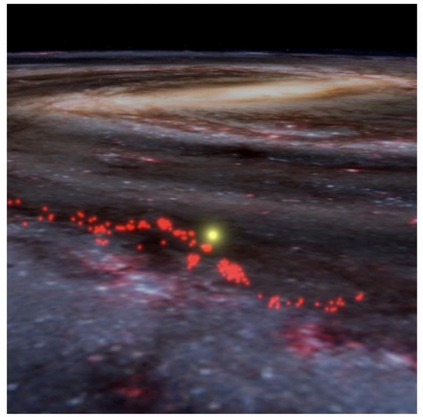
DIMENSIONS OF DISCOVERY

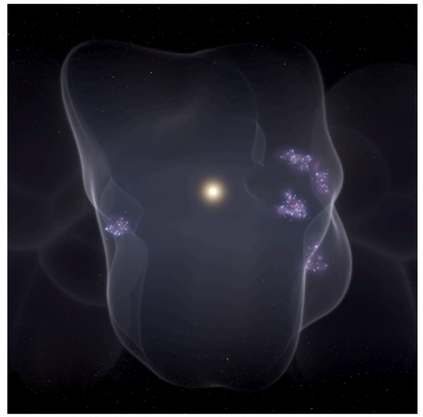
A web page created by Alyssa Goodman to showcase the use of technology in research, education, and communication, of science and more.

What's happening "these days?" A sampler of ongoing and recent projects.



The Radcliffe Wave

A gigantic "wave" of dense gas that forms the spine of the Local Arm of the Milky Way.



The Local Bubble

A 1000-light-year-wide bubble surrounding the Sun and Earth is apparently responsible for

PredictionX

The best place to learn more about the past, present, and future of the future. Through dynamic online learning, PredictionX uncovers the role of uncertainty in the world around us.

Data + Climate

A collaboration of researchers at Harvard and Google, making data discoverable and available

15 minutes

A Peek at how we See the Universe with

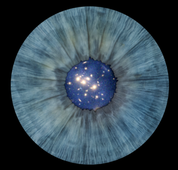
++++

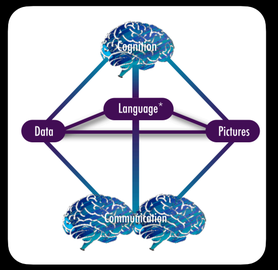
Alyssa A. Goodman
Center for Astrophysics | Harvard & Smithsonian
& Radcliffe Institute for Advanced Study

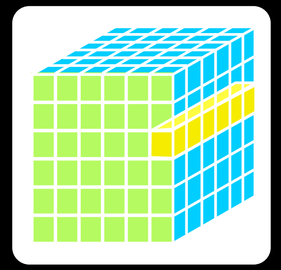
1 hour and15 minutes

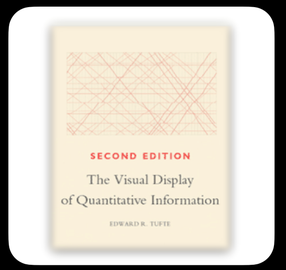
1 hour and15 minutes

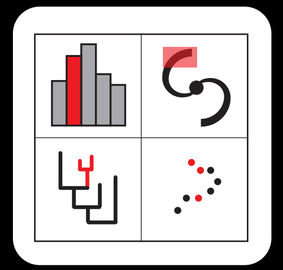
SEEING MORE OF THE UNIVERSE

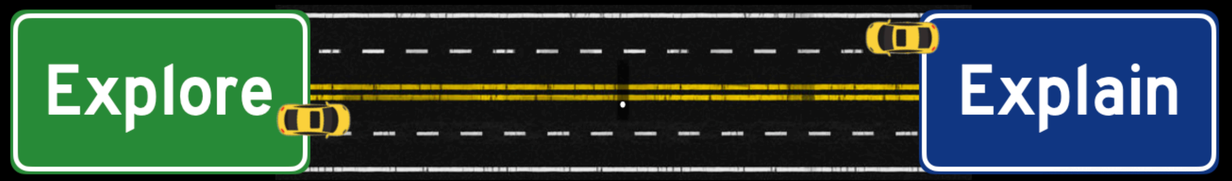












glue
multidimensional data exploration

multiple data sets analyzed together

selections across data sets

multi-layer images, with additional points, curves, and selection layers

selections across all views

standard x-y (2D) plots

multi-layer 3D volumetric rendering

3D point clouds

data sets attributes linked (UI not shown)

external tool plug-ins (e.g. WorldWide Telescope)

table viewer (not shown)

spectrum (profile) display/analysis tools

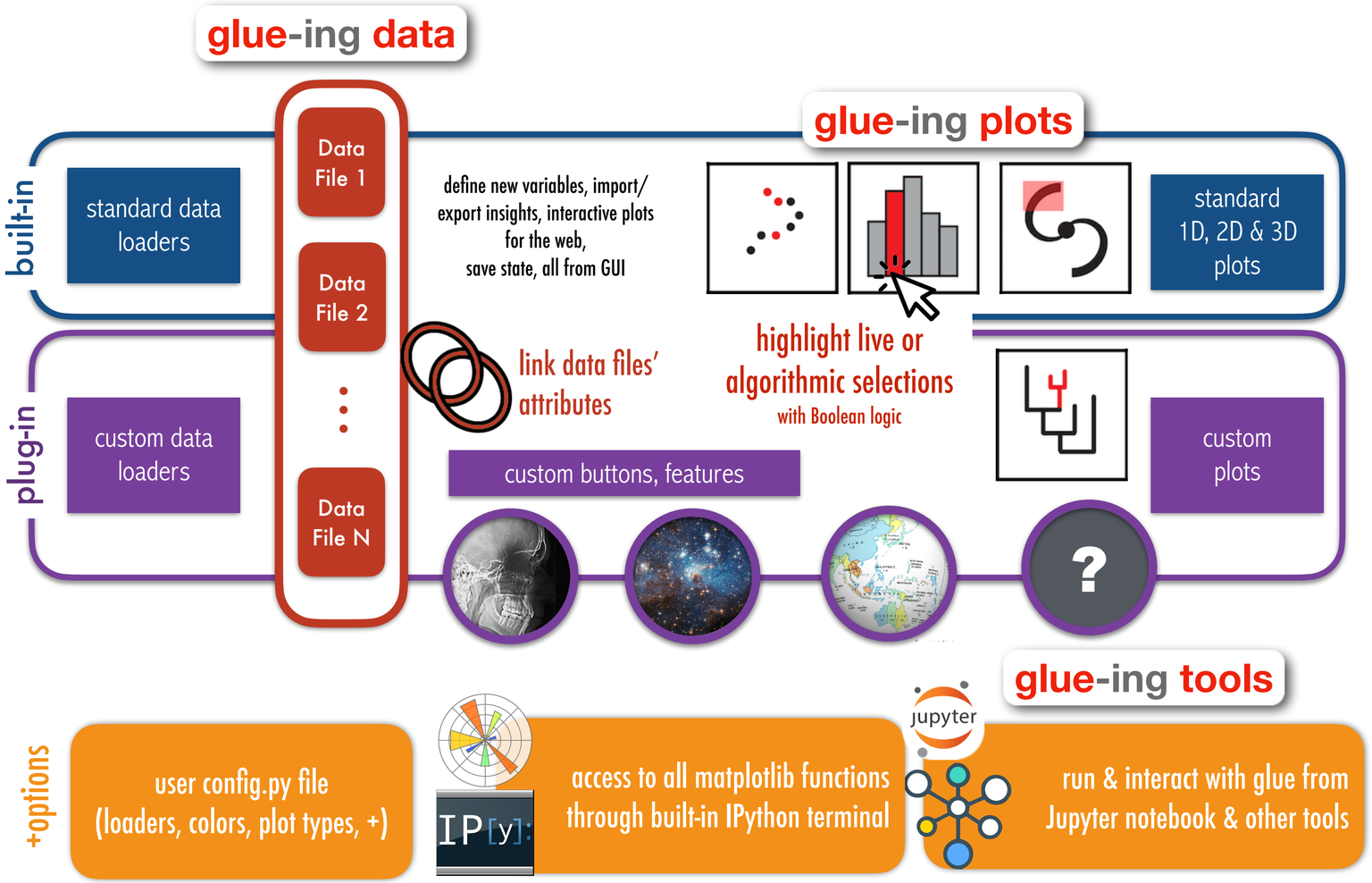
stats calculator (not shown)

2D plots from 3D data, in user-defined e.g. non-orthogonal coordinates

custom plot types (not shown)

The Three Meanings of "glue"

multidimensional data exploration



glueviz.org

Partial list of contributors & collaborators
(listed with current affiliation, unless *)

Founders
Alyssa Goodman (CfA)
Chris Beaumont (Netflix)
Michelle Borkin (Northeastern)
Thomas Robitaille (Aperio, lead developer)

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Patricia Udomprasert
Peter Williams
Catherine Zucker

STScI
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Arfon Smith*
et al.(!!)

