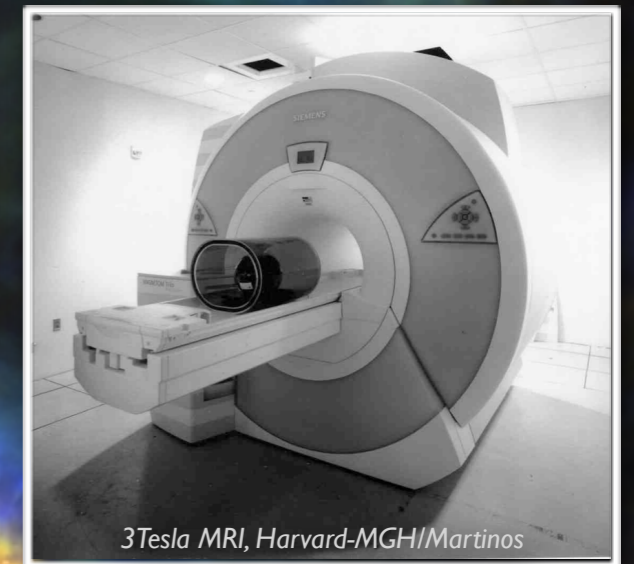
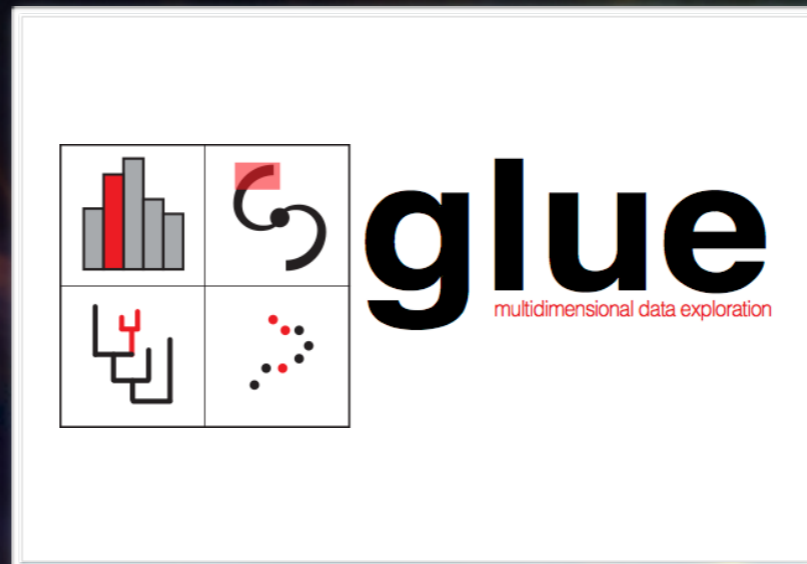
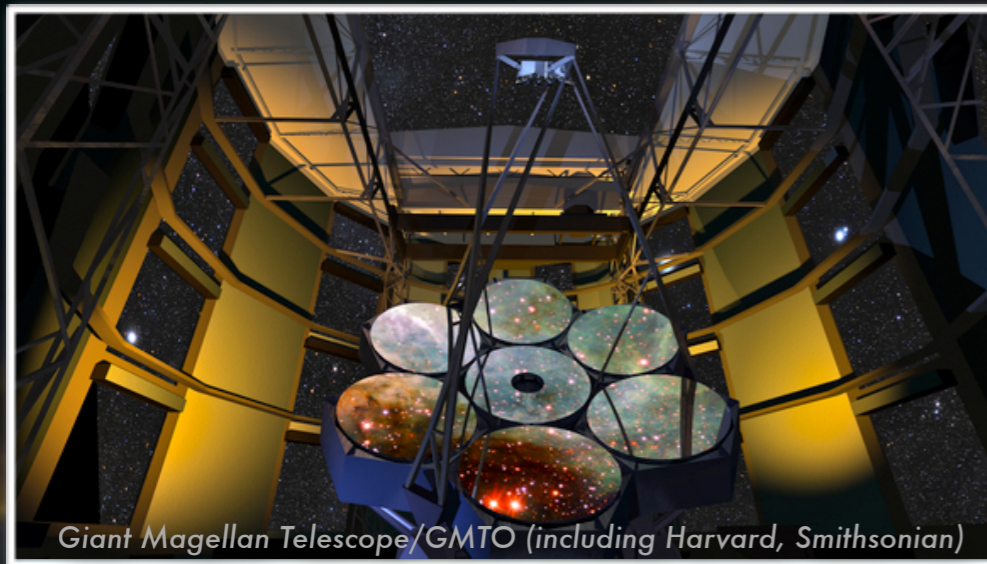


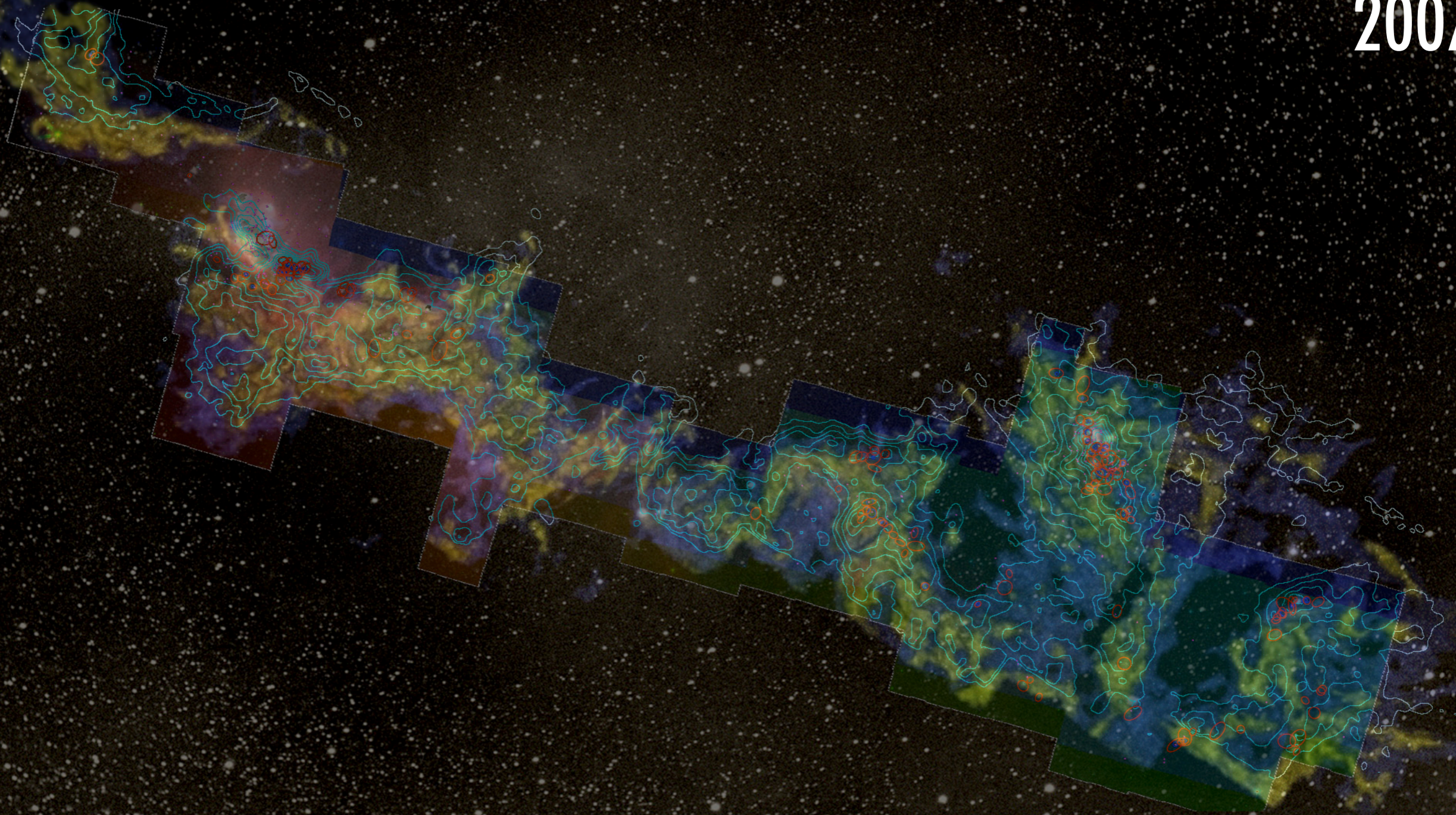
From the Universe to the Table, and Back



Ask me
about...

Alyssa A. Goodman
Professor of Astronomy
Founding Director, Initiative in Innovative Computing at Harvard

