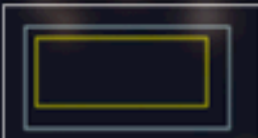
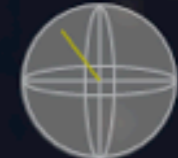
<http://gsss.stsci.edu/Acknowledgements/DataCo>

1 of 1

N

Cygnus

00:03:37



RA : 21h07m02s  
Dec : 42:14:09

Cygnus

NGC7027

Done



NGC 7027



WorldWide Telescope

click "Research, Information"

Finder Scope



Classification: Planetary Nebula in Cygnus

NGC7027

RA:	21h07m01s	Magnitude:	10.5
Dec:	42 : 14 : 10	Distance:	n/a
Alt:	02 : 35 : 57	Rise:	23:50
Az:	342 : 29 : 06	Transit:	09:40
		Set:	19:35

Name: NGC7027

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...more data ...or more literature




Look At: Sky

Imagery: Digitized Sky Survey (Color)




Cygnus NGC7027



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NASA

RA : 21h07m02s  
Dec : 42:14:09

# Literature



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# "Seamless Astronomy" (Tools)



# Data



Registries"



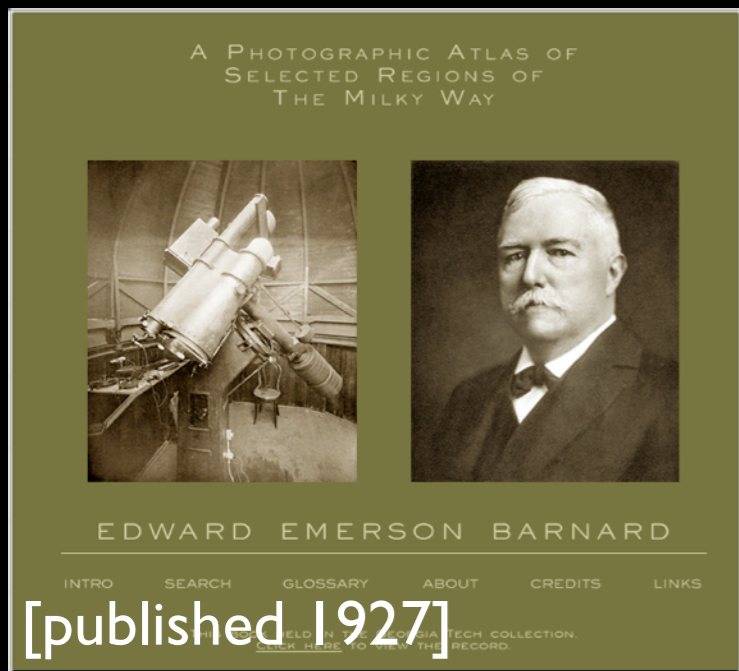
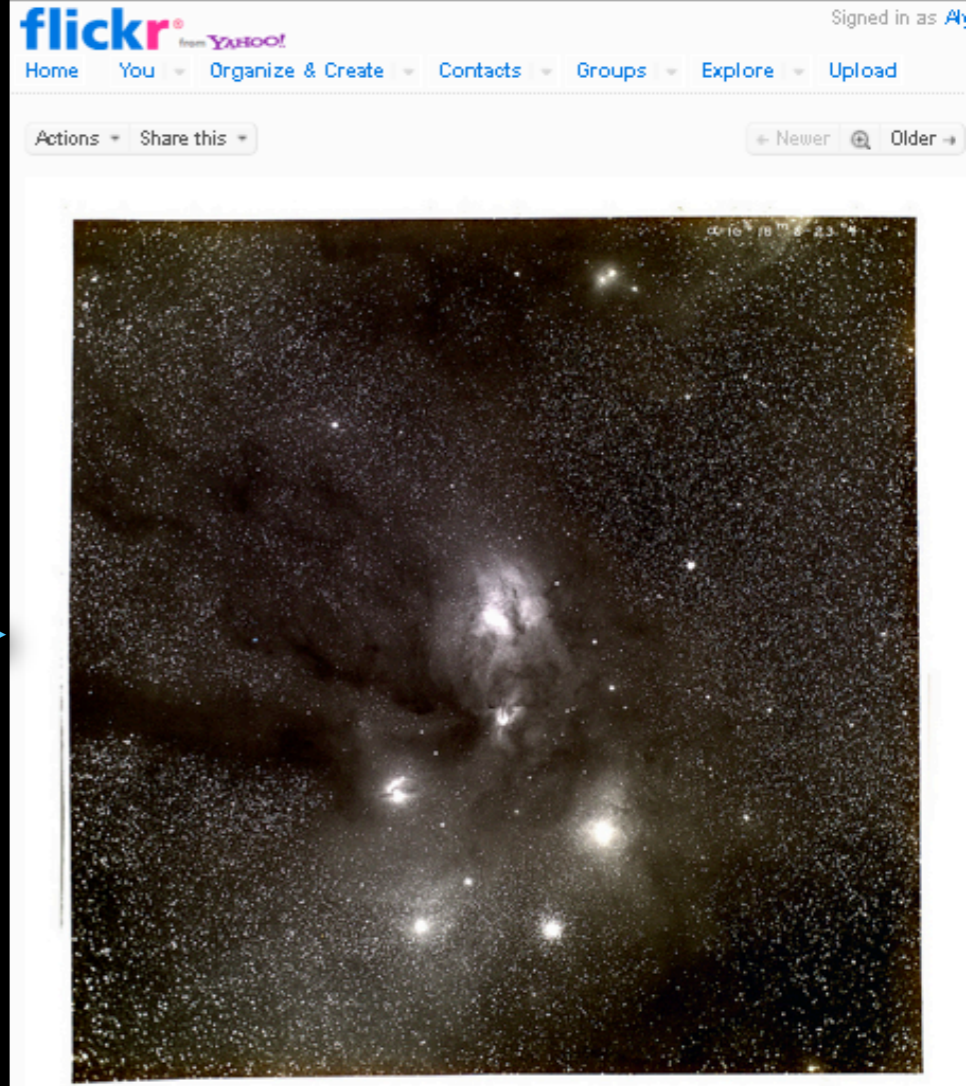
DataScope