Northeastern University
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et al. (The Jackson Laboratory)

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Nathan Goldbaum*
Matt Turk

OpenSpace (plug-in)
Micah Acinapura
Carter Emmart
Jackie Faherty
et al.

CDS (plug-in)
Thomas Boch

ESASky (plug-in)
Marcos López-Caniego

glue is supported by
NSF, NASA (JWST), and glue solutions, inc.,
and many generous open source contributors

glue
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glue-ing data

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Link Editor

Click on two datasets to set up links or click on an existing connection to edit links. Selected datasets are shown in green. When one dataset is selected, the colors show directly and indirectly linked (blue) and inaccessible (red) datasets.

Orion_A_J_3x3
Orion_A_H_3x3
Orion_A_Ks_3x3
12CO_CARMANRO
C18O_CARMANRO
megeath_fixed[J_AJ_144_192_table4]
13CO_CARMANRO

Dataset 1
Orion_A_J_3x3
Main components
PRIMARY
Coordinate componer
Pixel Axis 0 [y]
Pixel Axis 1 [x]
Declination
Right Ascension

Dataset 2
Orion_A_H_3x3
Main components
PRIMARY
Coordinate componer
Pixel Axis 0 [y]
Pixel Axis 1 [x]
Declination
Right Ascension

Links between Dataset 1 and Dataset 2
identity(Right Ascension <-> Right Ascension)
identity(Declination <-> Declination)

Link details
Dataset 1 attributes
x
Right Ascension
Dataset 2 attributes
output
Right Ascension

Glue attributes
Create advanced link
Remove link
Cancel
OK

glue is an open-source Python library to **explore relationships** within and between related datasets

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glue
multidimensional data exploration

enabled by javascript output

plotly

AAS 2015

d3po

d3po is a project designed to allow an astronomer (or an
interactive, publication-quality figure that has staged bui
can be previewed at d3po.org, and represents a figure fro
figure describes how metalicity affects color in cool stars,
dragging in the scatter plots to understand the power of lin

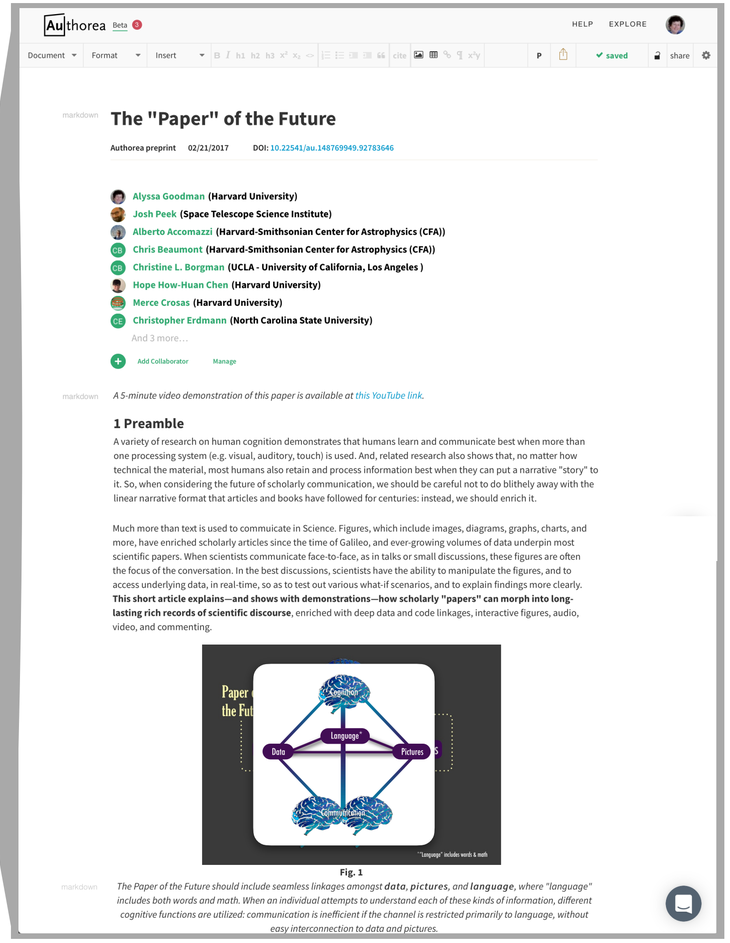
Right now we are in search of alpha testers, who have figure
their hands a little dirty (No javascript skills needed). In futur
figures interactively. We are also exploring implementation of
version expected in January 2014.

Installing your own d3po server

```
git clone git@github.com:adrn/d3po.git
cd d3po
virtualenv --no-site-packages venv
source venv/bin/activate
pip install -r pip-requirements.txt
python run.py
```


Four Centuries of Discovery | A Chasm in Mass | Little Siblings | Close Cousins | The Strangers

After Galileo discovered the first four moons of Jupiter, it took nearly three hundred years to discover the next one.



Authorea Beta

HELP EXPLORE

Document Format Insert saved share

markdown

The "Paper" of the Future

Authorea preprint 02/21/2017 DOI: 10.22541/au.148769949.92783646

Alyssa Goodman (Harvard University)
Josh Peek (Space Telescope Science Institute)
Alberto Accomazzi (Harvard-Smithsonian Center for Astrophysics (CFA))
Chris Beaumont (Harvard-Smithsonian Center for Astrophysics (CFA))
Christine L. Borgman (UCLA - University of California, Los Angeles)
Hope How-Huan Chen (Harvard University)
Merce Crosas (Harvard University)
Christopher Erdmann (North Carolina State University)
And 3 more…

Add Collaborator Manage

markdown

A 5-minute video demonstration of this paper is available at this YouTube link.