2007



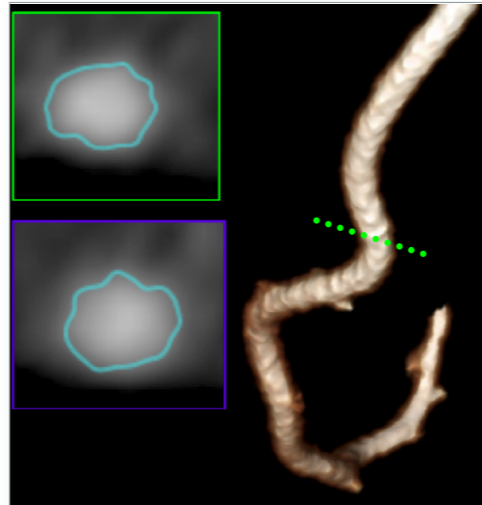
AstronomicalMedicine@iig

COMPLETE

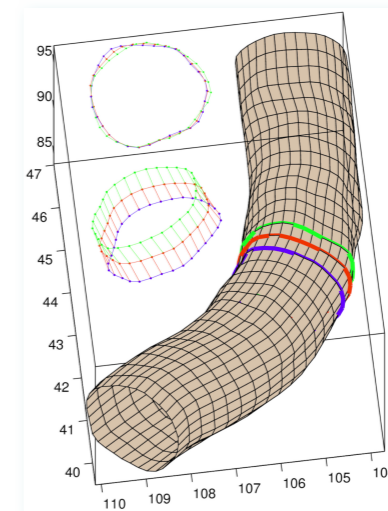
2011: Patients Troubled Hearts, in 3D



Obtain patient CT data



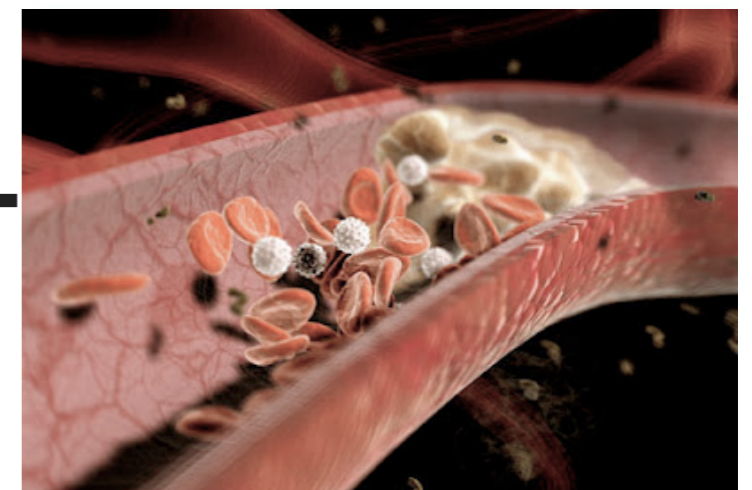
Segment arteries



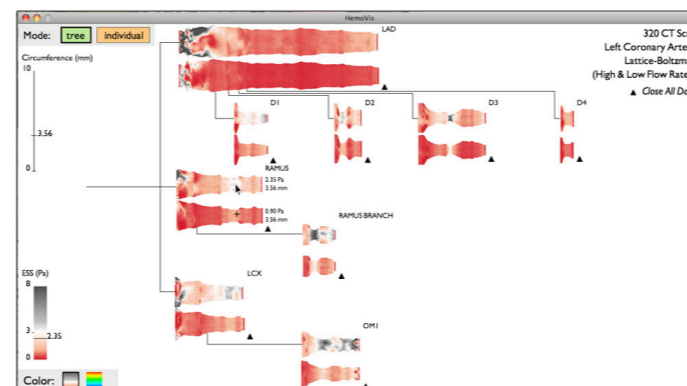
Generate patient geometries



Patient specific flow simulation



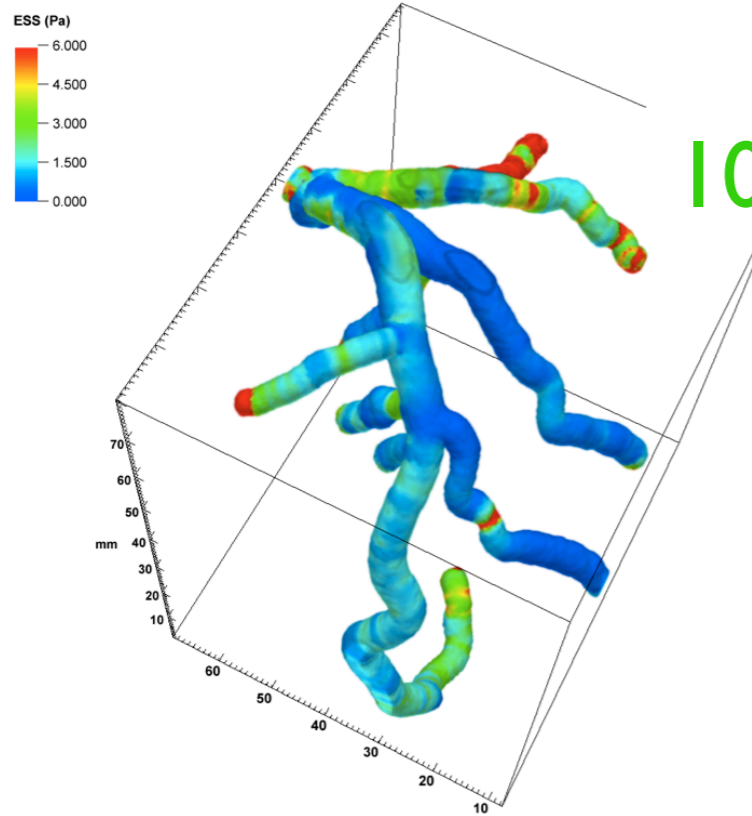
Visualize/analyze data



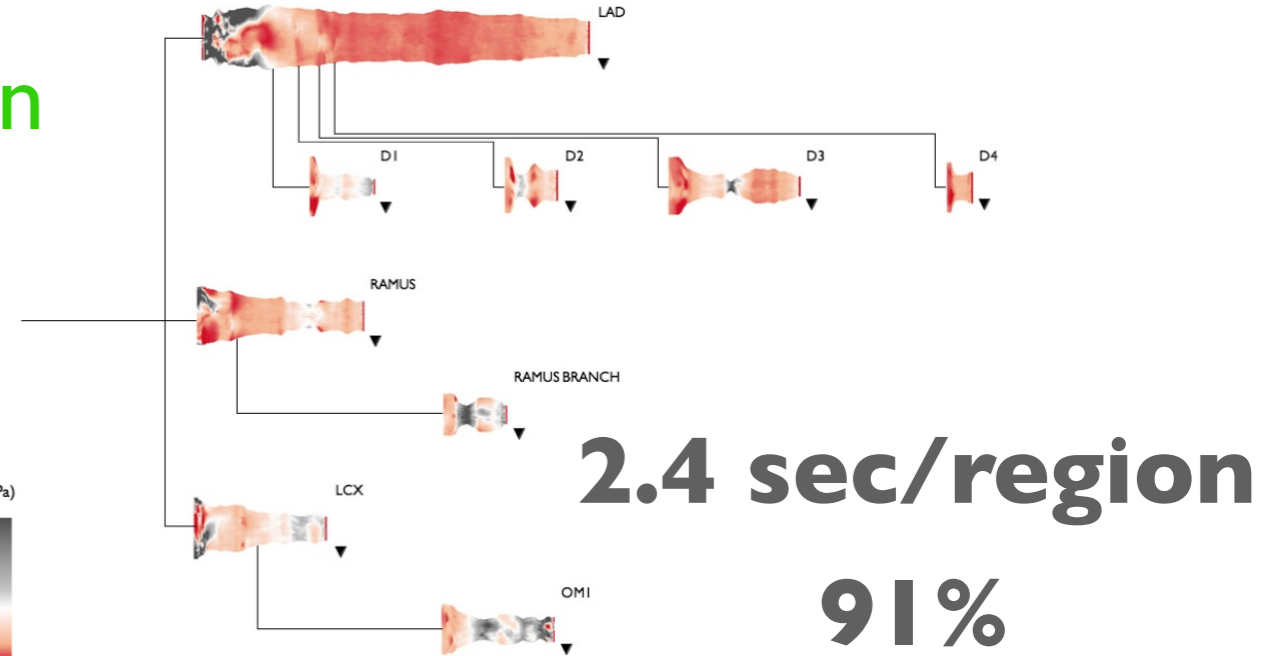
Clinical decision



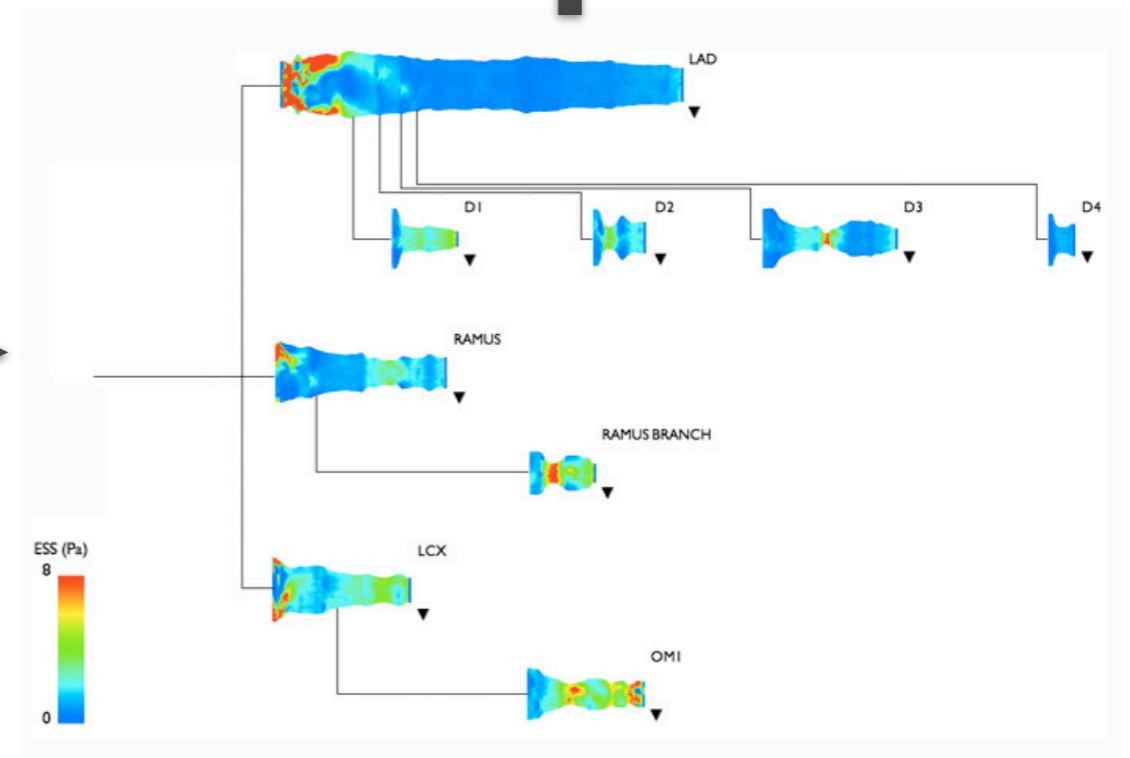
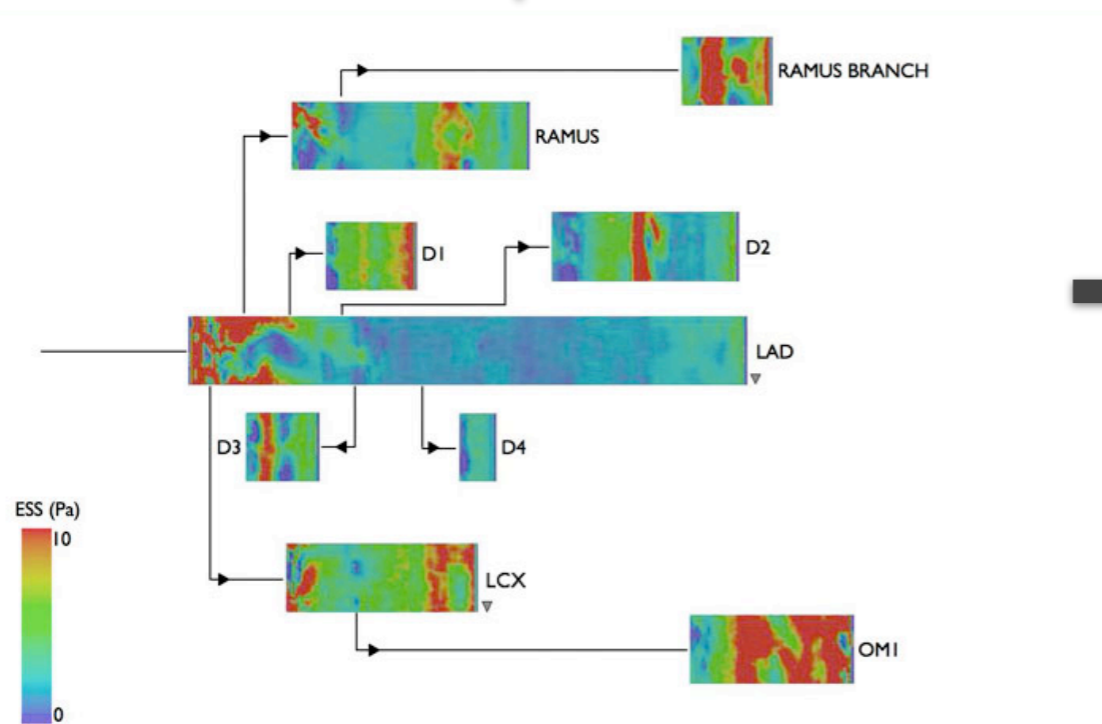
How much does good visualization matter?

