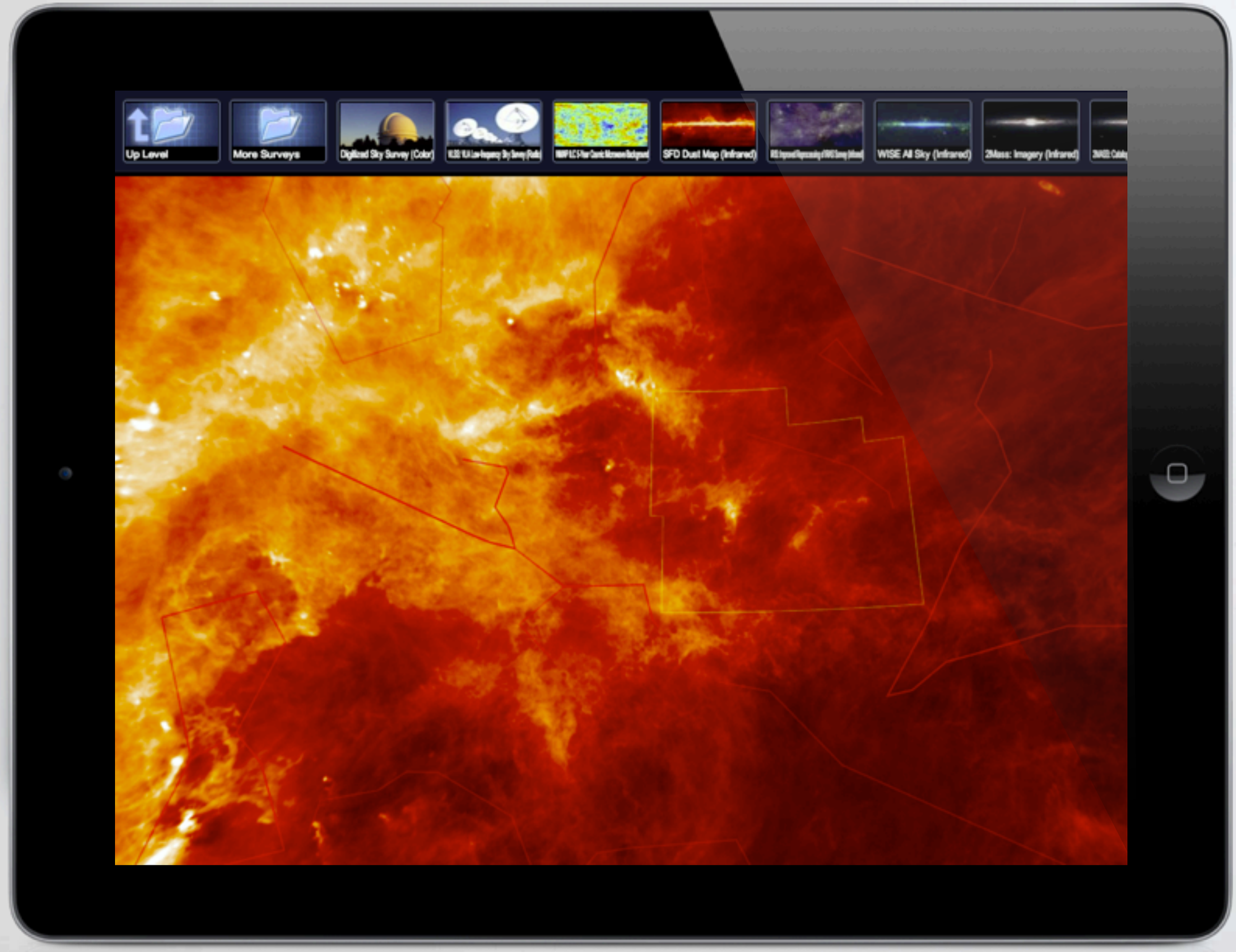
EDUCATING ASTROINFORMATICISTS



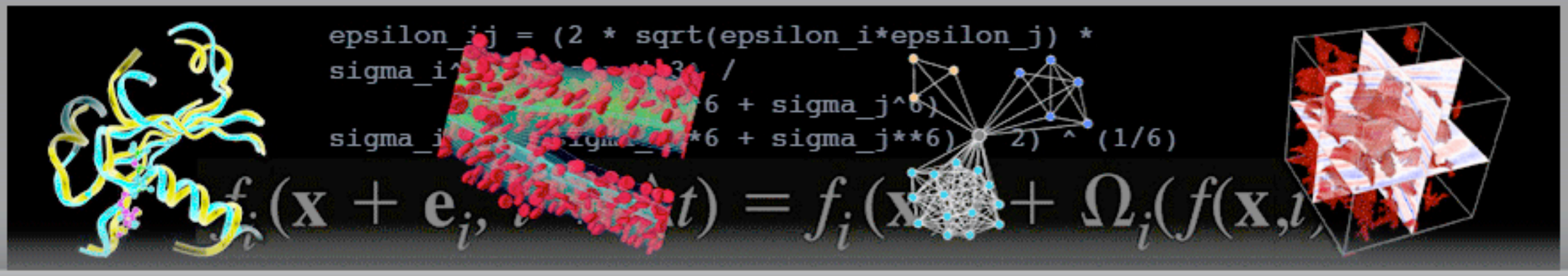
Alyssa A. Goodman, Harvard-Smithsonian Center for Astrophysics