1 Preamble

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

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

Fig. 1

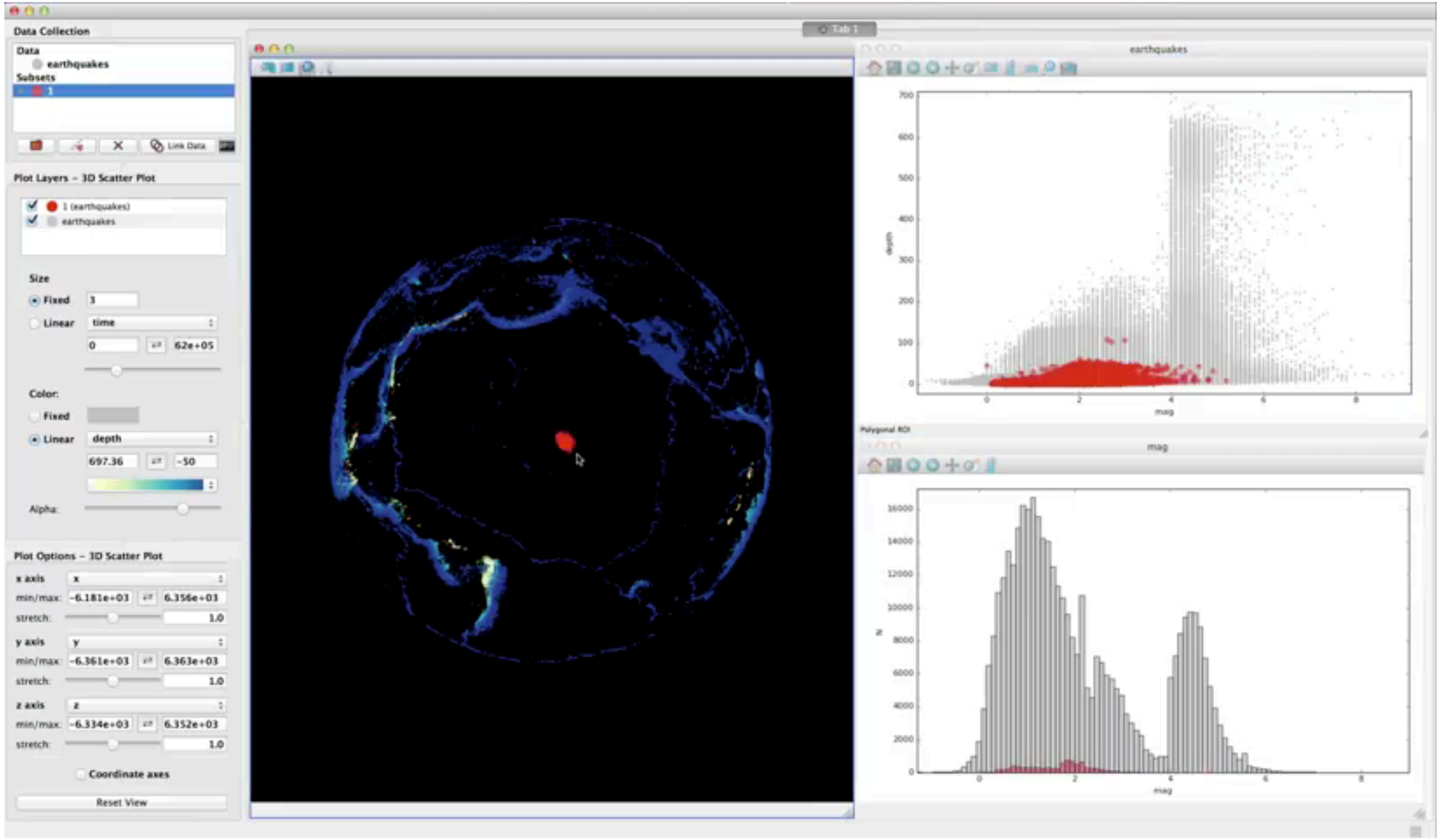
markdown

*The Paper of the Future should include seamless linkages amongst **data**, **pictures**, and **language**, where "language" includes both words and math. When an individual attempts to understand each of these kinds of information, different cognitive functions are utilized: communication is inefficient if the channel is restricted primarily to language, without easy interconnection to data and pictures.*

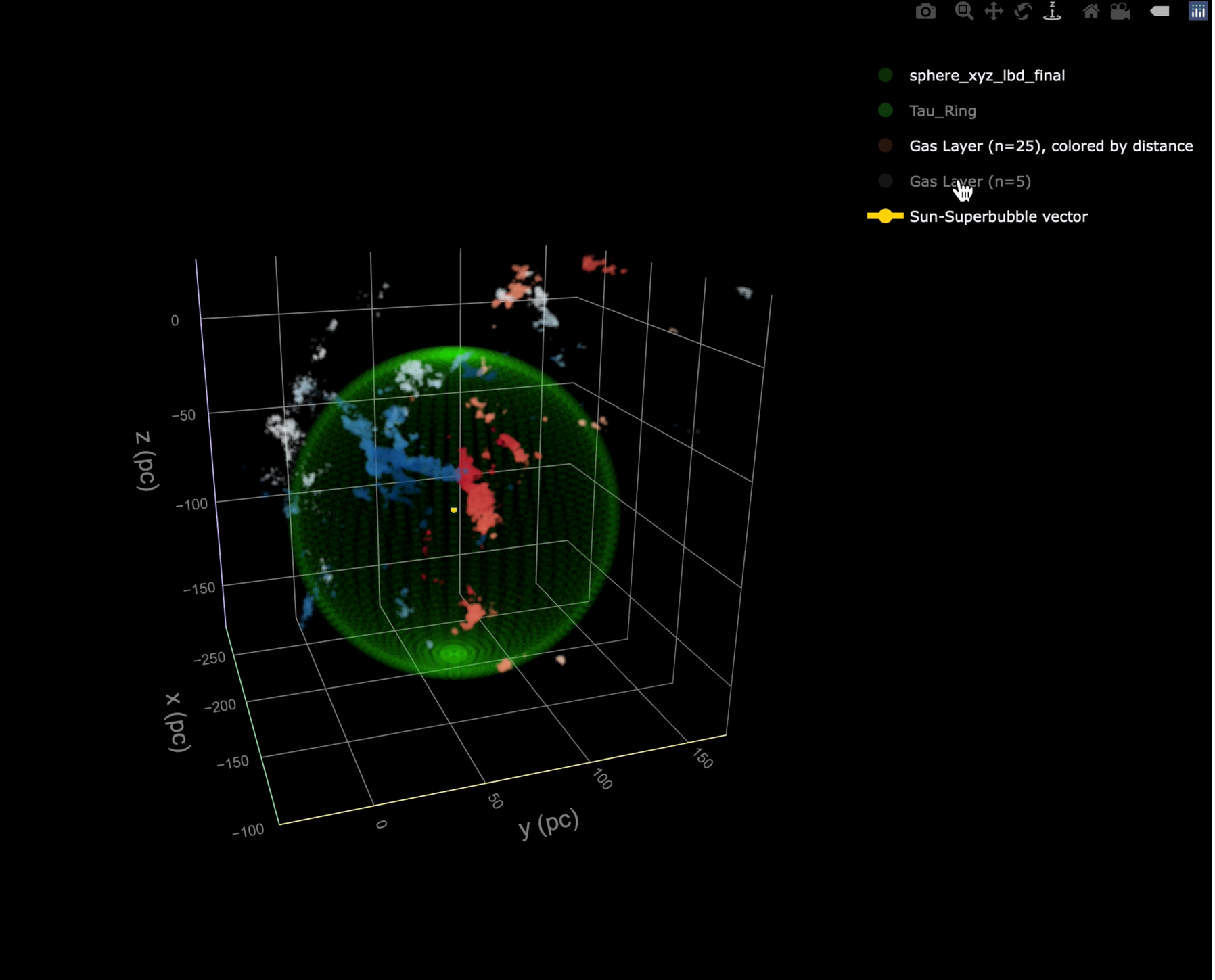
WATCH a DEMO video, and find S/W links,
on YouTube at tinyurl.com/PotF-Demo

many thanks to Alberto Pepe, Josh Peek, Chris Beaumont, Tom Robitaille, Adrian Price-Whelan, Elizabeth Newton, Michelle Borkin & Matteo Cantiello for making the PotF posible.

