What anyone can do right now

What computer scientists do

What scientists do

What we should do?

3D PDF 2009

PotF 2015

10QViz 2018

glupyter 2019

+ more, together

glue

Open D… | Data | IPython Terminal | Open Session | Export Session | Add/edit arithmetic attributes | Selection Mode: | Preferences | View Error Console

Data Collecti…

Data
- 13…
- c18…
- 12co
- Orion_A_H_3x3[PRIMARY]
- megeath_tom_fix[J_AJ_144_192_table4]

Subsets
- Disks
- Protostars
- Protostars_at_HighAK
- Highest AK Protostar

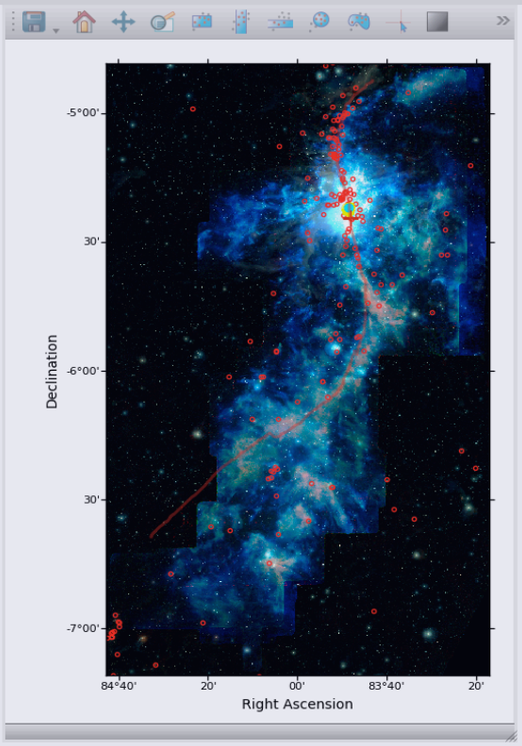
Plot Layers - 1D Profile
- [ ] Highest AK Protostar (12co)
- [ ] Protostars_at_HighAK (12co)
- [ ] Protostars (12co)
- [ ] Disks (12co)
- [x] 12co
- [ ] Highest AK Protostar (c18o)
- [ ] Protostars_at_HighAK (c18o)
- [ ] Protostars (c18o)
- [ ] Disks (c18o)
- [x] c18o
- [ ] Highest AK Protostar (13co)

attribute: PRIMARY
color
opacity
linewidth: 1

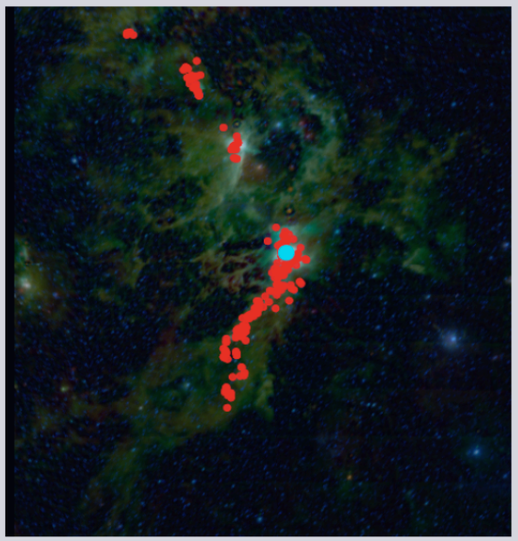
Plot Options - 1D Profile

General | Limits | Axes

function: Maximum
reference: 13co
x axis: Velocity
normalize

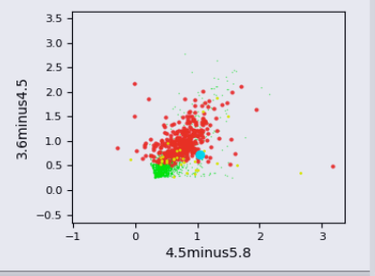


WorldWideTelescope (WWT)

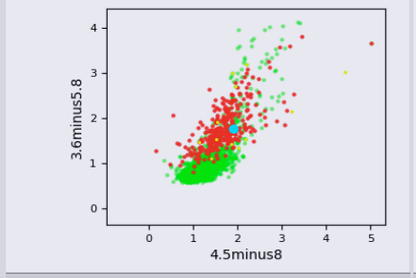


Tab 1 | Tab 3

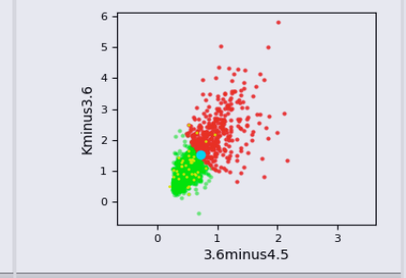
2D Scatter



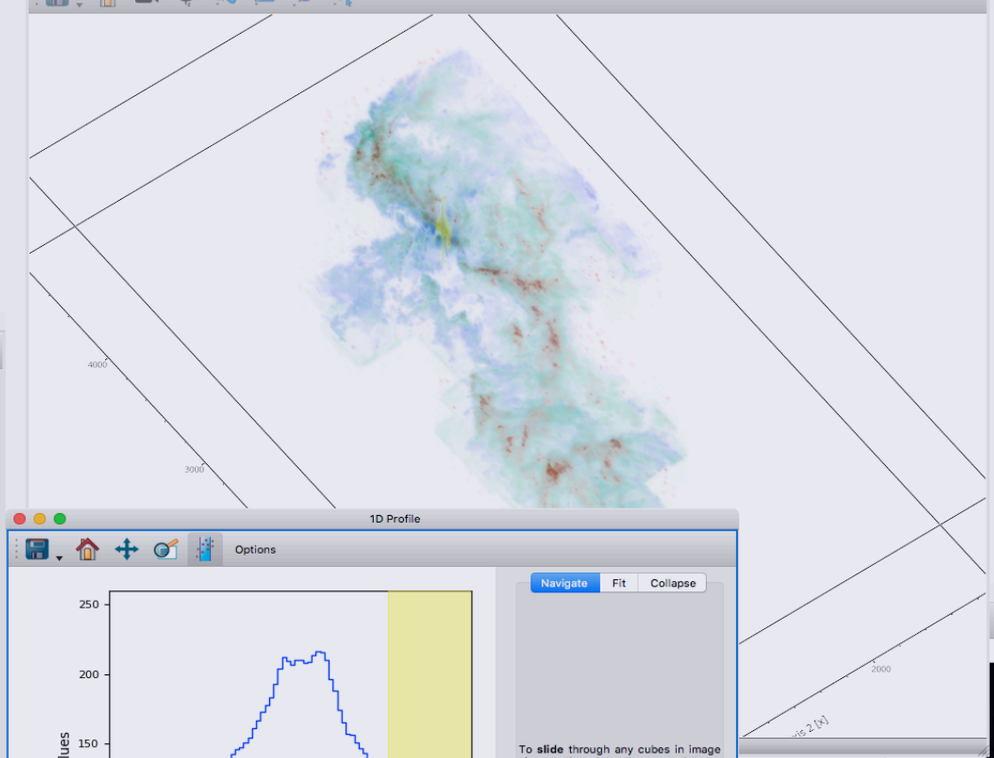
2D Scatter



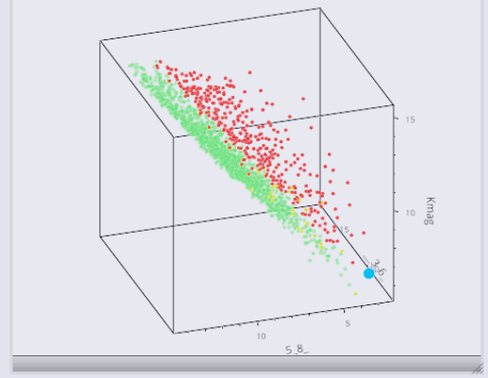
2D Scatter



3D Volume Rendering

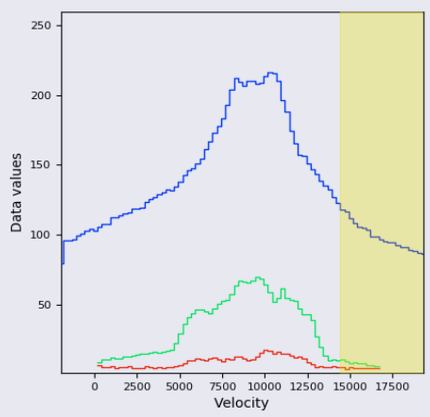


3D Scatter



1D Profile

Options



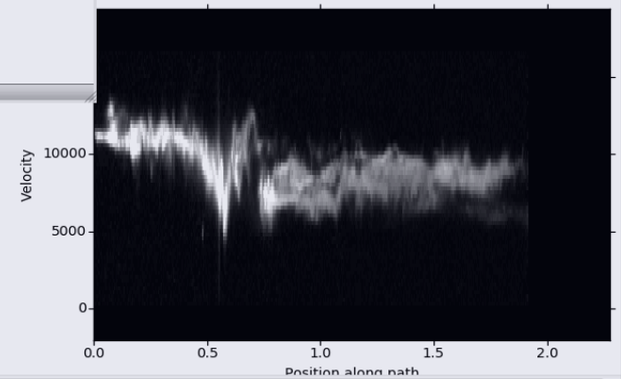
Navigate | Fit | Collapse

To **slide** through any cubes in image viewers that show the same data as the one here, drag the handle from side to side.

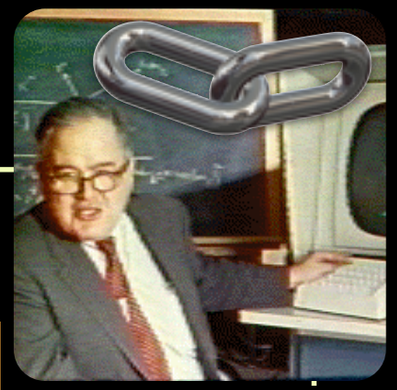
Note that modifying the sliders in the image viewers will not change the slider here or in other viewers.

CLICK and DRAG to define selection, CTRL-CLICK and DRAG to move selection

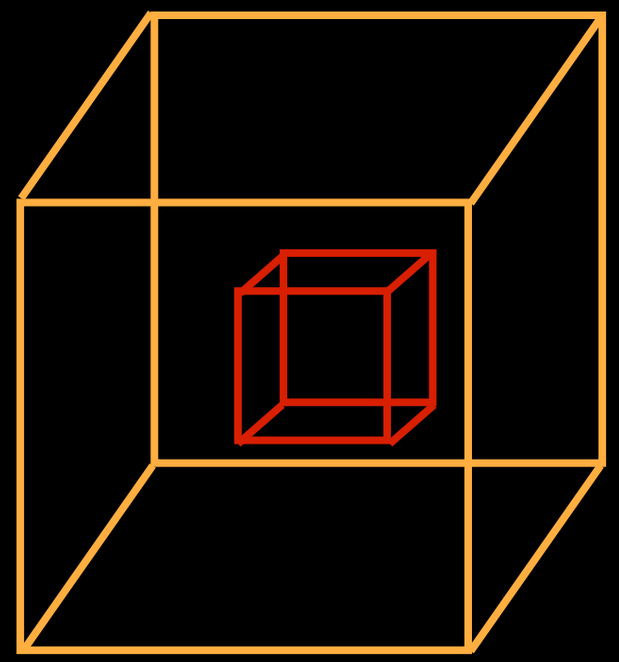
Custom Slice



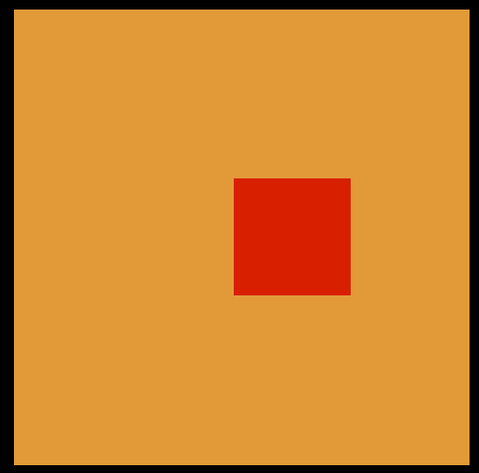
LINKED VIEWS OF HIGH-DIMENSIONAL DATA



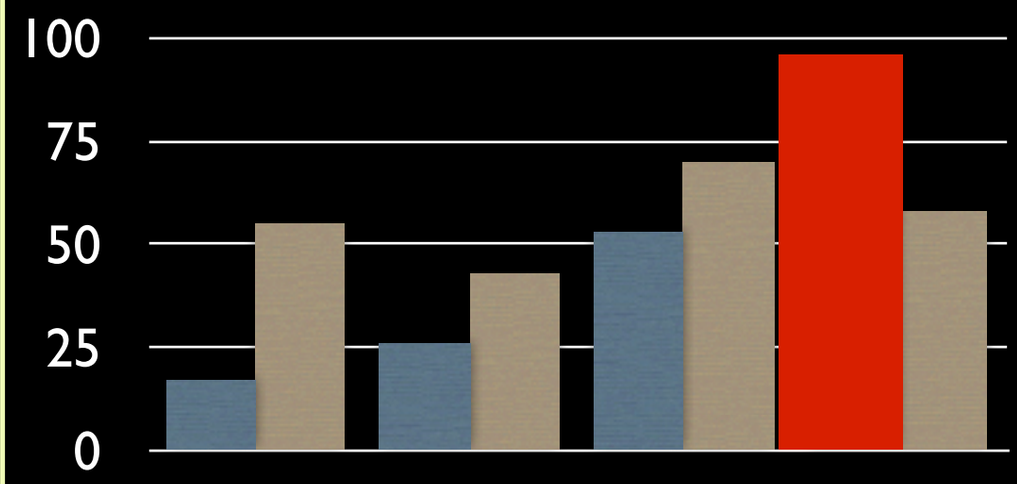
John Tukey



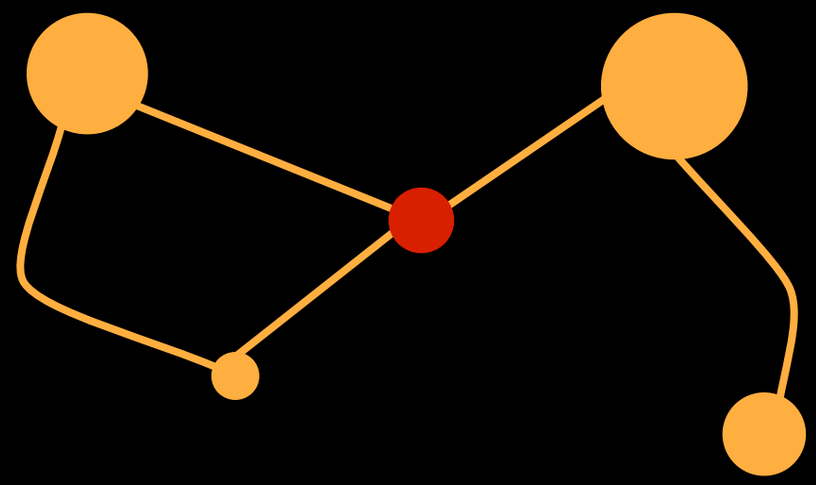
3D



2D



Data Abstraction



figure, by M. Borkin, reproduced from Goodman 2012, "Principles of High-Dimensional Data Visualization in Astronomy"

Updates on the Model Needed!

Model Reoptimization in progress

Work Started at ISM3D Last Year

Colorscale -> HI4Pi

Red -> CO Clouds (Miville-Deschênes et al. 2017)

b = -0.5 and b = -0.5

GLON (deg)

VLSR (km/s)

(Dhanesh Krishnarao)

Model Parameters

- Same Parameters as HI Model (Liszt & Burton 1980)
- Assume Gas rotates as a Cylinder
  - $v(x,y,z) = f(x,y)$
- Replace $n_0(z)$ with $n_0(z)$
  - $n_0(z) = n_{0,0} \exp(-½ z^2 / H_z^2)$
- Two free parameters: $n_{0,0}$ and H_z
- Predict Optical Emission Line Spectra
  - Compare with WHAM

[NII] [OIII] HI4Pi

Hα Hβ [SII]

Note: Have more than just Hα Emission Line

(Dhanesh Krishnarao)

-110 km/s < V_{LSR} < -50 km/s

HI4Pi

+50 km/s < V_{LSR} < +110 km/s

www.astronomy.dk

Galactic Latitude (degrees)

Galactic Longitude (degrees)

Hα = 1.1 R

Hα = 0.6 R

Hα = 0.3 R

Fermi Bubble

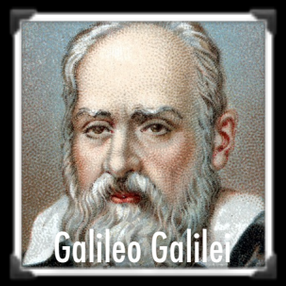
DK (Dhanesh Krishnarao)

Not only unlikely to observe "original" cloud gas, but...

Use the millions of lines-of-sight available in models to estimate distribution of metallicities.