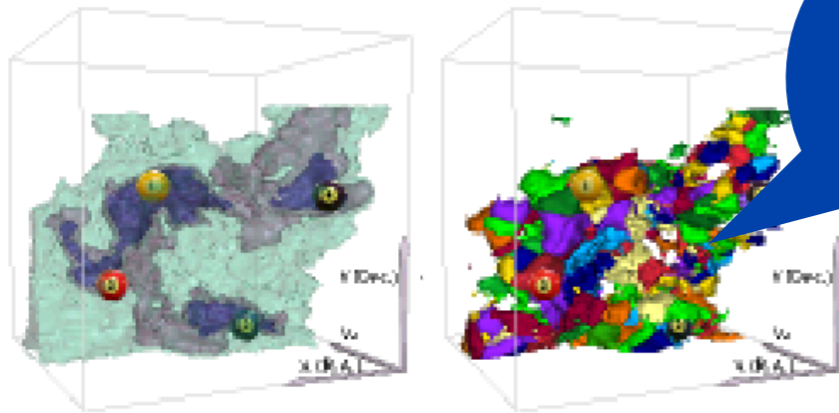


10.2 sec/region
39%



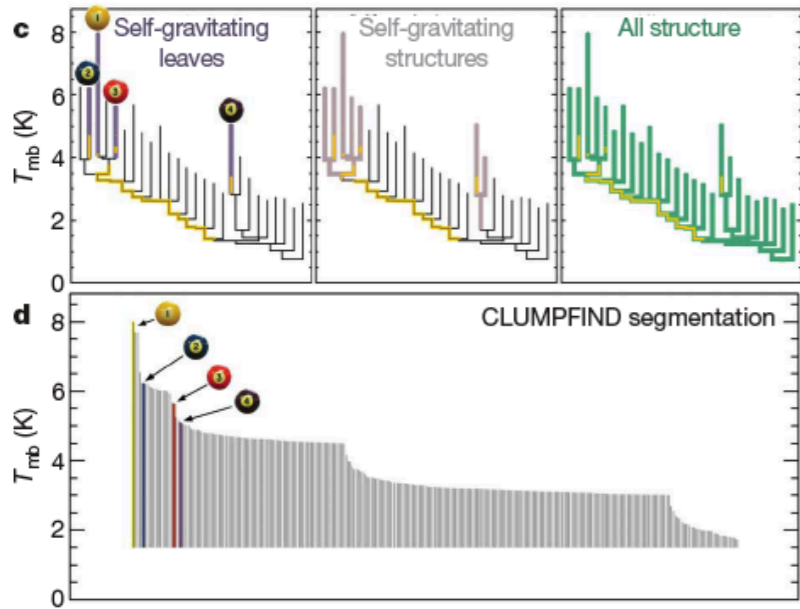
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91%





Ask me about
the future of
scholarly
publishing...