Linked Views of High-dimensional Data (in Python) glue, c. 2015



video by Tom Robitaille, lead glue developer

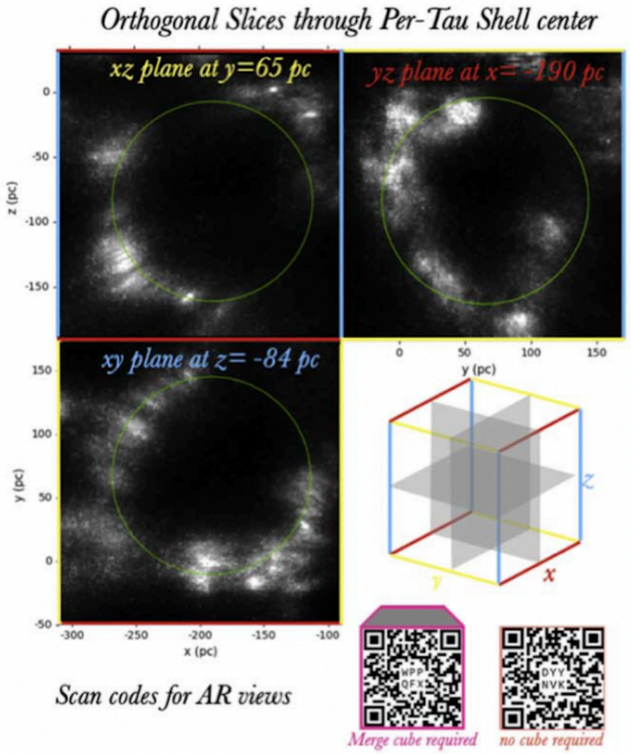


AAS 2021

glue
multidimensional data exploration

plotly

Augmented Reality



The glue software had its origins in the astronomy world--and so did the glue project's first foray into Augmented Reality.

On this page, you can find: on-screen interactive figures; QR codes to launch AR figures using just a smartphone camera; demo videos; and more information explaining how glue and related software is used in the production and publication of AR figures.

If you are interested in learning more about AR applications please drop us a line. We would be happy to either collaborate (via our team's government-sponsored research teams) or consult (via glue solutions, inc.), depending on the nature of your request.

What's next? We are working on a "1-click" AR-export path from glue and gluypter that will produce AR figures viewable direclty in a browser, with no install required.

AAS 2021

glue multidimensional data exploration

plotly

Truly "Reproducible" (and Re-Usable) Research

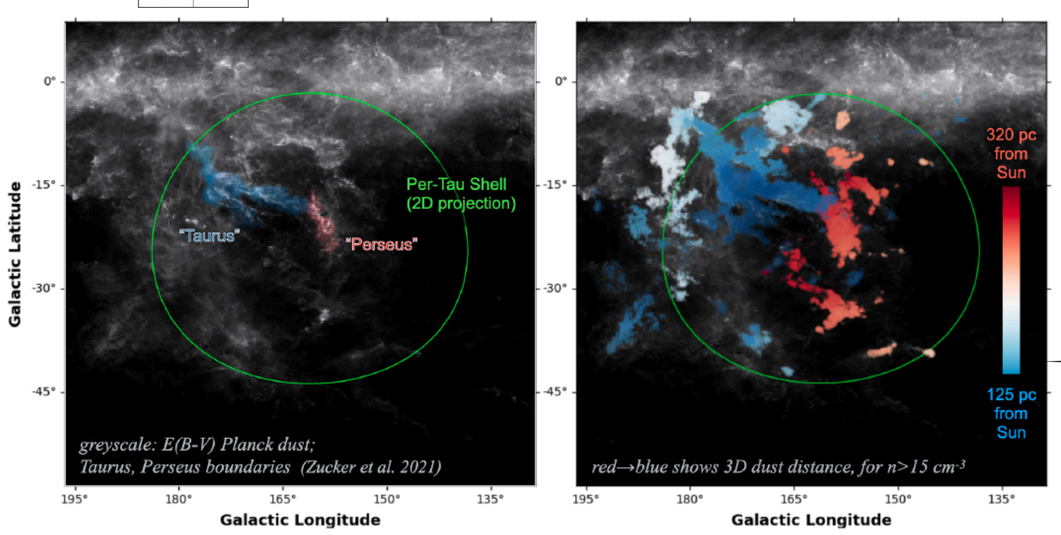
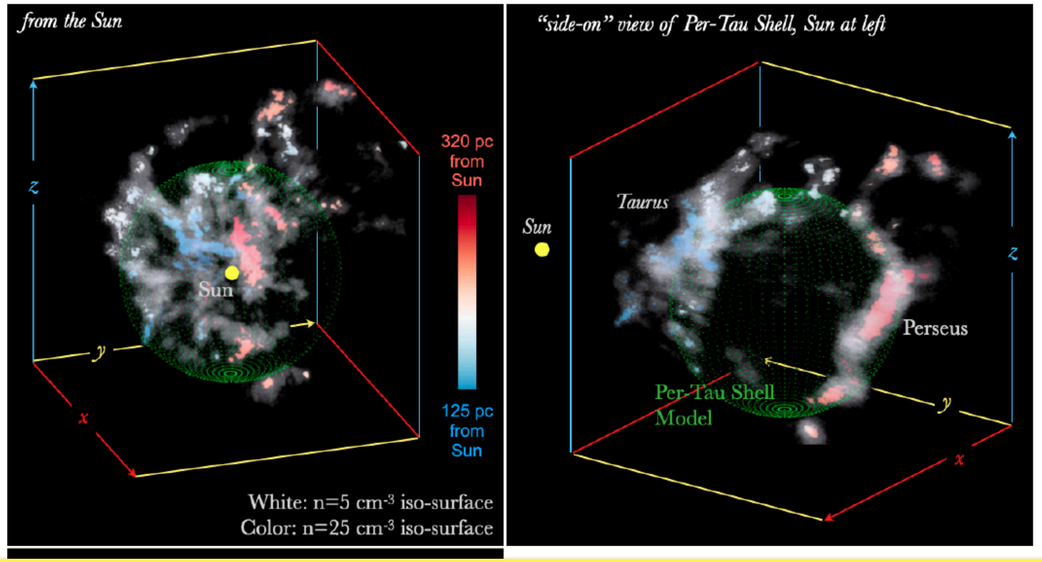


FIG. 1.— Finding Chart. **Left:** The Perseus-Taurus region as seen with Planck E(B-V) dust (Abergel et al. 2014). The Taurus and Perseus molecular clouds are



All the figures presenting 2D & 3D data in this paper are from a single .glu "session" file, were deposited in an online "Dataverse," along with the data needed to run the paper's session. The ApJL contain sthe 3D interactive figure and link to the Dataverse.

(as in earlier & upcoming ApJ papers by Zucker et al. 2019, 2020, 2021, and Nature papers by Alves et al. 2020, and Zucker et al. 2022)

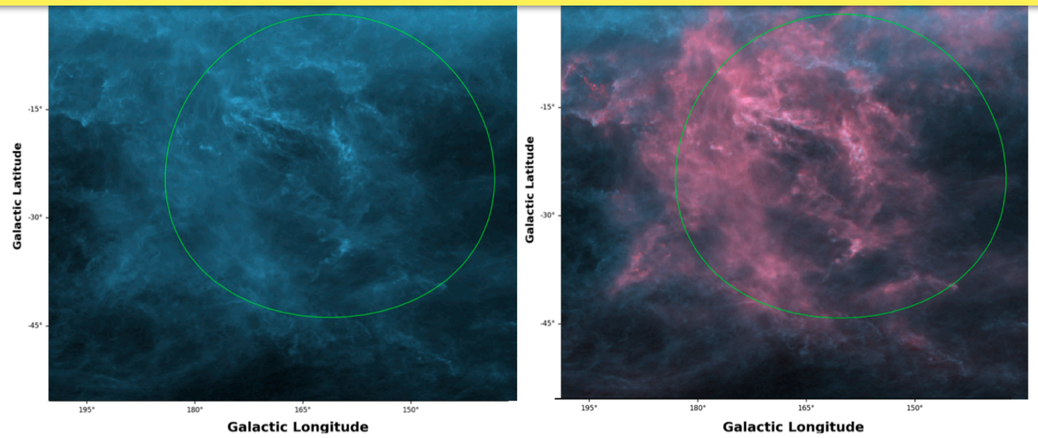


FIG. 6.— Comparing 3D dust to 2D dust. Left: The Planck $E(B-V)$ dust map (in blue) tracing the total dust column density integrated along the LOS. Right: The Planck $E(B-V)$ dust map overlaid with the projection of the 3D dust map (in red) on the plane of the sky. The two maps are in excellent agreement. The 3D dust includes all dust within the L20 3D map limits (e.g., the California Nebula which is located at a larger distance is excluded and does not show in red).