HARVARD 2012

HARVARD
School of Engineering and Applied Sciences

INSTITUTE FOR APPLIED COMPUTATIONAL SCIENCE

RE-ENGINEERING GRADUATE EDUCATION TO POWER 21ST-CENTURY DISCOVERY AND INNOVATION



Master of Science degree

Harvard's first degree program in Computational Science and Engineering is an intensive year of coursework leading to the Master of Science

The Harvard Graduate School of Arts and Sciences is now accepting applications for a new **Master of Science** (SM) degree program in Computational Science and Engineering.

To apply for Fall 2013 admission, go to gsas.harvard.edu/apply. Applications must be complete by Dec. 14, 2012.

The **one-year** SM program, developed by IACS, will provide rigorous training in the mathematical and computing foundations of CSE. Complementing the foundational coursework will be independent research projects and elective courses focusing on the

GSAS admissions information

Master of Engineering (two-year) degree

Our faculty: The CSE Program Committee

Industry involvement in the program

Graduate study at SEAS

Courses of instruction

FAQ

IACS brochure

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IACS

Contact
Rosalind Reid
617-384-9091

New master's program is

HARVARD 2012

IACS Courses

Institute for Applied Computational Science
Harvard School of Engineering and Applied Sciences

IACS course websites provide course resources, links to computational tools, news and discussion tools for students. As courses are launched, we will share resources and ideas and provide shared question-and-answer tools to allow students to learn from one another.

More about IACS

Fall 2012 courses

- **Computer Science 205:** Computing Foundations for Computational Science
- **Applied Math 205:** Computing Foundations for Computational Science
- **Applied Computation 263:** Data and Computation on the Internet

Spring 2012 courses

- **Applied Math 207:** Advanced Scientific Computing: Stochastic Optimization Methods
- **Applied Math 274:** Computational Fluid Dynamics
- **Applied Math 275:** Computational Design of Materials
- **Computer Science 207:** Systems Design for Computational Science

Fall 2011 courses

- **Applied Math 205:** Advanced Scientific Computing: Numerical Methods
- **Computer Science 205:** Computing Foundations of Computational Science