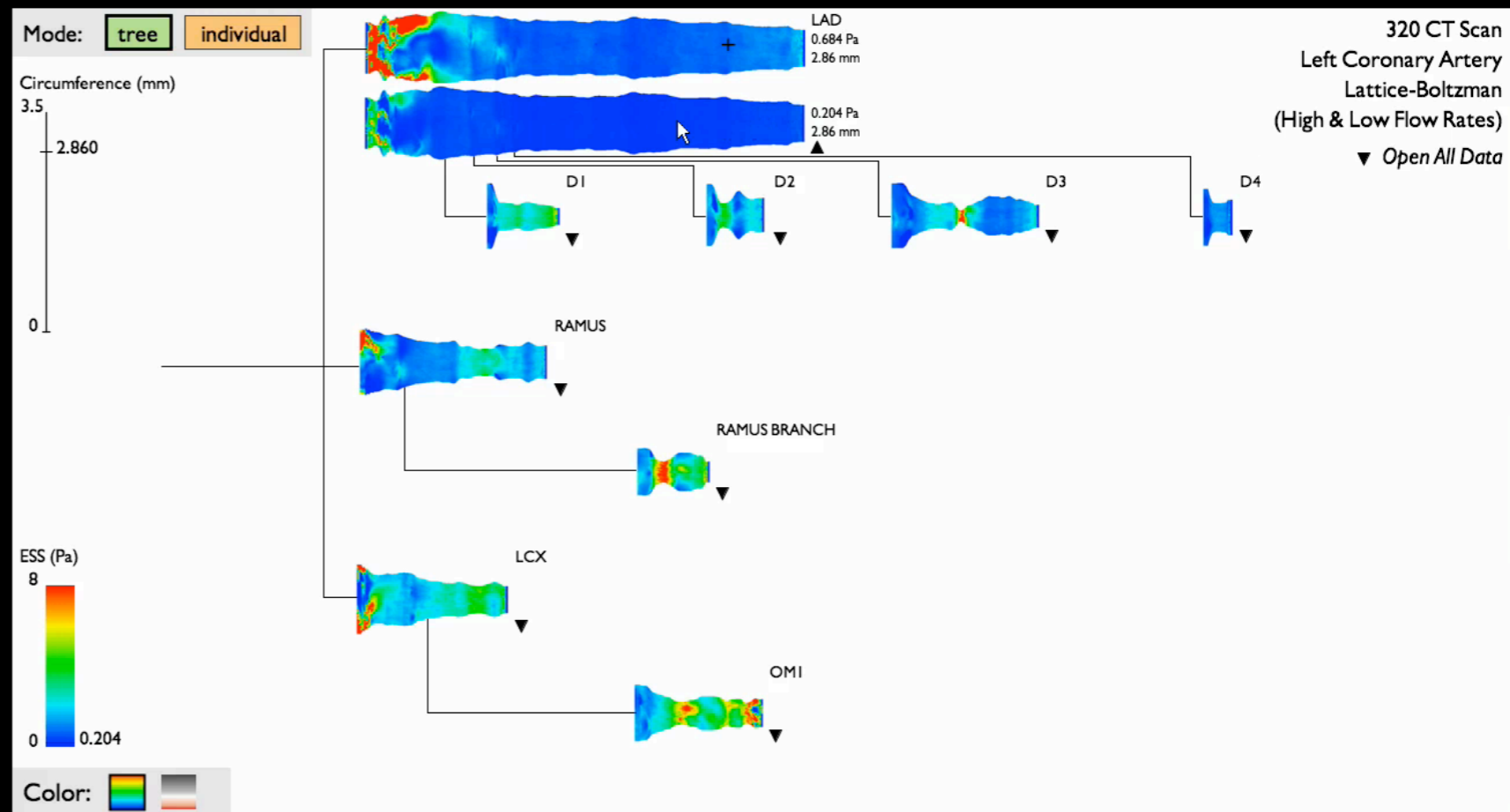
Interactive Linked Views

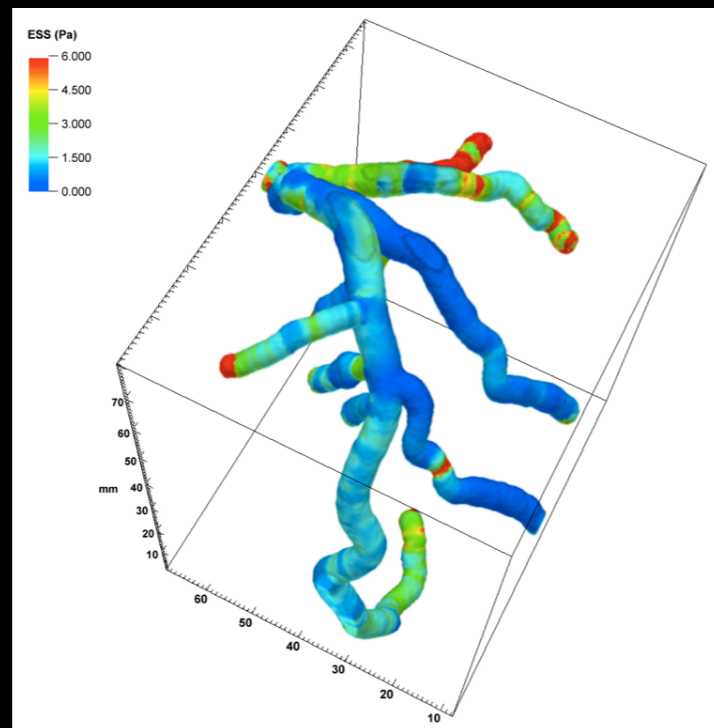


Goodman et al. 2009

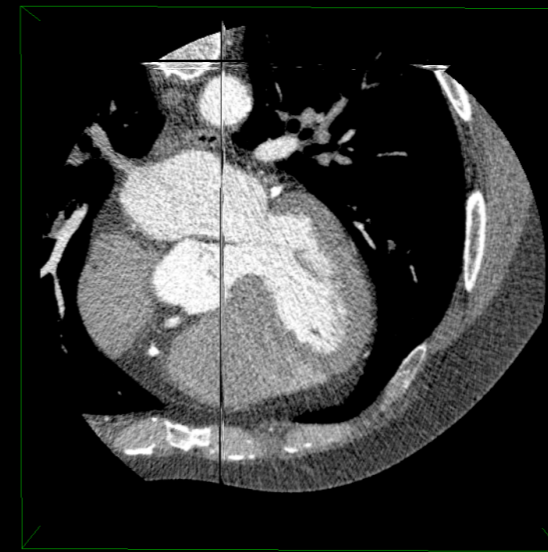
← Astro
Med ↓

Borkin et al. 2011





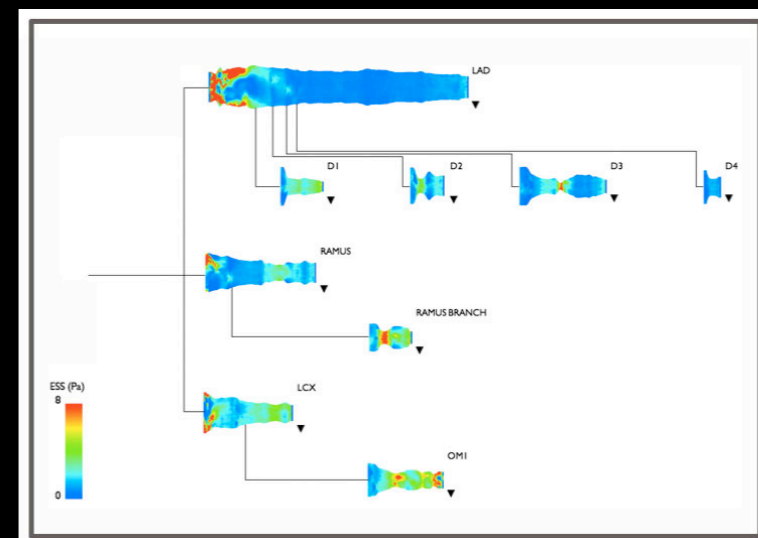
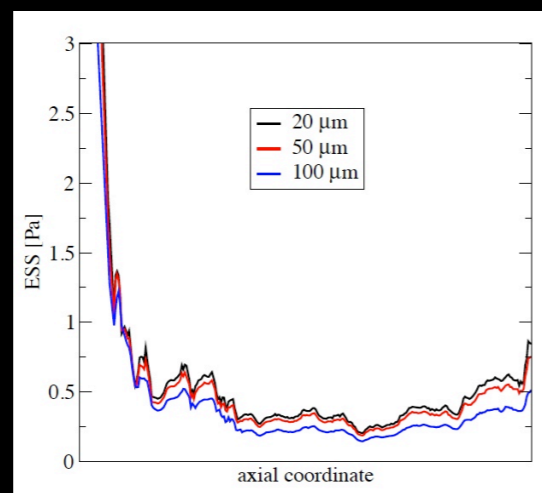
3D



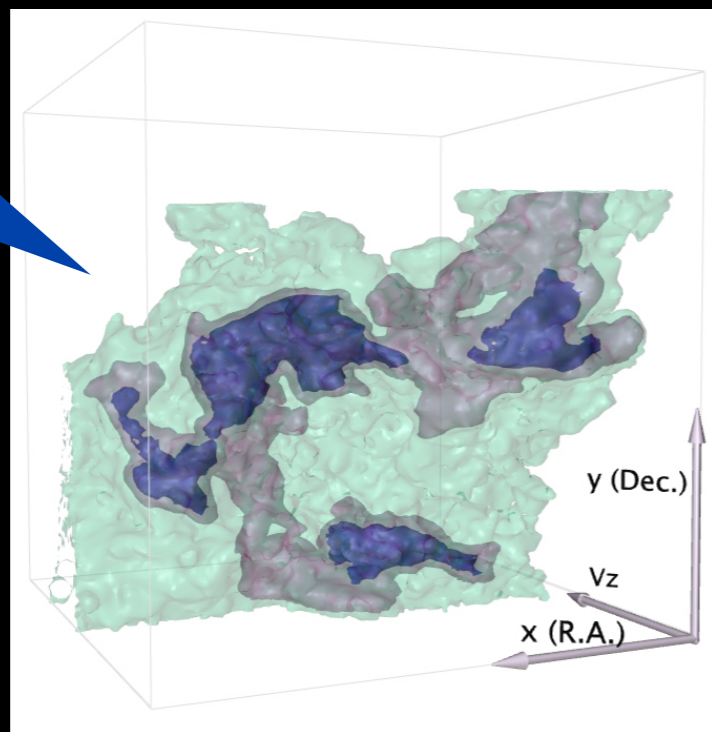
2D

Data Abstraction

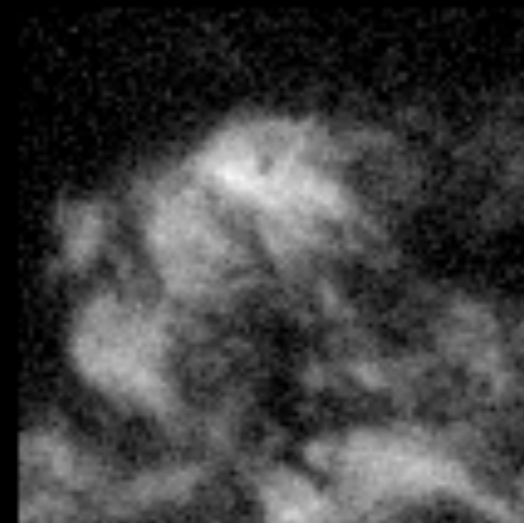
Statistics



Ask me about "3D selection"



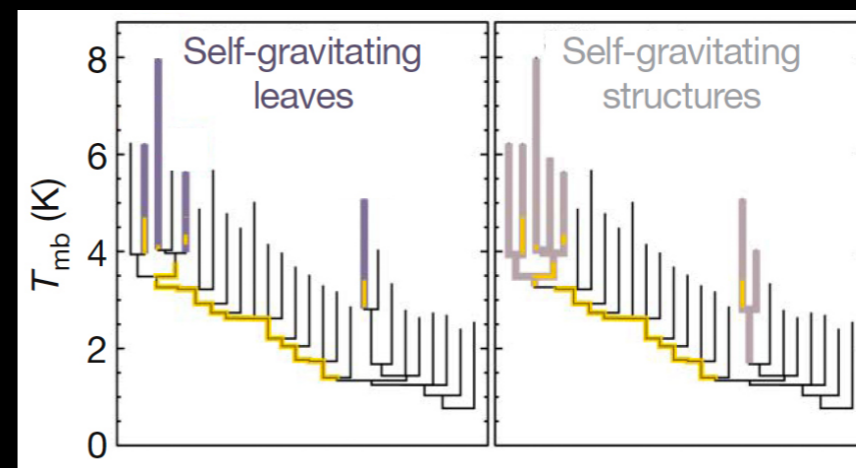
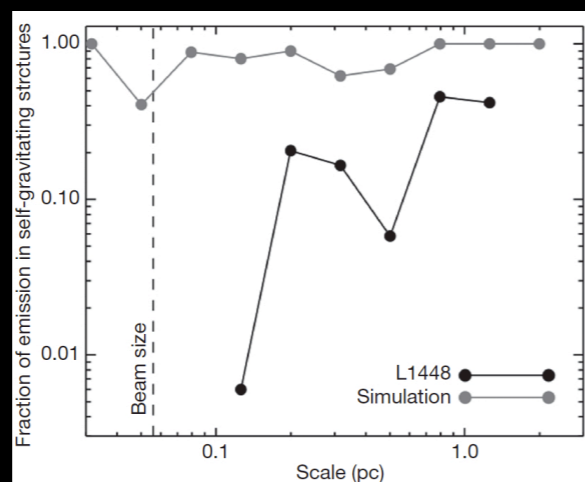
3D



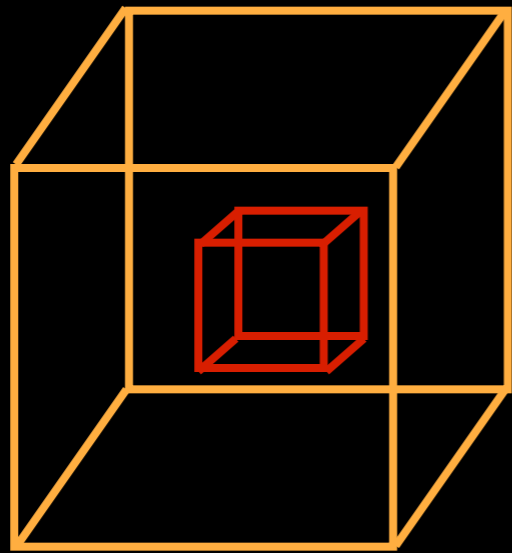
2D

Data Abstraction

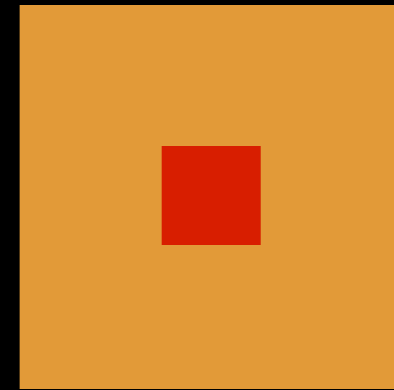
Statistics



"Linked Views"

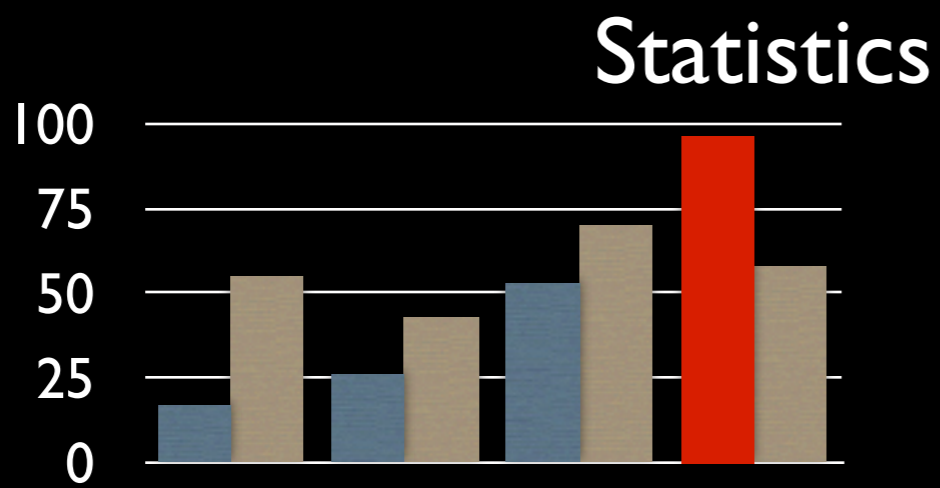
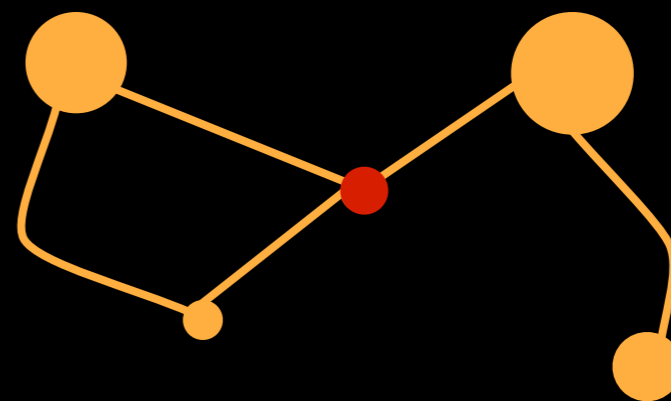