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# “Seamless Astronomy” ...

astrometry.net + flickr + WWT



**barnardoph**  
 E.E. Barnard's image of Ophiuchus  
[www.library.gatech.edu/bpdi/bpdi.php](http://www.library.gatech.edu/bpdi/bpdi.php)

Comments and faves **astrometry.net**

**astrometry.net** (6 days ago | reply | delete)  
 Hello, this is the blind astrometry solver. Your results are:  
 (RA, Dec) center:(246.421365149, -23.6749819397) degrees  
 (RA, Dec) center (H:M:S, D:M:S):(16:25:41.128, -23:40:29.935)  
 Orientation:178.34 deg E of N  
 Pixel scale:52.94 arcsec/pixel  
 Parity:Reverse ("Left-handed")  
 Field size :9.41 x 9.41 degrees

Your field contains:  
 The star Antares ( $\alpha$ Sco)  
 The star Graffias ( $\beta$ 1 Sco)  
 The star Al Niyat ( $\sigma$ Sco)  
 The star  $\tau$ Sco  
 The star  $\omega$ 1 Sco  
 The star  $\nu$  Sco  
 The star  $\omega$ 2 Sco  
 The star  $\omega$  Oph  
 The star  $\lambda$  Sco  
 The star  $\rho$  Sco  
 IC 4592  
 IC 4601  
 NGC 6121 / M 4  
 IC 4603  
 IC 4604 / rho Oph nebula  
 IC 4605

[View in World Wide Telescope](#)

# Coming (using astrometry.net++) very soon...



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

The image shows a dark, star-filled field with a prominent, bright, circular feature in the center, likely representing a historical astronomical image layer.



Faceted Heat  
Map of Articles  
on the Sky

The image displays a world map with a color-coded overlay representing the density of articles. The map is titled "SecurityMax" and includes a legend at the top showing a color scale from 0% to 100%. The text "Sasser", "Blaster", and "MyDoom": Why Your Network Can't Stop Them" is visible at the top, and "Monday, December 13th" is visible in the middle. The map shows high concentrations of articles in North America and Europe.