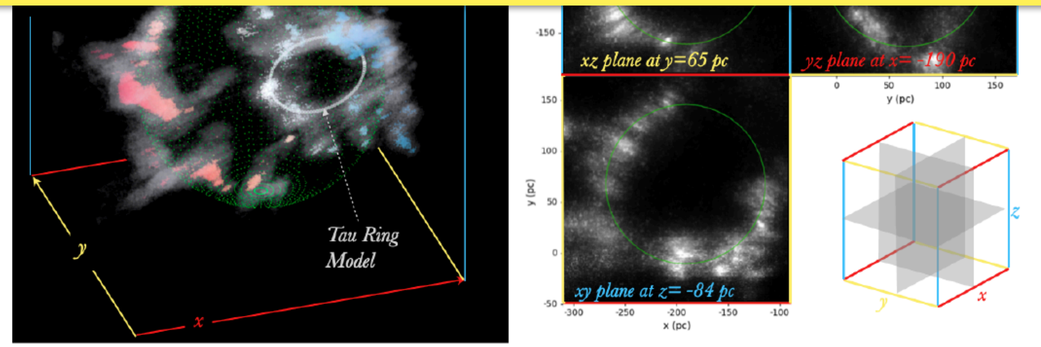
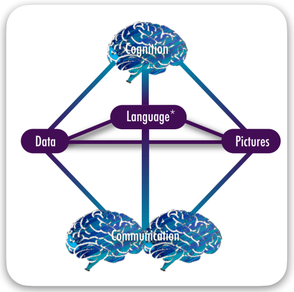
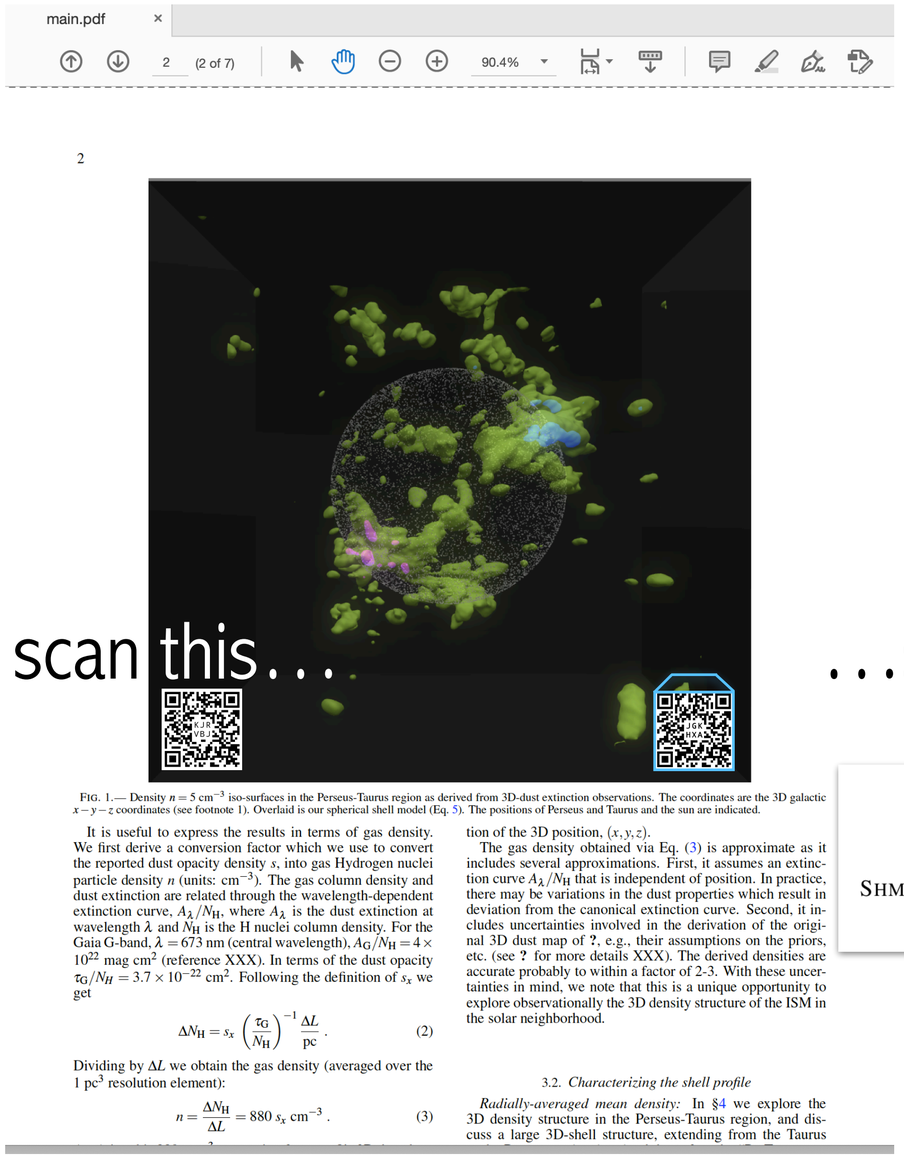


FIG. 2.— 3D views of the Per-Tau shell (see Fig. 5 for more visualizations). Plotted are density iso-surfaces at levels $n = 5$ cm^{-3} (grey) and $n = 25$ cm^{-3} (color), overlaid with our spherical shell model (Table 1). The $n = 25$ cm^{-3} surfaces are colored by distance from the sun. **Upper-left:** View from the sun (compare with Fig. 1). **Upper-right:** A side view of the region. Perseus and Taurus and their diffuse envelopes are arranged on two opposing sides of the Per-Tau shell. **Lower-left:** Another side view emphasizing the Tau Ring. The ellipse is the Tau Ring model (Appendix B). **Lower-right:** 2D density slices along the xy, xz, yz planes. All planes intersect at shell's center. In all panels xyz are the Heliocentric Cartesian Galactic Coordinates.
An interactive version of this figure is available here.

Publishing's interactive Cutting-Edge & (Augmented) Future



scan this…

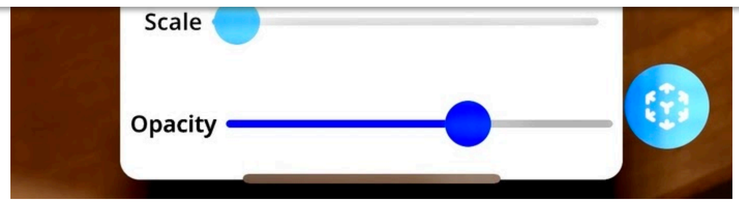


BIALY ET AL. 2021

…see this

THE PER-TAU SHELL:
A GIANT STAR-FORMING SPHERICAL SHELL REVEALED BY 3D DUST OBSERVATIONS

SHMUEL BIALY[1]*, CATHERINE ZUCKER[1], ALYSSA GOODMAN[1,2], MICHAEL M. FOLEY[1], JOÃO ALVES[2,3], VADIM A. SEMENOV[1], ROBERT BENJAMIN[4], REIMAR LEIKE[5,6], TORSTEN ENßLIN[5,6]