3D

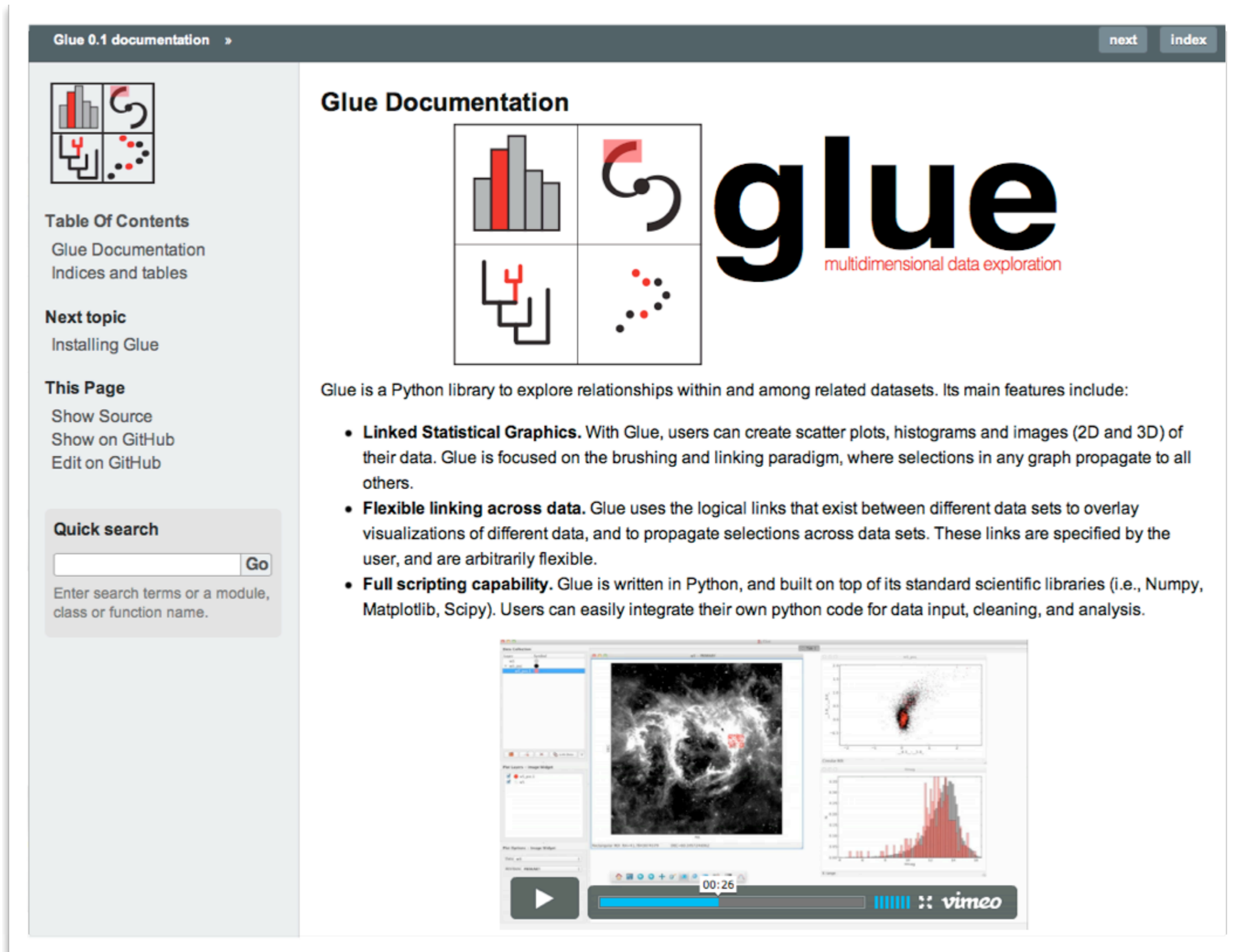


2D

Data Abstraction



“Multidimensional Data Exploration” using “Linked Views”



Glue 0.1 documentation > next index

Glue Documentation

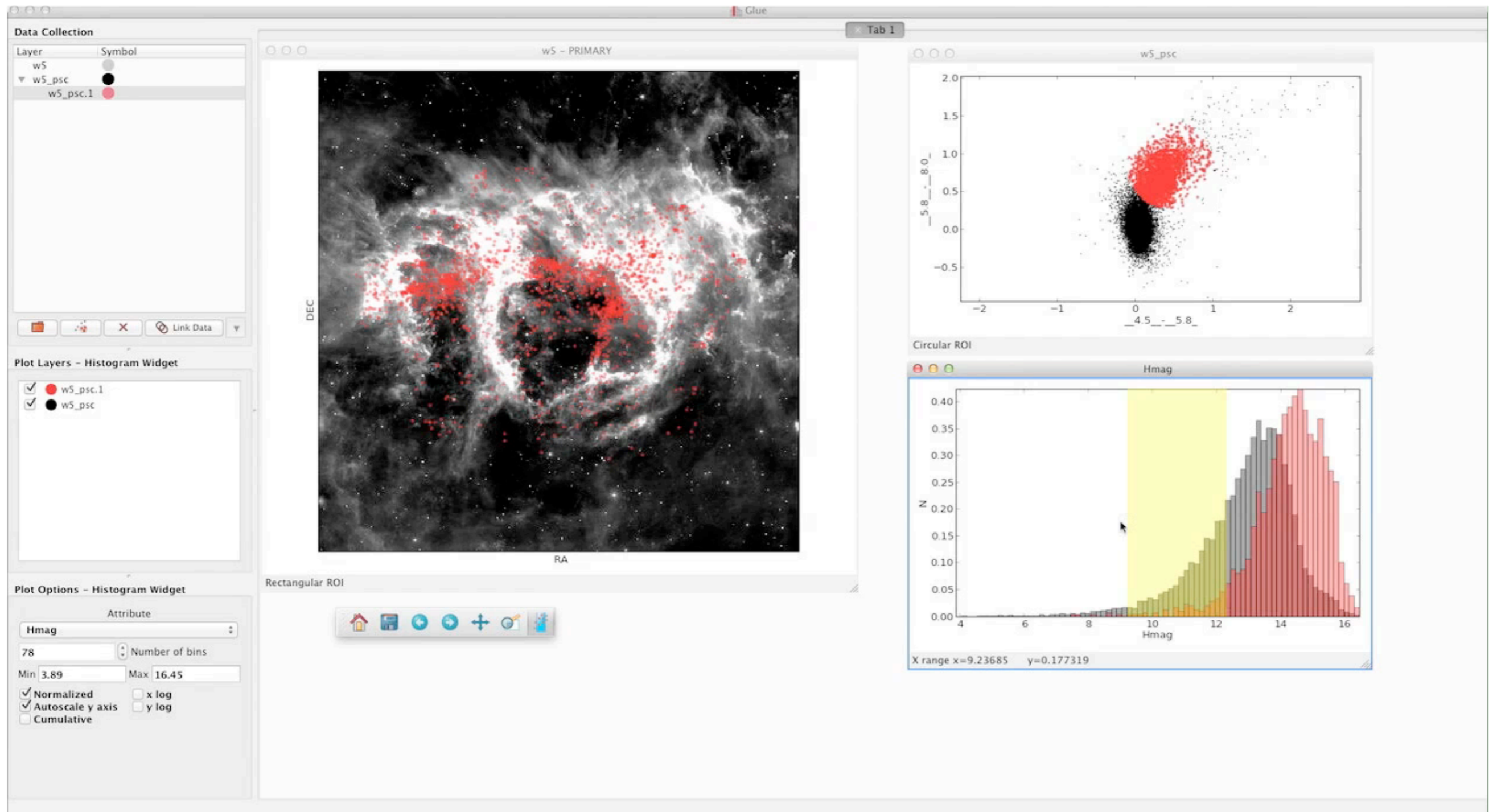
glue
multidimensional data exploration

Glue is a Python library to explore relationships within and among related datasets. Its main features include:

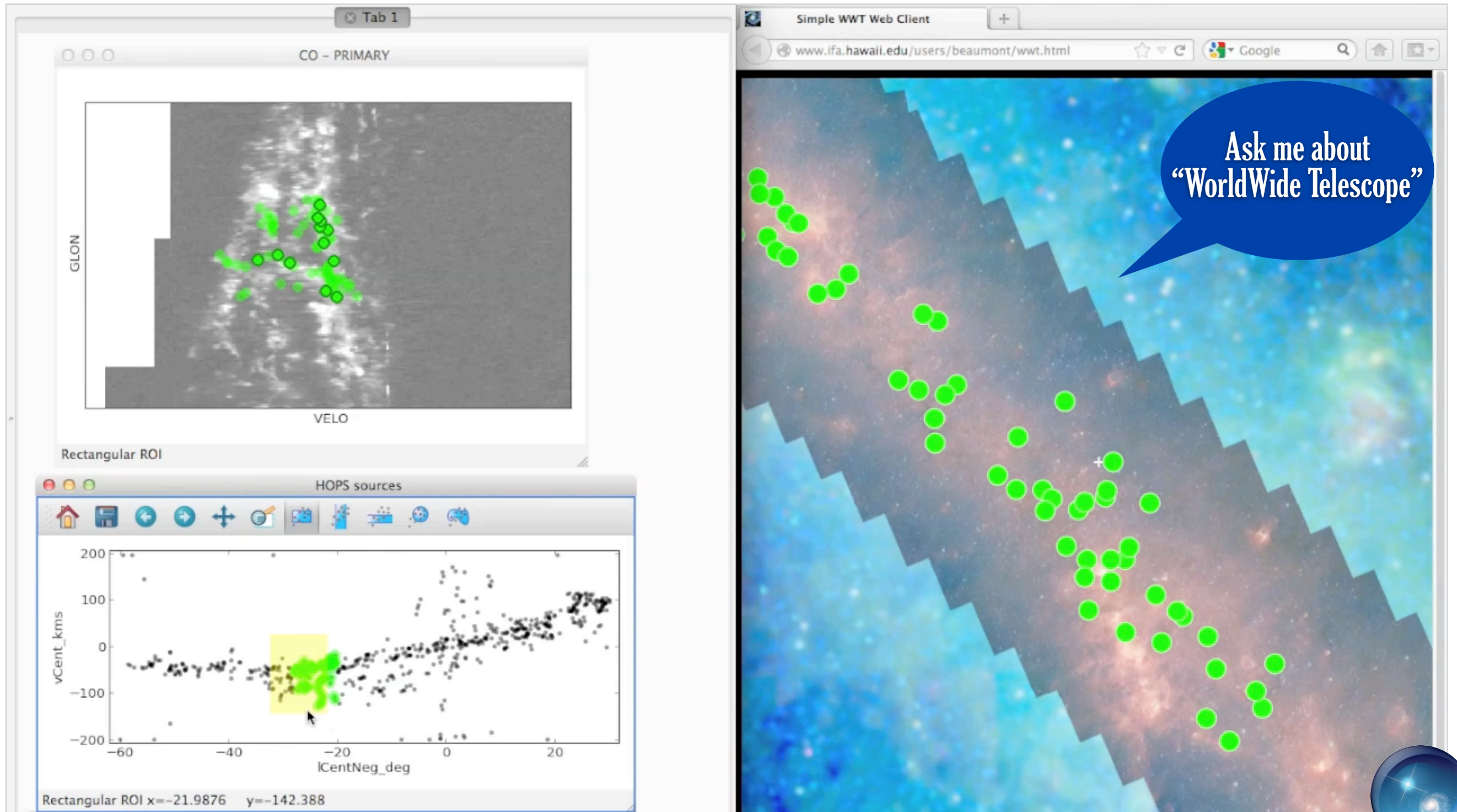
- **Linked Statistical Graphics.** With Glue, users can create scatter plots, histograms and images (2D and 3D) of their data. Glue is focused on the brushing and linking paradigm, where selections in any graph propagate to all others.
- **Flexible linking across data.** Glue uses the logical links that 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.

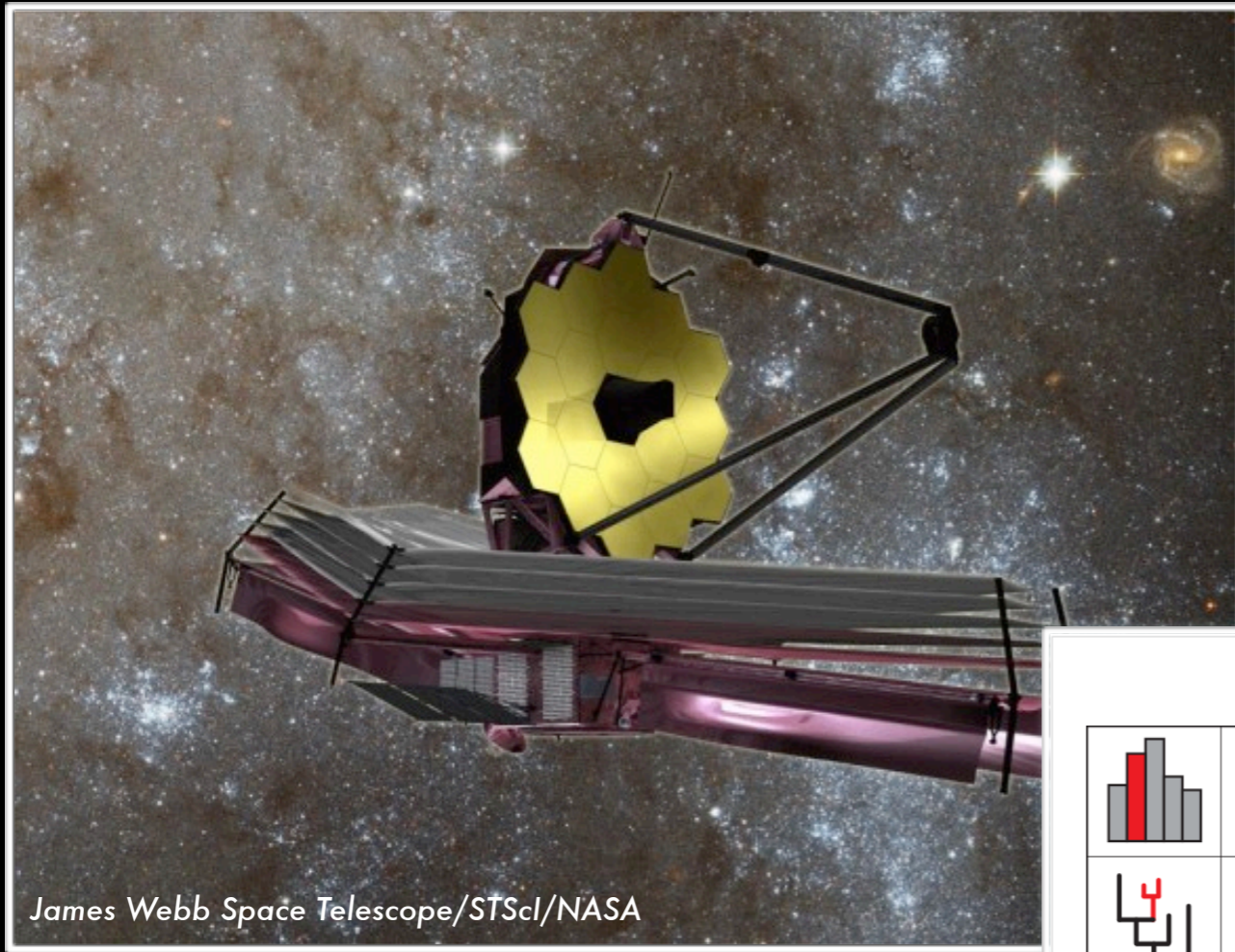
00:26 vimeo

"Multidimensional Data Exploration" using "Linked Views"

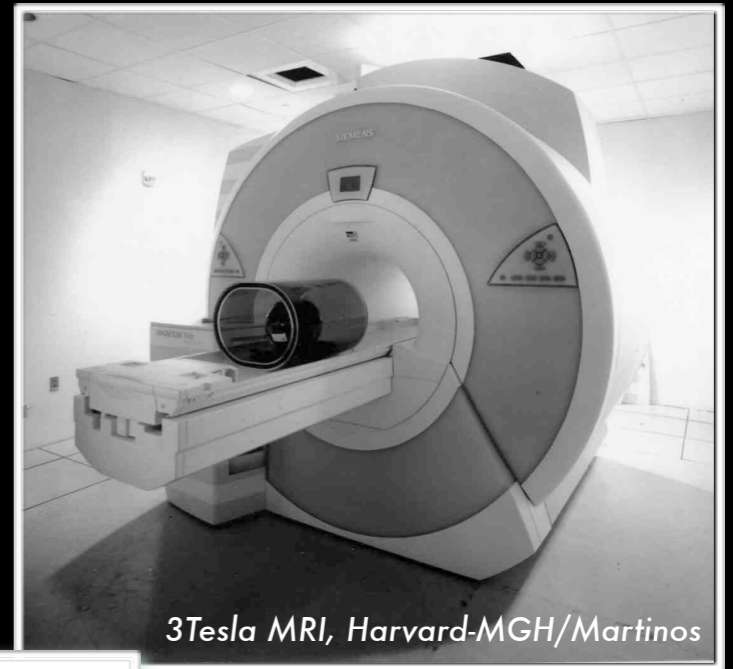


“Multidimensional Data Exploration” using “Linked Views”

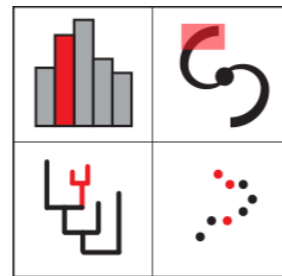




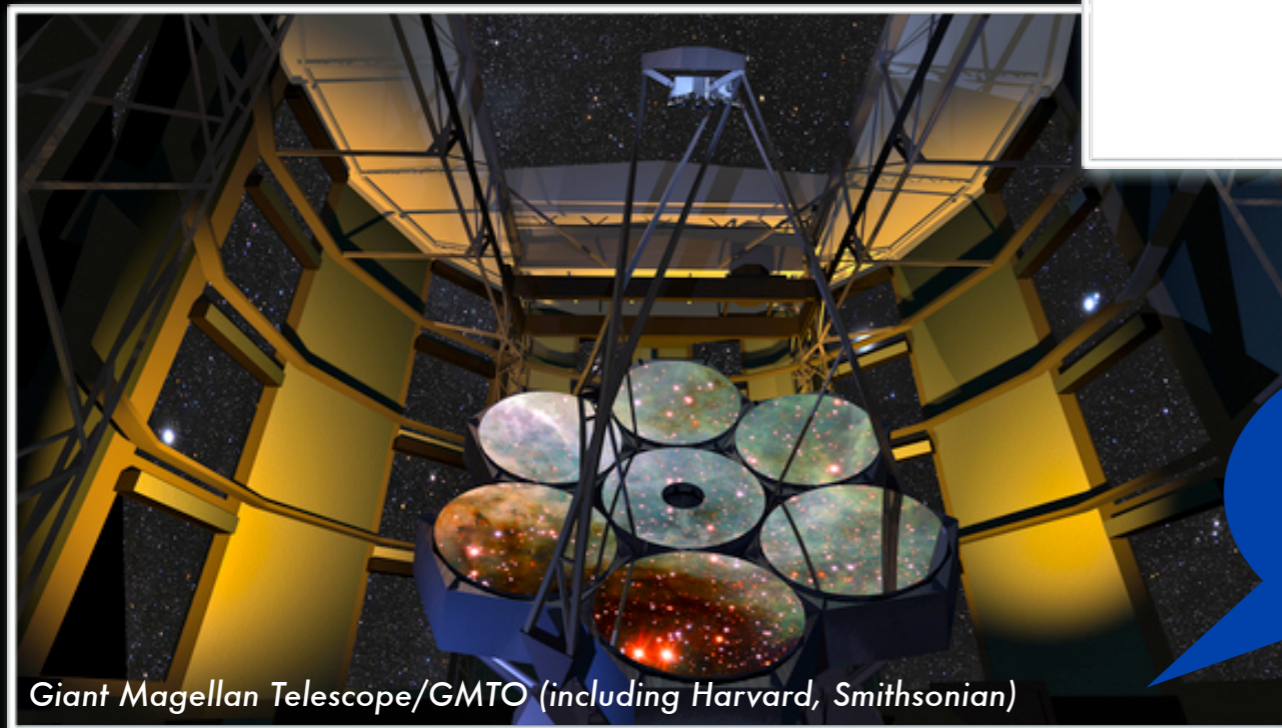
James Webb Space Telescope/STScI/NASA



3Tesla MRI, Harvard-MGH/Martinos



glue
multidimensional data exploration



Giant Magellan Telescope/GMTO (including Harvard, Smithsonian)