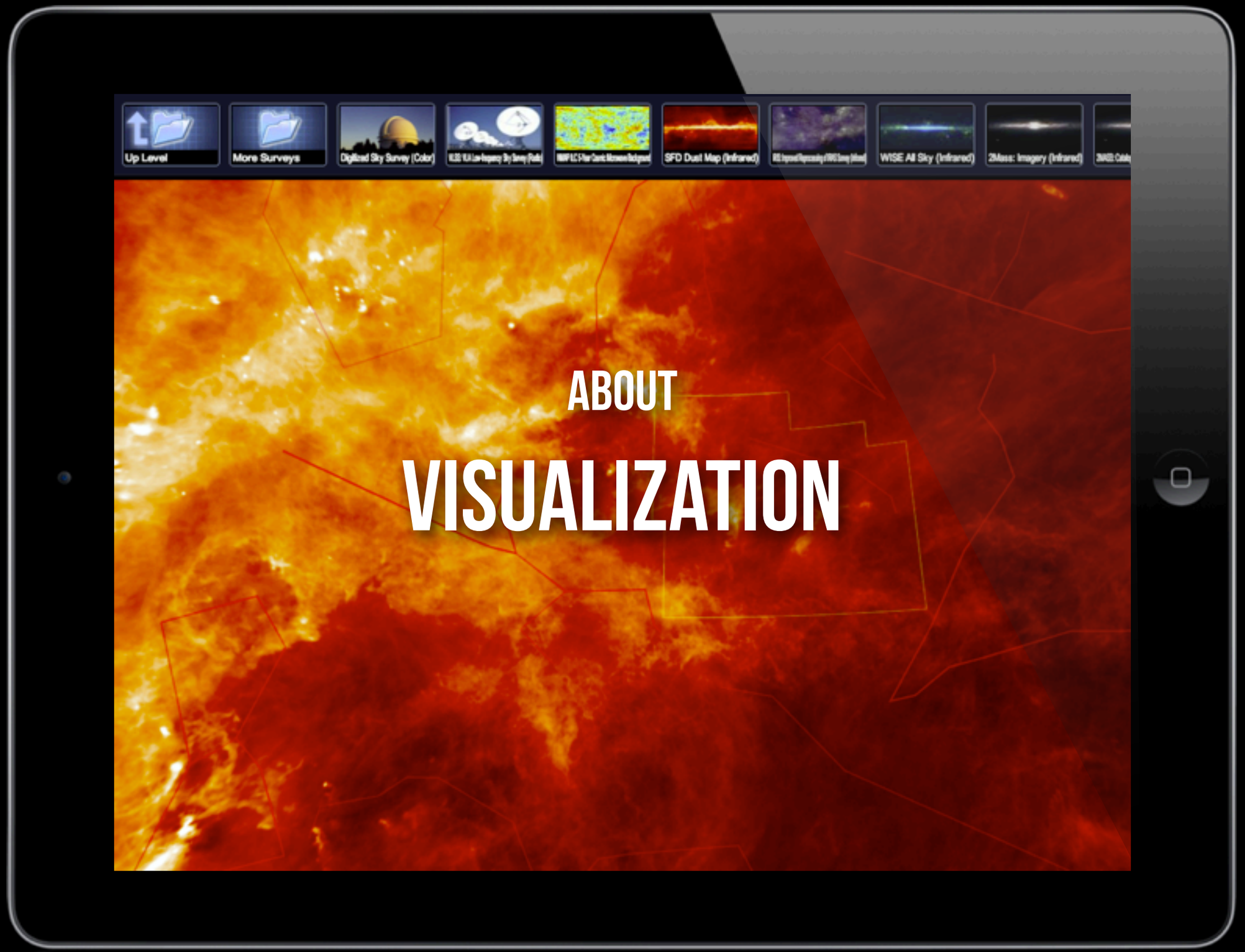
HARVARD 2012

The Art of Numbers

Harvard EMR 19

http://isites.harvard.edu/icb/icb.do?keyword=k84386

EDUCATING ASTROINFORMATICISTS



Astron. Nachr. / AN **333**, No. 5/6, 505 – 514 (2012) / **DOI** 10.1002/asna.201211705

Principles of high-dimensional data visualization in astronomy

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Harvard-Smithsonian Center for Astrophysics, Cambridge, MA, USA

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Published online 2012 Jun 15

Key words cosmology: large-scale structure – ISM: clouds – methods: data analysis – techniques: image processing – techniques: radial velocities

Astronomical researchers often think of analysis and visualization as separate tasks. In the case of high-dimensional data sets, though, interactive *exploratory data visualization* can give far more insight than an approach where data processing and statistical analysis are followed, rather than accompanied, by visualization. This paper attempts to charts a course toward "linked view" systems, where multiple views of high-dimensional data sets update live as a researcher selects, highlights, or otherwise manipulates, one of several open views. For example, imagine a researcher looking at a 3D volume visualization of simulated or observed data, and simultaneously viewing statistical displays of the data set's properties (such as an x-y plot of temperature vs. velocity, or a histogram of vorticities). Then, imagine that when the researcher selects an interesting group of points in any one of these displays, that the same points become a highlighted subset in all other open displays. Selections can be graphical or algorithmic, and they can be combined, and saved. For tabular (ASCII) data, this kind of analysis has long been possible, even though it has been under-used in astronomy. The bigger issue for astronomy and other "high-dimensional" fields, though, is that no extant system allows for full integration of images and data cubes within a linked-view environment. The paper concludes its history and analysis of the present situation with suggestions that look toward cooperatively-developed open-source modular software as a way to create an evolving, flexible, high-dimensional, linked-view visualization environment useful in astrophysical research.

http://adsabs.harvard.edu/abs/2012AN....333..505G

"HIGH-DIMENSIONAL DATA"

