

Charlie Lada's Universe, Past, Present & Future

Alyssa Goodman

with many thanks to Catherine Zucker, João Alves,
Tom Robitaille, Curtis Wong, Jonathan Fay & Peter Williams

September 27, 2019, Crete

The Past

Scott
Kenyon

Steve
Ruden

Frank
Bertoldi

David
Wilner

Alex
Rudolph

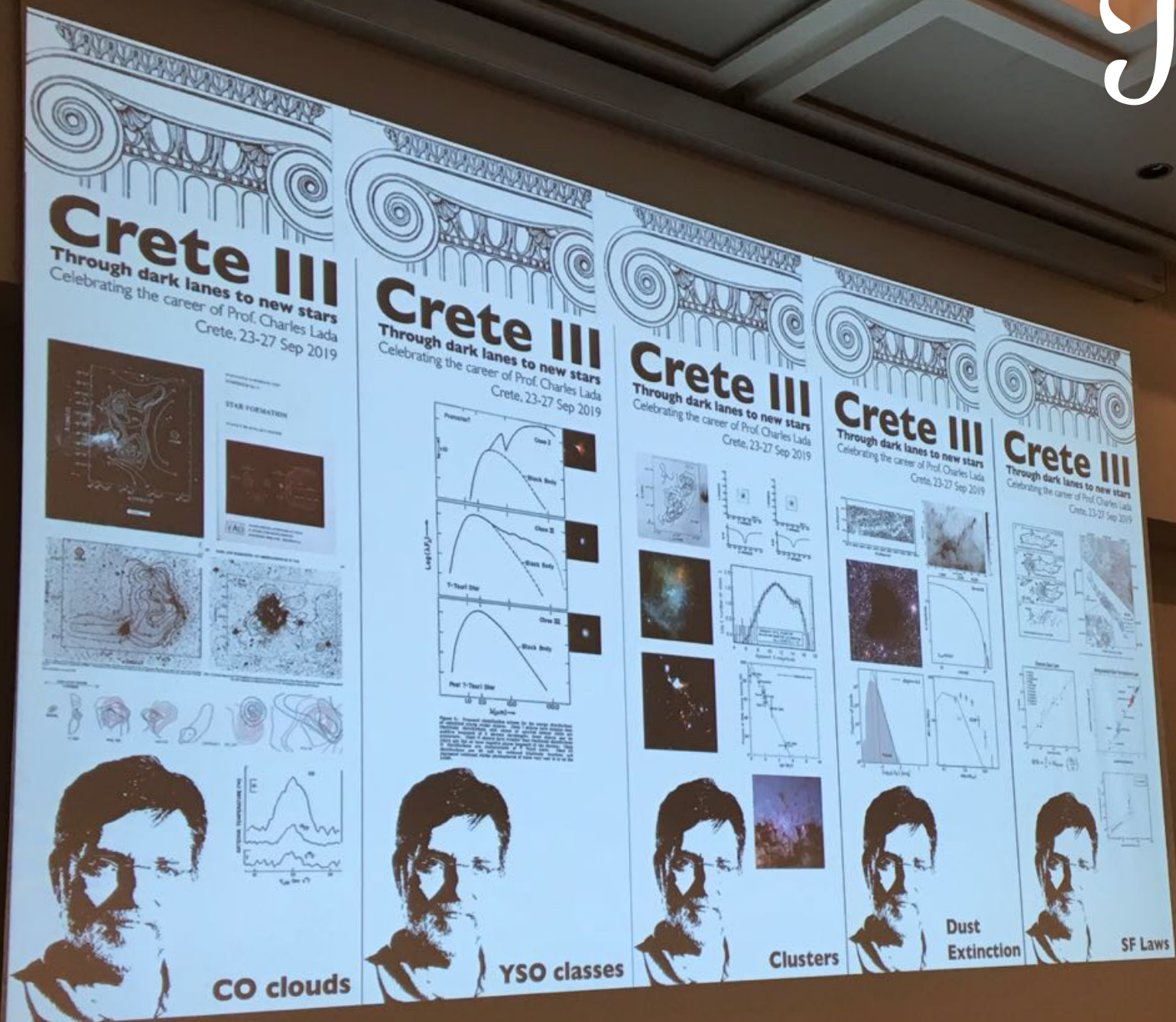
Gary
Fuller

Elizabeth
Lada



CRETE I

The Past



The Past



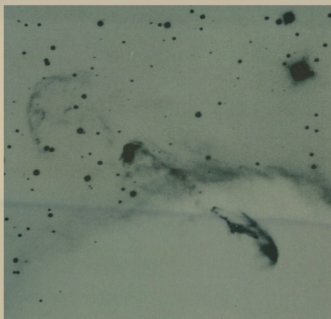
Daniele Galli

The Crete-I School that I attended as a student was an extraordinary event that opened up my mind. The Proceedings volume of that School is the most worn-out science book I keep in my office. For all students of my generation, the two complementary reviews, by Charlie on observations, and Frank Shu on theory, were basic references to study over and over again, every time trying to go deeper and deeper.

I am very grateful to Charlie and Nick, among many other things, for making possible such an influential and absolutely unforgettable School.

CRETE I

The Physics of
Star Formation and
Early Stellar Evolution



Edited by
Charles J. Lada and Nikolaos D. Kylafis



The “Unforgettable” Past

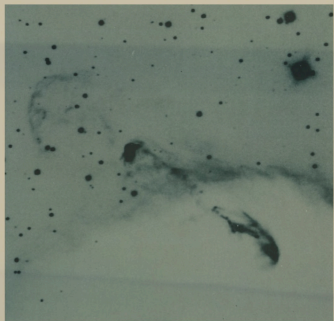


Daniele Galli

The Crete-I School that I attended as a student was an extraordinary event that opened up my mind. The Proceedings volume of that School is the most worn-out science book I keep in my office. For all students of my generation, the two complementary reviews, by Charlie on observations, and Frank Shu on theory, were basic references to study over and over again, every time trying to go deeper and deeper.

I am very grateful to Charlie and Nick, among many other things, for making possible such an influential and absolutely unforgettable School.

The Physics of
Star Formation and
Early Stellar Evolution



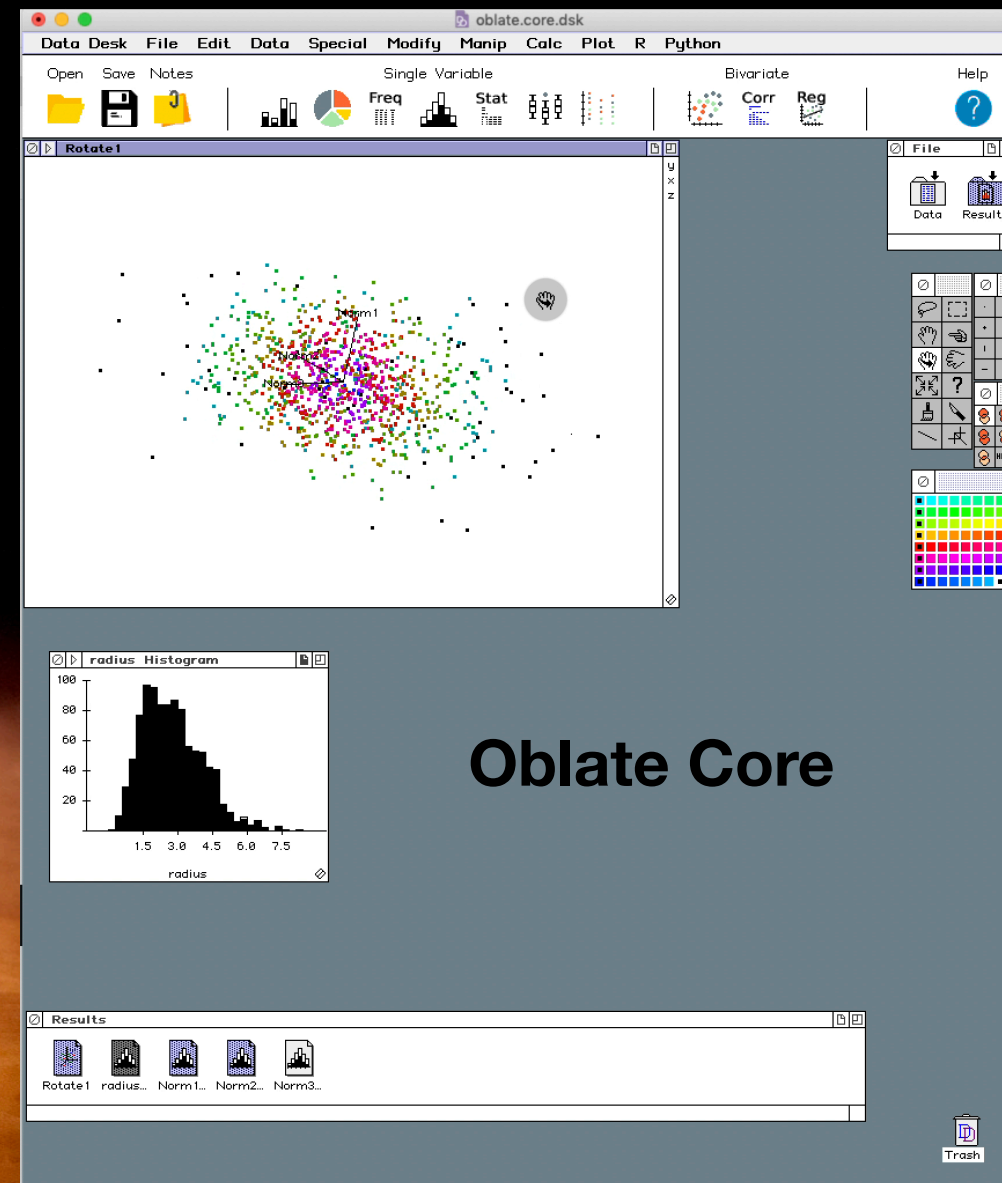
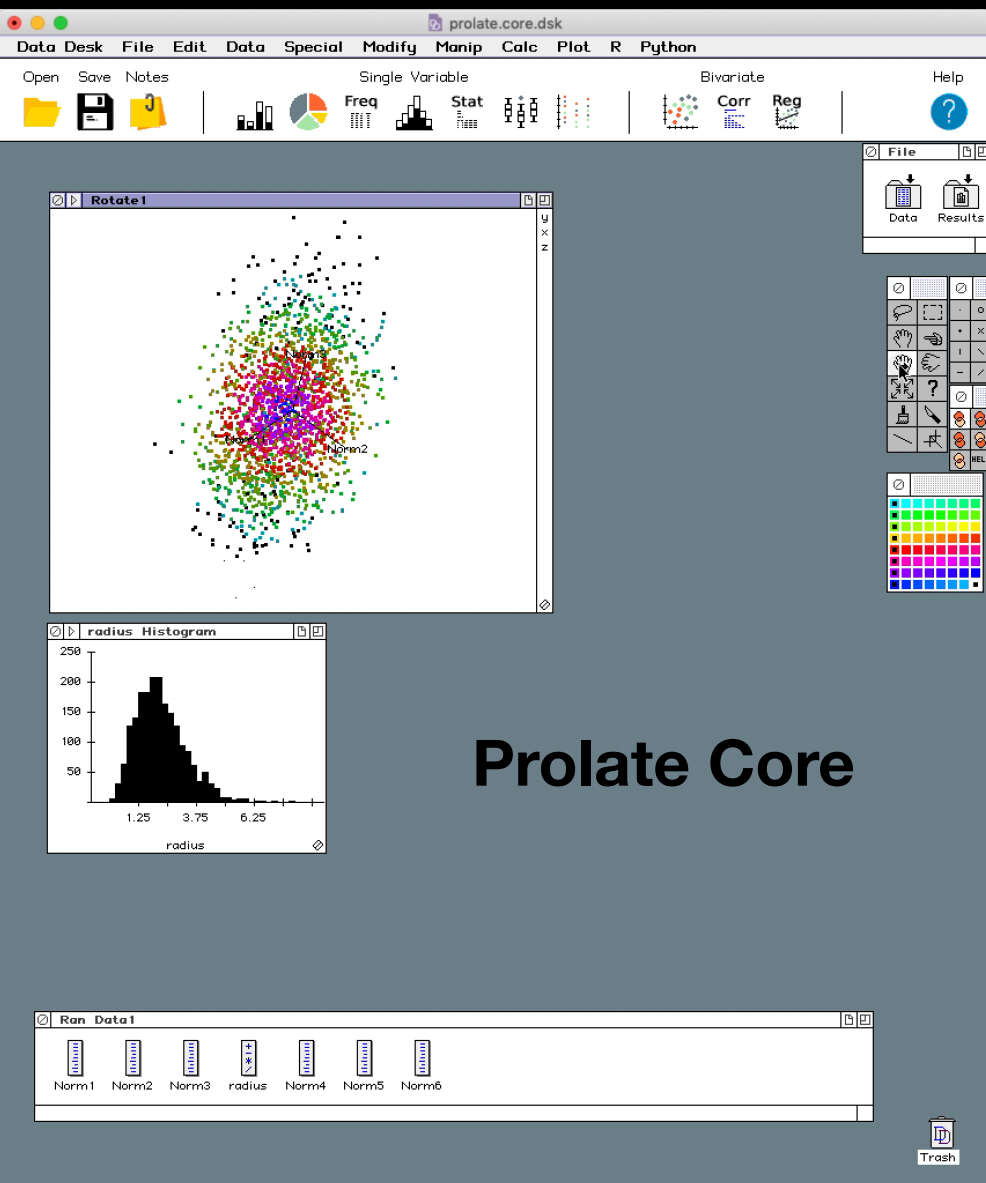
Edited by