GLUEING TOGETHER THE UNIVERSE


Tom Robitaille


Galileo Galilei


Jorma Harju


Mike Chen


Shuo Kong


Catherine Zucker


John Huchra


Chris Beaumont


Josh Peek


Stefan Meingast


Cara Battersby


Michelle Borkin


Alberto Pepe


Josefa Großschedl


Rowan Smith

Alyssa A. Goodman

Harvard-Smithsonian Center for Astrophysics, Radcliffe Institute, @aagie

GLUEING TOGETHER THE UNIVERSE







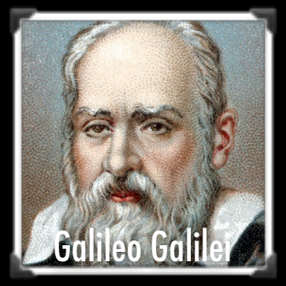









GLUEING TOGETHER THE UNIVERSE


Galileo Galilei


Jorma Harju


Mike Chen

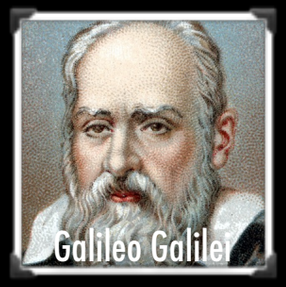

Shuo Kong


Catherine Zucker


John Huchra

Planet **Core** **“Cloud”** **GMC** **Galaxy** **Universe**

GLUEING TOGETHER THE UNIVERSE


Galileo Galilei


Jorma Harju


Mike Chen


Shuo Kong

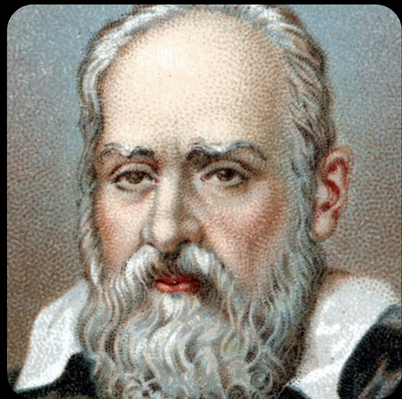

Catherine Zucker


John Huchra

Planet Core "Cloud" GMC Galaxy Universe

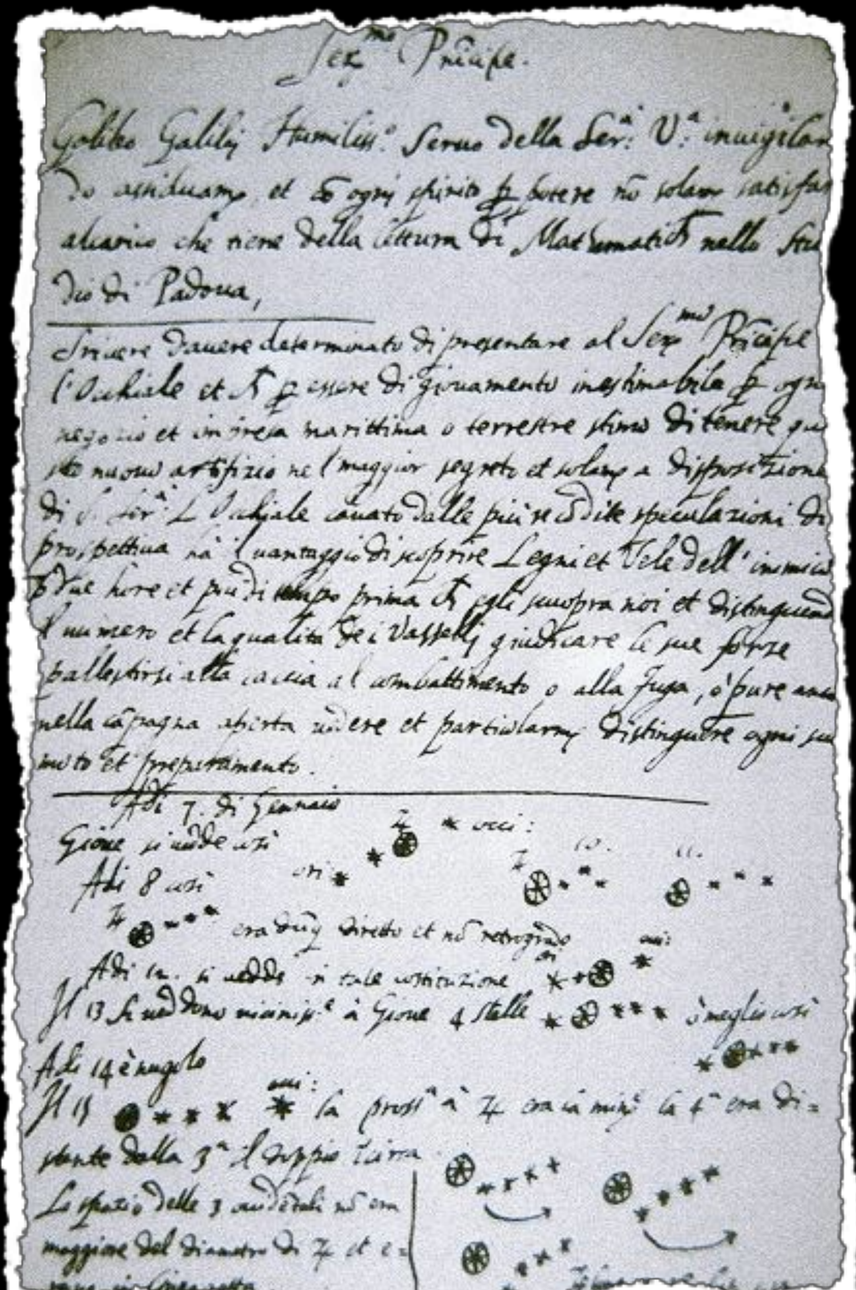

Rowan Smith

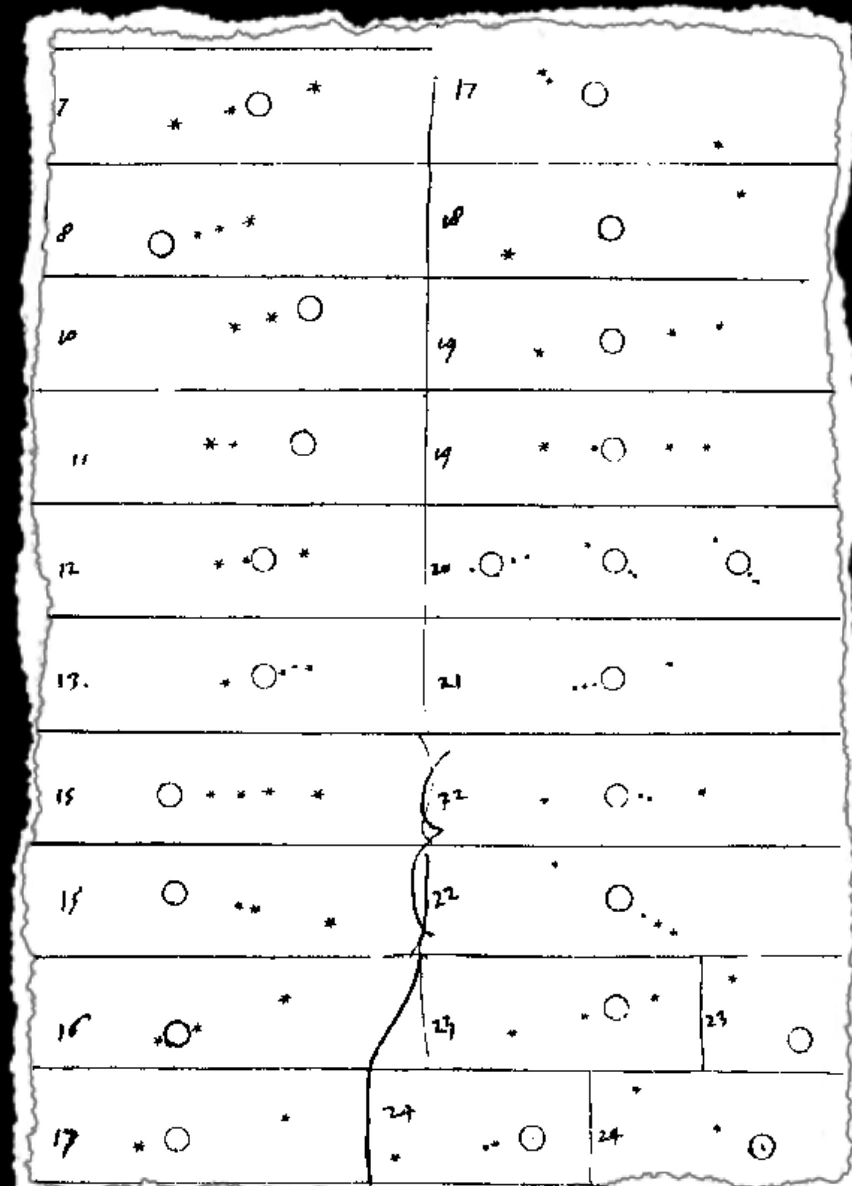
Simulations too!

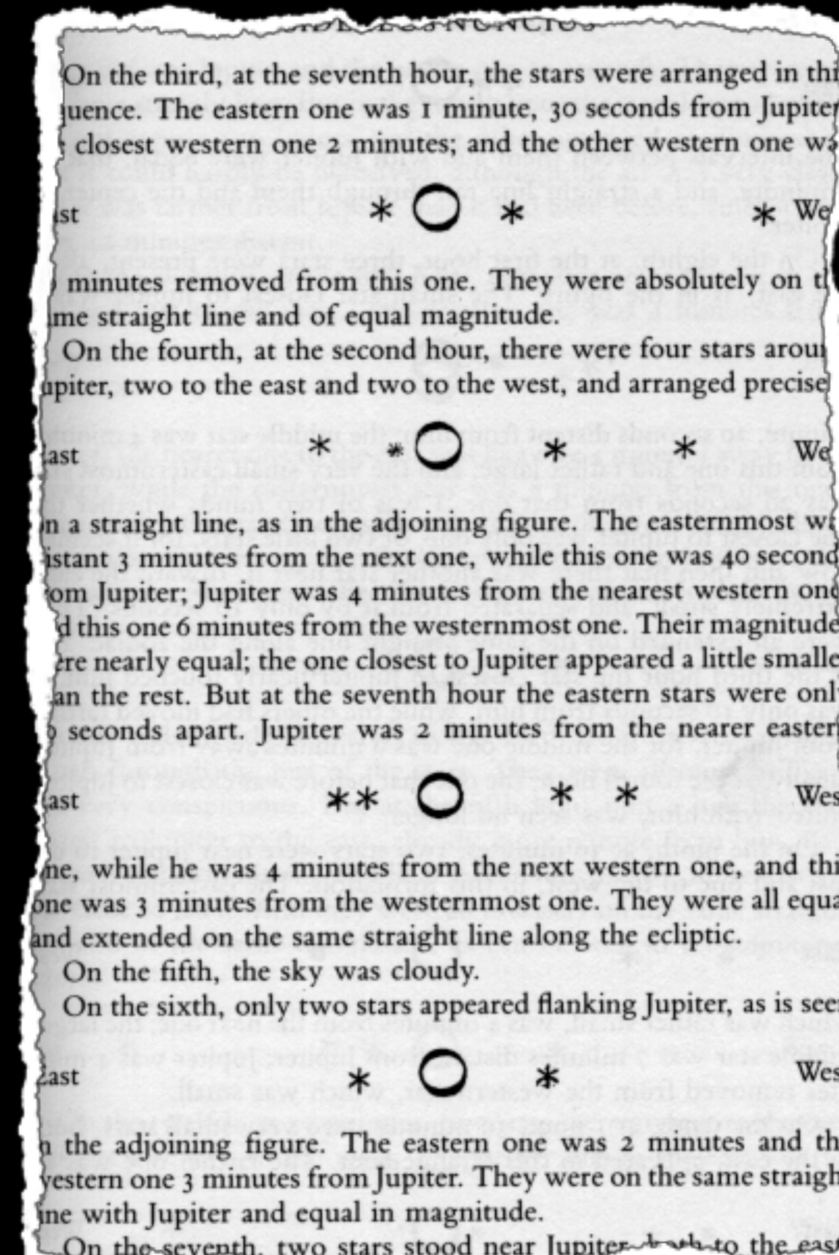


GALILEO GALILEI

(1564-1642)







On the third, at the seventh hour, the stars were arranged in thi
uence. The eastern one was 1 minute, 30 seconds from Jupiter
closest western one 2 minutes; and the other western one wa

ast * O * * We

minutes removed from this one. They were absolutely on t
me straight line and of equal magnitude.

On the fourth, at the second hour, there were four stars arou
upiter, two to the east and two to the west, and arranged precise

ast * * O * * We

n a straight line, as in the adjoining figure. The easternmost w
istant 3 minutes from the next one, while this one was 40 second
om Jupiter; Jupiter was 4 minutes from the nearest western on
d this one 6 minutes from the westernmost one. Their magnitude
ere nearly equal; the one closest to Jupiter appeared a little smalle
an the rest. But at the seventh hour the eastern stars were onl
seconds apart. Jupiter was 2 minutes from the nearer easter

ast ** O * * Wes

ne, while he was 4 minutes from the next western one, and thi
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

ast * O * Wes

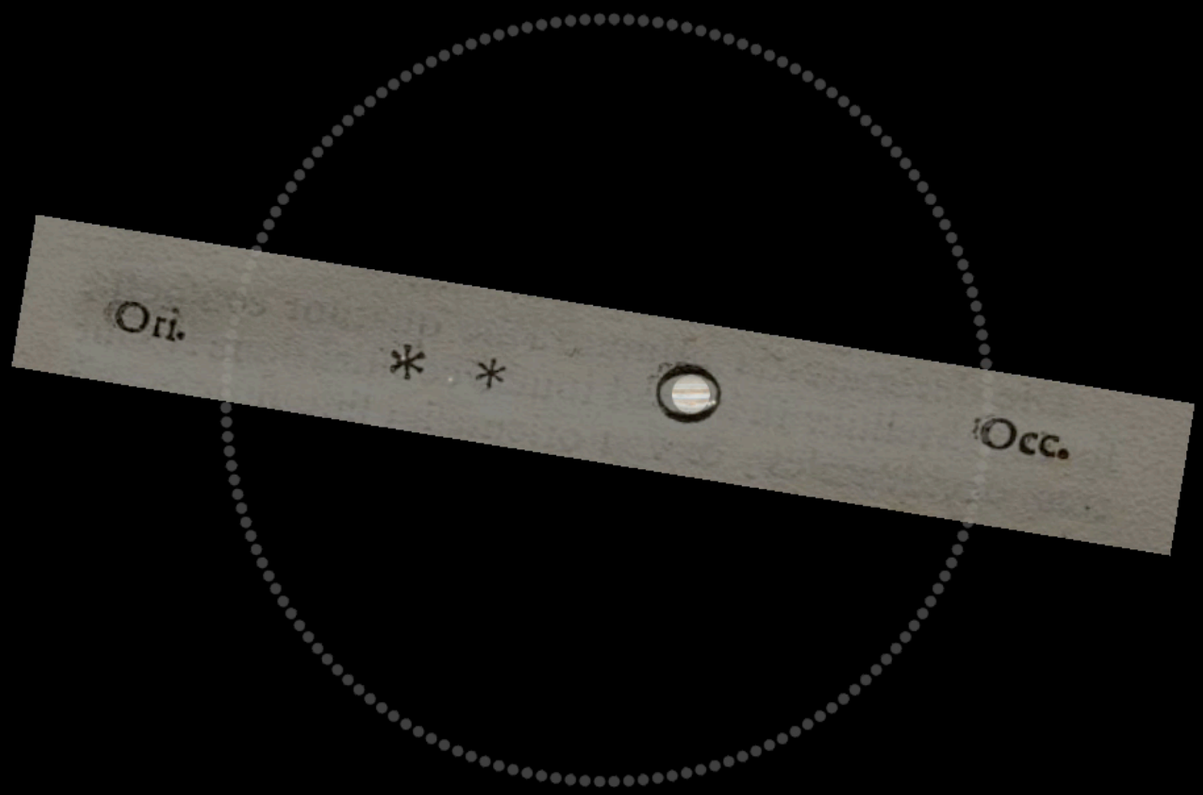
n the adjoining figure. The eastern one was 2 minutes and th
vestern one 3 minutes from Jupiter. They were on the same straigh
ne with Jupiter and equal in magnitude.

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

Notes for & re-productions of Siderius Nuncius

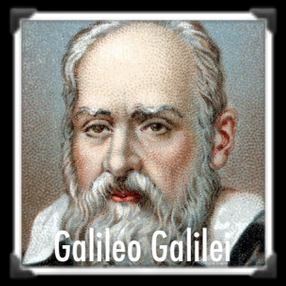
GALILEO GALILEI

January 11, 1610



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

GLUEING TOGETHER THE UNIVERSE



d3po/Authorea: Peek, Price-Whelan, Pepe, Beaumont, Borkin, Newton;
PoF: Goodman, Peek; et al. 2015 WWT: Wong, Fay et al.; Astrometry.net: Hogg, Lang, Roweis et al.

glue

FEATURED ARTICLES ABOUT PLANS BLOG FEEDBACK HELP ALYSS

PUBLIC ROUGH DRAFT Index Settings Fork Quickedit Word Count 42 Comments Export Unfollo

The "Paper" of the Future

3

Alyssa Goodman, Josh Peek, Alberto Accomazzi, Chris Beaumont, Christine L. Borgman, pe Chen, Merce Crosas, Christopher Erdmann, August Muench, Alberto Pepe,

+ Add author Re-arrange authors

demonsration of this paper is available at this YouTube link.

2

Adrian Price-Whelan

Galileo Galilei

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

Elisabeth Newton

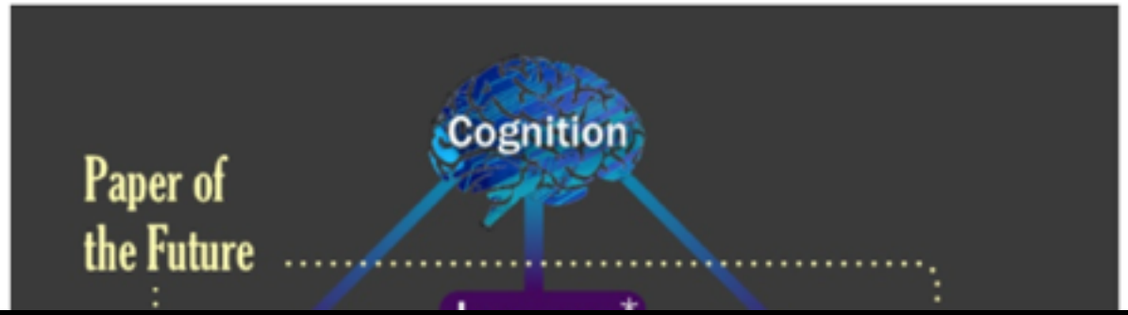
Josh Peek

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

Michelle Borkin

Alberto Pepe

0



Konrad Hinsen 3 days ago · Public
Many good suggestions, but if the goal is "long-lasting rich records of scientific discourse", a more careful and critical attitude towards electronic artifacts is appropriate. I do see it concerning videos, but not a word on the much more critical situation in software. Archiving source code is not sufficient: all the dependencies, plus the complete build environment, would have to be conserved as well to make things work a few years from now. An "executable figure" in the form of an IPython notebook wil...
more

Merce Crosas 3 days ago · Public
Konrad, good points; this has been a concern for the community working on reproducibility. Regarding data repositories, Dataverse handles long-term preservation and access of data files in the following way: 1) for some data files that the repository recognizes (such as R Data, SPSS, STATA), which depend on a statistical package, the system converts them into a preservation format (such as a tab/CSV format). Even though the original format is also saved and can be accessed, the new preservation format gua...
more

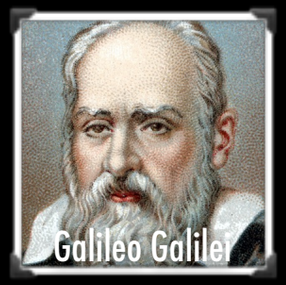
Konrad Hinsen 1 day ago · Public
That sounds good. I hope more repositories will follow the example of Dataverse. Figshare in particular has a very different attitude, encouraging researchers to deposit as much as possible. That's perhaps a good strategy to change habits, but in the long run it could well backfire when people find out in a few years that 90% of those deposits have become useless.