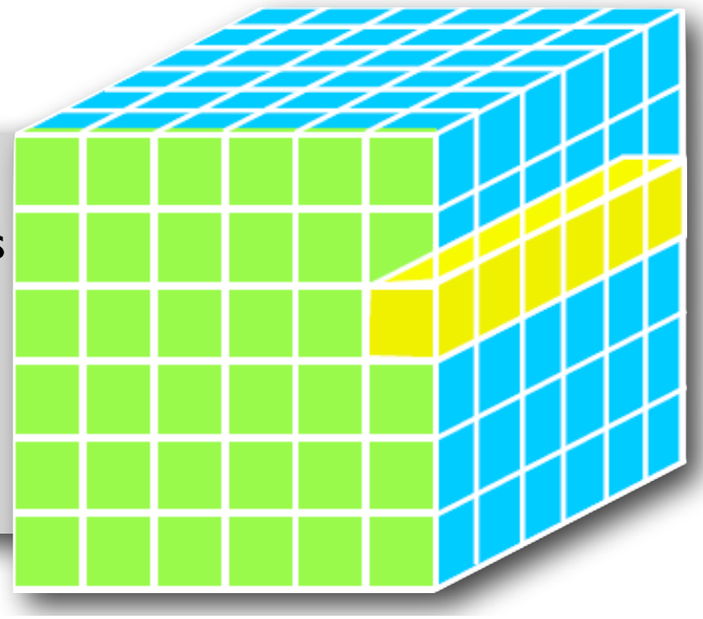
GENERALLY

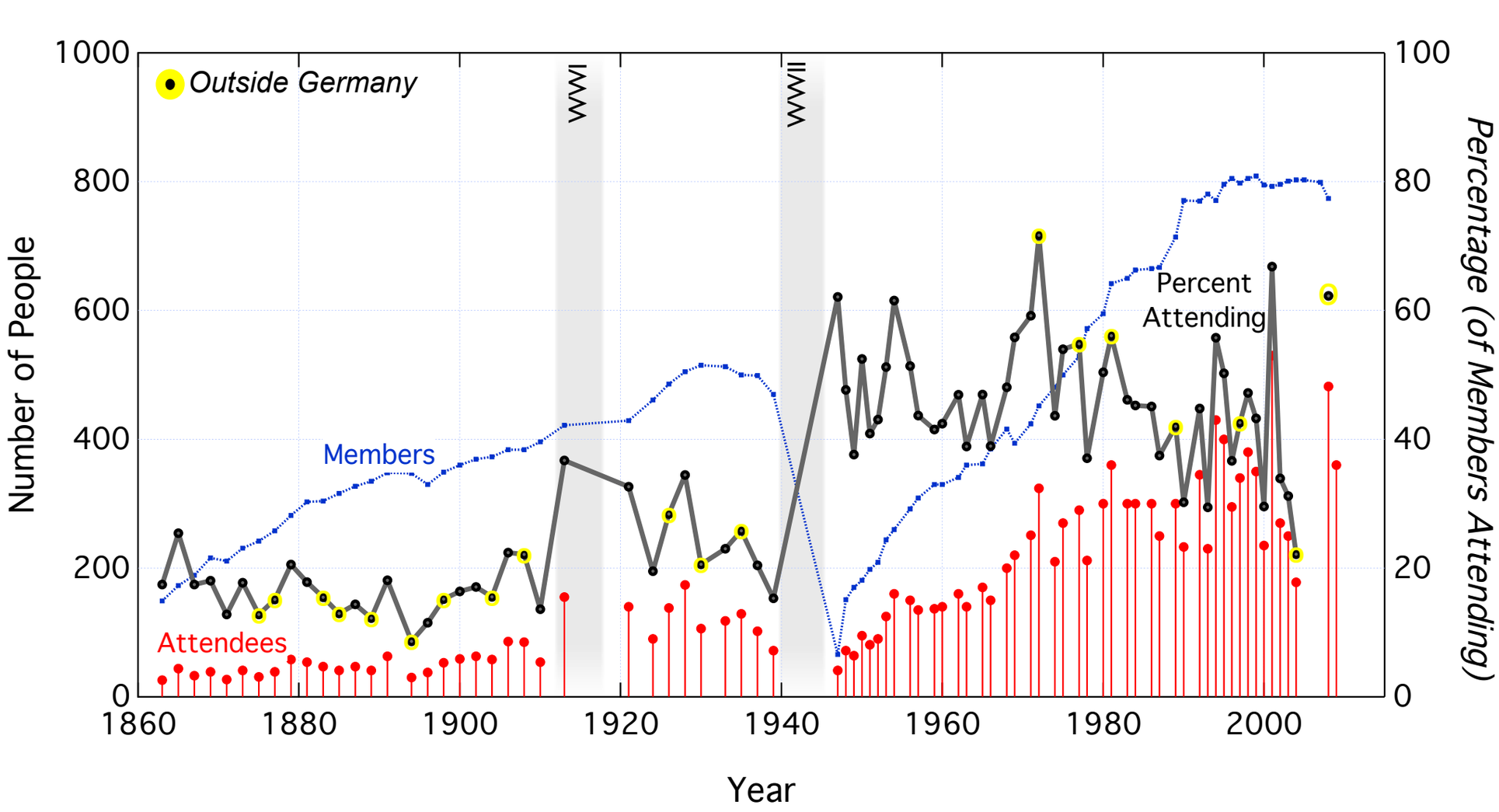
1D: *Columns* = Spectra, SEDs, Time Series