Charles J. Lada and Nikolaos D. Kylafis



CRETE I

The “Unforgettable” Past



CRETE I

At Present

[Feedback](#)[ORCID](#)[About](#)[Sign Up](#)[Log In](#)

QUICK FIELD: [Author](#) [First Author](#) [Abstract](#) [All Search Terms](#)

[← Start New Search](#)

Your search returned **242** results

Property
+property:refereed

[Date](#)[Export](#)[Explore](#)

AUTHORS

- ☐ Lada, C 242
- ☐ Alves, J 70
- ☐ Lombardi, M 40
- ☐ Lada, E 32
- ☐ Muench, A 25

[more](#)

COLLECTIONS

- ☐ astronomy 241
- ☐ general 6
- ☐ physics 3

REFEREED

- ☐ refereed 242

AFFILIATIONS

KEYWORDS

PUBLICATIONS

[Show highlights](#)[Show abstracts](#)[Hide Sidebars](#)[Go To Bottom](#)

- ☐ 2019A&A...622A.149G 2019/02 cited: 7
VISION - Vienna survey in Orion. III. Young stellar objects in Orion A
Großschedl, Josefa Elisabeth; Alves, João; Teixeira, Paula S. [and 14 more](#)

- ☐ 2018A&A...620A..24H 2018/11 cited: 2
The HP2 Survey. IV. The Pipe nebula: Effective dust temperatures in dense cores
Hasenberger, Birgit; Lombardi, Marco; Alves, João [and 3 more](#)

- ☐ 2018A&A...619A.106G 2018/11 cited: 21
3D shape of Orion A from Gaia DR2
Großschedl, Josefa E.; Alves, João; Meingast, Stefan [and 16 more](#)

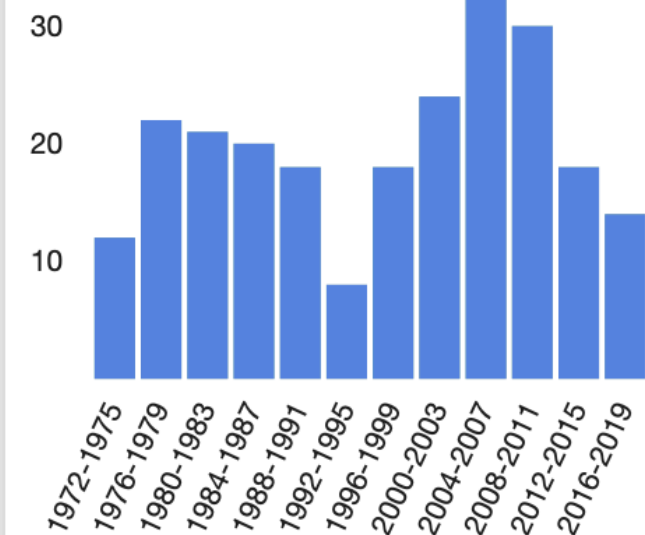
- ☐ 2018A&A...618A.119M 2018/10
A global correlation linking young stars, clouds, and galaxies. Towards a unified view of star formation
Mendigutía, I.; Lada, C. J.; Oudmaijer, R. D.

- ☐ 2018A&A...612A..81R 2018/05 cited: 1
Gathering dust: A galaxy-wide study of dust emission from cloud

Years

[Citations](#)[Reads](#)

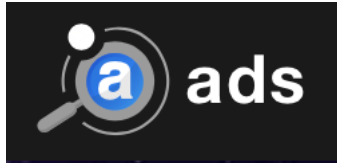
■ refereed ■ non refereed



Limit results to papers from

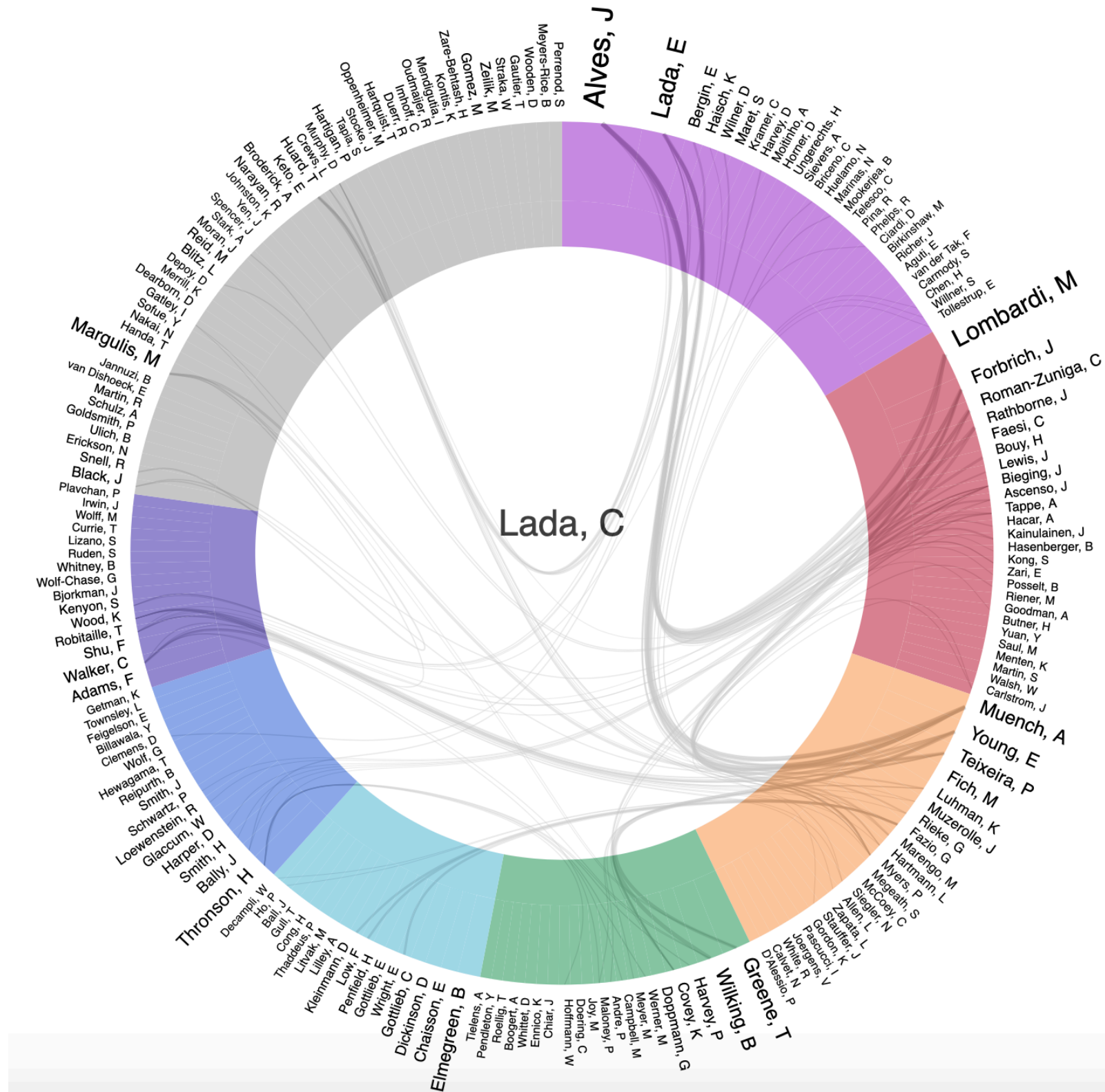
to [Apply](#)

At Present



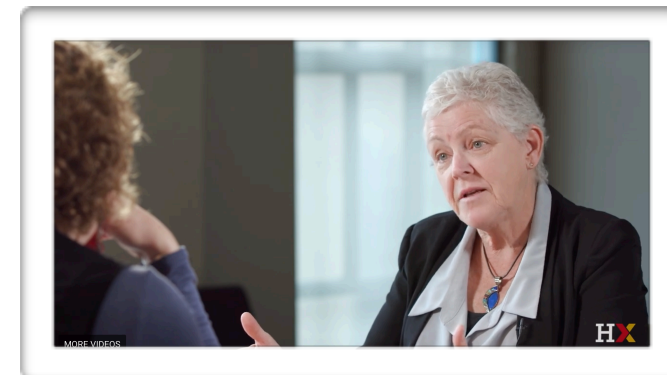
new show resolution source similar distribution
base mass young obtain identify column
use near density formation model
infrared large form region significant
detect result low find dense indicate
object datum present observation
space cloud high observe spitzer suggest
emission provide study investigate molecular
structure range dust star extinction
telescope nearby

At Present





(I can predict) The Future



PREDICTIONX: THE PAST & PRESENT OF THE FUTURE



ESSENTIALS

**Phenomena
→ Predictions**

**Predictive Systems
Framework**

 **Understanding
Uncertainty**

Study Design

► **Why Predict?**



Omens, Oracles & Prophecies

Mesopotamian
Haruspicy

Roman
Augury

Chinese
Oracle Bones

Oracle
of Delphi

Aztec
Rituals

Egyptian
Priests

Tarot

**The
Diviner's
Guide**

Turkish
Tasseography

Maya
Spacetime

Yoruba
Ifa

Casting
Lots

Greek
Astronomy

Astrology

Comets
of Doom

► **cross-cultural
conversations**



THE RISE OF THEORY

 Ancient
Mesopotamia,
Egypt, Greece &
Rome

 **The Path
to Newton**

► Indian
Mathematics
European
Renaissance

► The Royal Society

 **John Snow
& Cholera**
 Cholera Map

 **Lost without
Longitude
(Navigation)**

 Help, I'm Lost!
Tools of the
Navigator



MODERN SIMULATION

Health

- Epidemiology
- Personal Genomics
- Population Genetics

Wealth

- Personal
Finance
(Global)
Economics

The Future of the Future

- Artificial
Intelligence
-  Derek's Day

Earth

- Climate Change
- Tent Tarot
- Earthquakes

Space

Futures
of our Universe

The Future



Charlie Lada's Universe

[Feedback](#)[ORCID](#)[About](#)[Sign Up](#)[Log In](#)

QUICK FIELD: [Author](#) [First Author](#) [Abstract](#) [All Search Terms](#)

[← Start New Search](#)

Your search returned **242** results

Property
+property:refereed

[Date](#)[Export](#)[Explore](#)

AUTHORS

- ☐ Lada, C 242
- ☐ Alves, J 70
- ☐ Lombardi, M 40
- ☐ Lada, E 32
- ☐ Muench, A 25

[more](#)

COLLECTIONS

- ☐ astronomy 241
- ☐ general 6
- ☐ physics 3

REFEREED

- ☐ refereed 242

AFFILIATIONS

KEYWORDS

PUBLICATIONS

[Show highlights](#)[Show abstracts](#)[Hide Sidebars](#)[Go To Bottom](#)

2019A&A...622A.149G 2019/02 cited: 7



VISION - Vienna survey in Orion. III. Young stellar objects in Orion A

Großschedl, Josefa Elisabeth; Alves, João; Teixeira, Paula S. [and 14 more](#)



2018A&A...620A..24H 2018/11 cited: 2



The HP2 Survey. IV. The Pipe nebula: Effective dust temperatures in dense cores

Hasenberger, Birgit; Lombardi, Marco; Alves, João [and 3 more](#)



2018A&A...619A.106G 2018/11 cited: 21



3D shape of Orion A from Gaia DR2

Großschedl, Josefa E.; Alves, João; Meingast, Stefan [and 16 more](#)



2018A&A...618A.119M 2018/10



A global correlation linking young stars, clouds, and galaxies. Towards a unified view of star formation

Mendigutía, I.; Lada, C. J.; Oudmaijer, R. D.