[e.g.ADS-CDS-WWT]

Collaborators: Alberto Accomazzi (CfA); Jonathan Fay (MSR); Alyssa Goodman (CfA); David Hogg (NYU); Gus Muench (CfA); Alberto Pepe (CfA)+advice from Pierre Fernique (CDS) & Thomas Bock (CDS)

# Literature



WIKIPEDIA  
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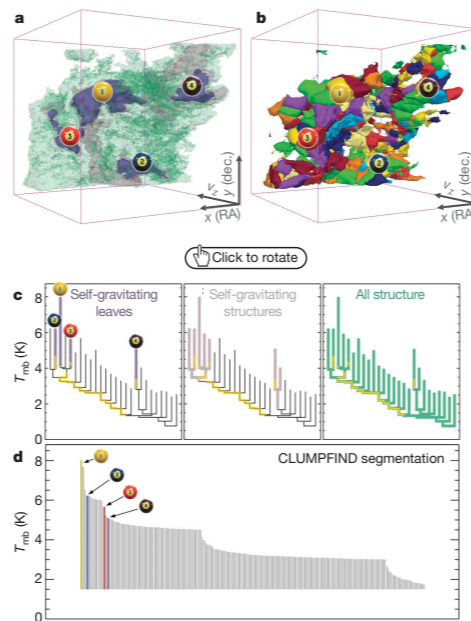


Blogs, Wikis, etc.

# "Seamless Astronomy" (Tools)

LETTERS

NATURE | Vol 457 | 1 January 2009



**Figure 2** | Comparison of the 'dendrogram' and 'CLUMPFIND' feature-identification algorithms as applied to  $^{13}\text{CO}$  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  $T_{\text{mb}}$  (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 ( $-0.5 \text{ km s}^{-1}$ ) to back ( $8 \text{ km s}^{-1}$ ).

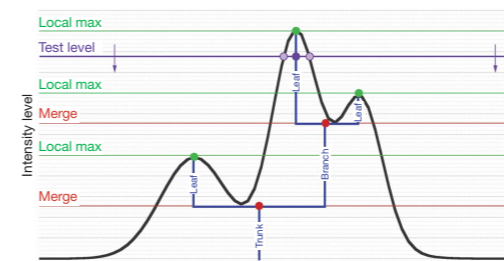
data, CLUMPFIND typically finds features on a limited range of scales, above but close to the physical resolution of the data, and its results can be overly dependent on input parameters. By tuning CLUMPFIND's two free parameters, the same molecular-line data set<sup>8</sup> can be used to show either 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'<sup>9</sup> 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'<sup>10</sup>. Although well developed in other data-intensive fields<sup>11,12</sup>, it is curious that the application of tree methodologies so far in astrophysics has been rare, and almost exclusively within the area of galaxy evolution, where 'merger trees' are being used with increasing frequency<sup>13</sup>.

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 ( $\sigma_v$ ) and luminosity ( $L$ ). The volumes can have any shape, and in other work<sup>14</sup> 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  $\alpha_{\text{obs}}$  only represents the ratio of kinetic energy to gravitational energy at one point in time, and does not explicitly capture external over-pressure and/or magnetic fields<sup>16</sup>, 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



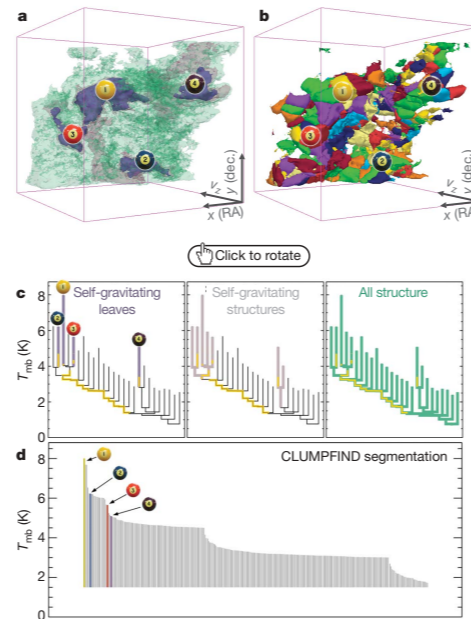
# "Registries"



DataScope

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# Data in *Literature*



**Figure 2 | Comparison of the 'dendrogram' and 'CLUMPFIND' feature-identification algorithms as applied to  $^{13}\text{CO}$  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  $T_{\text{mb}}$  (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 ( $-0.5 \text{ km s}^{-1}$ ) to back ( $8 \text{ km s}^{-1}$ ).