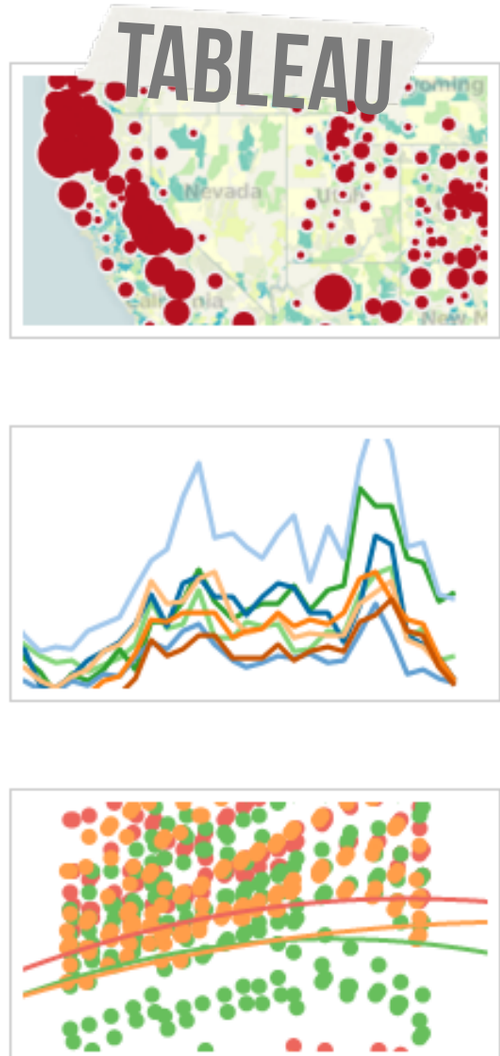
2D: *Faces or Slices* = Images

3D: *Volumes* = 3D Renderings, 2D Movies

4D: *Time Series of Volumes* = 3D Movies

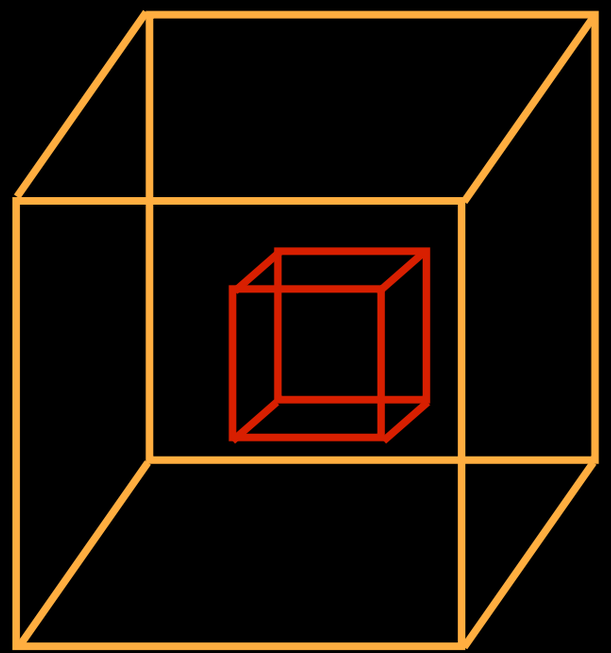




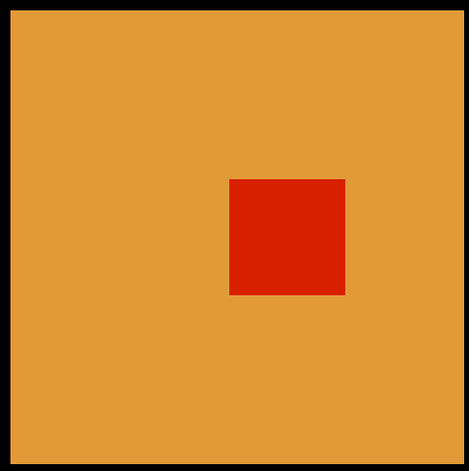


figures reproduced from Goodman 2012, "Principles of High-Dimensional Data Visualization in Astronomy"