Christine L. Borgman 4 months ago · Private
"publications"

d3po/Authorea: Peek, Price-Whelan, Pepe, Beaumont, Borkin, Newton;
PoF: Goodman, Peek; et al. 2015 WWT: Wong, Fay et al.; Astrometry.net: Hogg, Lang, Roweis et al.

GLUEING TOGETHER THE UNIVERSE


Tom Robitaille


Galileo Galilei


Jorma Harju


Mike Chen


Shuo Kong


Catherine Zucker


John Huchra


Chris Beaumont


Michelle Borkin

Planet

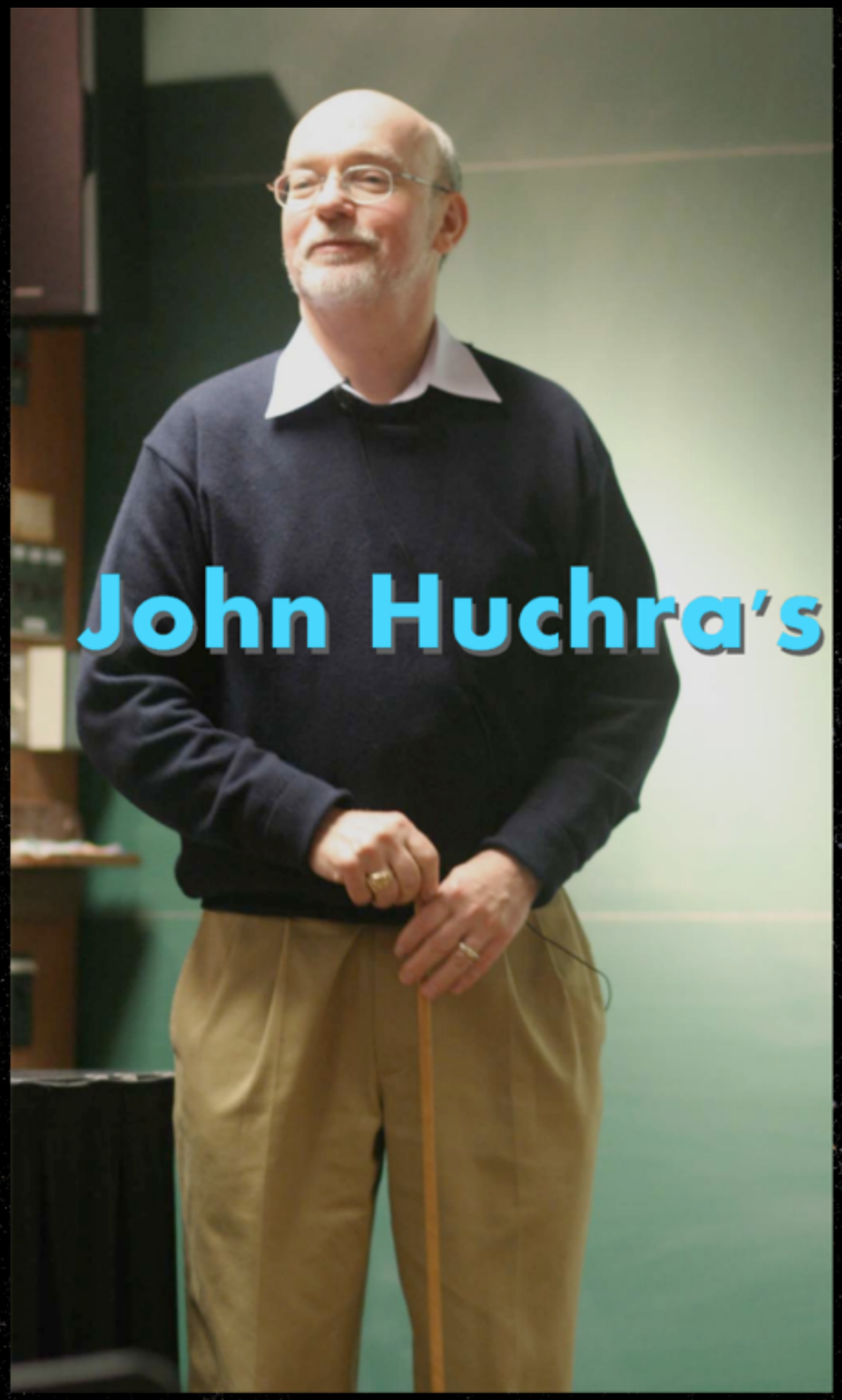
Core

"Cloud"

GMC

Galaxy

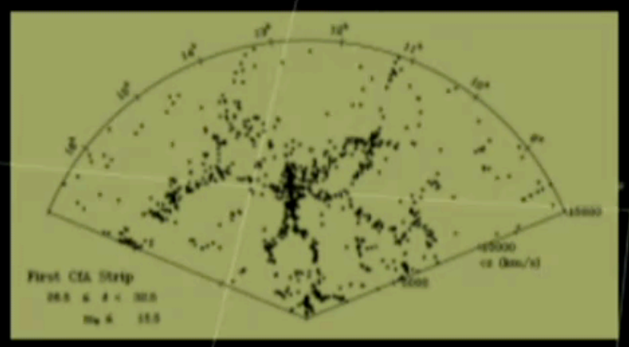
Universe



John Huchra's Universe

This WorldWide Telescope Tour was created to thank
John Huchra (1948-2010) for the knowledge and cheer he gave us all.

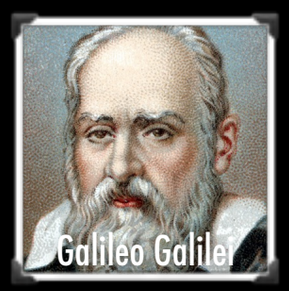
strip of galaxies on the Sky in CfA1 Redshift Survey



famous stickman “wedge” diagram

“John Huchra’s Universe” WWT Tour: Producer/Writer: Alyssa Goodman; Narrator/Editor: Robert Kirshner; Music: Jeremy Cushman

GLUEING TOGETHER THE UNIVERSE


Galileo Galilei


Jorma Harju


Mike Chen


Shuo Kong

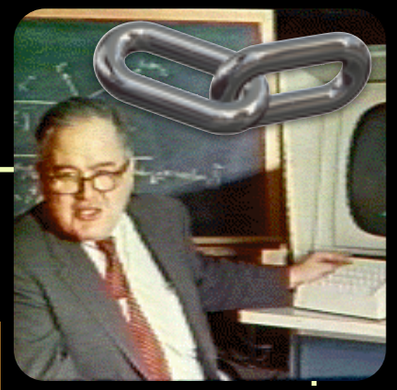

Catherine Zucker


John Huchra

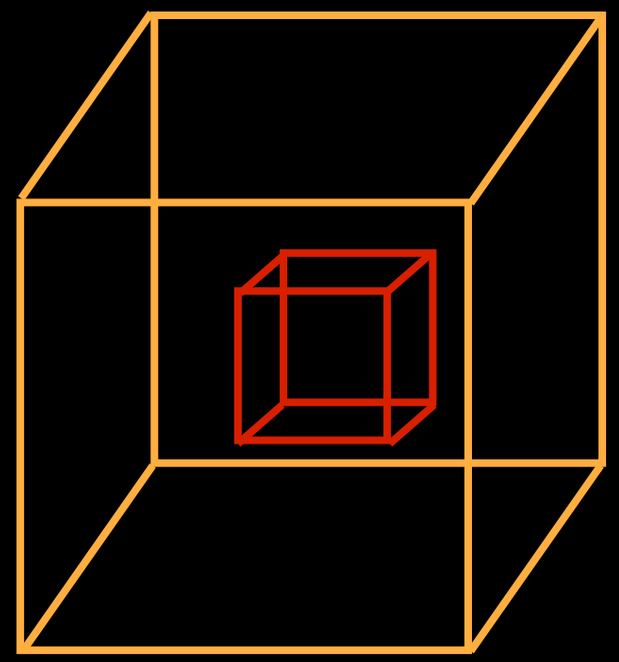
Planets Cores "Filaments" GMCs GALAXIES UNIVERSE


glue
multidimensional data exploration

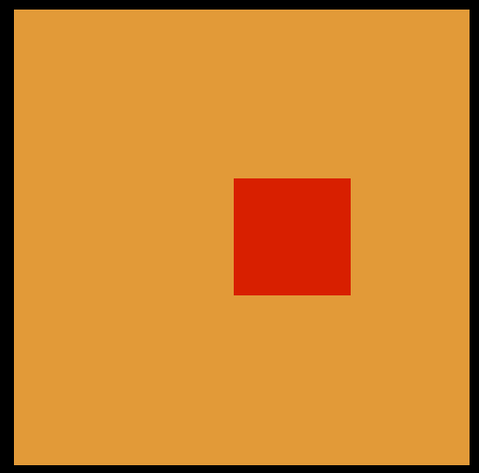
LINKED VIEWS OF HIGH-DIMENSIONAL DATA



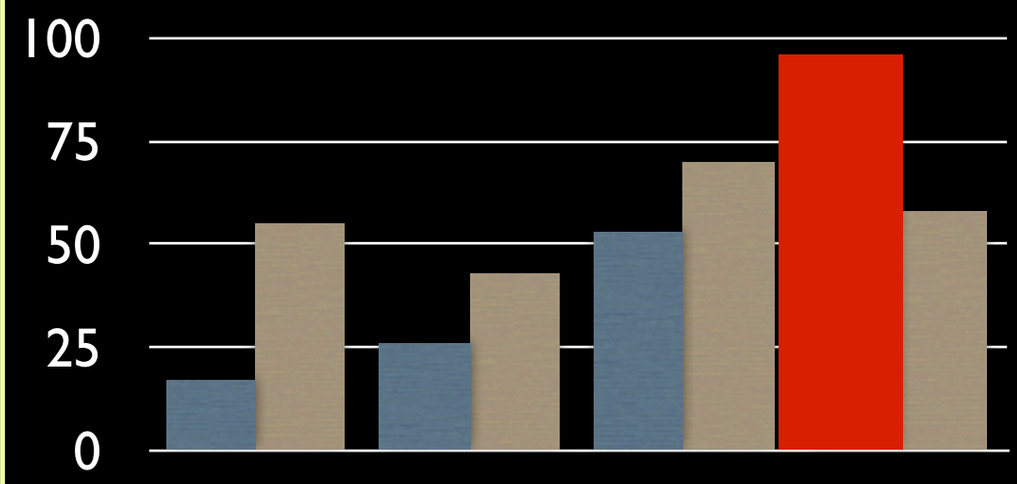
John Tukey



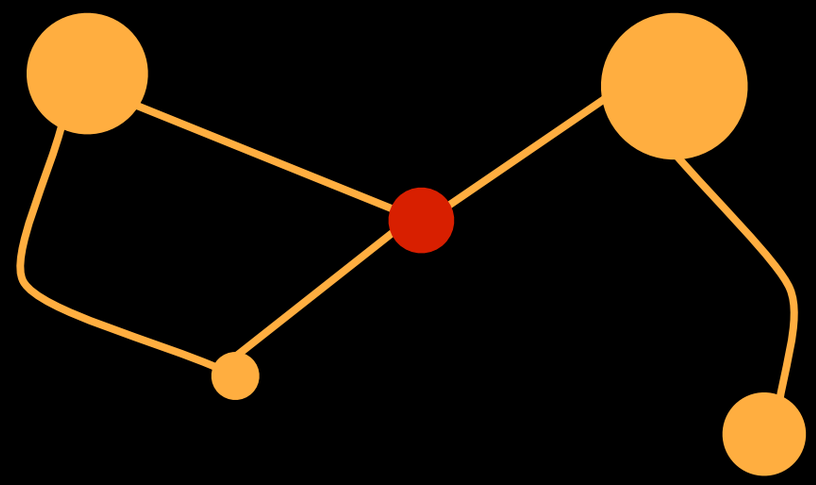
3D



2D



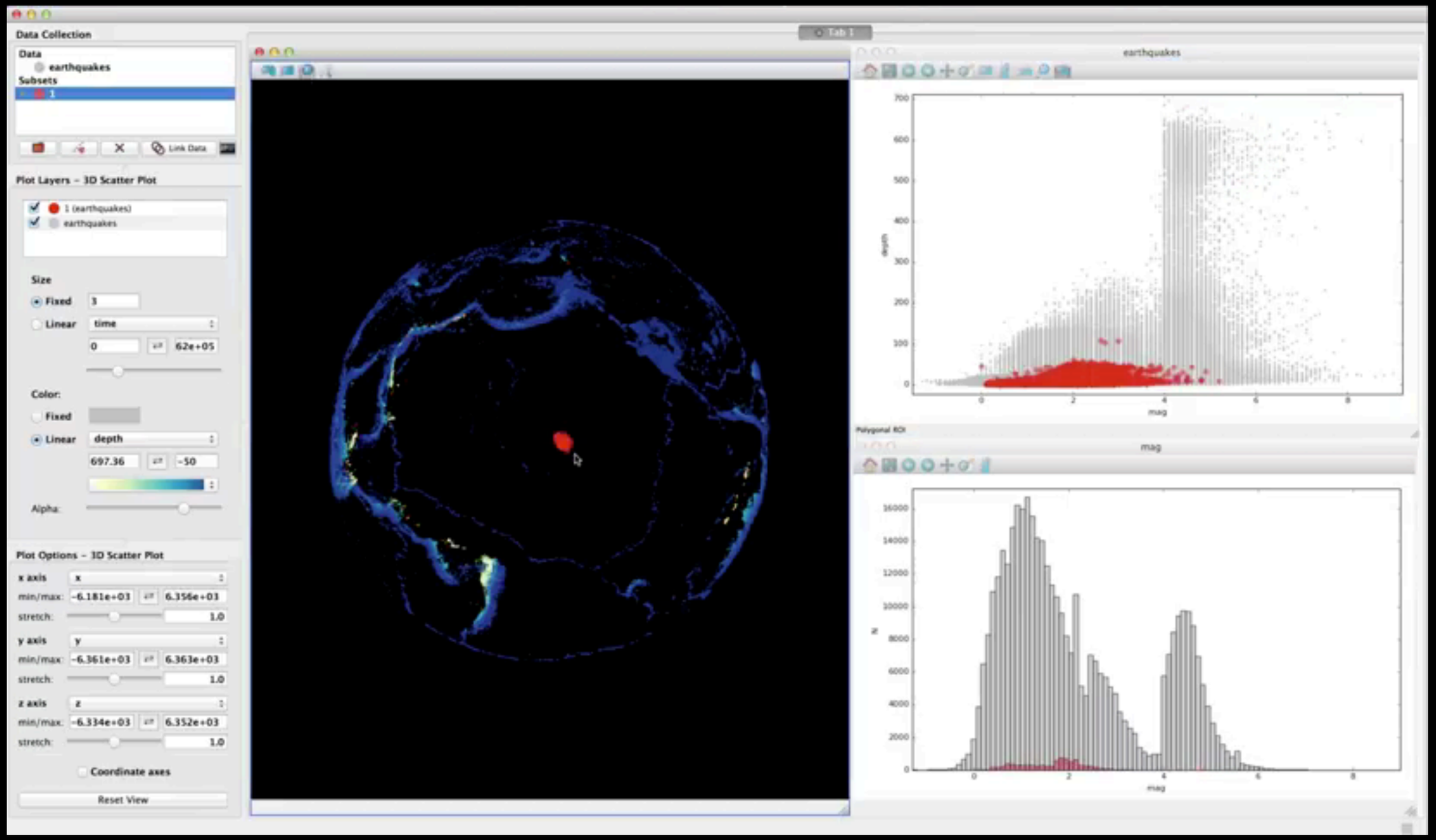
Data Abstraction



figure, by M. Borkin, reproduced from Goodman 2012, "Principles of High-Dimensional Data Visualization in Astronomy"

LINKED VIEWS OF HIGH-DIMENSIONAL DATA (IN PYTHON)