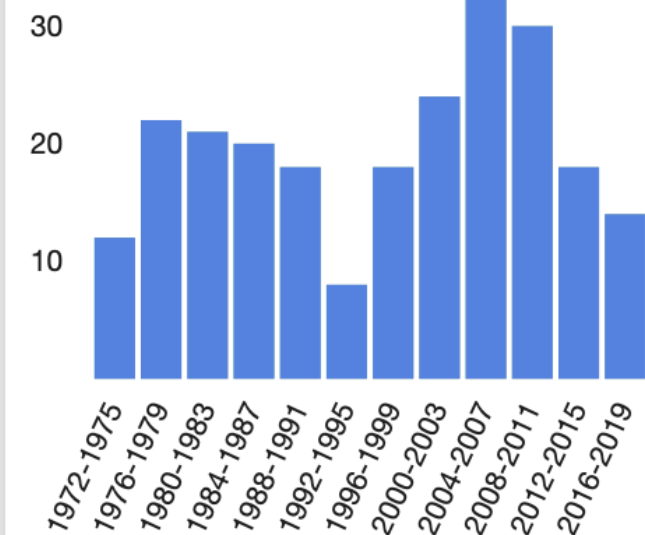
2018A&A...612A..81R 2018/05 cited: 1



Gathering dust: A galaxy-wide study of dust emission from cloud

[Years](#)[Citations](#)[Reads](#)

■ refereed ■ non refereed



Limit results to papers from

to

[Apply](#)

Charlie Lada's Universe

[Portal](#)[Simbad](#)[VizieR](#)[Aladin](#)[X-Match](#)[Other](#)[Help](#)

SIMBAD query result

**other query
modes :**

[Identifier
query](#)[Coordinate
query](#)[Criteria
query](#)[Reference
query](#)[Basic
query](#)[Script
submission](#)[TAP](#)[Output
options](#)[Help](#)

Query : IdentList

C.D.S. - SIMBAD4 rel 1.7 - 2019.09.21CEST15:21:09

Show entries

Search:

	Identifier	typed ident	Otype	ICRS (J2000) RA	ICRS (J2000) DEC	Mag U	Mag B	Mag V
1	M 42	Orion	HII	05 35 17.3	-05 23 28			
2	NGC 300	NGC300	GiG	00 54 53.4460065856	-37 41 03.182962667	8.83	8.69	8.13
3	NAME Mon OB1 G	NGC2264G	PoC	06 41 12	+09 55.6			
4	NGC 2264	NGC2264	OpC	06 40 58	+09 53.7			3.9
5	IRAS 03407+3152	HH211	cor	03 43 56.52	+32 00 52.8			
6	NAME Mon R2	Mon R2	HII	06 07 46.6	-06 22 59			
7	IC 5146	IC 5146	SFR	21 53 24	+47 16.0		7.82	7.2
8	NAME Taurus Dark Cloud	Taurus	SFR	04 41.0	+25 52			
9	NGC 2547	NGC 2547	OpC	08 09 52.360	-49 10 35.01			
10	NGC 2362	NGC 2362	OpC	07 18 41	-24 57.3			4.1
11	NAME Coalsack Nebula	Coalsack	DNe	12 31 19	-63 44.6			

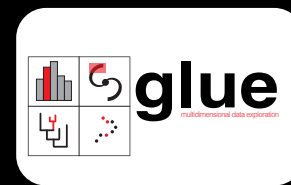
Charlie Lada's Universe



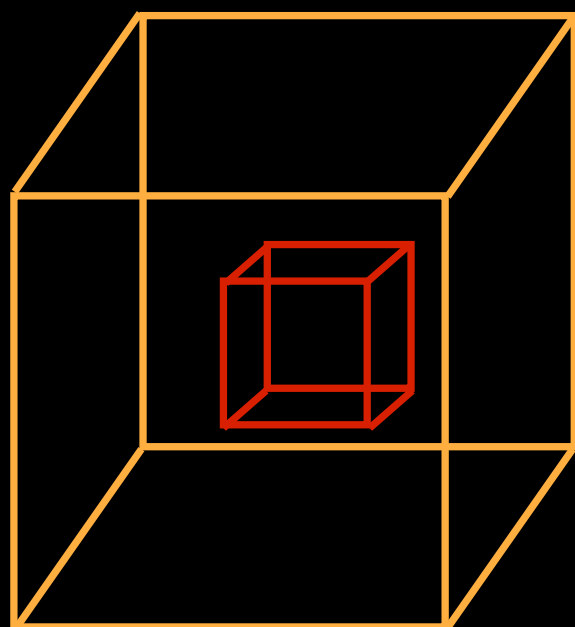
Past



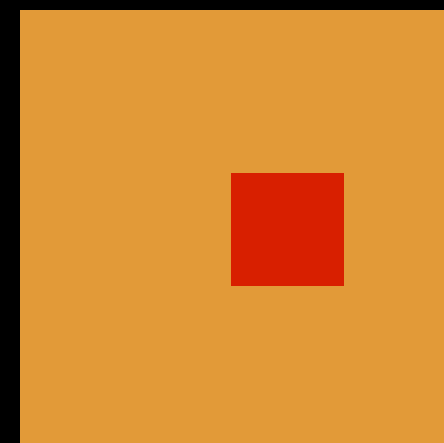
Present



Future

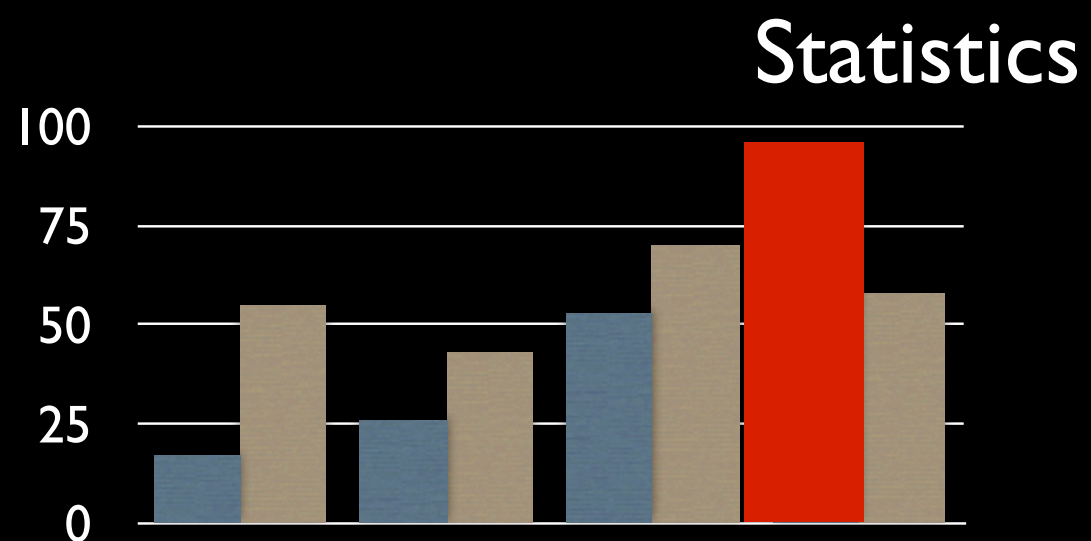
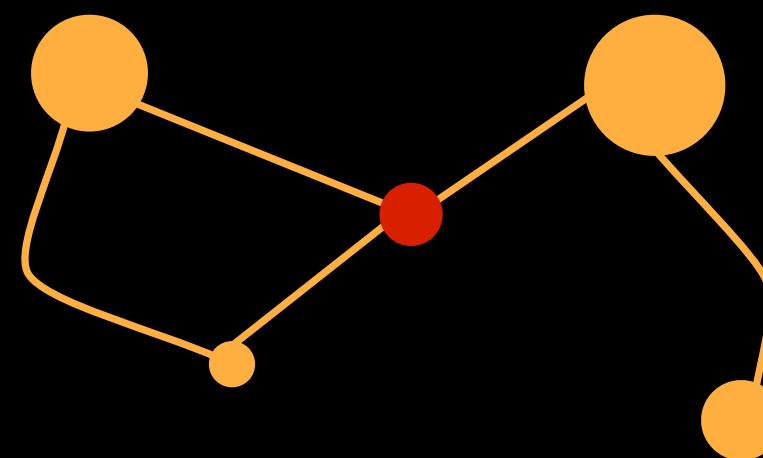


3D



2D

Data Abstraction



Linked views of high-dimensional data



~~Five~~ **Five** steps revealing a wispy veil in 3D

1. “glue” data sets to each other
 2. drag data sets to visualize
 3. inspect cubes with 2D sliders
 4. adjust color
 5. inspect cubes as (superimposed) 3D volumes
- + bonus—comparison with traditional views & sliders

sample ALMA (spectral-line) data cubes courtesy of Jorma Harju

Find out more about glue, and download for free, at glueviz.org

No merging of data sets—just glue them.