LINKED VIEWS OF HIGH-DIMENSIONAL DATA

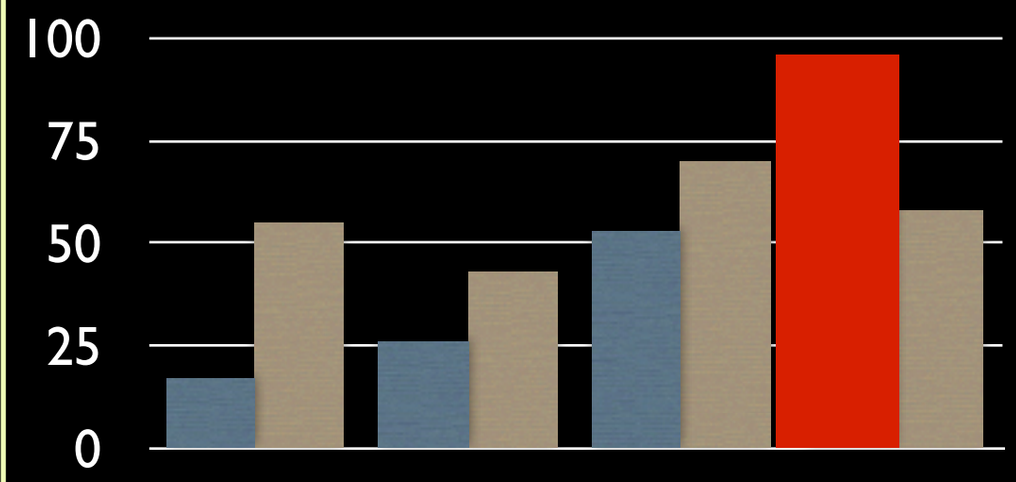


3D

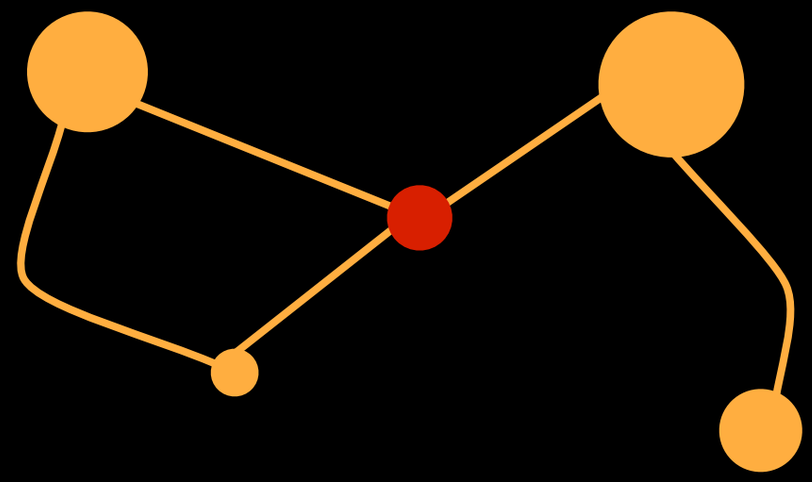


2D

Statistics



Data Abstraction



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

TUKEY'S "FOUR ESSENTIALS" OF LINKED VIEWS (C. 1972)

Picturing

Rotation

Isolation

Masking

Selection

and these *"need to work together"*
in a *"dynamic display"*

Brushing

Linking

Results...

1. for immediate insight
2. as visual source of ideas for statistical algorithms (...relation to SVM)