GLUE

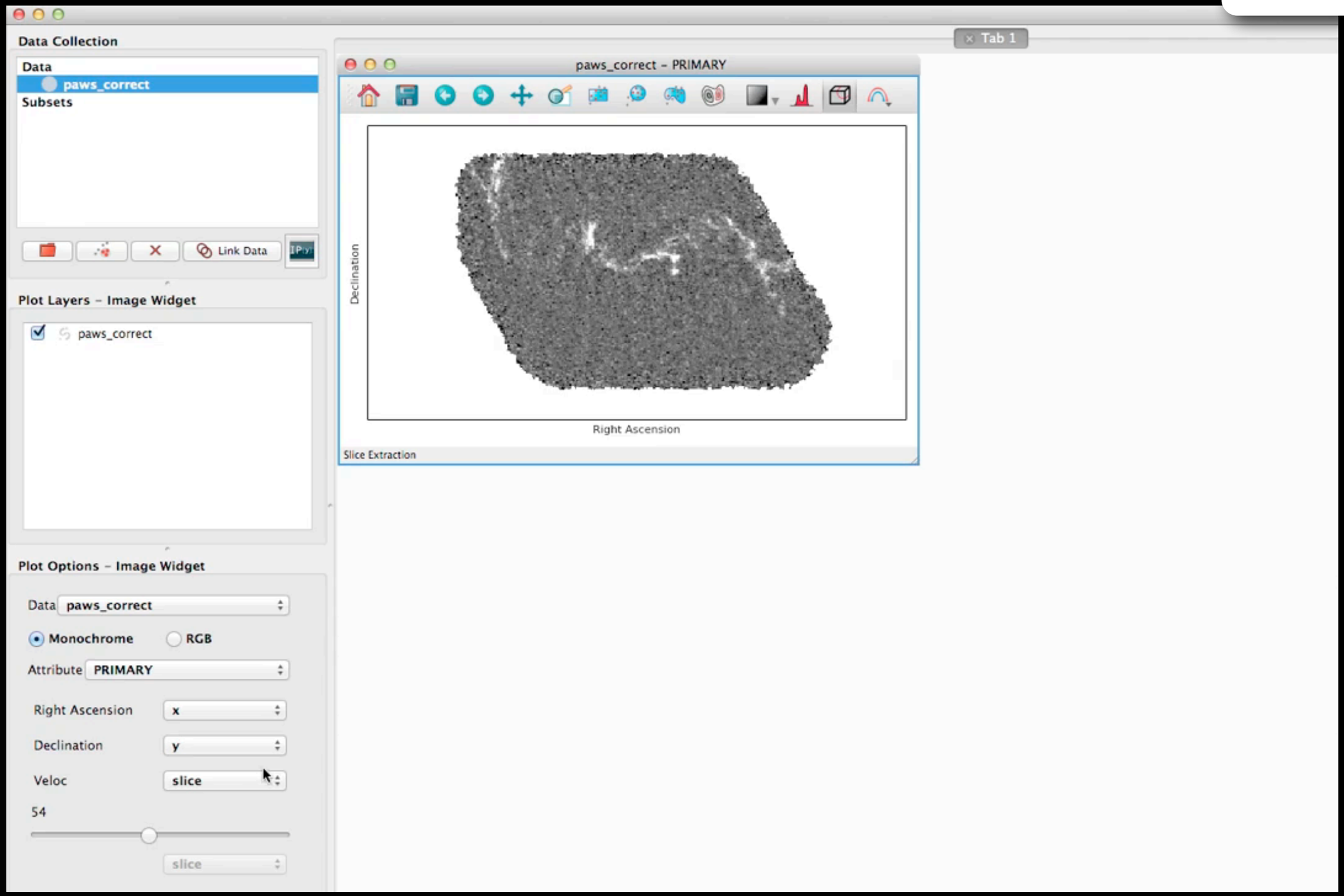


video by Tom Robitaille, lead glue developer

glue created by: C. Beaumont, M. Borkin, P. Qian, T. Robitaille, M. Breddels, and A. Goodman, PI

LINKED VIEWS OF HIGH-DIMENSIONAL DATA (IN PYTHON)

GLUE



video by Tom Robitaille, lead glue developer

glue created by: C. Beaumont, M. Borkin, P. Qian, T. Robitaille, M. Breddels, and A. Goodman, PI

SNEAK PREVIEW: GLUE (W/GAIA DATA!) IN THE BROWSER

and scholarly papers with/in "Jupyter" notebooks

glue in the browser

Video courtesy of Maarten Breddels, consulting developer

glue: a new instrument for discovery

multidimensional data exploration

built-in

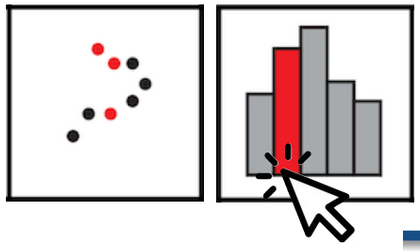
standard data loaders

Data File 1

Data File 2

Data File N

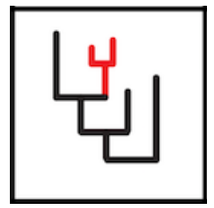
define new variables, import/export insights, interactive plots for the web, save state, all from GUI



standard 1D, 2D & 3D plots

link data files' attributes

highlight live or algorithmic selections with Boolean logic

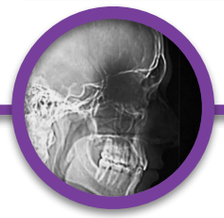


custom plots

plug-in

custom data loaders

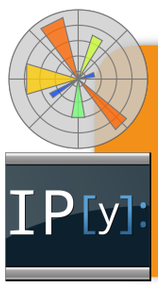
custom buttons, features



?

+options

user config.py file (loaders, colors, plot types, +)



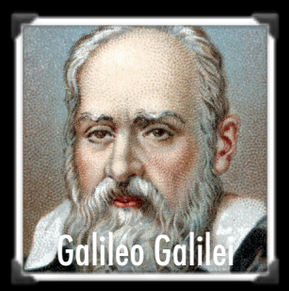
access to all matplotlib functions through built-in IPython terminal

jupyter

run & interact with glue from Jupyter notebook & other tools

glueviz.org

GLUEING TOGETHER THE UNIVERSE


Galileo Galilei


Jorma Harju


Mike Chen


Shuo Kong


Catherine Zucker


John Huchra

Planets Cores "Filaments" GMCs GALAXIES UNIVERSE

No merging of data sets—just glue them.

python File Edit View Canvas Data Manager Plugins Help 79% Tue May 29 10:39 PM Alyssa

Glue

Open Data | Export Data/Subsets | Link Data | IPython Terminal | Open Session | Export Session | Add/edit arithmetic attributes | Selection Mode: | Preferences

Data Collection

Data
- meth_cube_hdrfixed
- onh2d_cube_hdrfixed

Subsets

Plot Layers

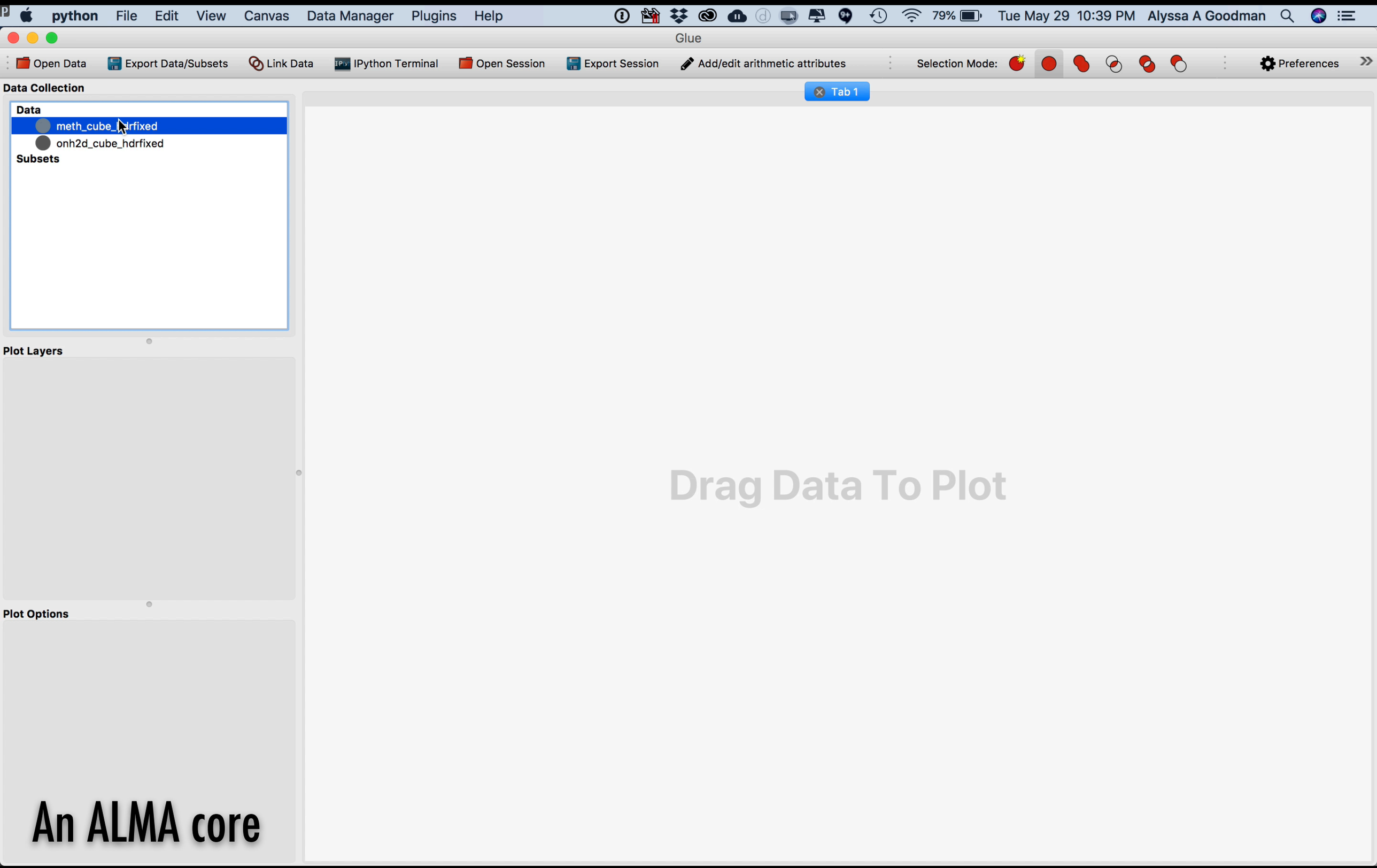
Plot Options

Tab 1

Drag Data To Plot

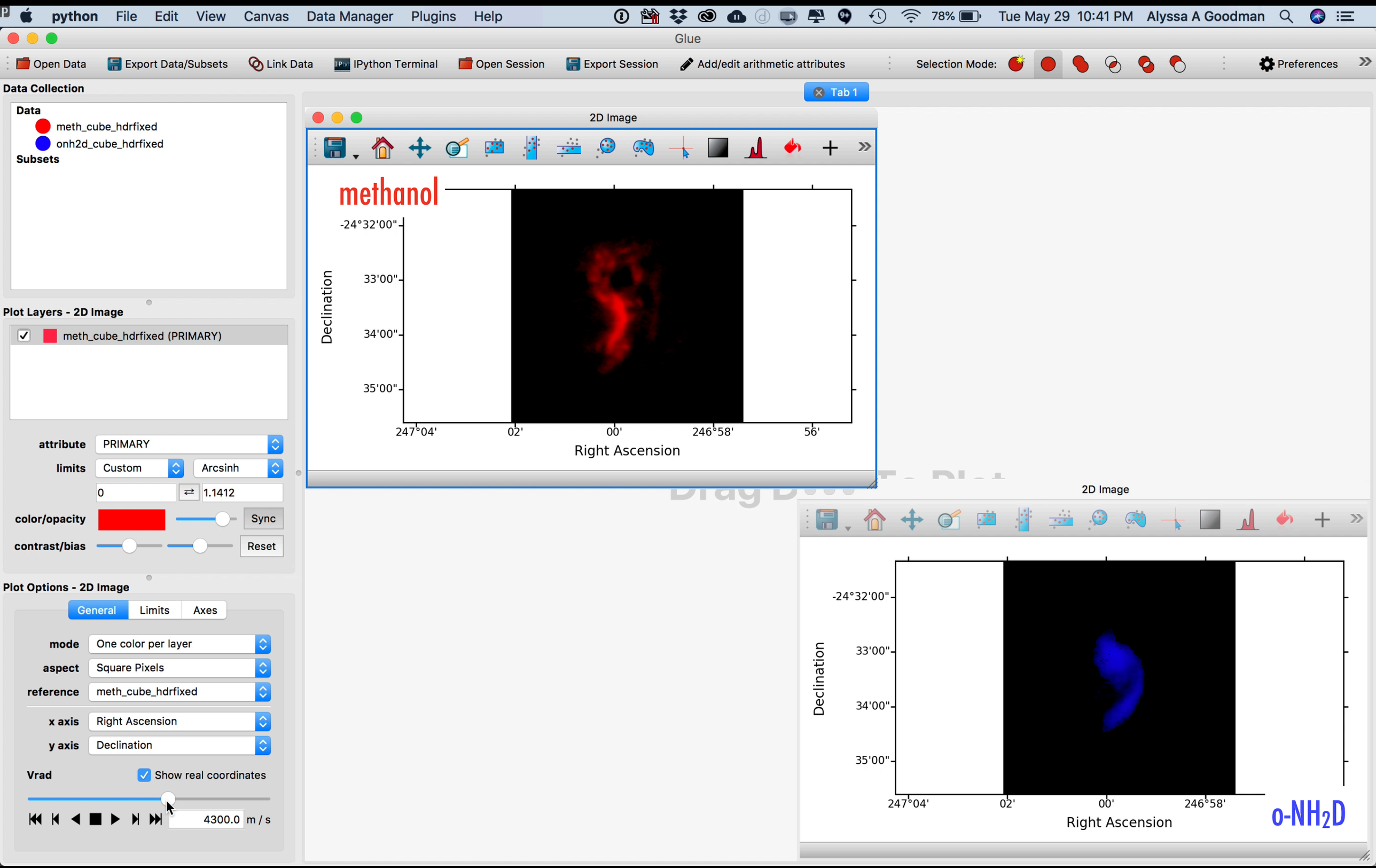
An ALMA core

Just drag to visualize, e.g. series of 2D "channel maps."

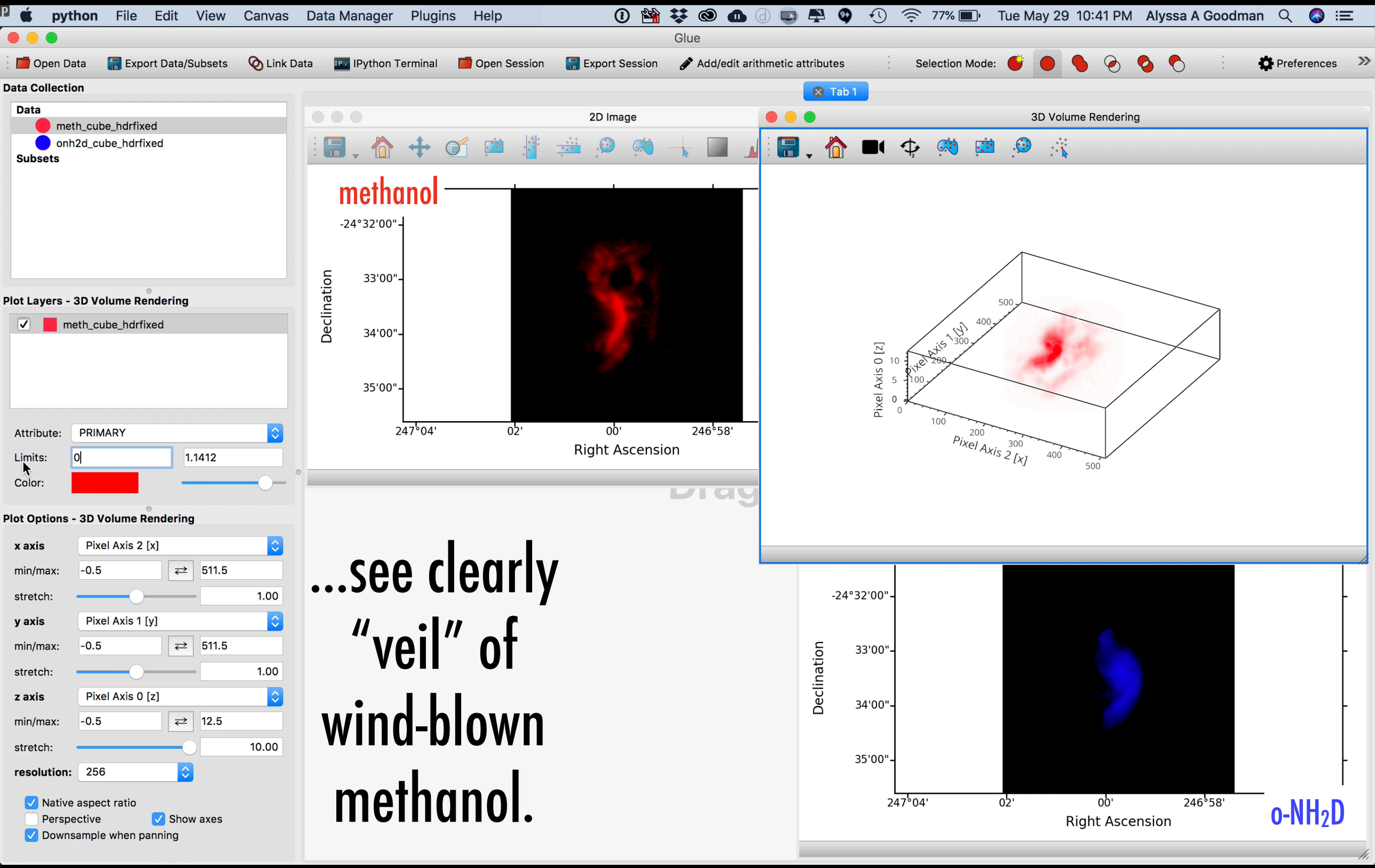


An ALMA core

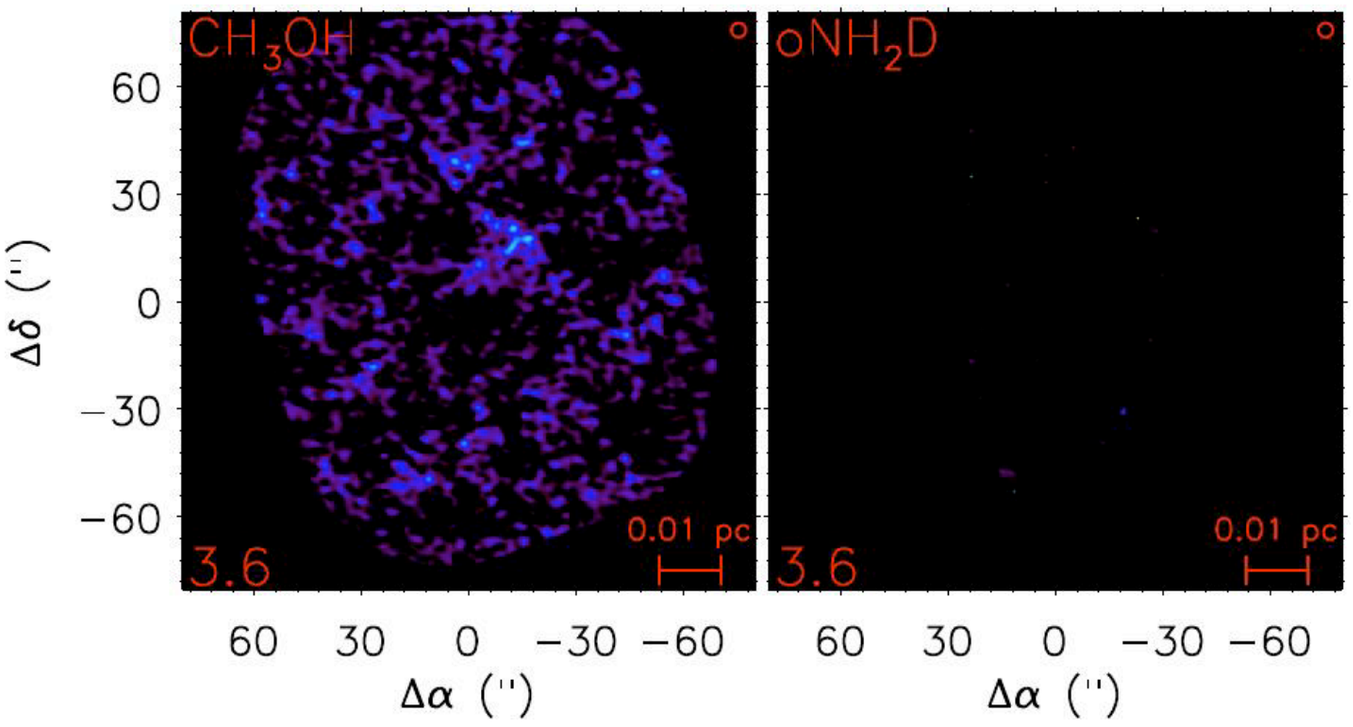
Adjust so each tracer is a different color.