python File Edit View Canvas Data Manager Plugins Help

Glue Jorma Harju

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

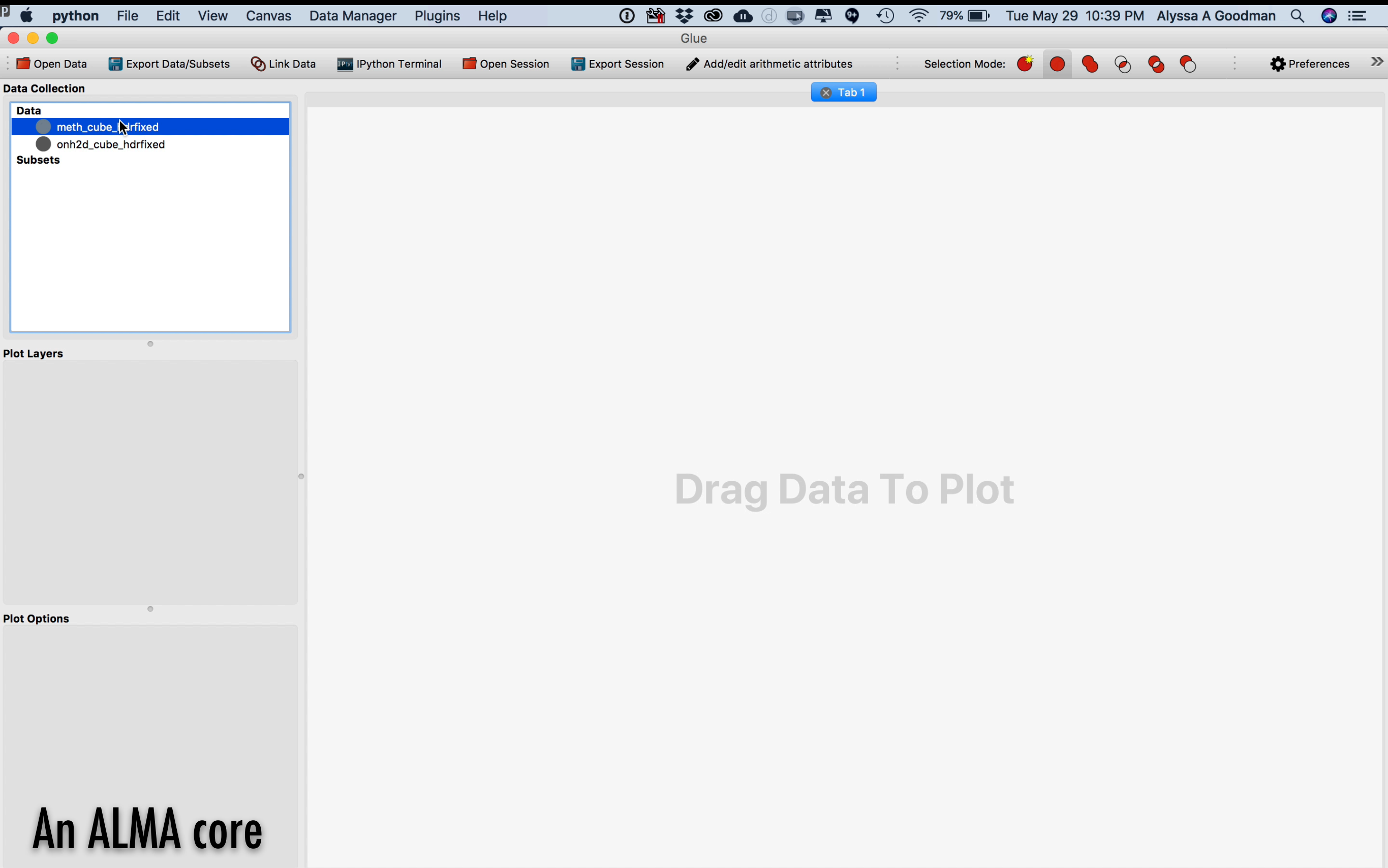
Plot Options

Tab 1

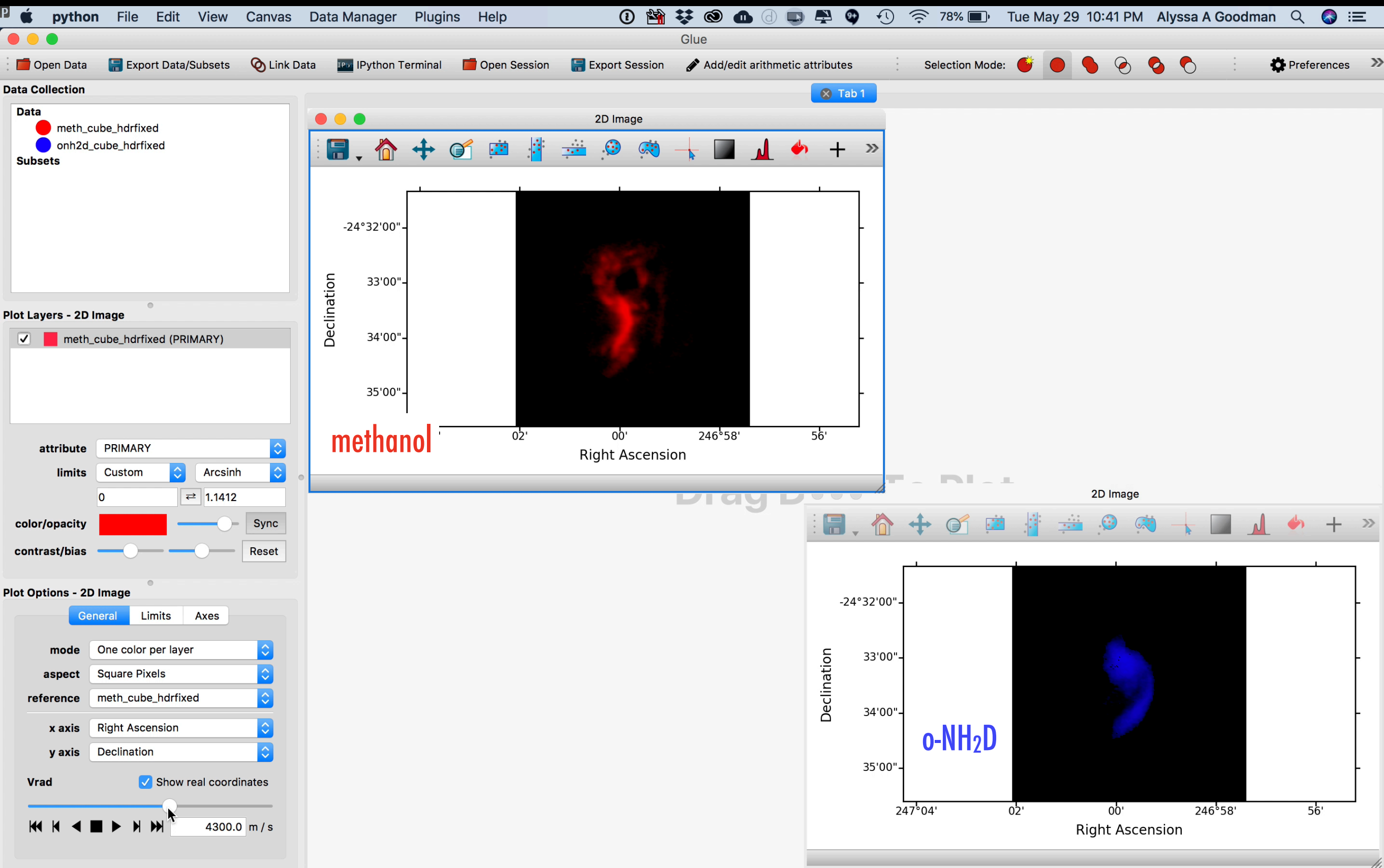
Drag Data To Plot

An ALMA core

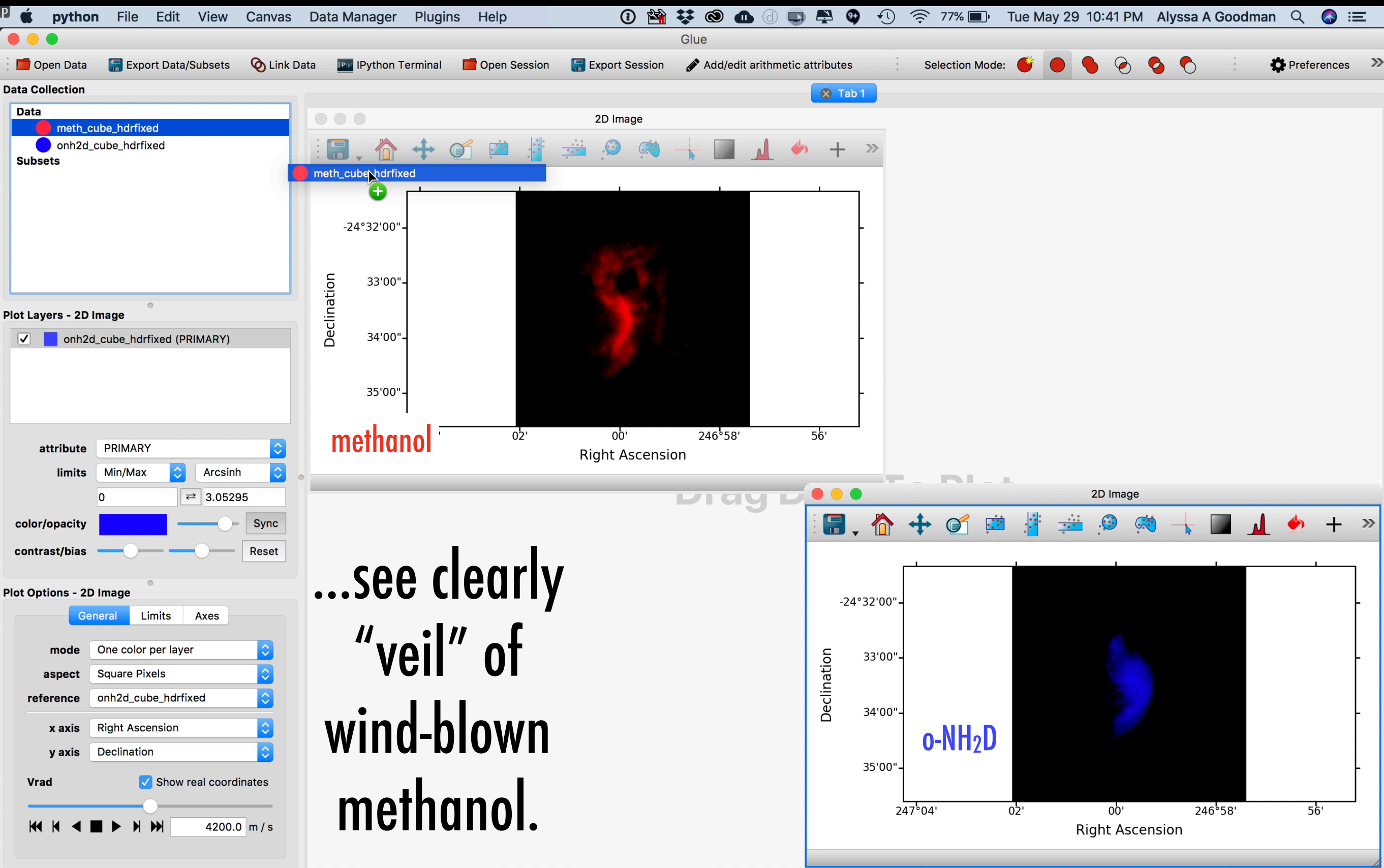
Just drag to visualize, e.g. series of 2D “channel maps.”



Adjust so each tracer is a different color.