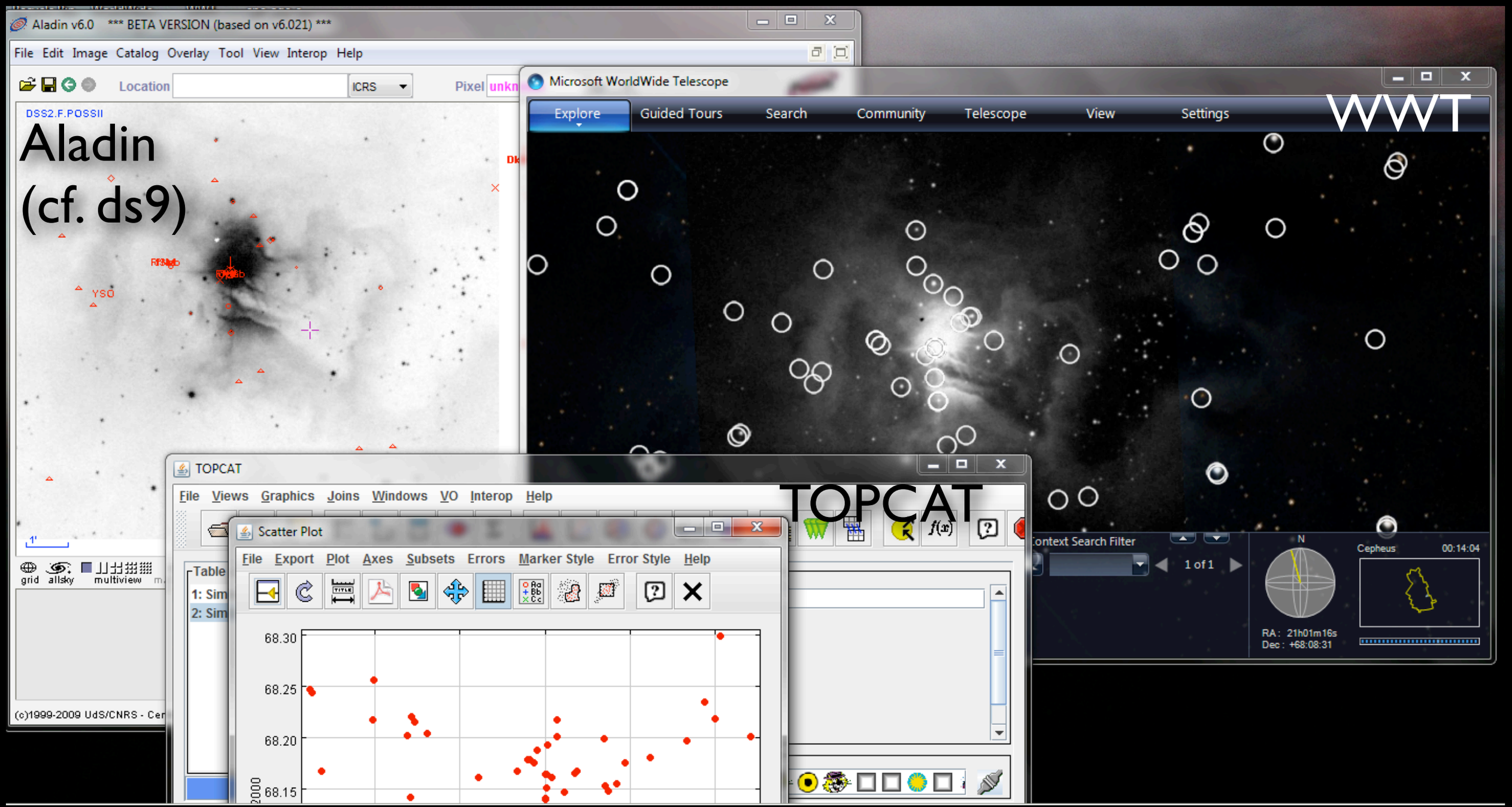
Warning

"details of control can make or break such a system"

Watch the PRIM-9 video at: http://stat-graphics.org/movies/prim9.html

LINKING VIEWS USING SAMP

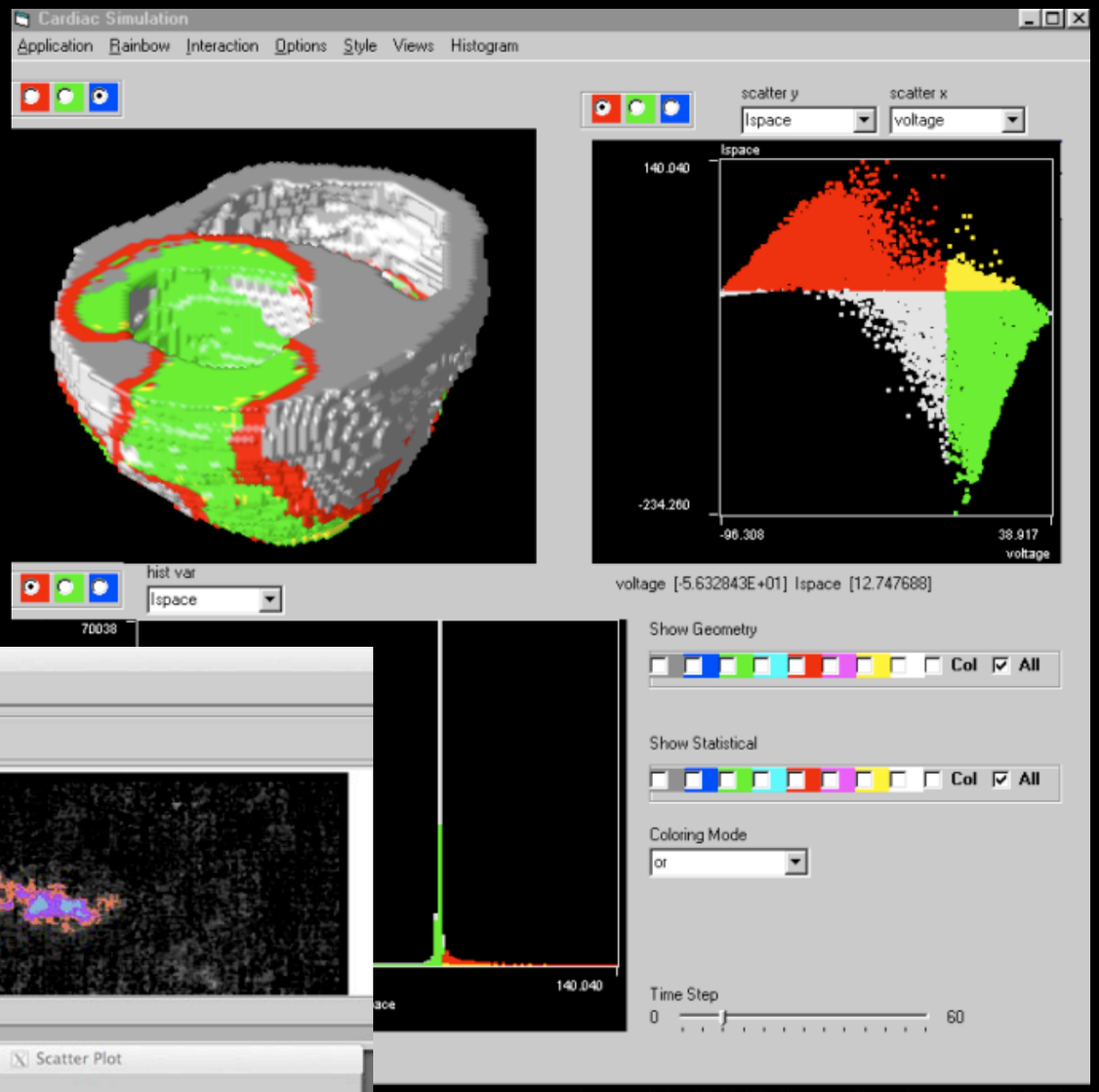
(SAMP CREATOR IS MARK TAYLOR)