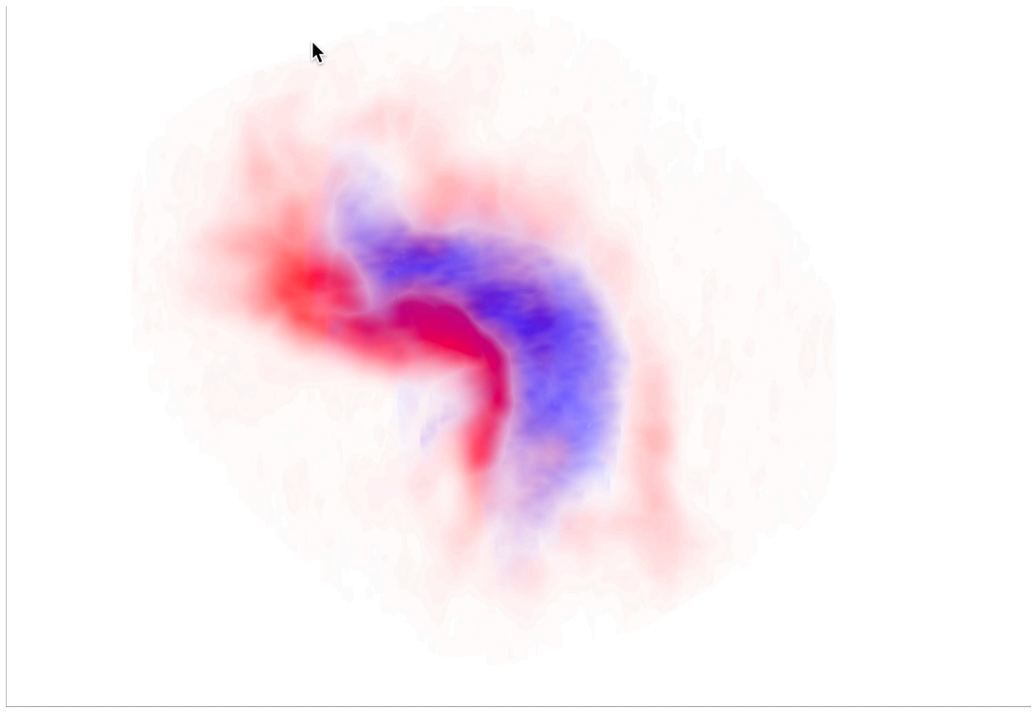
Create 3D views...



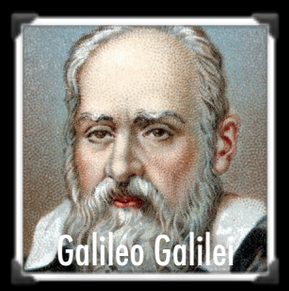
Traditional Rainbow Channel maps



glue



GLUEING TOGETHER THE UNIVERSE


Galileo Galilei


Jorma Harju


Mike Chen


Shuo Kong


Catherine Zucker


John Huchra

Planets Cores "Filaments" GMCs GALAXIES UNIVERSE

BONES IN GLUE+WWT

Glue

Data Collection

Data
- HOPS_ammonia_catalog_ICRS
- Nessie_13CO_ThrUMMS_slab
- Nessie_GLIMPSE_8micron_cropped
- Nessie_HIGAL_Column_Density[PRIMA...

Subsets
- Nessie
  - Nessie (HOPS_ammonia_catalog_I...
  - Nessie (Nessie_13CO_ThrUMMS_sl...
  - Nessie (Nessie_GLIMPSE_8micron_...
  - Nessie (Nessie_HIGAL_Column_De...

Link data

Plot Layers - WorldWideTelescope (WWT)

- [x] Nessie (HOPS_ammonia_catalog_ICRS)
- [ ] HOPS_ammonia_catalog_ICRS

Color:
Size: 3
Opacity:
RA: ra
Dec: dec
Center view on layer

Plot Options - WorldWideTelescope (WWT)

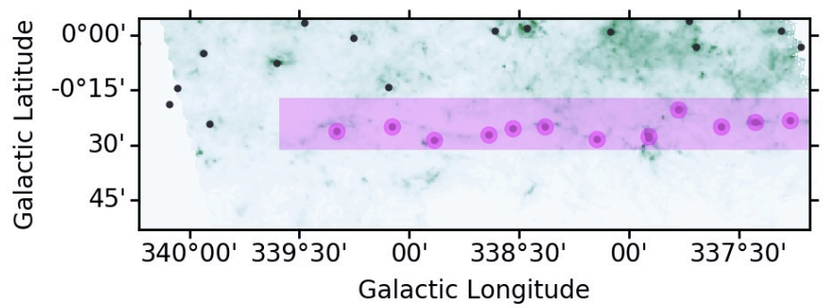
Foreground: IRIS: Improved Reprocessing
Opacity:
Background: Digitized Sky Survey (Color)
- [x] Galactic Plane mode

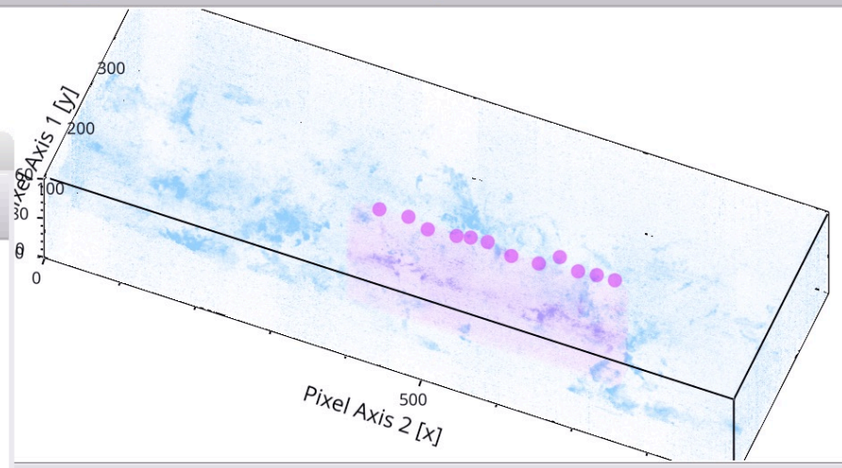
Selection Mode:

View Console

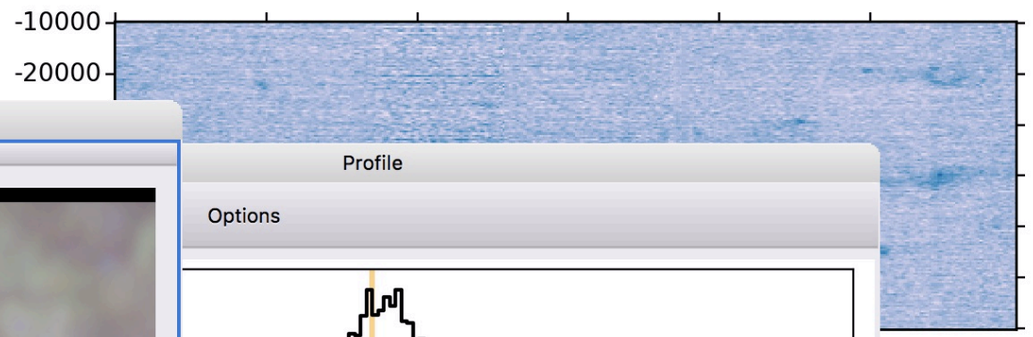
Tab 1

2D Image





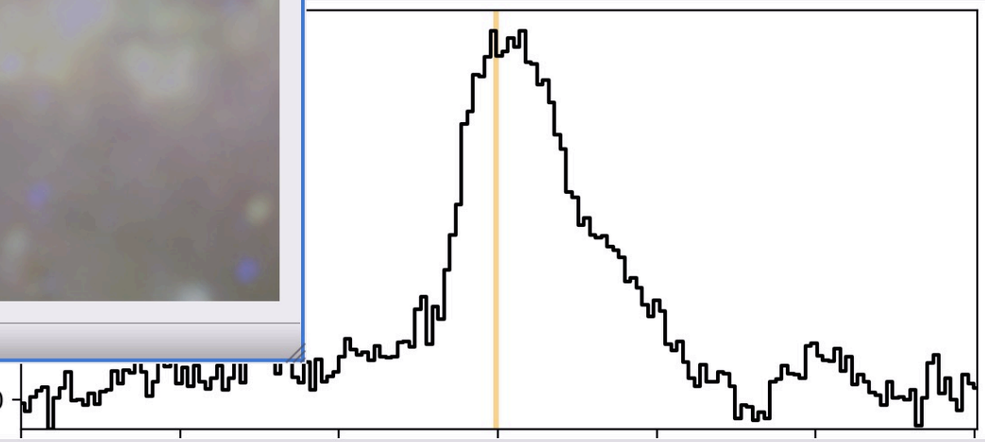
Custom Slice



WorldWideTelescope (WWT)

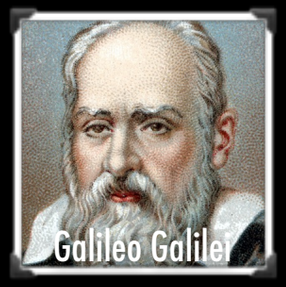
Profile

Options



glue

GLUEING TOGETHER THE UNIVERSE


Galileo Galilei


Jorma Harju


Mike Chen


Shuo Kong


Catherine Zucker

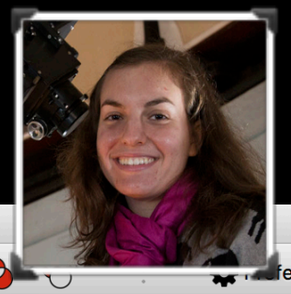

John Huchra

Planet Core "Cloud" GMC Galaxy Universe


Rowan Smith

Simulations too!

Simulations too!



Glue

Open Data | Export Data/Subsets | Link Data | IPython Terminal | Open Session | Export Session | Add/edit arithmetic attributes | Selection Mode: | ferences

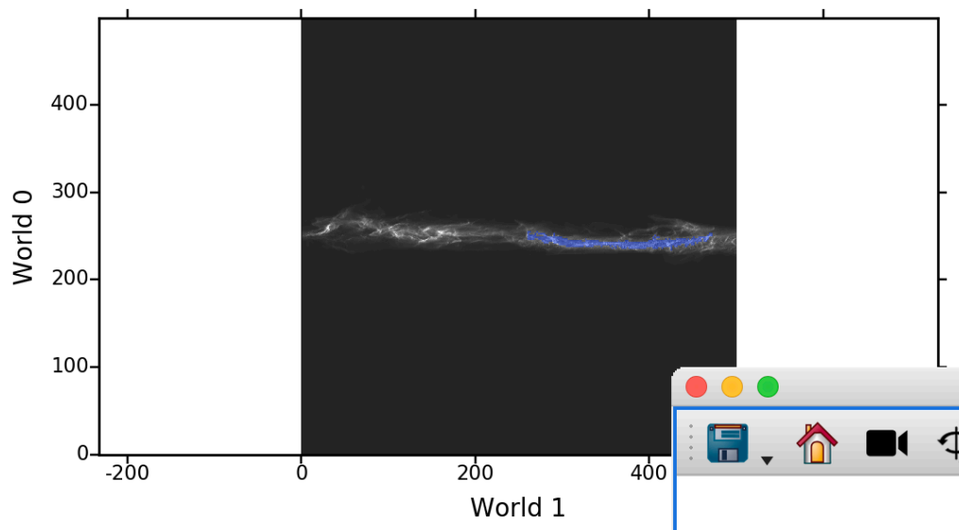
Data Collection

Data
- x90y40_NH2_0deg
- x90y40_nH2
- x90y40_filmask_0deg

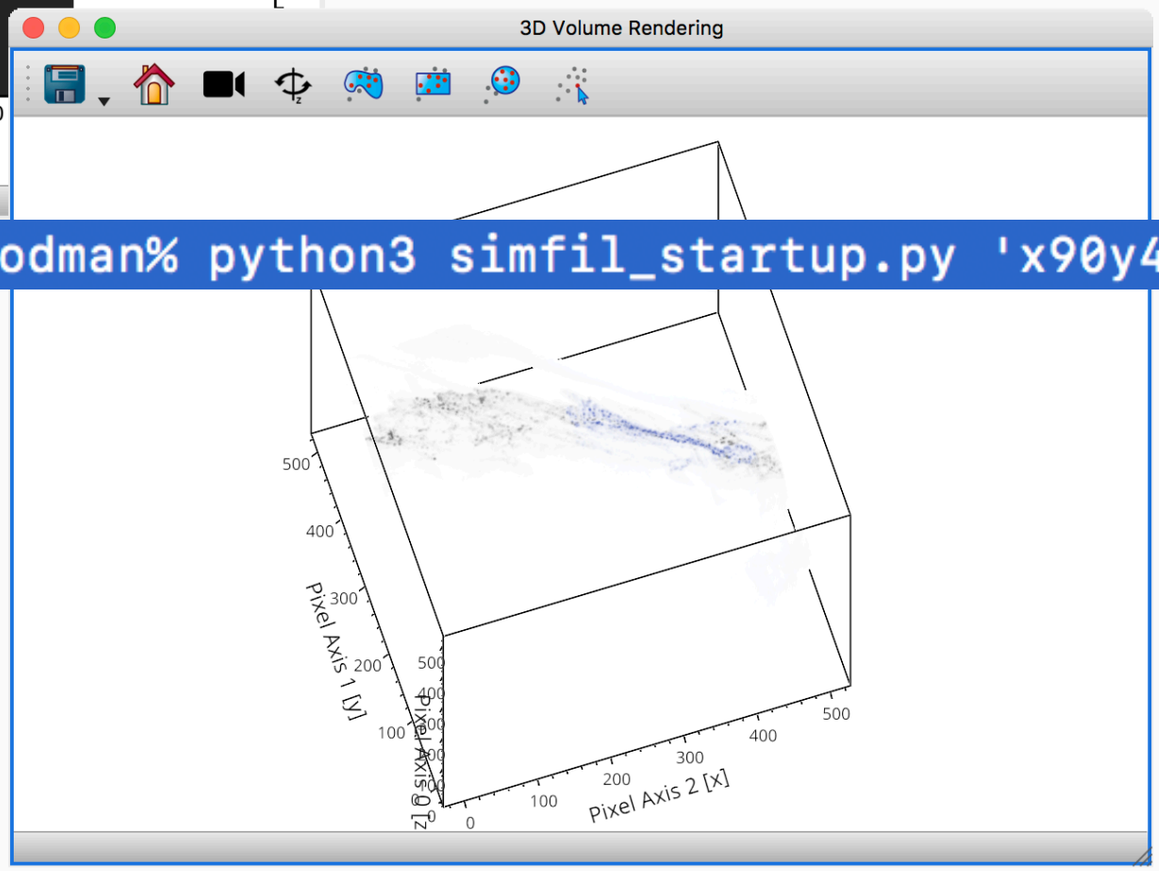
Subsets
- filmask_zero

Tab 1

2D Image



3D Volume Rendering



Plot Layers - 3D Volume Rendering

- ☑ filmask_zero (x90y40_nH2)
- ☑ x90y40_nH2

Attribute: PRIMARY

Color:

Subset: Data Outline

:~/Google Drive/Glue Stuff/SimFil_Glue] aagoodman% python3 simfil_startup.py 'x90y40'

x axis Pixel Axis 2 [x]
min/max: -28.5749 ⇄ 527.575
stretch: 1.00

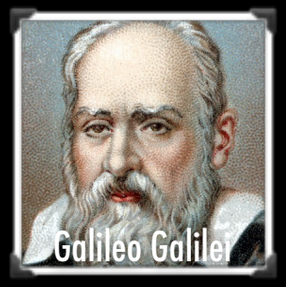
y axis Pixel Axis 1 [y]
min/max: -28.5749 ⇄ 527.575
stretch: 1.00

z axis Pixel Axis 0 [z]
min/max: -28.5749 ⇄ 527.575
stretch: 1.00

resolution: 256

☐ Native aspect ratio
☐ Perspective ☑ Show axes
☑ Downsample when panning

GLUEING TOGETHER THE UNIVERSE


Galileo Galilei


Jorma Harju


Mike Chen


Shuo Kong


Catherine Zucker

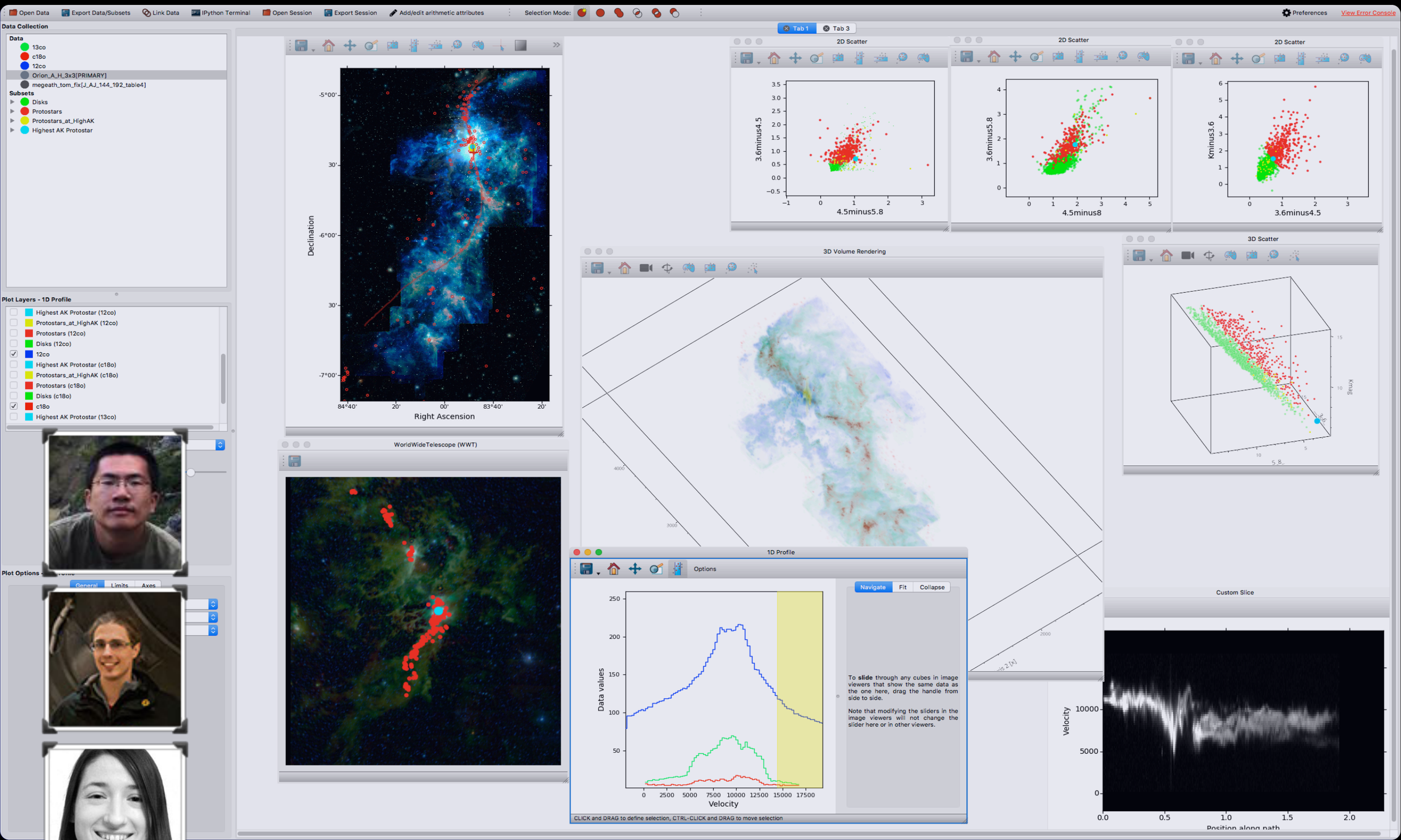

John Huchra

Planet Core "Cloud" GMC Galaxy Universe


Rowan Smith

Simulations too!

GMC (Orion NRO+CARMA with VISION with Megeath Spitzer with Gaia with...)



GMC (Orion NRO+CARMA with VISION with Megeath Spitzer with Gaia with...)

combined data sources

new findings

linked-view exploratory analysis of high-dimensional data

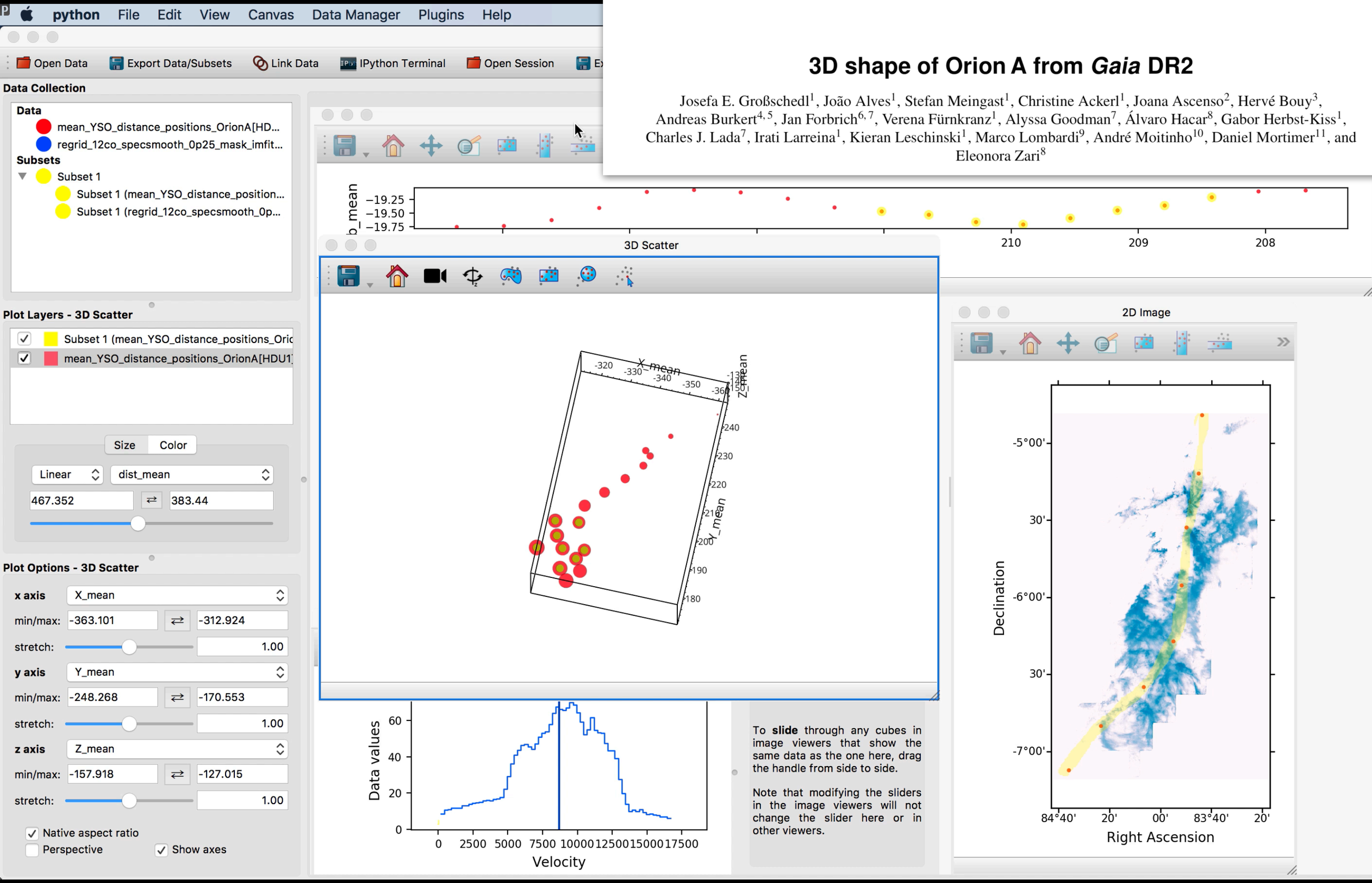
plug-in architecture

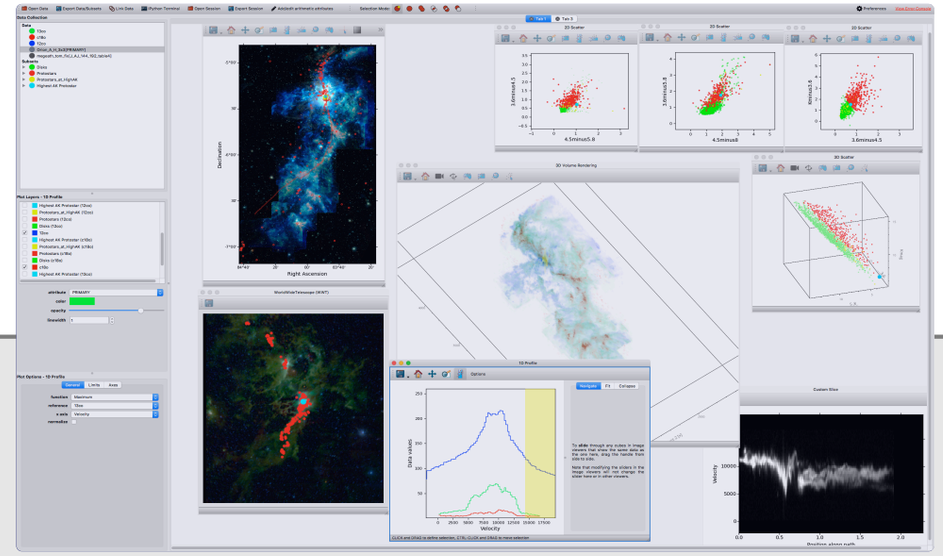
Orion, plus Gaia

Astronomy & Astrophysics manuscript no. GROSSSCHEDL_3D_shape_OrionA_arXiv ©ESO 2018
August 21, 2018

3D shape of Orion A from *Gaia* DR2

Josefa E. Großschedl[1], João Alves[1], Stefan Meingast[1], Christine Ackerl[1], Joana Ascenso[2], Hervé Bouy[3], Andreas Burkert[4,5], Jan Forbrich[6,7], Verena Fürnkranz[1], Alyssa Goodman[7], Álvaro Hacar[8], Gabor Herbst-Kiss[1], Charles J. Lada[7], Irati Larreina[1], Kieran Leschinski[1], Marco Lombardi[9], André Moitinho[10], Daniel Mortimer[11], and Eleonora Zari[8]





Preview

New Thinking on, and with, Data Visualization

Alyssa A. Goodman, Michelle A. Borkin, Thomas P. Robitaille

As the complexity and volume of datasets have increased along with the capabilities of modular, open-source, easy-to-implement, visualization tools, scientists' need for, and appreciation of, data visualization has risen too. Until recently, scientists thought of the "explanatory" graphics created at a research project's conclusion as "pretty pictures" needed only for journal publication or public outreach. The plots and displays produced during a research project – often intended only for experts – were thought of as a separate category, what we here call "exploratory" visualization. In this view, discovery comes from exploratory visualization, and explanatory visualization is just for communication. Our aim in this paper is to spark conversation amongst scientists, computer scientists, outreach professionals, educators, and graphics and perception experts about how to foster flexible data visualization practices that can facilitate discovery and communication at the same time. We present an example of a new finding made using the glue visualization environment to demonstrate how the border between explanatory and exploratory visualization is easily traversed. The linked-view principles as well as the actual code in glue are easily adapted to astronomy, medicine, and geographical information science – all fields where combining, visualizing, and analyzing several high-dimensional datasets yields insight. Whether or not scientists can use such a flexible "undisciplined" environment to its fullest potential without special training remains to be seen. We conclude with suggestions for improving the training of scientists in visualization practices, and of computer scientists in the iterative, non-workflow-like, ways in which modern science is carried out.

Comments: Submitted as an invited "Perspectives" Paper for PNAS, in conjunction with the 2018 Sackler Colloquium

Categories

Primary: Instrumentation and Methods for Astrophysics (astro-ph.IM)

Cross lists: Astrophysics | Instrumentation and Methods for Astrophysics | Add

This article is currently submitted.

View Article

(on arXiv, includes references & Orion details)

TEN QUESTIONS TO ASK WHEN CREATING A VISUALIZATION

The 10 Questions

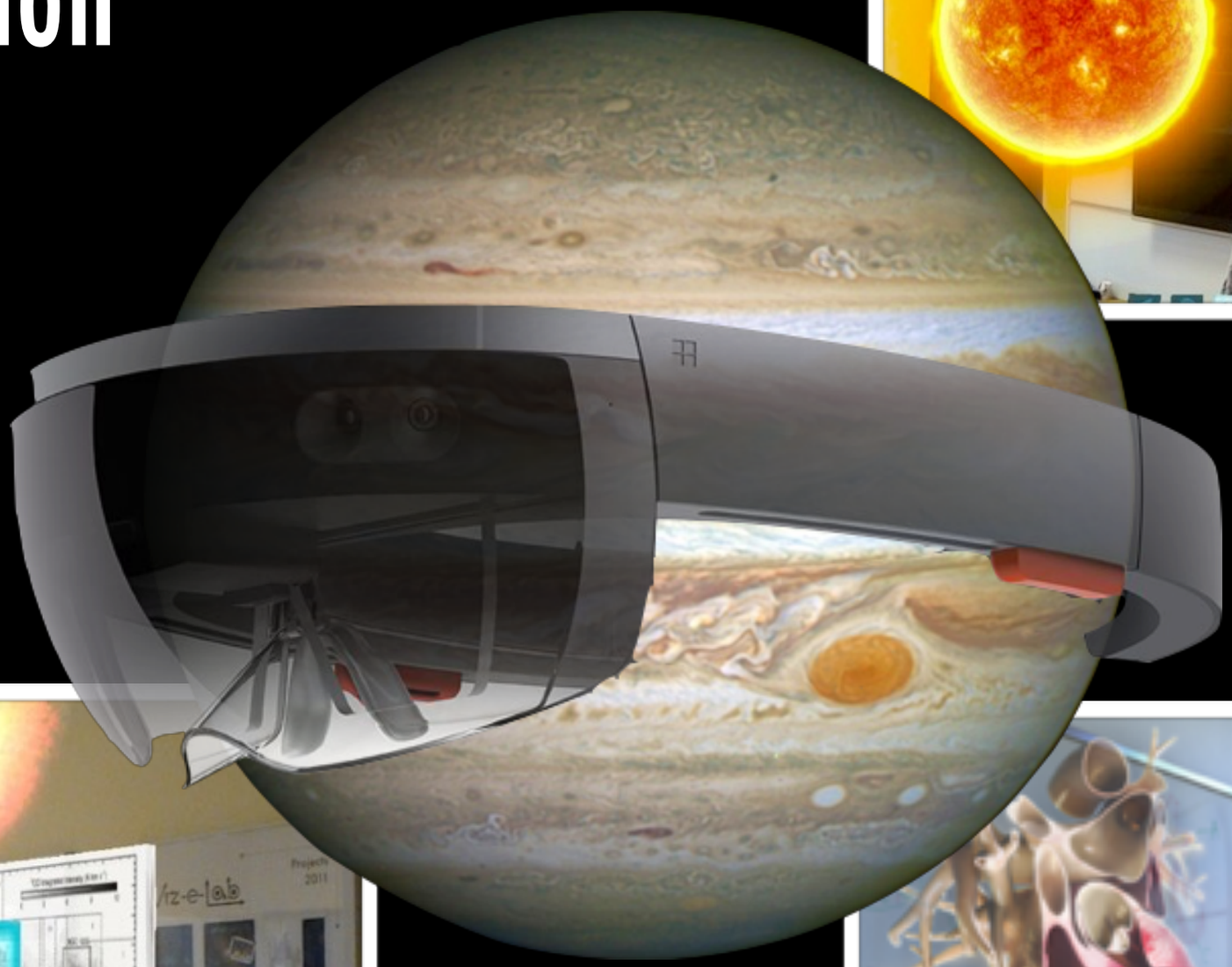
1. **Who** | Who is your audience? How expert will they be about the subject and/or display conventions?
2. **Explore-Explain** | Is your goal to explore, document, or explain your data or ideas, or a combination of these?
3. **Categories** |Do you want to show or explore pre-existing, known, human-interpretable, categories?
4. **Patterns** |Do you want to identify new, previously unknown or undefined patterns?
5. **Predictions & Uncertainty** | Are you making a comparison between data and/or predictions? Is representing uncertainty a concern?
6. **Dimensions** | What is the intrinsic number of dimensions (not necessarily spatial) in your data, and how many do you want to show at once?
7. **Abstraction & Accuracy** | Do you need to show all the data, or is summary or abstraction OK?
8. **Context & Scale** | Can you, and do you want to, put the data into a standard frame of reference, coordinate system, or show scale(s)?
9. **Metadata** | Do you need to display or link to non-quantitative metadata? (including captions, labels, etc.)
10. **Display Modes** | What display modes might be used in experiencing your display?

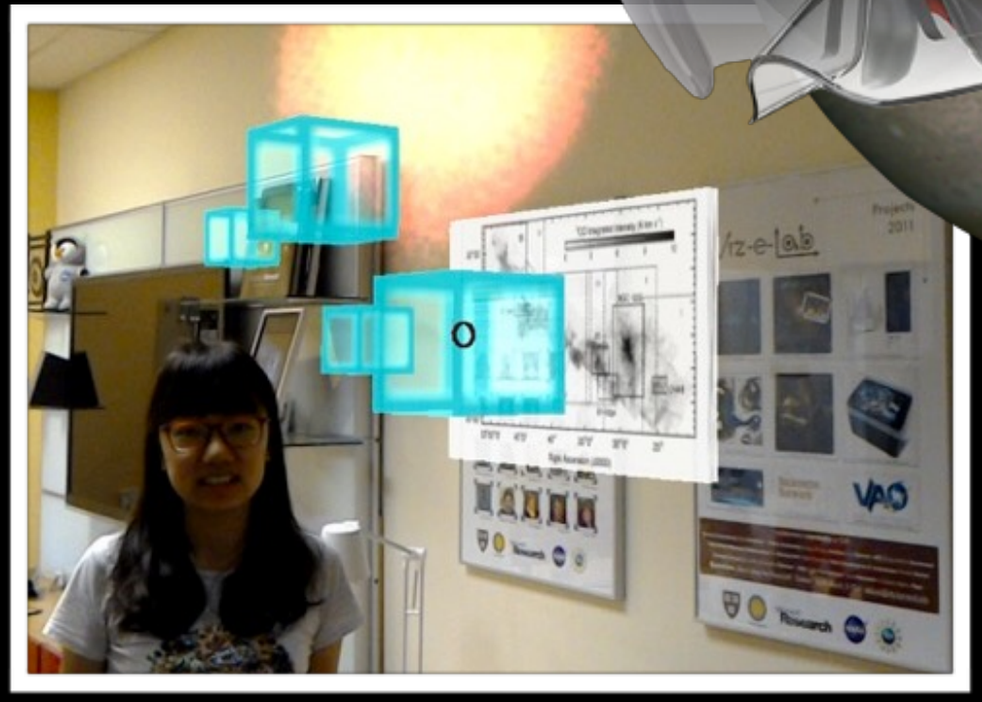
Join the 10QViz Conversation!

*To learn more about this site, please visit the **About** page.*

To read an in-process manuscript giving the scholarship behind the recommendations on this site, see Coltekin & Goodman 2018.