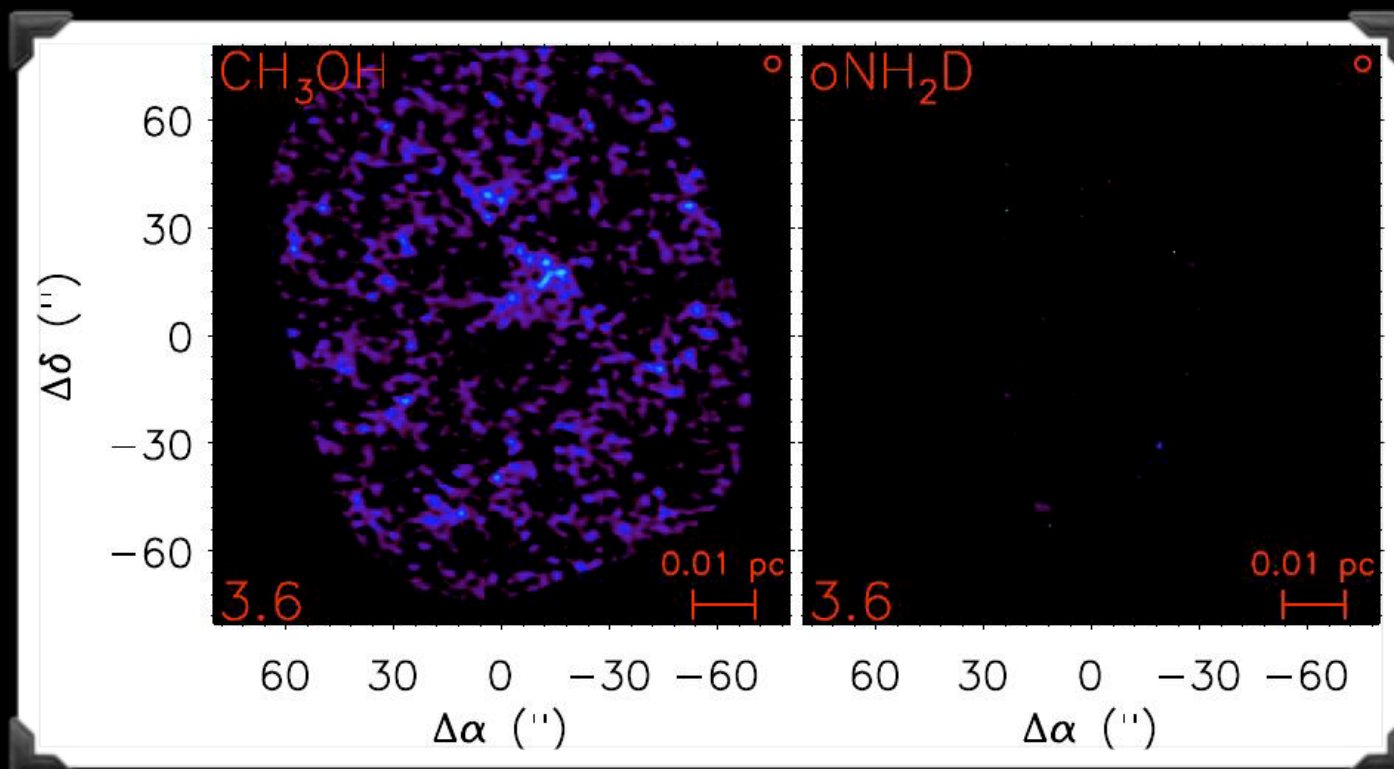


Create 3D views...