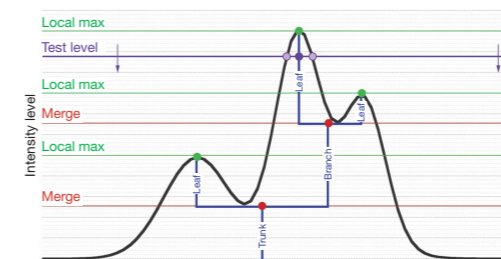
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Note: This work came from the "AstroMed" project [am.iic.harvard.edu](http://am.iic.harvard.edu)



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- 1999ApJ...520..706C Magnetic Fields in Molecular Clouds: Observations Confront Theory**  
Crutcher, Richard M.  
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Genzel, Reinhard.  
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(Lintott, Simpson et al.)

# “Citizen Science” & Outreach

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Using public data from the Kepler mission, we are searching for planets around other stars.

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Ambassadors Program

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### About the WWT Telescope Ambassadors Program



WorldWide Telescope (WWT) is a rich visualization environment that functions as a virtual telescope, allowing anyone to make use of professional astronomical data to explore and understand the universe. As of early 2010, the new WWT Ambassadors Program is recruiting astronomically-literate volunteers, including retired scientists and engineers—all of whom will be trained to be experts in using WWT as a teaching tool. Ambassadors will give volunteer presentations at public libraries, community centers, museums, and schools, demonstrating WWT's power to help laypeople visualize and understand our universe.

[Read more](#)

### John Huchra's Universe

Submitted by [patudom](#) on Jan. 11

**John Huchra**, former president of the **American Astronomical Society**, passed away on October 8, 2010.

John's colleagues at the Harvard-Smithsonian Center for Astrophysics, in collaboration with the creators of WorldWide Telescope at Microsoft Research, have created a new, interactive, WWT Tour to honor John and his career. The Tour primarily focuses on John's quest to map the Universe in three dimensions. It is 12.5 minutes long.

The Tour is best experienced inside the WorldWide Telescope program itself. (Note: You must have the version of WWT released on 1/13/2011 to view all of this Tour's content. You can download it from [here](#).) As viewed within the WWT program, the Tour content is interactive, allowing users to pause and explore the parts of the Universe featured in the tour, explore web hyperlinks, and more. For those who do not have the desktop client, the Tour has been posted as a video as well.

Video (Interactive WWT features will be disabled)

### John Huchra's Universe



Friends of John Huchra have released a new WWT Tour to honor John and his work. The Tour primarily focuses on John's quest to map the Universe in three dimensions. You can view the Tour [here](#).

### Upcoming

- [Cyberlearning Tools for STEM Education Conference](#)  
Mar. 8 - Mar. 9
- [Cambridge Science Festival](#)  
Apr. 30 - May. 10

[wwtambassadors.org](http://wwtambassadors.org)

What else  
should you/we do?  
(Your part.)

**From:** Jaime Pineda <[jaime.e.pineda@gmail.com](mailto:jaime.e.pineda@gmail.com)>  
**Subject:** Fwd: arXiv submission submit/0313285  
**Date:** September 7, 2011 8:25:59 AM EDT  
**To:** Alyssa Goodman , Jens Kauffmann , Hector Arce , Scott Schnee , Jonathan Foster , Mario Tafalla Thomas Robitaille <[trobaille@cfa.harvard.edu](mailto:trobaille@cfa.harvard.edu)> and [3 more...](#)

This is the info regarding the astro-ph submission... in case you want to **claim ownership :)**