Ask me about data sharing and big facilities

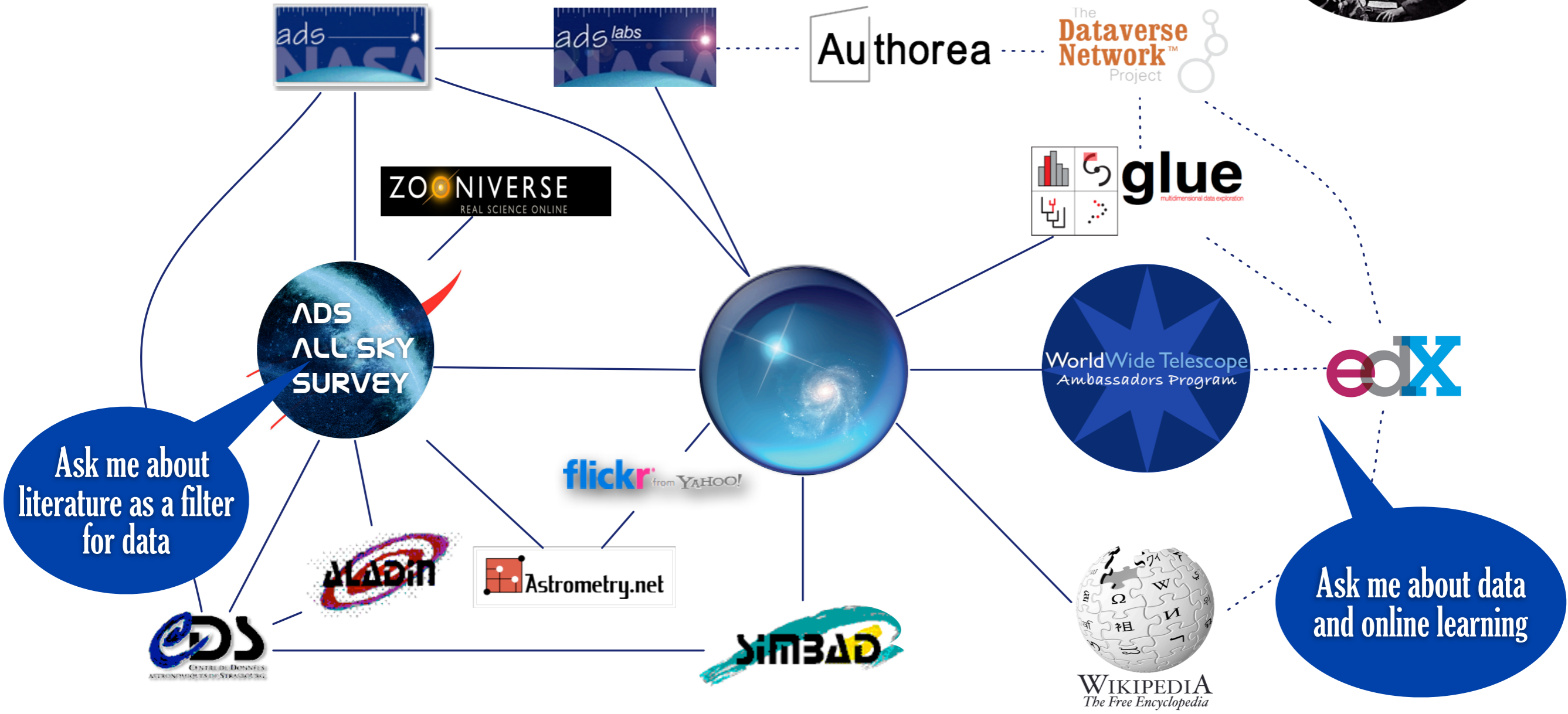


MEG, Harvard-MGH/Martinos



SEAMLESS ASTRONOMY

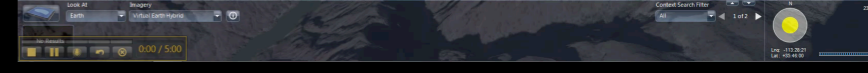
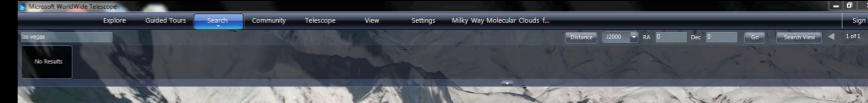
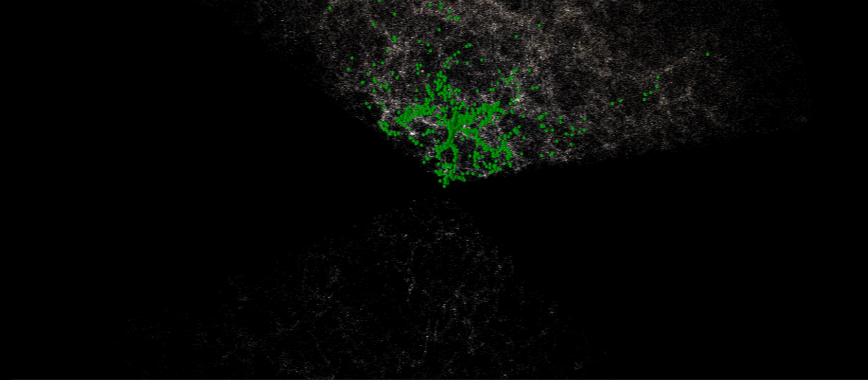
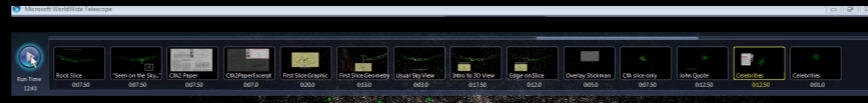
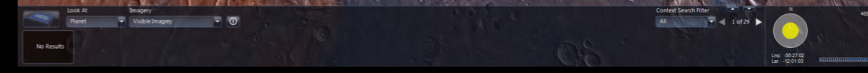
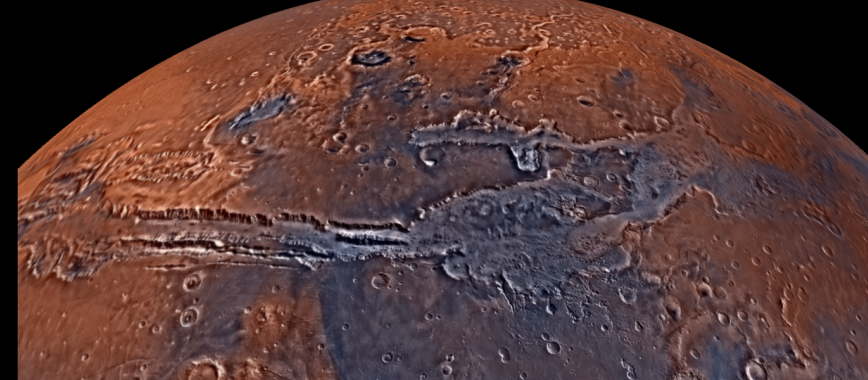
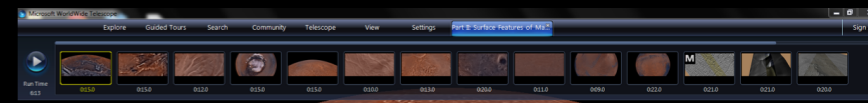
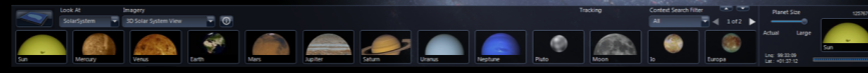
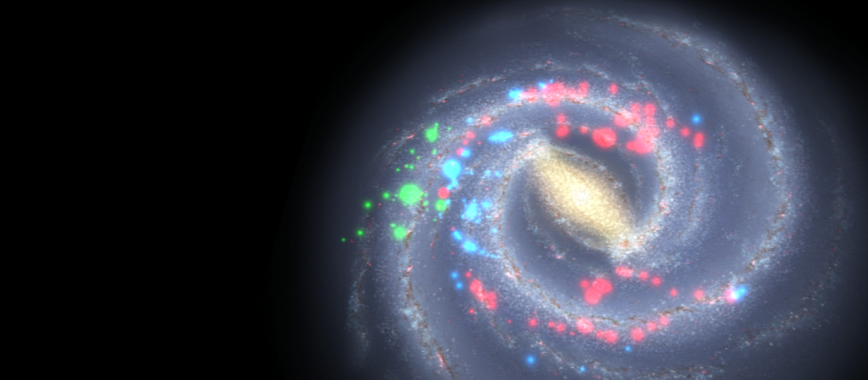
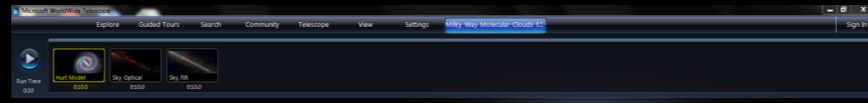
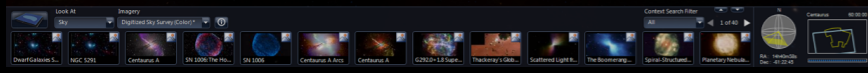
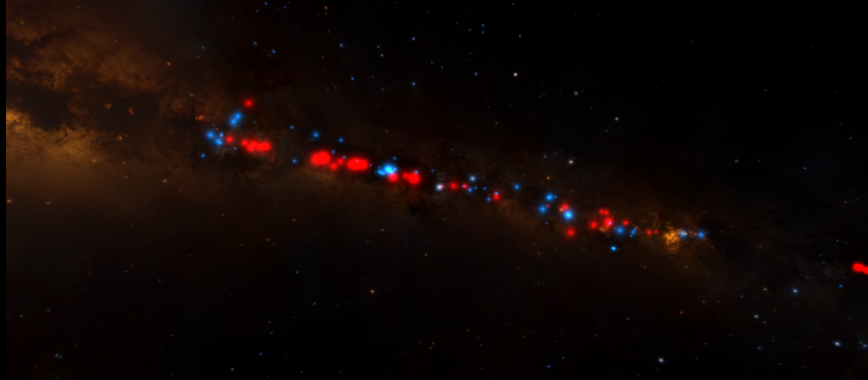
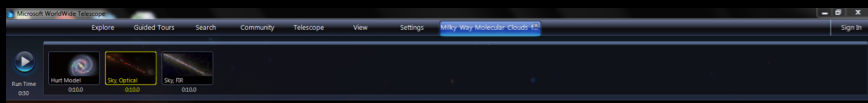
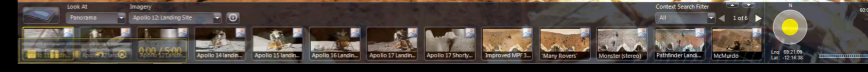
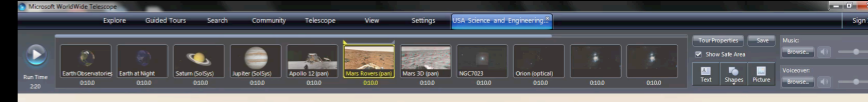
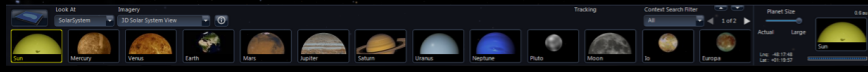
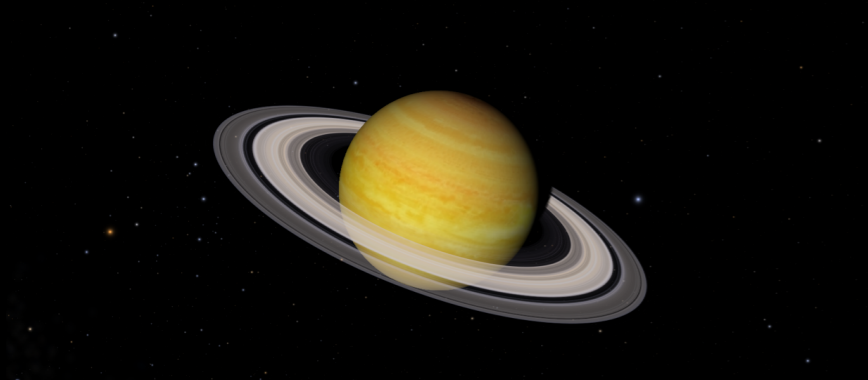
Linking scientific data, publications, and communities