COMPARISON

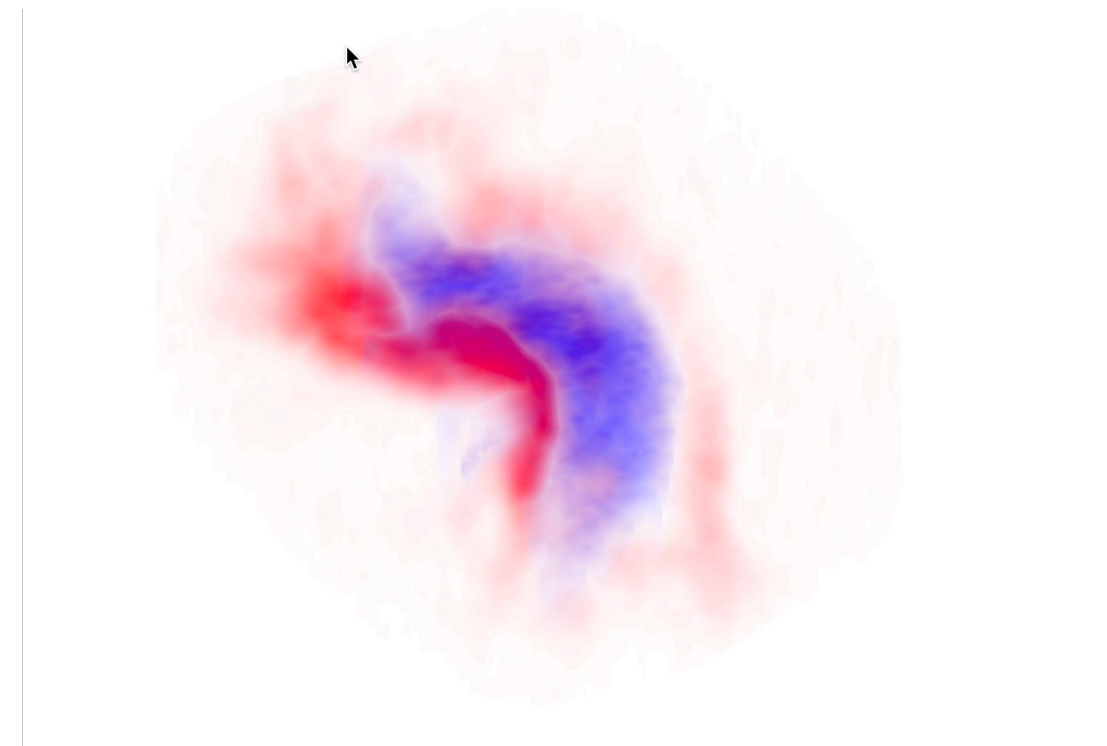
traditional **rainbow**
channel maps



result: happy unicorns

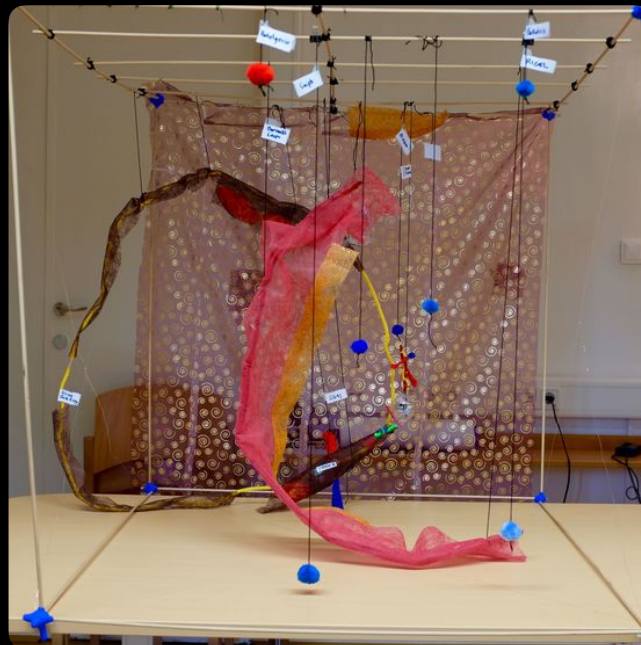


glue
volume visualization



result: previously unknown phenomenon
(veil of emission) revealed

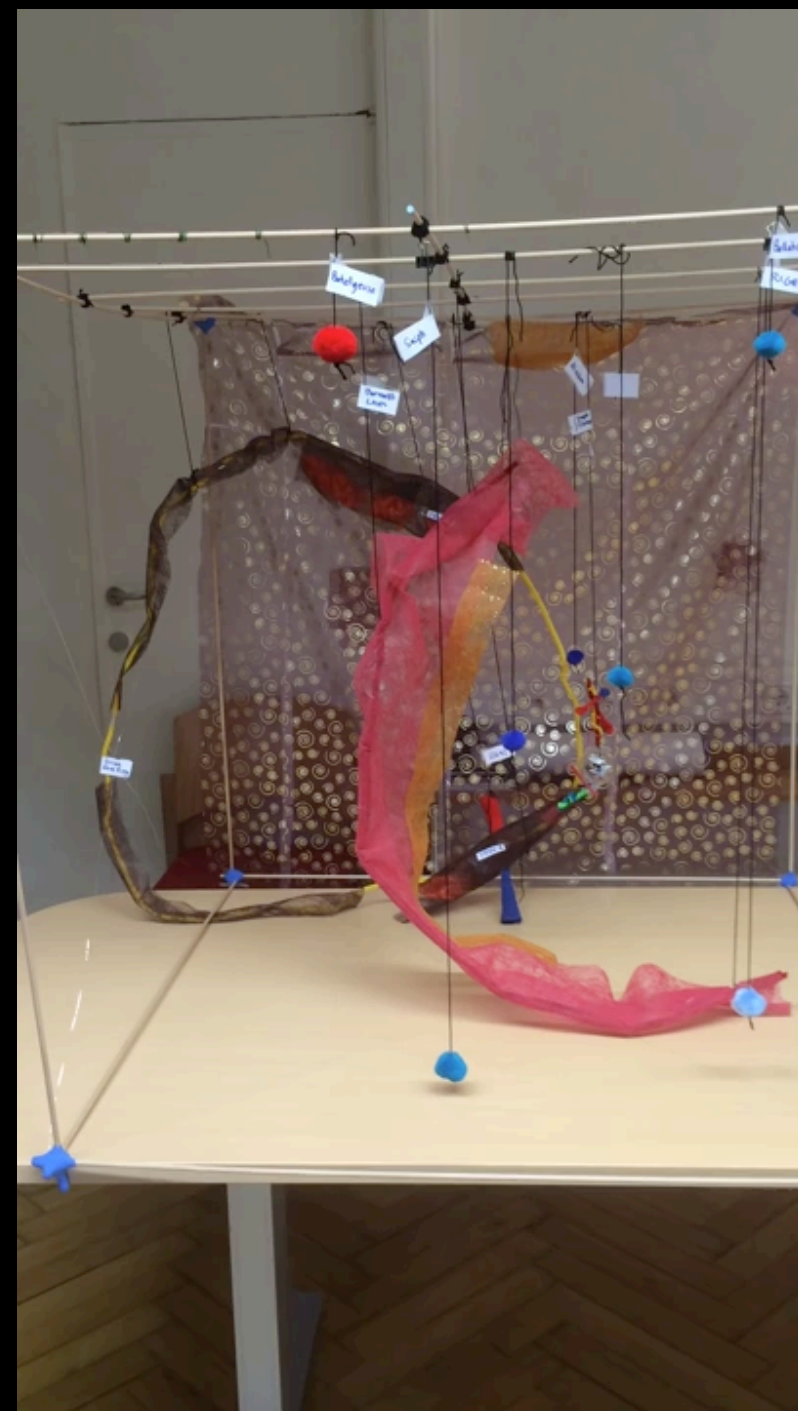
VIENNA



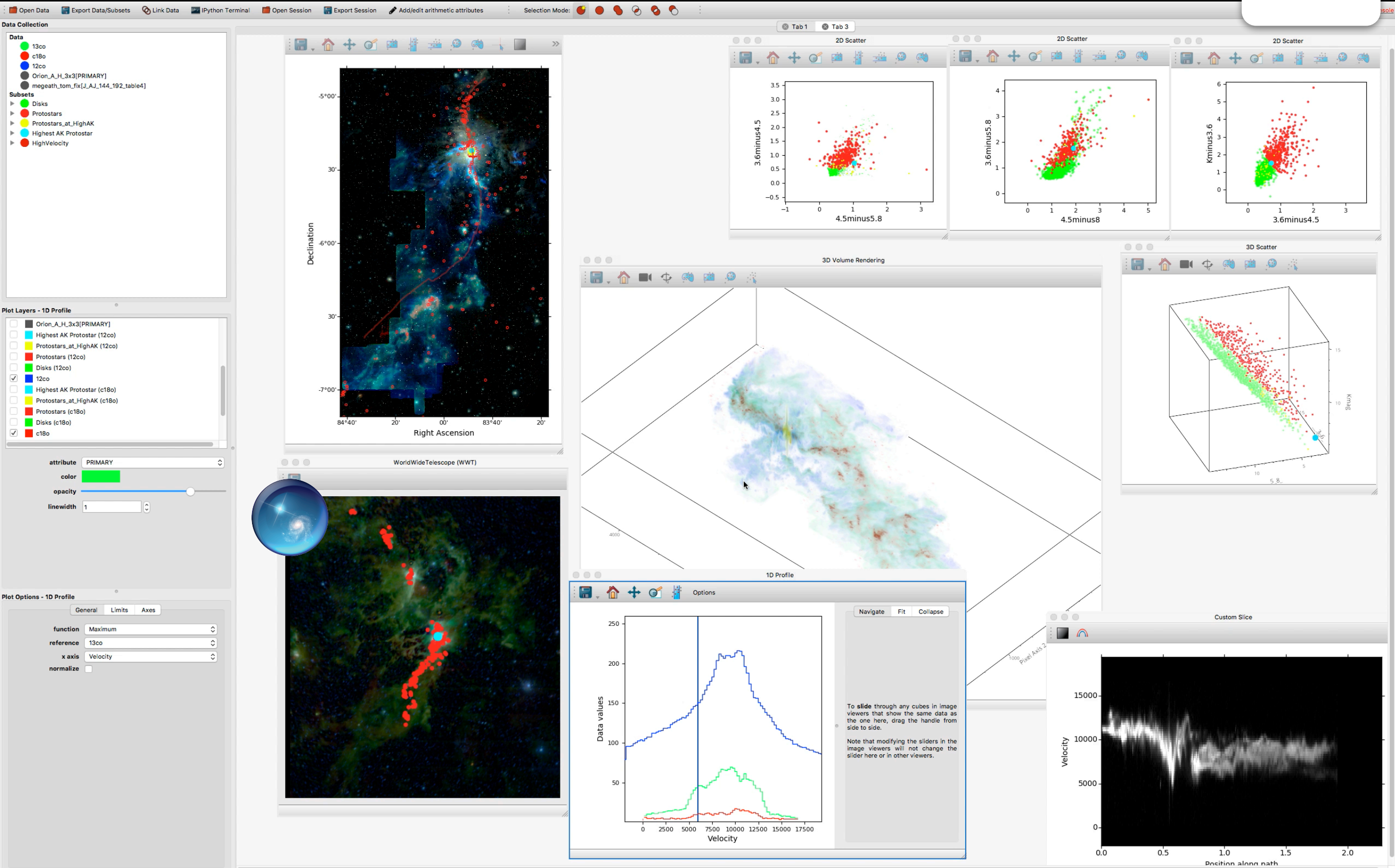
Orion, Viennese Style

a WorldWide Telescope Tour to accompany
the physical 3D model of Orion
created collaboratively by expert astrophysicists
at "Orion (Un)Plugged," held at the
University of Vienna, July 2015

with original medieval harp musical "interferometric" tribute to Orion, by Scott Wallace

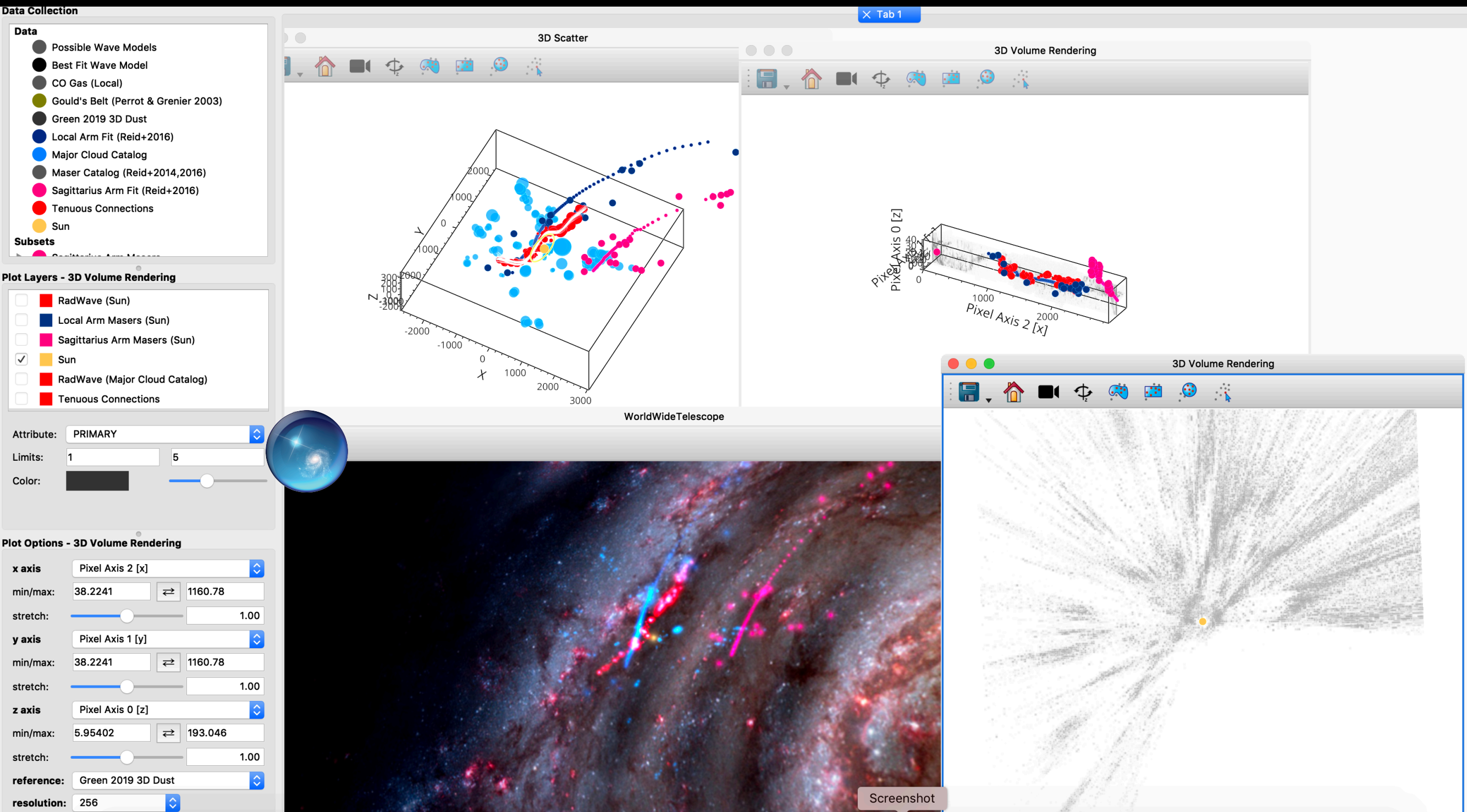
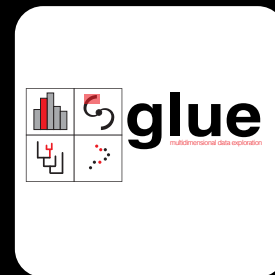


The Future



Data: CARMA-ORION (cubes), VISION survey (images), Alvaro Hacar (ALMA), Megeath catalog; demo online via Seamless Astronomy web site

The “Radcliffe” Wave



The “Radcliffe” Wave

(embargoed, please do not distribute)

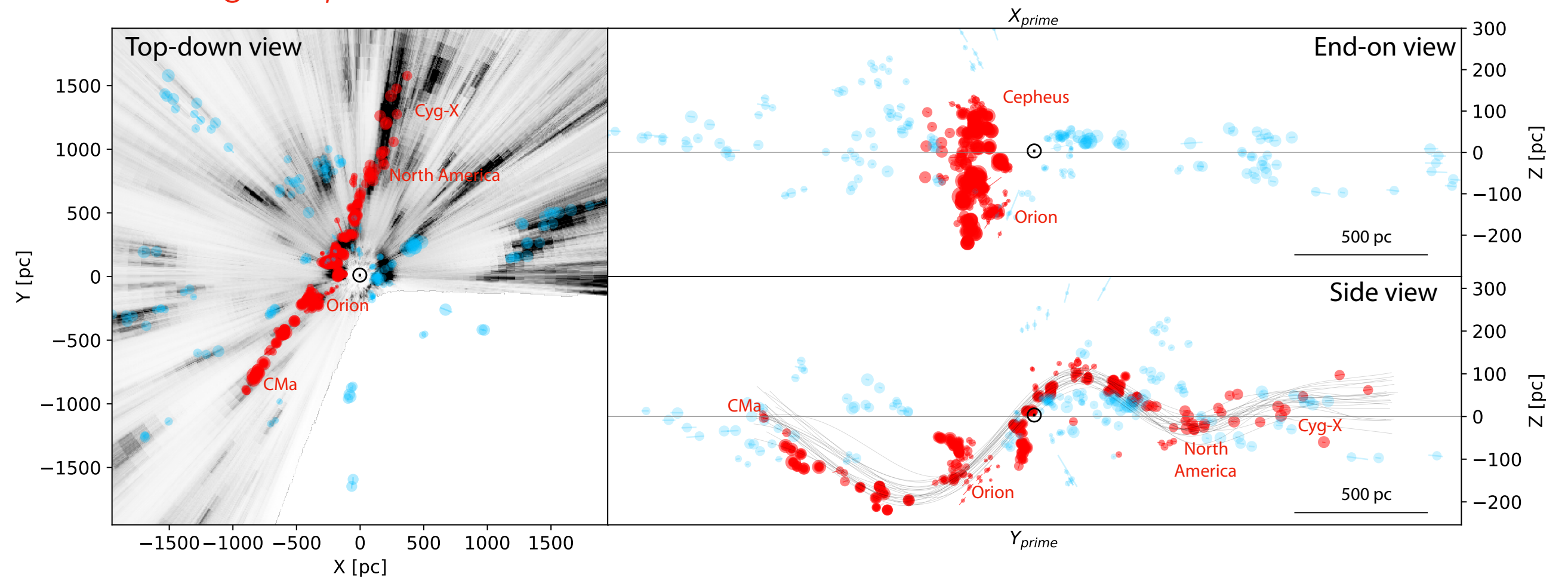
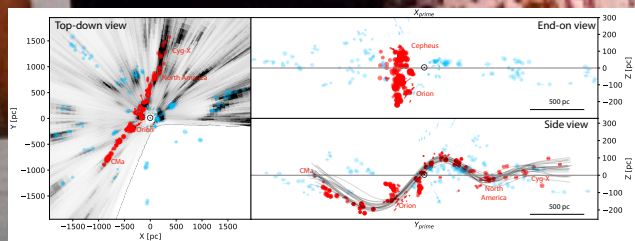


Table 3: Physical Properties of the Radcliffe Wave

Name	Median with 95% CI
Length	2.7 ± 0.2 kpc
Scatter	60 ± 15 pc
Amplitude	160 ± 30 pc
Mass	$\geq 3 \times 10^6 M_{\odot}$

João Alves, Catherine Zucker, Alyssa Goodman,
 Joshua Speagle, Stefan Meingast, Thomas
 Robitaille, Douglas Finkbeiner, Edward F.
 Schlafly, and Gregory Green 2019,
Nature (soon, we hope)

The Future



CRETE III++



Astronomy Picture of the Day

[Discover the cosmos!](#) Each day a different image or photograph of our fascinating universe is featured, along with a brief explanation written by a professional astronomer.