Cheers,  
Jaime

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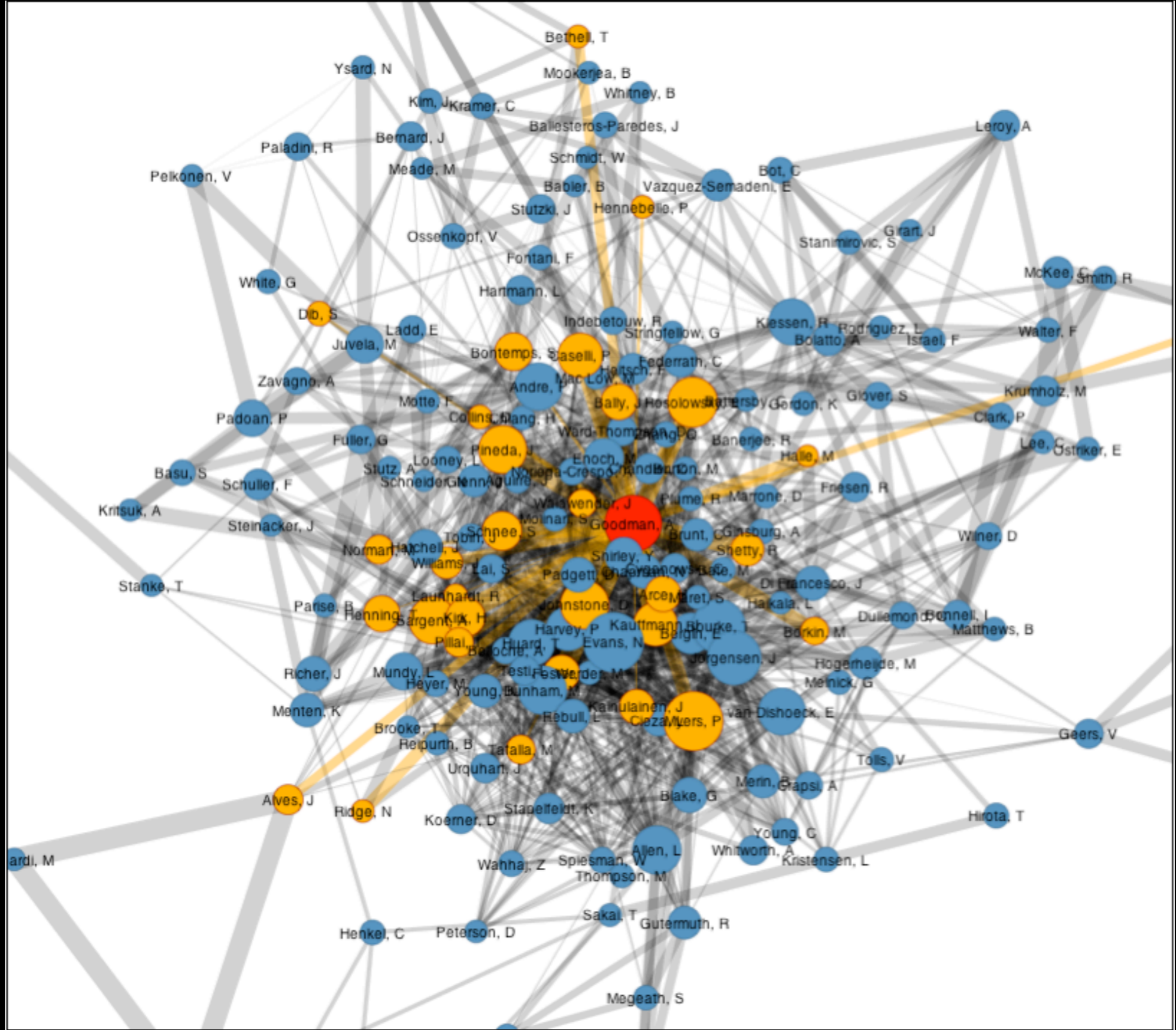
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**Title:** The enigmatic core L1451-mm: a first hydrostatic core? or a hidden VeLLO?  
**Authors:** Jaime E. Pineda, Hector G. Arce, Scott Schnee, Alyssa A. Goodman, Tyler Bourke, Jonathan B. Foster, Thomas Robitaille, Joel Tanner, Jens Kauffmann, Mario Tafalla, Paola Caselli, Guillem Anglada  
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# COMPLETE Citation Network *(from ADS Labs)*





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*"Solutions for scientists: modern software tools that facilitate research"*

Alyssa Goodman

Harvard-Smithsonian Center for Astrophysics