<https://www.cfa.harvard.edu/~agoodman/seamless/>



Made possible by MANY collaborators, listed at projects.iq.harvard.edu/seamlessastronomy



Experience WWT at worldwidetelescope.org

Evolution



ASTROPHYSICAL JOURNAL
 AN INTERNATIONAL REVIEW OF SPECTROSCOPY
 AND ASTRONOMICAL PHYSICS
 VOLUME I JANUARY 1895 NUMBER 1

ON THE CONDITIONS WHICH AFFECT THE SPECTRO-PHOTOGRAPHY OF THE SUN.
 By ALBERT A. MICHELSON.

The recent developments in solar spectro-photography are in great measure due to the device originally suggested by Janssen and perfected by Hale and Deslandres, by means of which a photograph of the Sun's prominences may be obtained at any time as readily as it is during an eclipse. The essential features of this device are the simultaneous movements of the collimator-slit across the Sun's image, with that of a second slit (at the focus of the photographic lens) over a photographic plate. If these relative motions are so adjusted that the same spectral line always falls on the second slit, then a photographic image of the Sun will be reproduced by light of this particular wavelength.

Evidently the process is not limited to the photography of the prominences, but extends to all other peculiarities of structure which emit radiations of approximately constant wavelength; and the efficiency of the method depends very largely upon the contrast which can be obtained by the greater extinction

LETTERS

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-p) data cube into an easily visualized representation called a "dendrogram". Although well developed in other data-intensive fields^{1,2,3}, 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 frequency⁴.

Figure 3 and its legend explain the construction of dendrograms schematically. The dendrogram quantifies how and where local maxima of emission energy 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 dendrogram of 3D data (see Fig. 3 and its legend), by sorting their "branches" to zero cross, which eliminates dimensional information on the x-axis while preserving all information about connectivity and hierarchy. Numbered "billed 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. 2b).

A dendrogram of a spectral line data cube allows for the estimation of key physical properties associated with volumes bounded by its surfaces, such as radius (R), velocity dispersion (σ), and luminosity (L). The volumes can have any shape, and in other work^{5,6} we focus on the significance of the specially elongated features seen in U1648 (Fig. 2b). The luminosity is an approximate proxy for mass, such that $M_{\text{gas}} \approx X_{\text{CO}}/X_{\text{H}_2}$ where $X_{\text{CO}} \approx 40 \times 10^{20} \text{ cm}^{-2} \text{ K}^{-1} \text{ km}^{-1}$ (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, $\alpha_{\text{obs}} = 5\sigma^2 R / (GM_{\text{gas}})$. 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-p space where self-gravity is significant. As α_{obs} only represents the ratio of kinetic energy to gravitational energy at one point in time, and does not explicitly capture external over-pressure and/or magnetic fields^{7,8}, its measured value should only be used as a guide to the longevity (boundariness) of any particular feature.

Figure 2 | Comparison of the dendrogram and CLUMPFIND feature-identification algorithms as applied to ¹³CO emission from the U1648 region of Perseus. A 3D visualization of the surface indicated by columns in the dendrogram shows in Purple. Illustrates the small-scale self-gravitating structures in the region corresponding to the leaves of the dendrogram. Left shows the smallest features that contain distinct self-gravitating leaves within them, and green corresponds to the surface in the data cube containing all of the significant emission. Dendrogram branches corresponding to self-gravitating objects have been highlighted in yellow over the range of α_{obs} (median beam temperature) non-zero values for which the virial parameter is less than 2. The x-y locations of the four "self-gravitating" leaves labeled with billed balls are the same as those shown in Fig. 1. The 3D visualization shows position, position-velocity (p-p-v) space. RA, right ascension, declination. For comparison with the ability of dendrograms to track hierarchical structure, it shows a parallel dendrogram of the CLUMPFIND segmentation (b), with the same four bills used in Fig. 1 and in a. An "orange" arrow indicates a link connecting the maximum emission value in each clump to the threshold value. A very large number of clumps appear in a 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 (interactions requires Adobe Acrobat version 7.0.8 or higher). In the printed version, the front face of each 3D cube (the "Name" view in the later online version) corresponds exactly to the paths of sky shown in Fig. 1. Lead velocity with respect to the Local Standard of Rest is shown from front (-) to back (+) km s⁻¹.

Figure 3 | Schematic illustration of the dendrogram process. Shows in the construction of a dendrogram from a hierarchical, non-dimensional emission profile (black). The dendrogram (blue) can be constructed by "clipping" a set constant emission level (purple) from above in tiny steps (represented in size here, light lines) until all the local maxima and minima are found, and connected as shown. The intersection of a leaf level with the emission is a set of points (for example the light purple dots) in one dimension, a plane curve in two dimensions, and an isosurface in three dimensions. The dendrogram of 3D data shown in Fig. 2a is the direct analogue of the tree shown here, only constructed from "isosurfaces" rather than "point" intersections. It has been sorted and flattened for representation on a 2D page, as fully representing dendrograms for 3D data cubes would require four dimensions.

Authors

Article view

OPEN SCIENCE ARTICLE

WORKING DRAFT

ALFISA GOODMAN

The Bones of the Milky Way

Alfisa Goodman, Josselyn Ains, Chris Beaumont, Tom Davis, James Jackson, Jens Kuffner, Thomas Nakariakov, Alberto Payer, Michelle Breen, Andrew Barker, Dale Burstein

Abstract. The very long, thin infrared dark cloud "Nessie" is even longer than had been previously claimed, and an analysis of its Galactic location suggests that it lies directly in the Milky Way's mid-plane, tracing out a highly elongated face-like feature within the prominent Scutum-Centaurus spiral arm. Re-analysis of mid-infrared imagery from the Spitzer Space Telescope shows that this IRDC is at least 7, and possibly as many as 8 times longer than had originally been claimed by Nessie's discoverers, Jackson et al. (2001). Its aspect ratio is therefore at least 130:1, and possibly as large as 800:1. A careful accounting of both the Sun's offset from the Galactic plane ($\approx 20 \text{ pc}$) and the Galactic center's offset from the ($l^{\text{gal}}, b^{\text{gal}}$) = (0, 0) position defined by the IAU in 1959 shows that the latitude of the true Galactic mid-plane at the 3.1 kpc distance to the Scutum-Centaurus Arm is not $b = 0$, but instead closer to $b = -0.5$, which is the latitude of Nessie to within a few pc. Arguably, Nessie lies in the Galactic mid-plane. An analysis of the radial velocities of low-density (LD) and high-density (HD), gas associated with the Scutum Arm features suggests that Nessie runs along the Scutum-Centaurus Arm in position-position-velocity space, which means it likely forms a dense "spine" of the arm in real space as well. No gas-phase emission to date has been associated with a galaxy's spiral arms, but recent simulations do suggest that highly elongated over-dense filaments should be associated with a galaxy's spiral arms. Nessie is situated in the closest major spiral arm to the Sun toward the inner Galaxy, and appears almost perpendicular to our line of sight, making it the nearest feature of its kind to date from our location (in shadow of an Arm's face, illuminated by the Galaxy beyond). Although the Sun's offset from the Galactic plane is not significant compared with the thickness of the plane as traced by Population I objects such as GMCs and HD regions, it may be significant compared with an extremely thin layer that might be traced out by Nessie-like objects. Future high-resolution molecular line data may therefore allow us to exploit the Sun's position above the plane to gain a small amount of perspective on the Galactic disk.

1665

..230 yr..

1895

...114 yr..

2009

...4 yr..

2013

PHOTOGRAPHS OF THE MILKY WAY.
 By E. E. BARNARD.

In my photographic survey of the Milky Way with the 6 Willard lens of this Observatory, I have come across many very remarkable regions. Some of these, besides being remarkable for showing the peculiar structure of the Milky Way, are singularly beautiful as simple pictures of the stars. I have selected two of these for illustration in THE ASTROPHYSICAL JOURNAL.



flickr from YAHOO!

Astrometry.net