2019 September 25



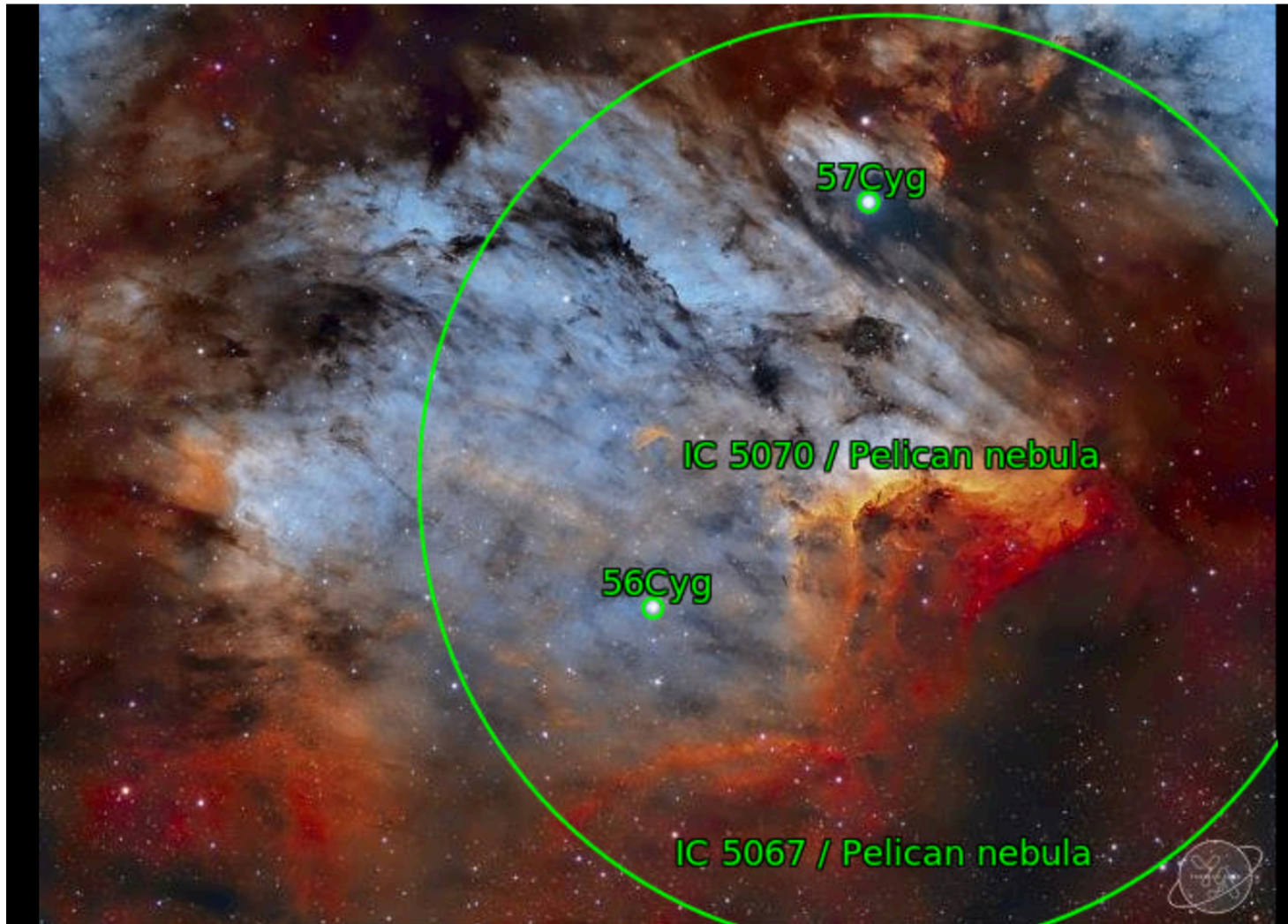
The Pelican Nebula in Gas, Dust, and Stars

Image Credit & Copyright: [Yannick Akar](#)

Explanation: The Pelican Nebula is slowly being transformed. IC 5070, the official designation, is divided from the larger [North America Nebula](#) by a [molecular cloud](#) filled with dark [dust](#). The [Pelican](#), however, receives much study because it is a particularly active mix of [star formation](#) and evolving gas clouds. The [featured picture](#) was produced in three specific colors -- light emitted by [sulfur](#), [hydrogen](#), and [oxygen](#) -- that can help us to better understand these interactions. The light from young energetic stars is slowly transforming the cold gas to hot gas, with the [advancing boundary](#) between the two, known as an [ionization front](#), visible in bright orange on the right. Particularly dense [tentacles](#) of cold gas remain. Millions of years from now this nebula might no longer be known as the [Pelican](#), as the [balance and placement of stars and gas](#) will surely leave something that appears completely different.

[Home](#)
[Explore](#)
[Upload](#)
[API](#)
[Support](#)
 [Search](#)

Images > Pelican_Akar_4554.jpg



Submitted by (1)
on 2019-09-25T09:04:44Z
as "Pelican_Akar_4554.jpg"
(Submission 2942576)
under [Attribution 3.0 Unported](#)

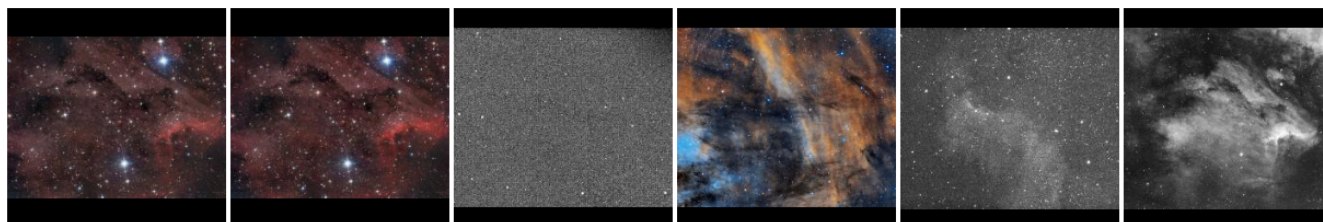
Job Status

Job 3628789:
Success

Calibration

Center (RA, Dec): (312.801, 44.074)
Center (RA, hms): 20^h 51^m 12.352^s
Center (Dec, dms): +44° 04' 25.778"
Size: 1.76 x 1.32 deg
Radius: 1.099 deg
Pixel scale: 1.39 arcsec/pixel
Orientation: Up is 272 degrees E of N
WCS file: [wcs.fits](#)
New FITS image: [new-image.fits](#)
Reference stars nearby (RA,Dec table): [rdls.fits](#)
Stars detected in your images (x,y table): [axy.fits](#)
Correspondences between image and reference stars (table): [corr.fits](#)
KMZ ([Google Sky](#)): [image.kmz](#)
World Wide Telescope: [view in WorldWideTelescope](#)

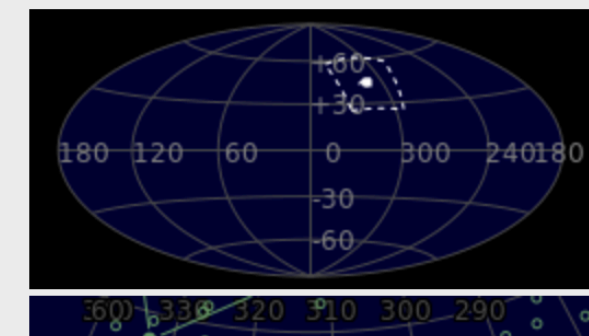
Nearby Images ([View All](#))



Comments

No comments.

Please [Sign In](#) to post comments.



Present: APOD in WWT

Home Explore Guided Tours Search Communities **View** Settings

Use Layer Manager to Control User Settings

Name My Location
Lat 47:43:01 Alt 100.0m
Lng -122:05:08
☐ View From This Location

2019/09/25 18:15:28
Real Time

☒ Galactic Plane Mode
View in ESASky

Look At: Sky Imagery: Digitized Sky Survey (Color) Image Crossfade:

Tracking: Pelican_Akar_4554.jpg 1 of 5

North America North America PN K 4-55 PN K 4-55 NGC 7000 DR21 (Mid-IR) DR21 (Composite) DR21 DR21 Cygnus Region NGC 7027 Cygnus OB2

Cygnus 04:33:42
RA: 20h50m22s
Dec: +44:15:21

Future: (all of) ADS in WWT



The Future

AUTHOREA ³

SIGN UP

20 VIEWS · 1 DOWNLOAD

Harvard-Smithsonian Center for Astrophysics (CFA) · Harvard University
· UCLA - University of California, Los Angeles · Authorea Team
· North Carolina State University · Space Telescope Science Institute
· UCLA GSEIS

The "Paper" of the Future

- 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...

Cite as: Alyssa Goodman, Josh Peek, Alberto Accomazzi, et al. The "Paper" of the Future. *Authorea*. February 21, 2017. DOI: <https://doi.org/10.22541/au.148769949.92783646> Download citation

A 5-minute video demonstration of this paper is available at [this YouTube link](#).

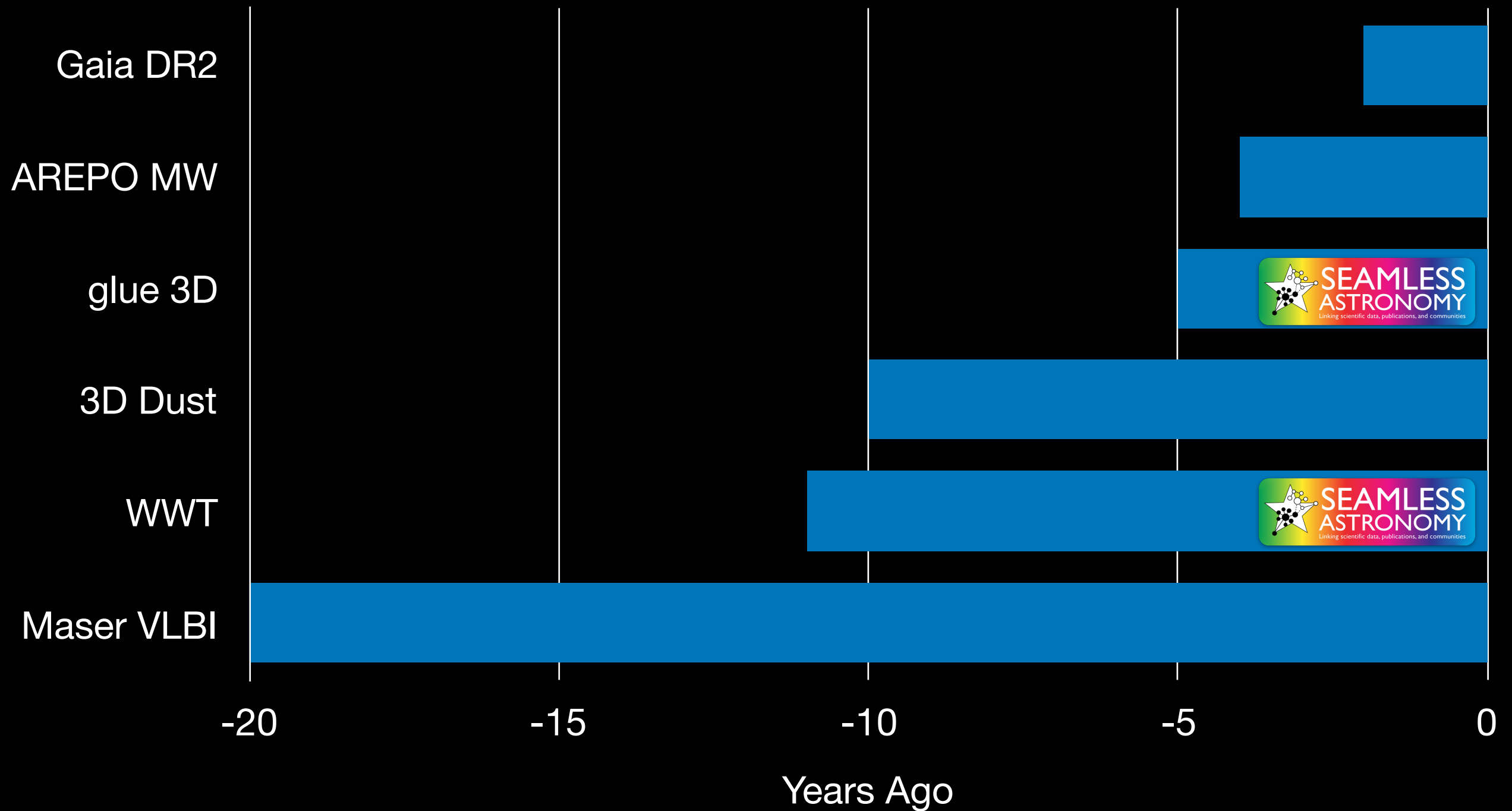
1 Preamble

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



Interactive Figures
Data-rich Literature
Code "in" Papers
Plug-n-Play Software

How/why is Catherine Zucker's thesis possible now?