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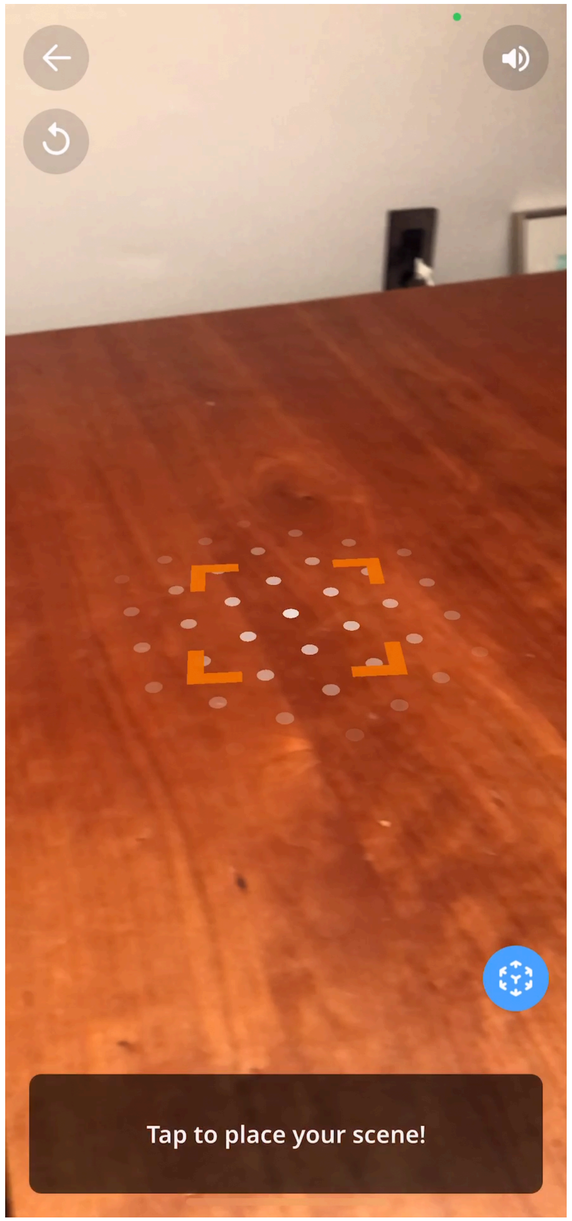
KJR
VBJ



NSF

HARVARD UNIVERSITY

glue
multidimensional data exploration

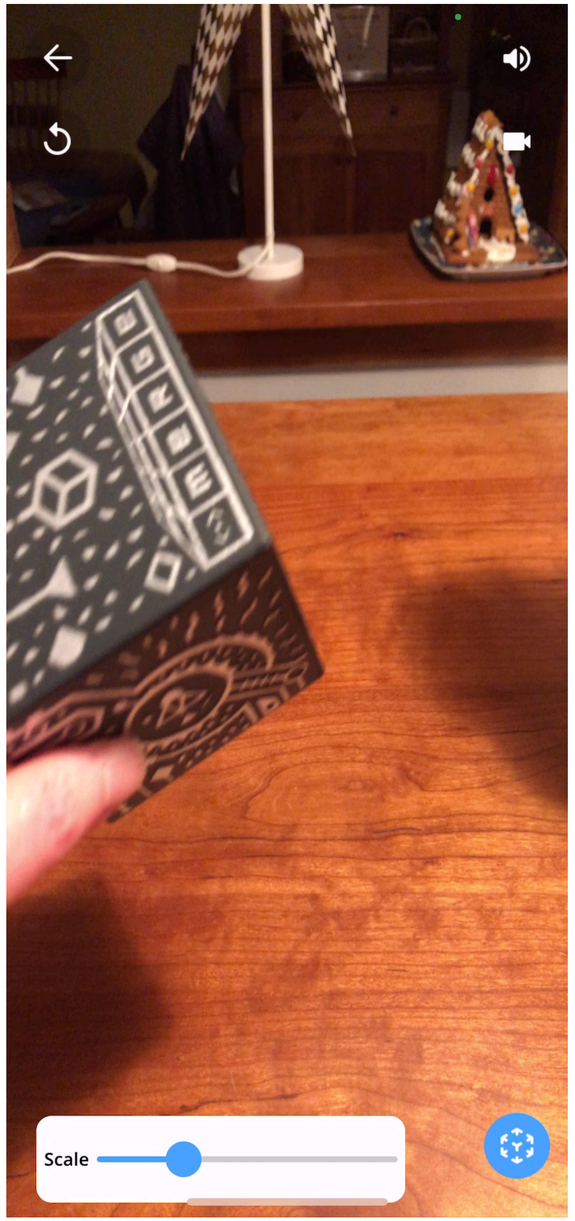
CO SPACES EDU

AMERICAN ASTRONOMICAL SOCIETY

JOHNS HOPKINS UNIVERSITY

STScI | SPACE TELESCOPE SCIENCE INSTITUTE

Northeastern University



JGK
HXA

DEMO DATA AND AR TECHNOLOGY WILL APPEAR IN BIALY ET AL. 2021

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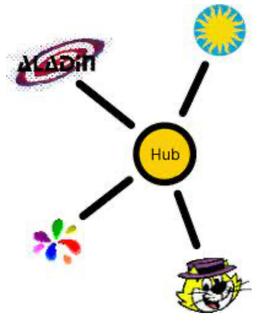
A 2021 "Science Platform": Plug-ins, Code-Sharing & Hubs



Credit: Mark Taylor et al. 2011

yt

vaex

glue
multidimensional data exploration

esa Sky

ALADIN

SAMP Hub

ASTRO DATALAB

Jdaviz

js9

ENABLED BY

The Astropy Project

GitHub

jupyter

NumPy

pandas

matplotlib

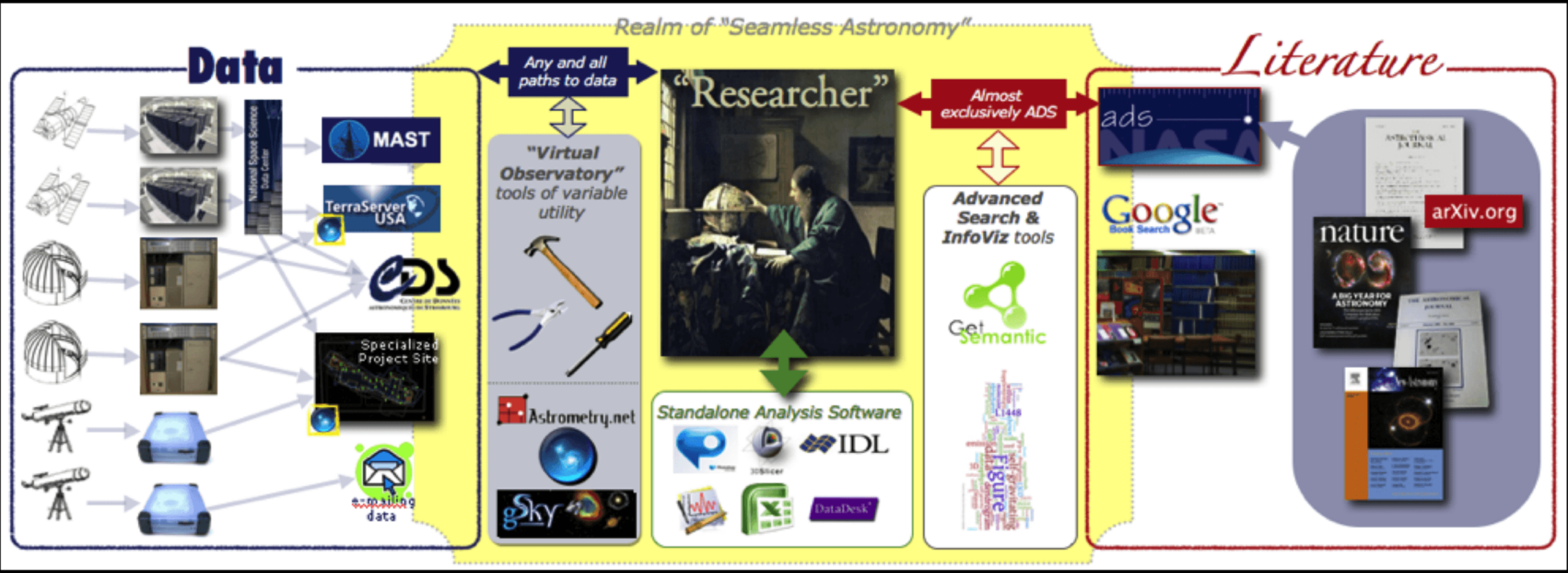
...

NOTE: I know this diagram has missing links! Please suggest via Slack & I'll add them during this session—slides will update online.