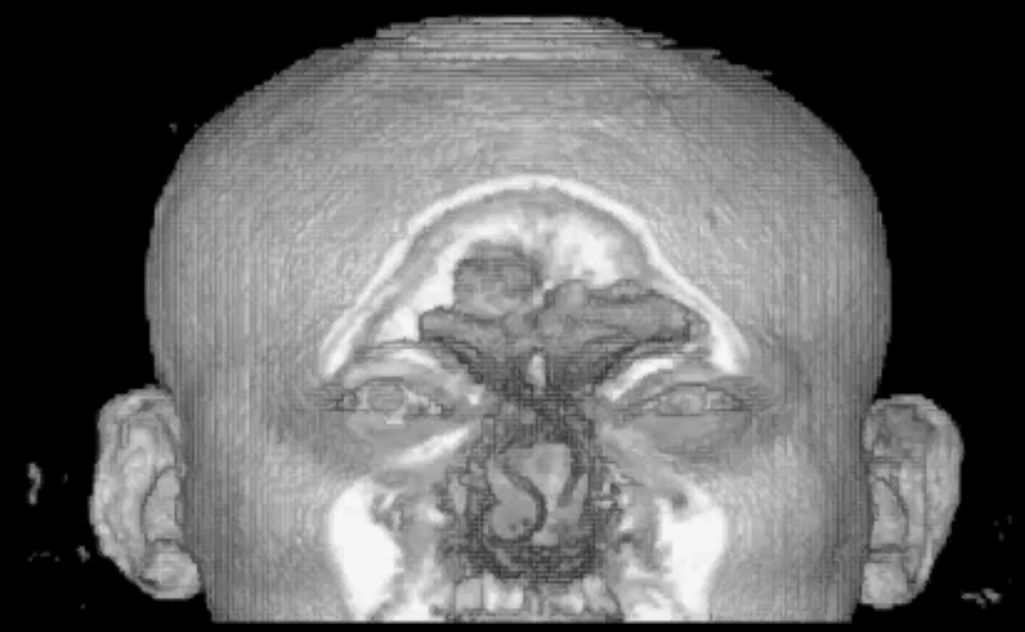
The challenge of 3D Selection





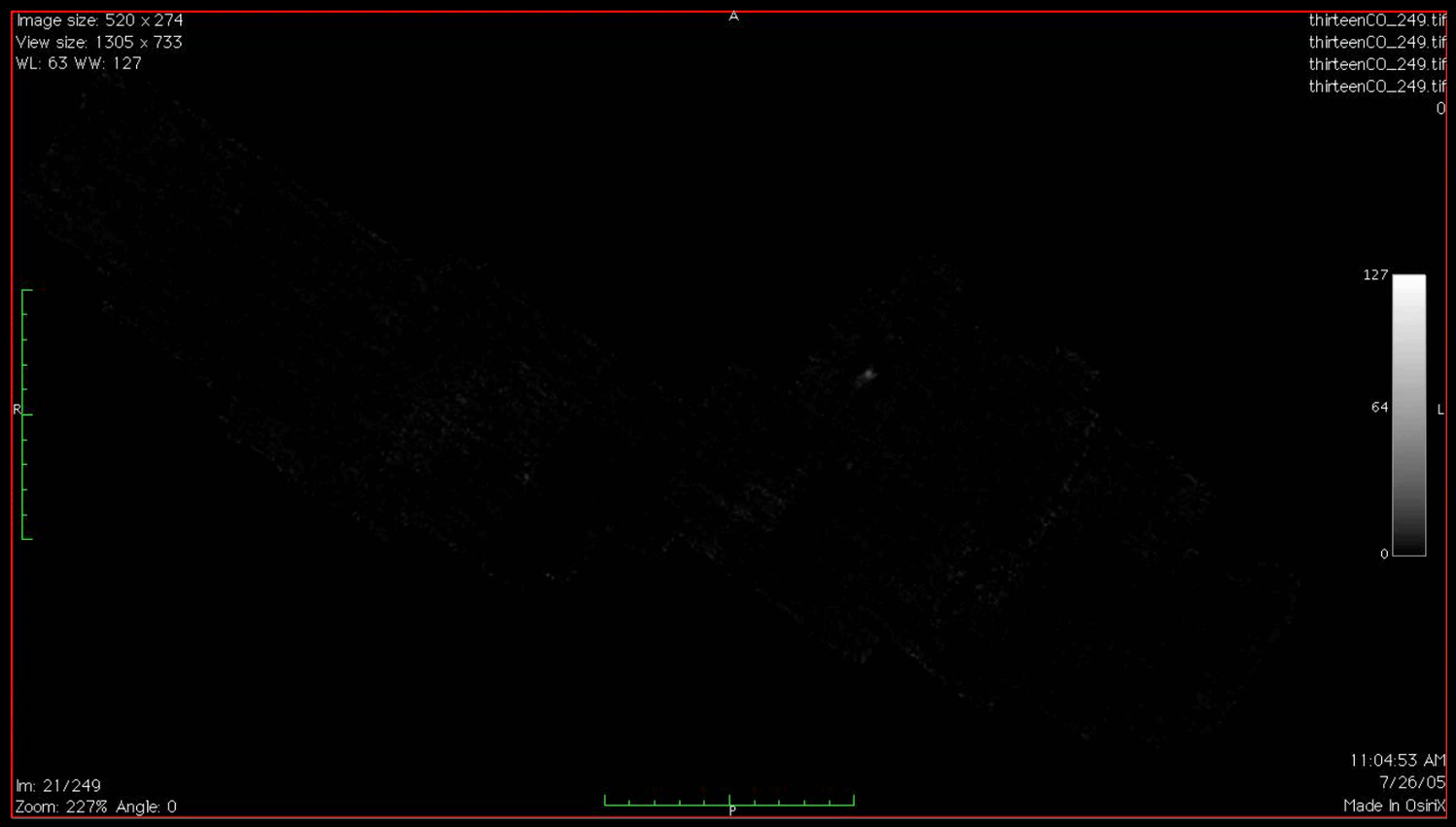
ASTRONOMICAL MEDICINE

“KEITH”



“z” is depth into head

“PERSEUS”



“z” is line-of-sight velocity

ASTRONOMICAL MEDICINE

mage size: 520 x 274
iew size: 1305 x 733
L: 63 WW: 127

mm peak (Enoch et al. 2006)

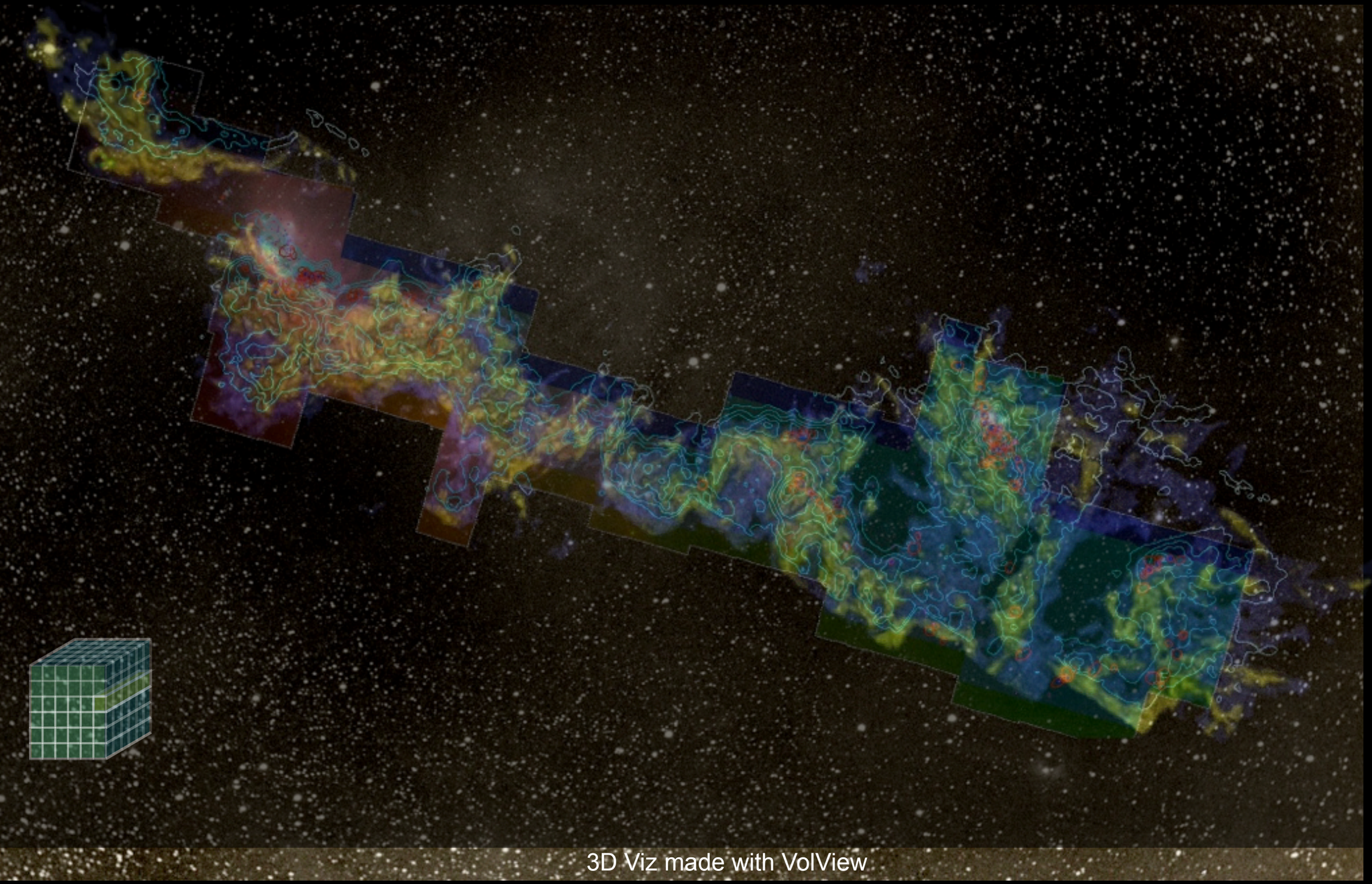
sub-mm peak (Hatchell et al. 2005, Kirk et al. 2006)

^{13}CO (Ridge et al. 2006)

mid-IR IRAC composite from c2d data (Foster, Laakso, Ridge, et al.)

Optical image (Barnard 1927)

n: 1/249
oom: 227% Angle: 0



3D Viz made with VolView

COMPLETE

ISM3D Tutorial links

Installing **glue**: http://glueviz.org/install.html

W5 off glue web site: https://tinyurl.com/w5demo

glue

multidimensional data exploration

glueviz.org github.com/glue-viz glueviz.slack.com

Linked-View Exploratory Visualization of High-Dimensional Data, for Everyone

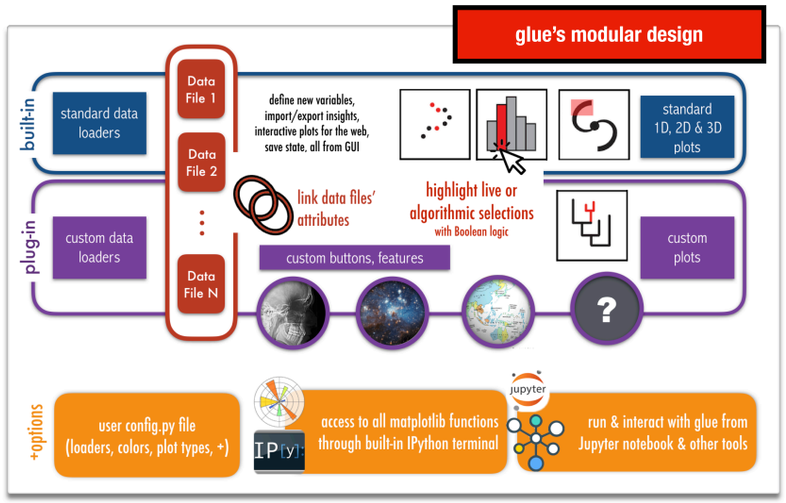
Alyssa **Goodman** (PI, Harvard)
Michellle **Borkin** (PI, Northeastern)
Thomas **Robitaille** (Lead Architect)

The **glue** project was founded in 2012, with funding from **NASA**'s **James Webb Space Telescope** (JWST) project. NASA contracts continue to support development of JWST-related (Astronomy) functionality.

Beginning in 2017, glue has also been funded by the **National Science Foundation**, under SI2-SSE 1739657/1740229: *Collaborative Research: A sustainable future for the glue multi-dimensional linked data visualization package.* The goal of the NSF SSE funding is to expand glue's functionality into domains beyond its traditional strengths in Astronomy and Medicine, by broadening both its user and developer communities.

All glue code is Open Source, at github.com/glue-viz

glue's modular design



Linked Visualizations

With Glue, users can create scatter plots, histograms and images (2D and 3D) of their data. Glue is focused on the brushing and linking paradigm, where selections in any graph propagate to all others.

Flexible linking across data

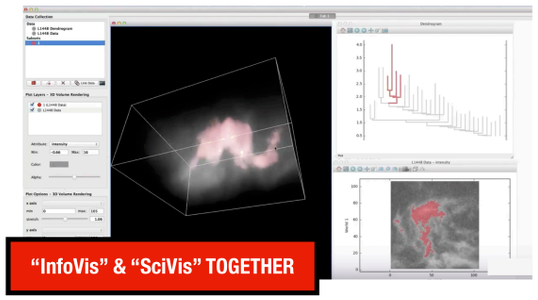
Glue uses the logical links that exist between different data sets to overlay visualizations of different data, and to propagate selections across data sets. These links are specified by the user, and are arbitrarily flexible

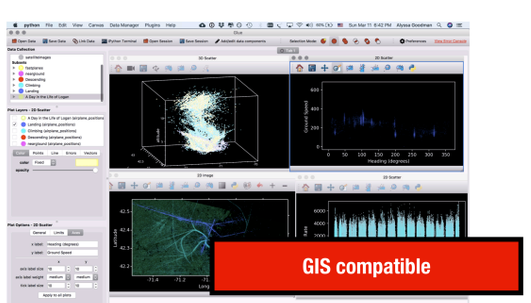
Full scripting capability

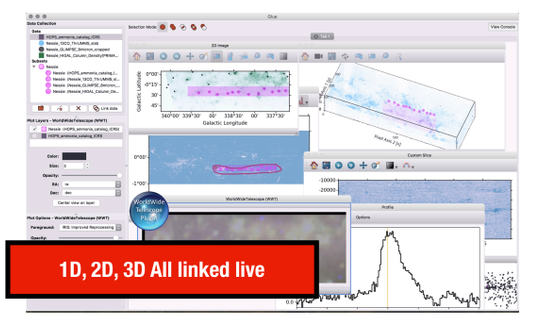
Glue is written in Python, and built on top of its standard scientific libraries (i.e., Numpy, Matplotlib, Scipy). Users can easily integrate their own python code for data input, cleaning, and analysis.

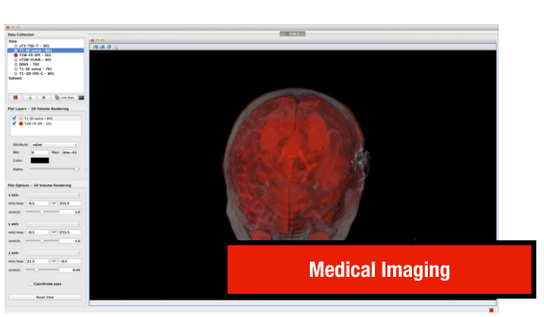
Want to plug-in your project or tool? Consider joining us for glue-con, right after JupyterCon, August 27-29, 2018, at Harvard.

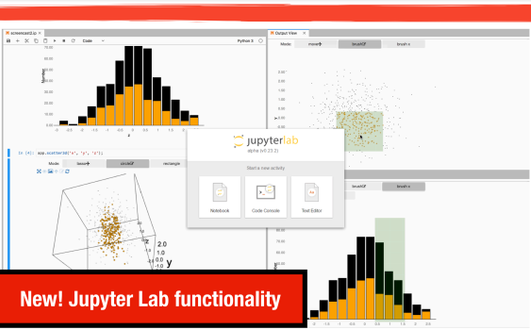
glue-con
multidimensional data exploration
2018, CAMBRIDGE, MA
projects.iq.harvard.edu/gluecon