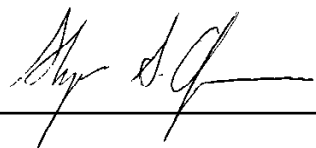




GIFT CERTIFICATE

ESPECIALLY FOR: Charlie Lada

COMPLIMENTS OF: Alyssa, Tom, Catherine & João

AUTHORIZED SIGNATURE: 

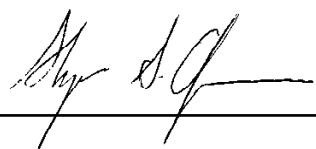
EXPIRATION DATE: Soon!!!
CERTIFICATE NO: 5146



GIFT CERTIFICATE

ESPECIALLY FOR: Charlie Lada

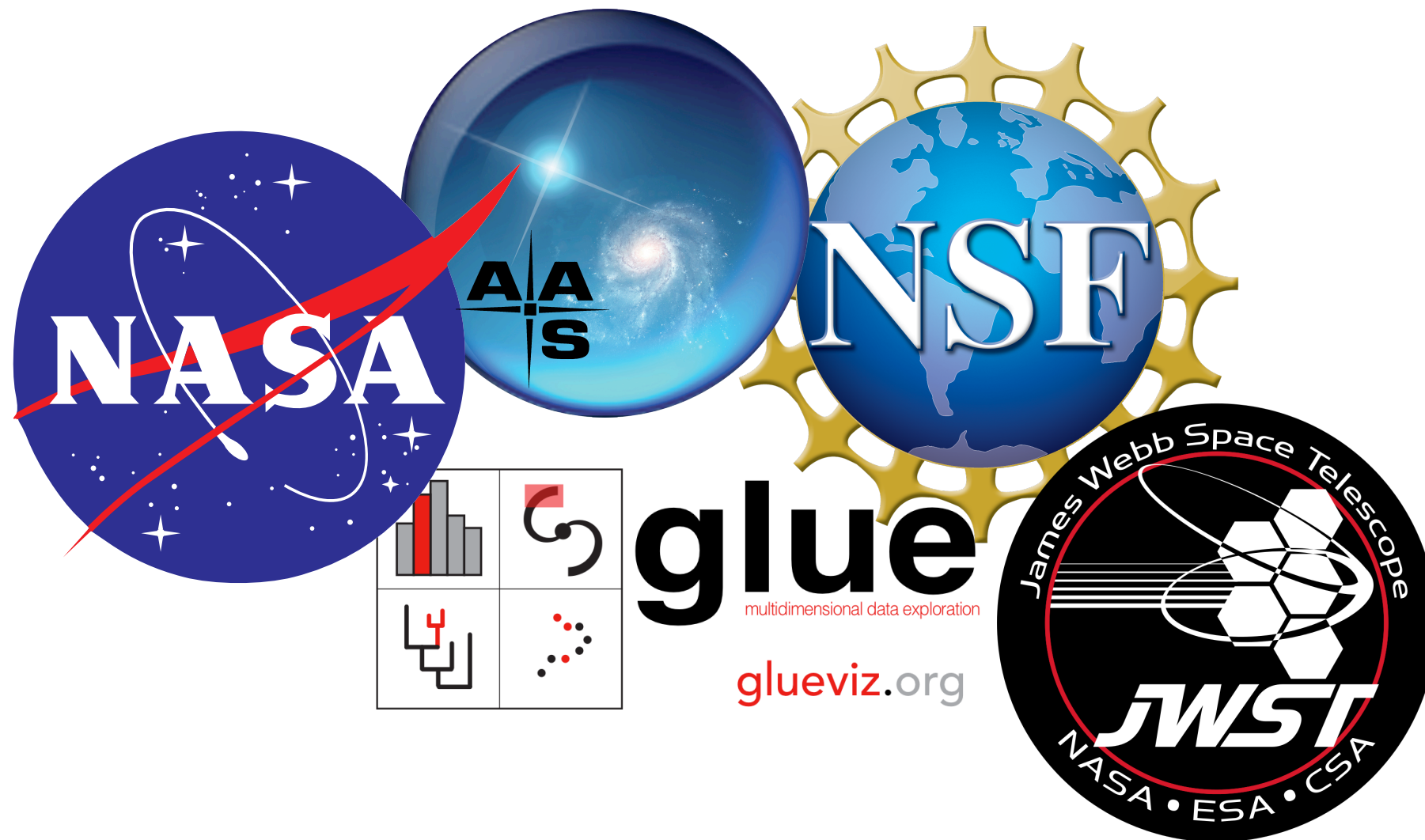
COMPLIMENTS OF: Alyssa & Curtis Wong

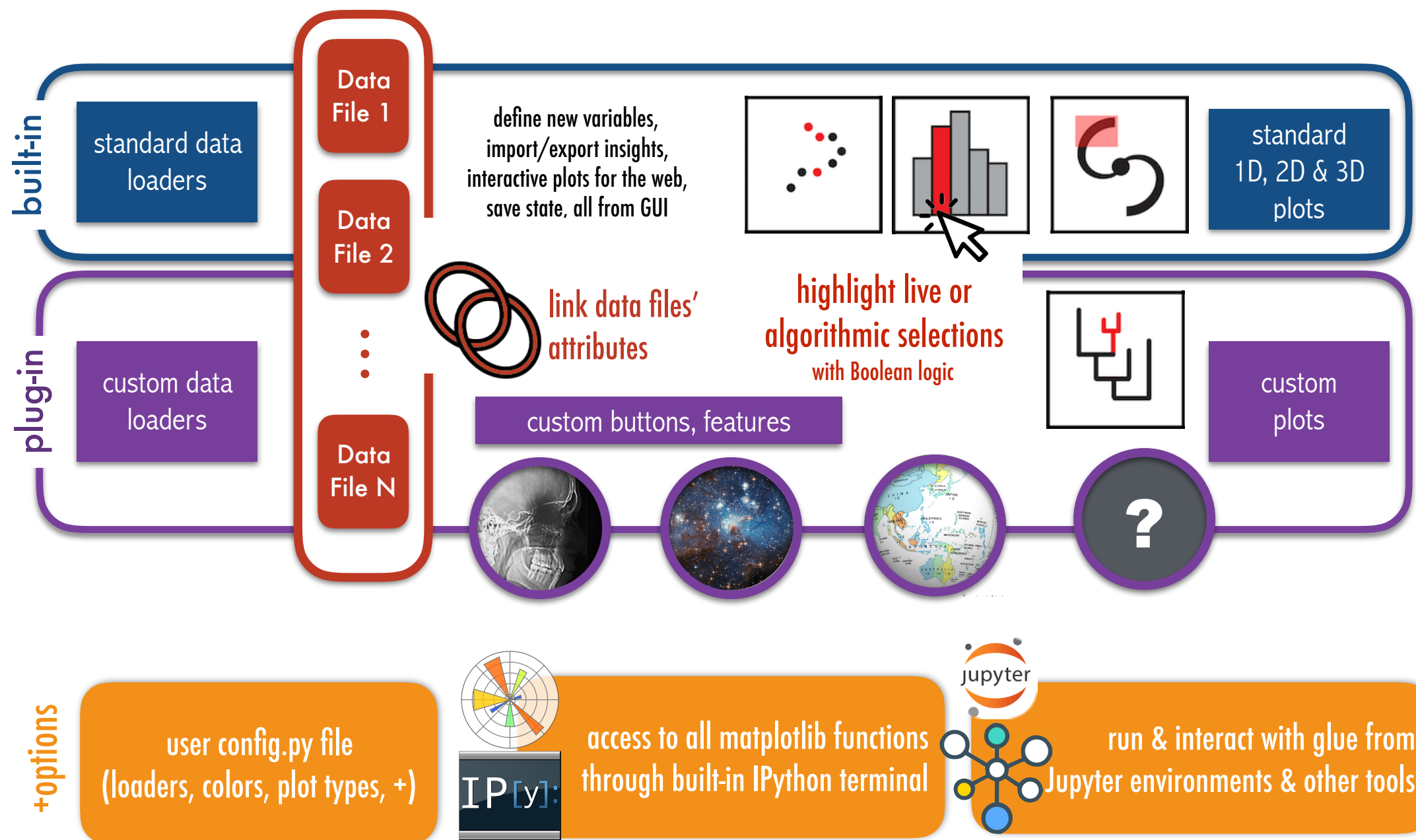
AUTHORIZED SIGNATURE: 

EXPIRATION DATE: Soon!!!
CERTIFICATE NO: 5146



With thanks to our sponsors...







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?



Now, visit the 10QViz conversation! There's so much more to talk about.

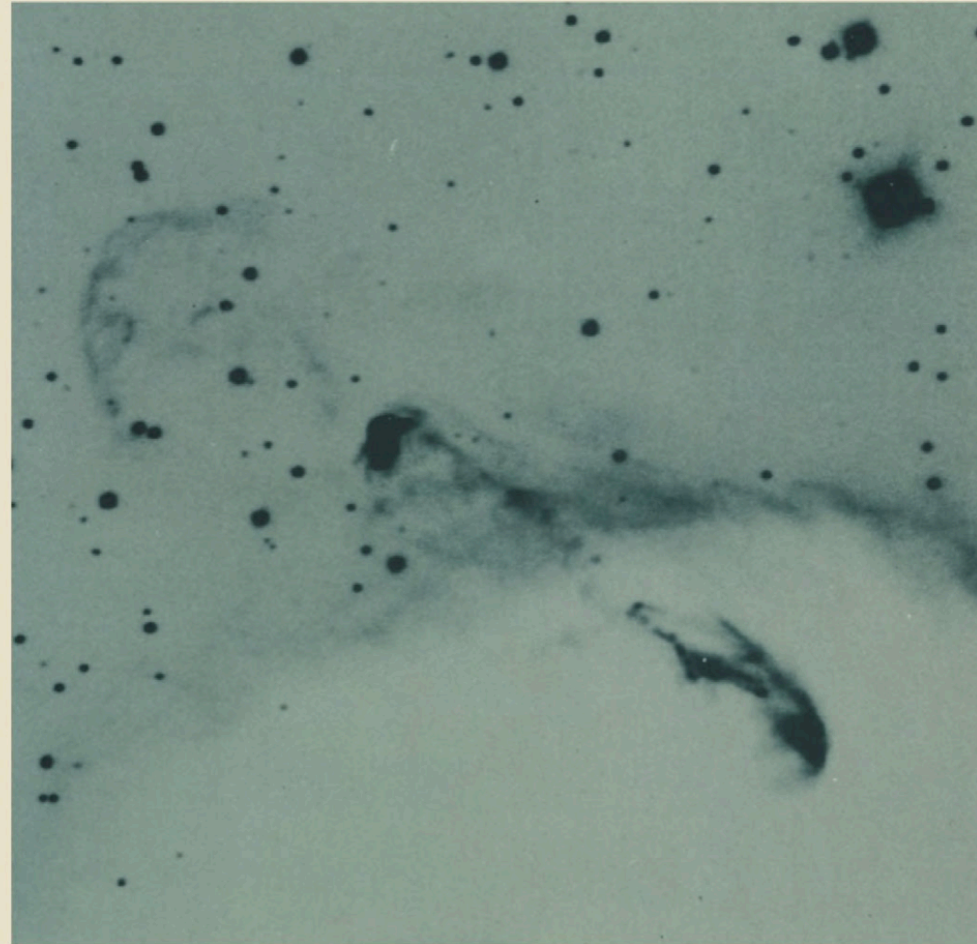


Curious about the **origins** of 10QViz? Try the [About](#) page.

Want to learn **how best to use** and **participate** in 10QViz? Try the [How to](#) page.

Want to read about the **scholarship** behind 10QViz.org's questions? [Write](#) to ask for a draft of our research paper, Coltekin & Goodman 2019.

The Physics of Star Formation and Early Stellar Evolution



Edited by

Charles J. Lada and Nikolaos D. Kylafis

Copyrighted material

Proceedings of the NATO Advanced Study Institute on
The Physics of Star Formation and Early Stellar Evolution
Agia Pelagia, Crete, Greece
May 27 – June 8, 1990

ISBN 978-0-7923-1367-0 ISBN 978-94-011-3642-6 (eBook)
DOI 10.1007/978-94-011-3642-6