SEAMLESS ASTRONOMY

Linking scientific data, publications, and communities

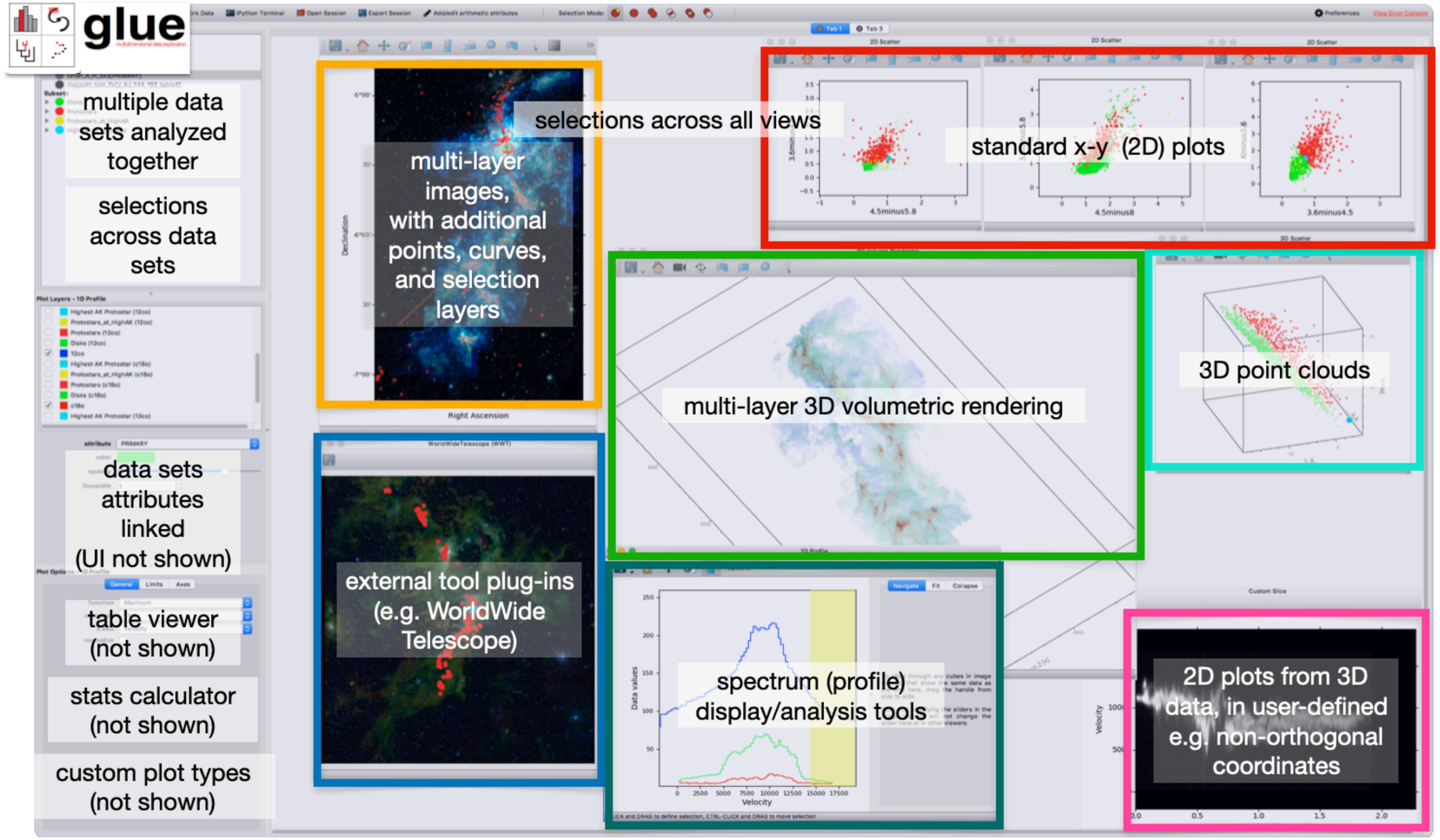
2010—



seamlessastronomy.org

New Thinking on, and with Data Visualization

Goodman, Borkin & Robitaille, 2018
(update for 2021 in process)