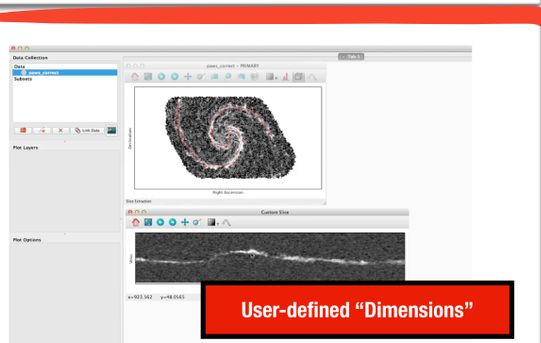






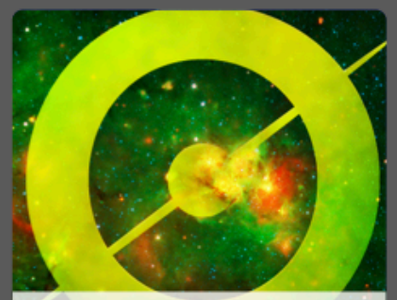






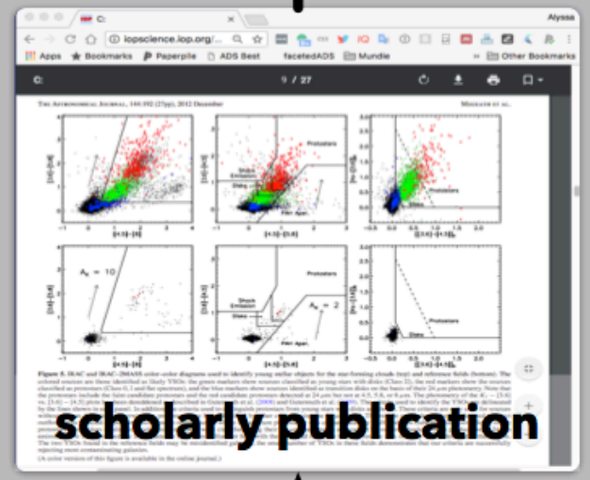
COLLABORATION

EXPLANATORY VISUALIZATION

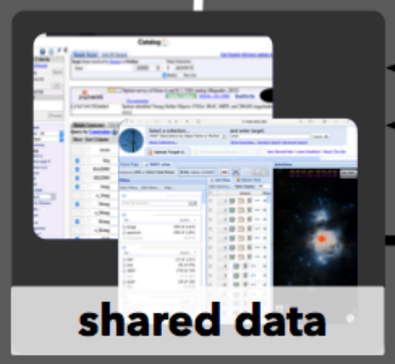


citizen science

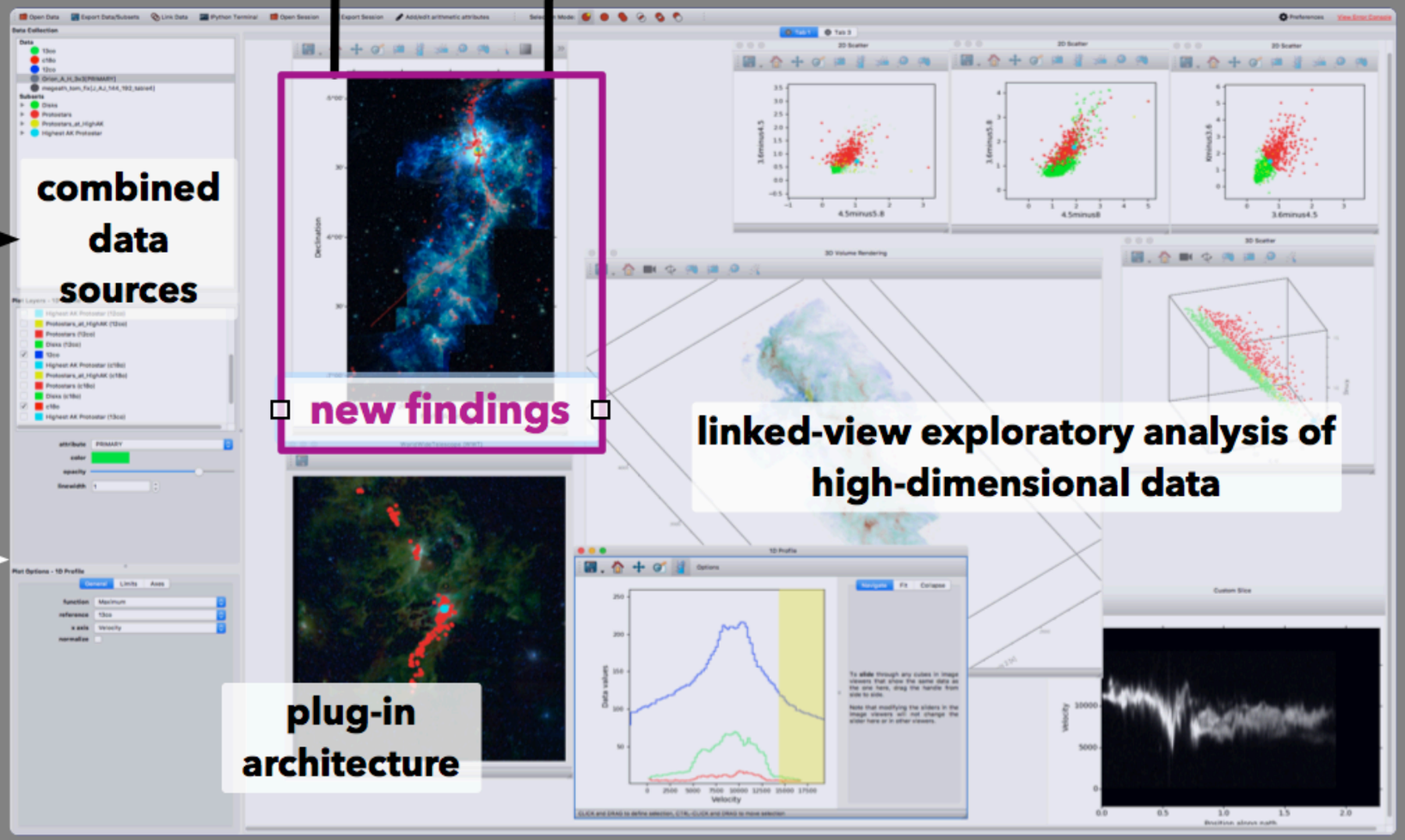
public outreach



scholarly publication



shared data

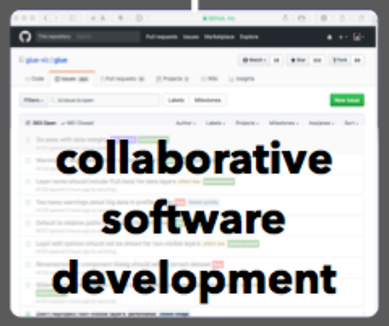


combined data sources

new findings

linked-view exploratory analysis of high-dimensional data

open source, modular, software



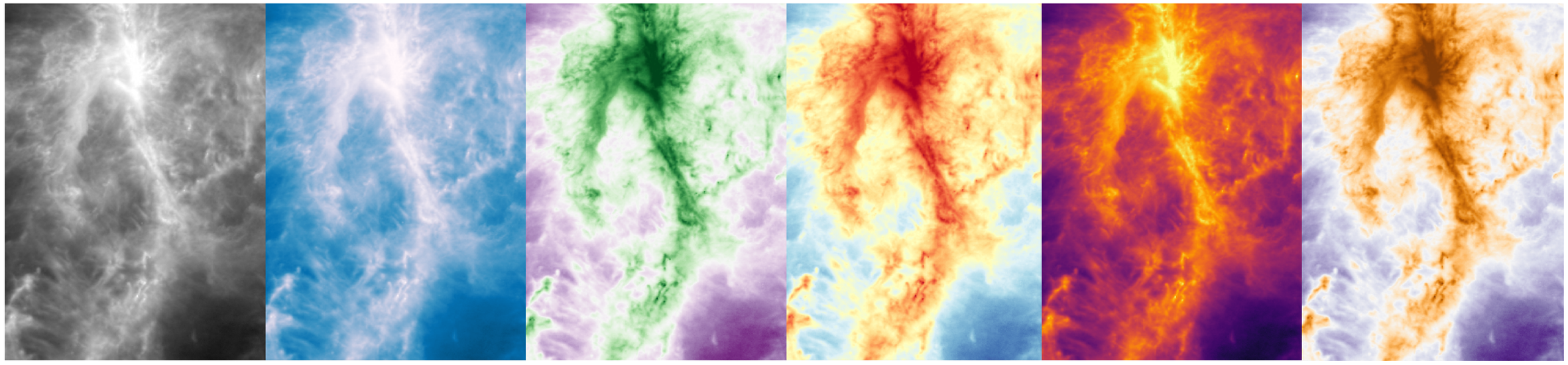
collaborative software development

plug-in architecture

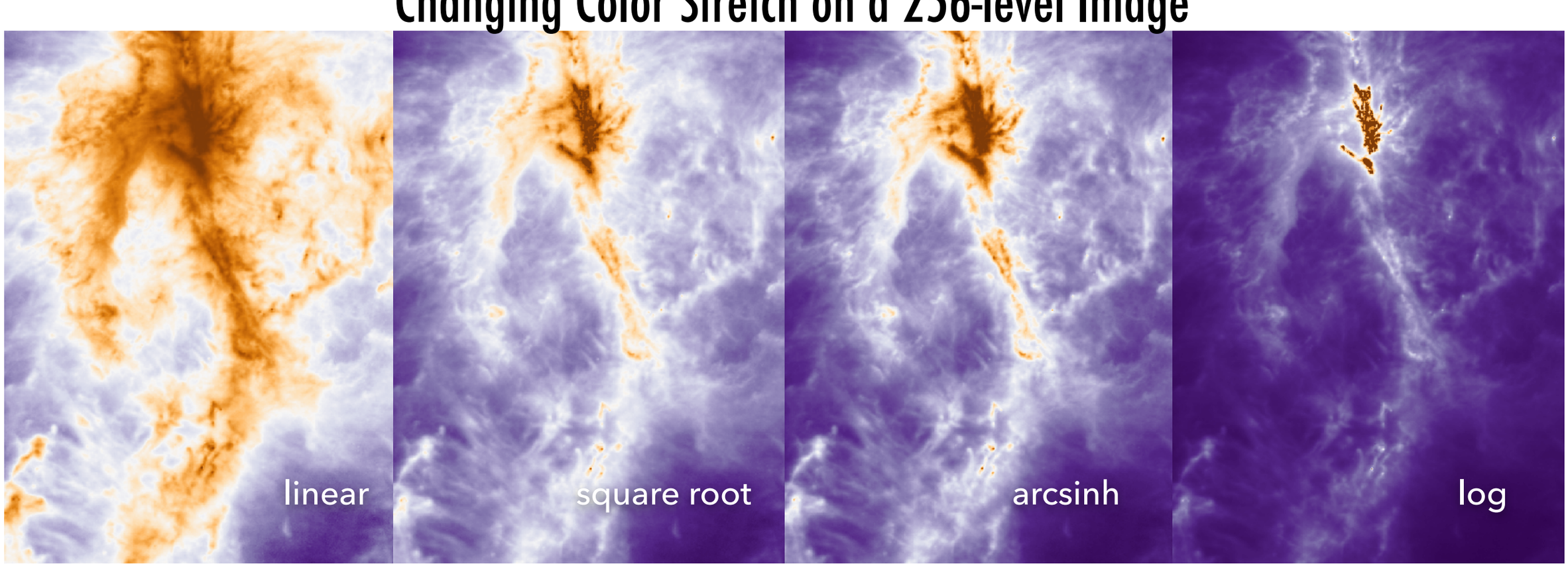
EXPLORATORY VISUALIZATION

DIMENSIONALITY AND COLOR

Changing Color Palette on a 256-level Image

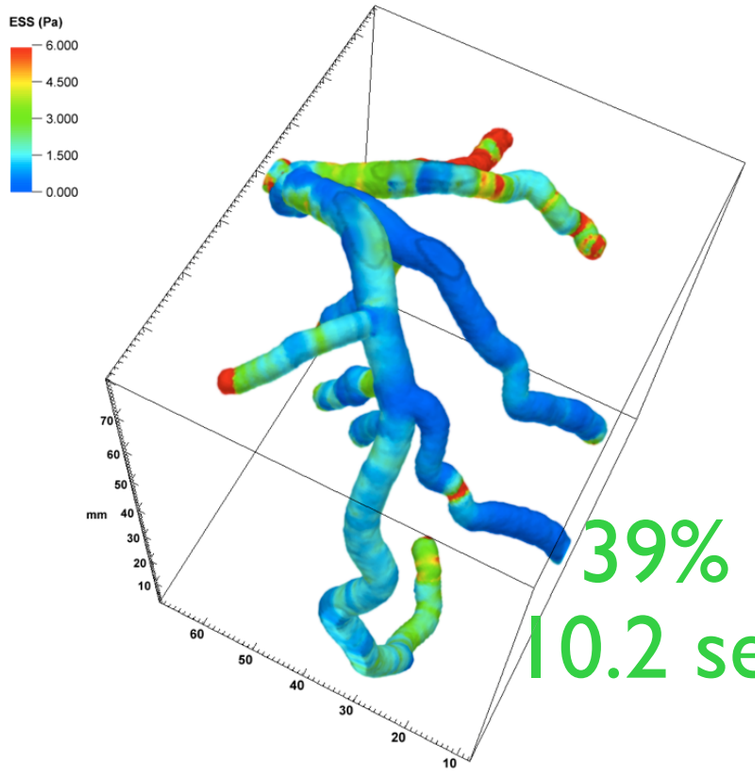


Changing Color Stretch on a 256-level Image

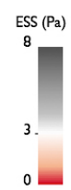


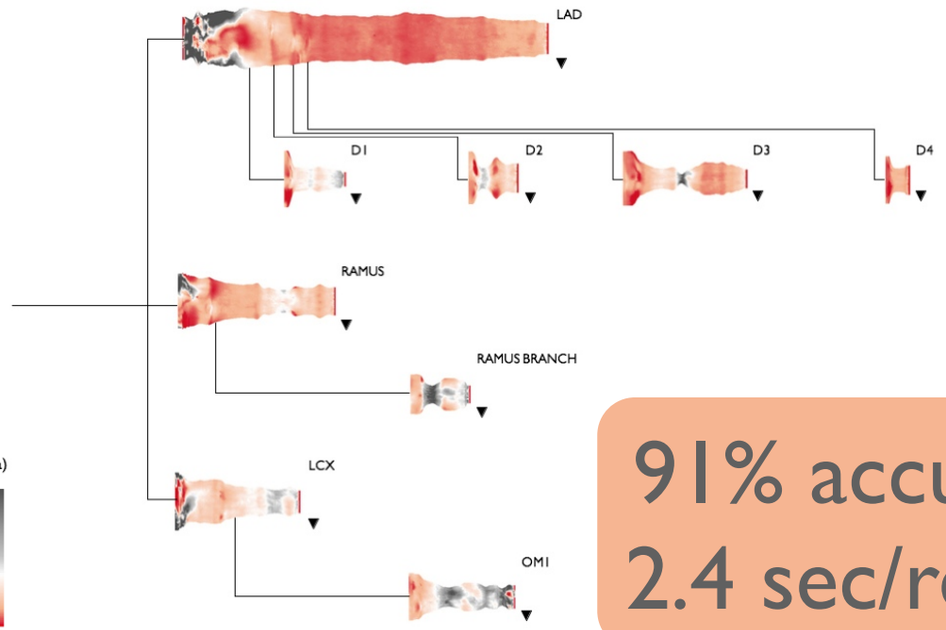
Orion data from the Herschel Space Telescope | #OrioninManyColors

DIMENSIONALITY AND COLOR

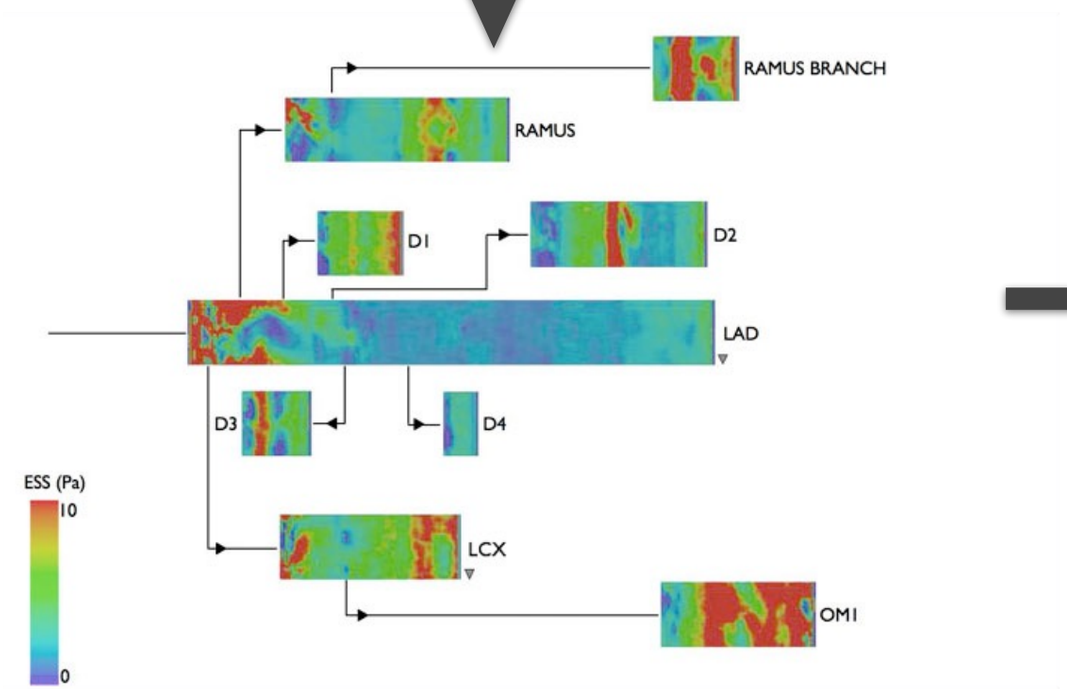


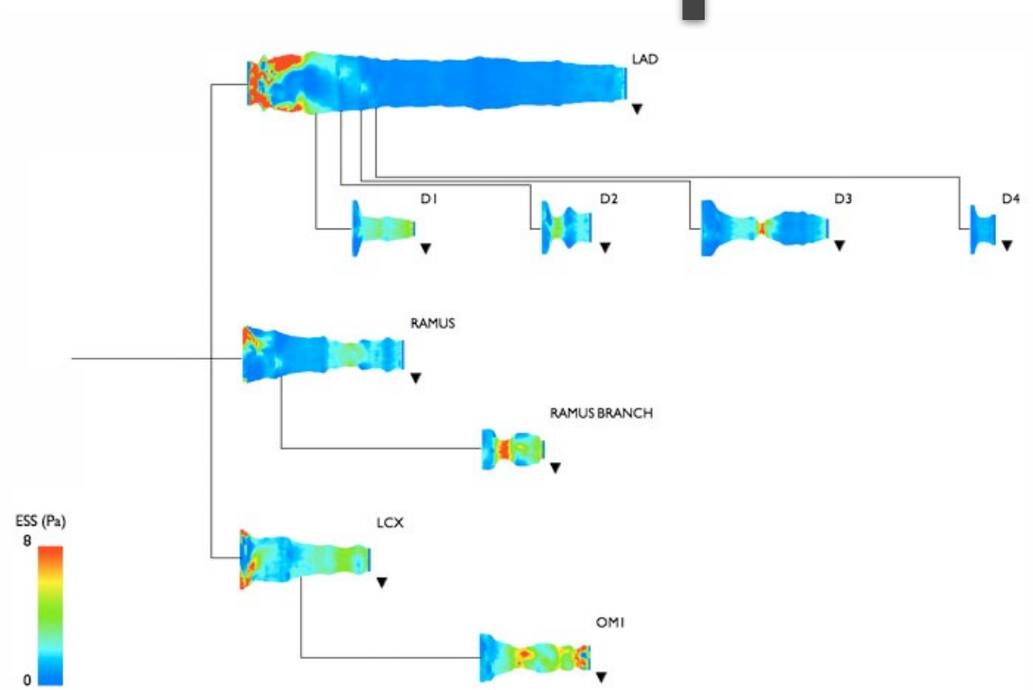
39% accurate
10.2 sec/region





91% accurate
2.4 sec/region





Borkin et al. 2011
cf. colorbrewer2.org