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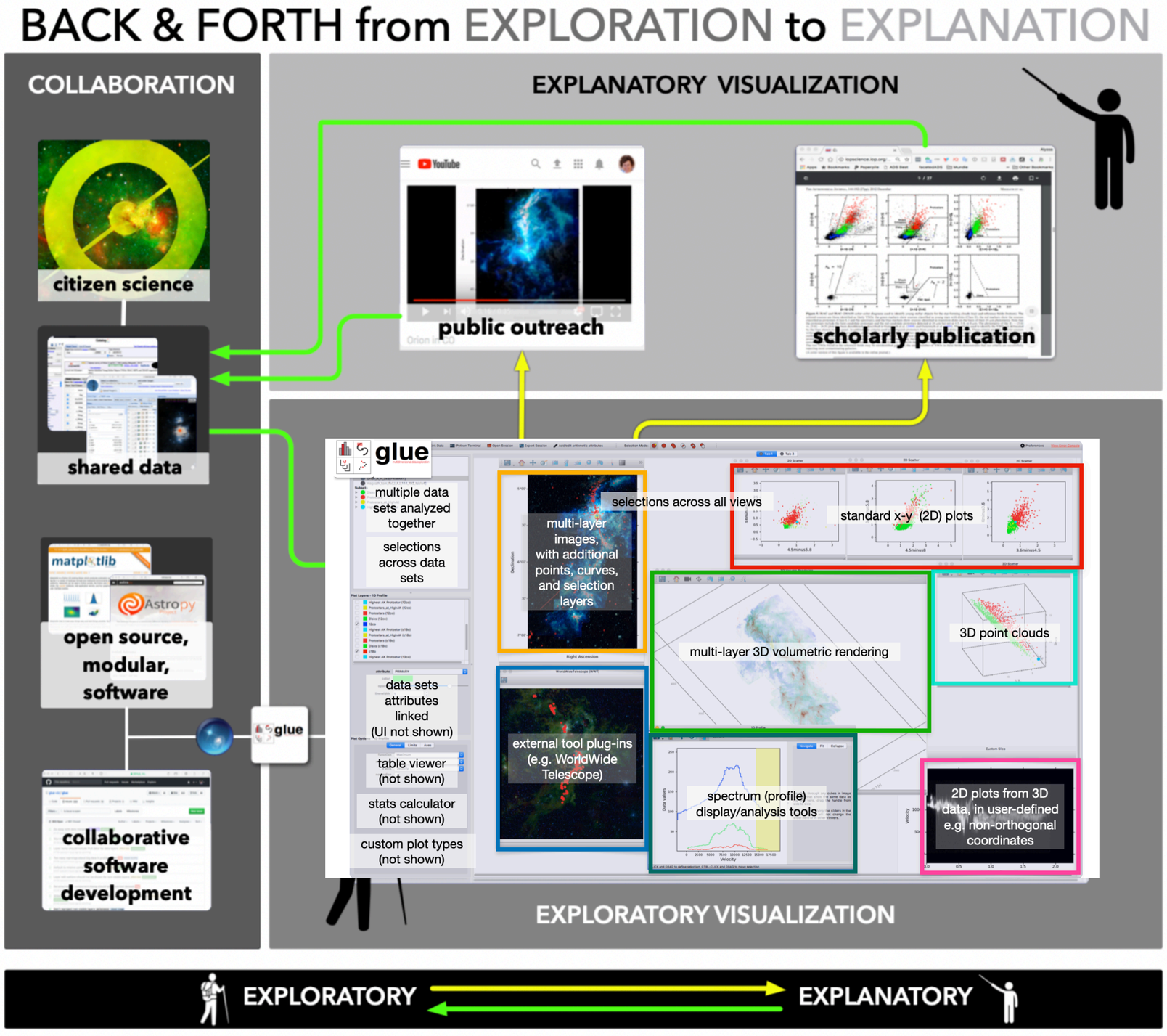
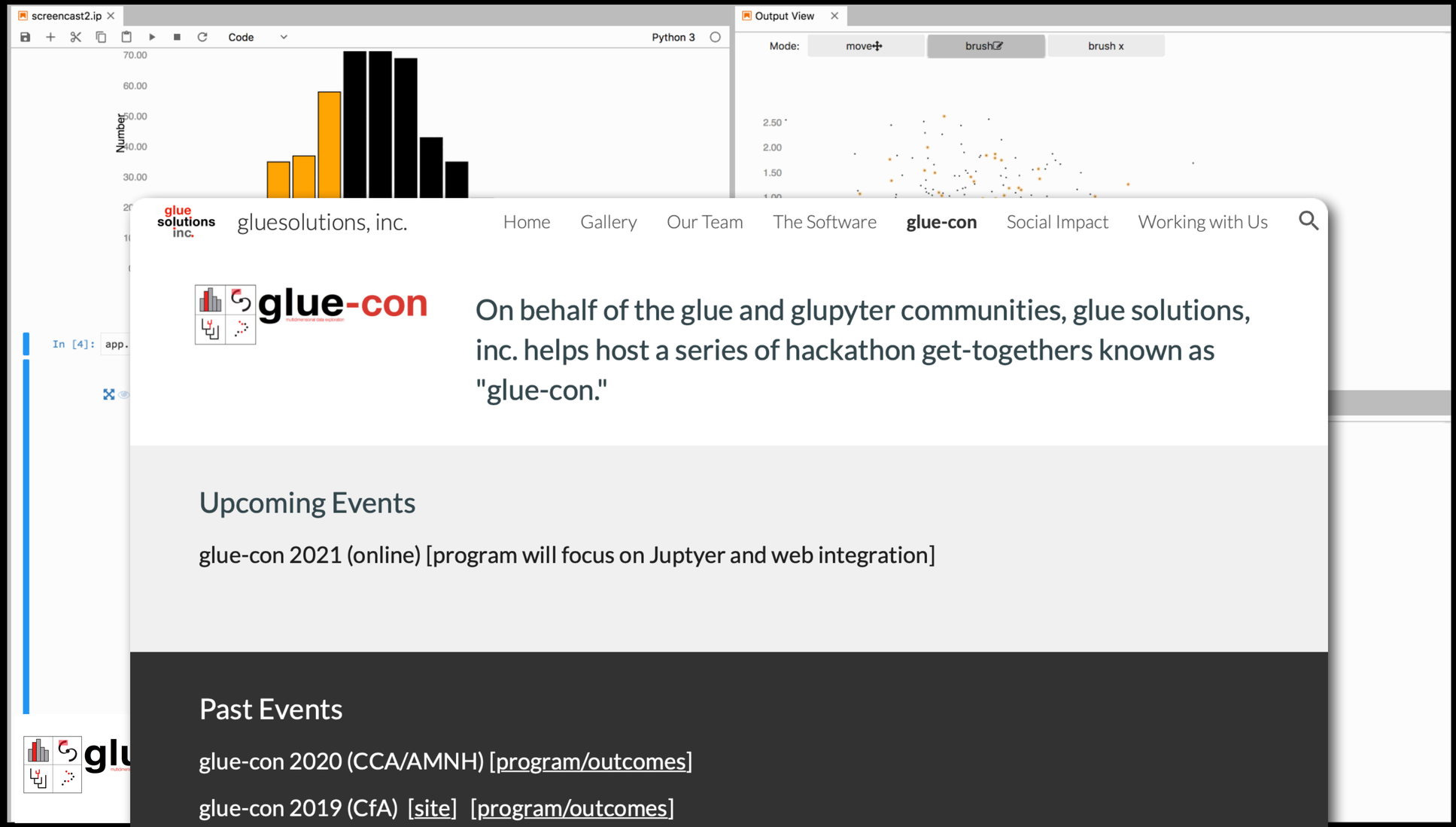
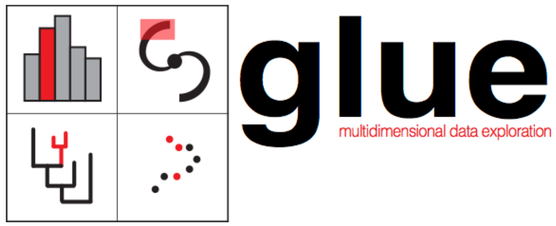


But Wait, Just one more Thing...Coming Soon: glue in ~Jupyter Lab





glueviz.org

Installing and running glue

Several installation methods for Glue are outlined in the sections below. If you run into issues, each page should provide relevant troubleshooting, and you can also check the Known issues and solutions page which collects some more general issues. If your problem is not described there, open a new issue on GitHub.

- Anaconda Python Distribution (Recommended)
- Installing with pip
- Installing PyQt or PySide
- Full list of dependencies
- Installing the latest developer version

Note

If you are using Apple M1 hardware, be sure to read Using glue on Apple M1 hardware before proceeding with the installation instructions.

Once glue is installed, you will be able to type:

```
glue
```

Extra Slides

esa Sky

esdc

esa

ESDC » ESASky » How To

- Home
- About ESDC
- Archival Research Visitor Programme
- Newsletter
- Science Archives
- Archive Image Browser
- ESASky
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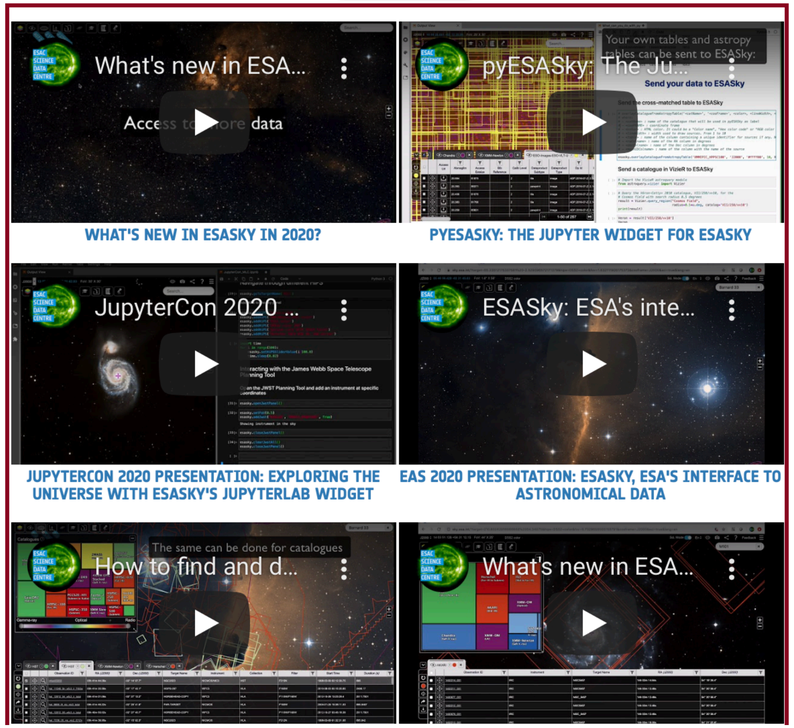
HOW TO USE ESASKY

ESASky is a science driven discovery portal providing full access to the entire sky as observed with Space astronomy missions. Short videos on how to use the tool are shown below and the general documentation can be found here.

Open ESASky



WHAT'S NEW IN ESASKY IN 2020?

PYESASKY: THE JUPYTER WIDGET FOR ESASKY

JUPYTERCON 2020 PRESENTATION: EXPLORING THE UNIVERSE WITH ESASKY'S JUPYTERLAB WIDGET

EAS 2020 PRESENTATION: ESASKY, ESA'S INTERFACE TO ASTRONOMICAL DATA

Open ESASky

sky.esa.int

Latest ESASky News

ESDC newsletter

ESASky & you

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ESASky Info

Release notes
General Documentation
Publications

ESASky related tools

EDDIE Cutout Service
ESASky Astroquery module
pyESASky widget
Javascript API

Contributing data to ESASky

Instructions

Learning with ESASky

Getting started
Educational Activities

https://www.cosmos.esa.int/web/esdc/esasky-how-to