figure, showing SAMP screenshot, reproduced from Goodman 2012, "Principles of High-Dimensional Data Visualization in Astronomy"

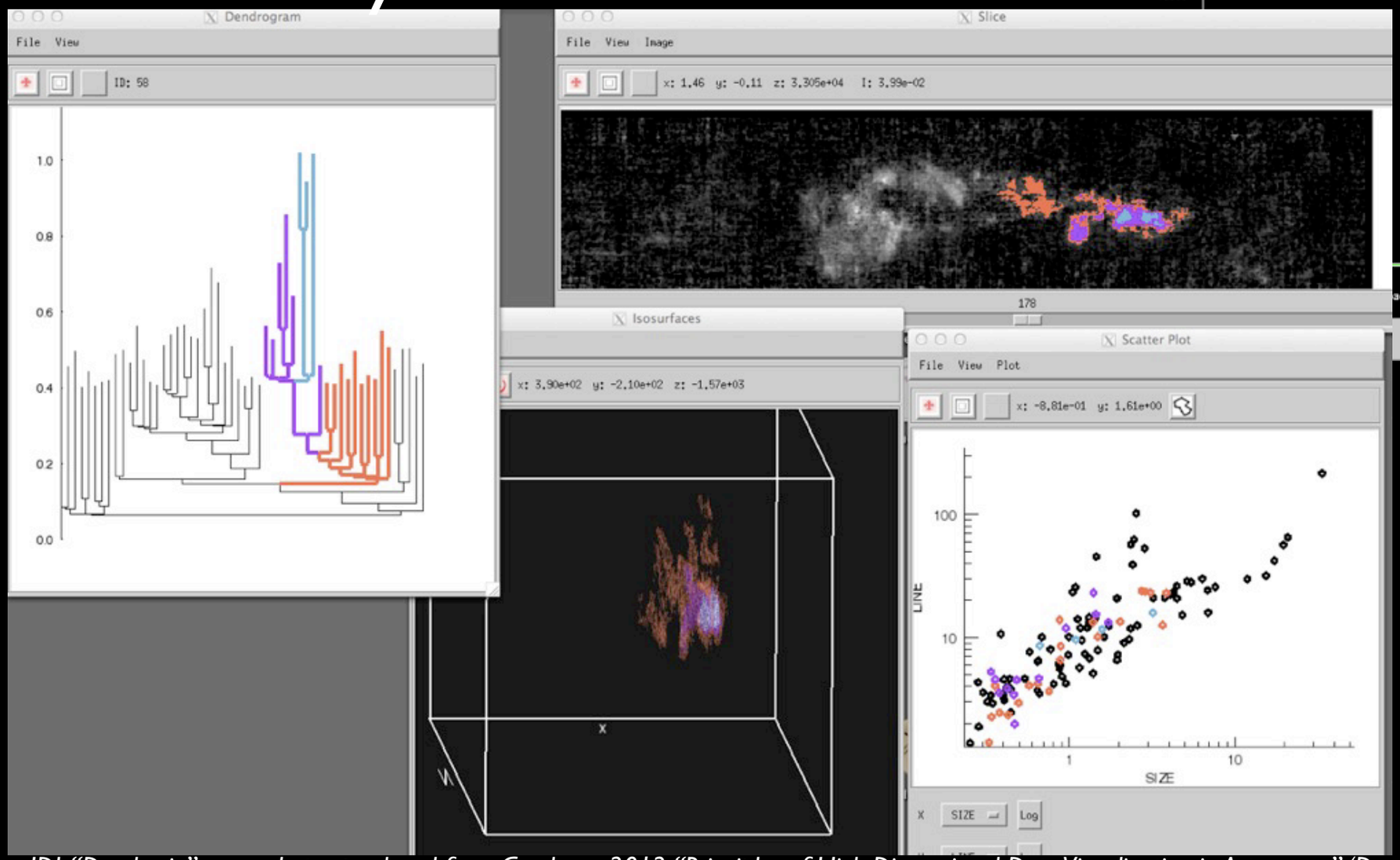
LINKING VIEWS "IN 3D"

Medicine



screenshot of WEAVE from Gresh et al. 2000, reproduced as shown in Goodman 2012

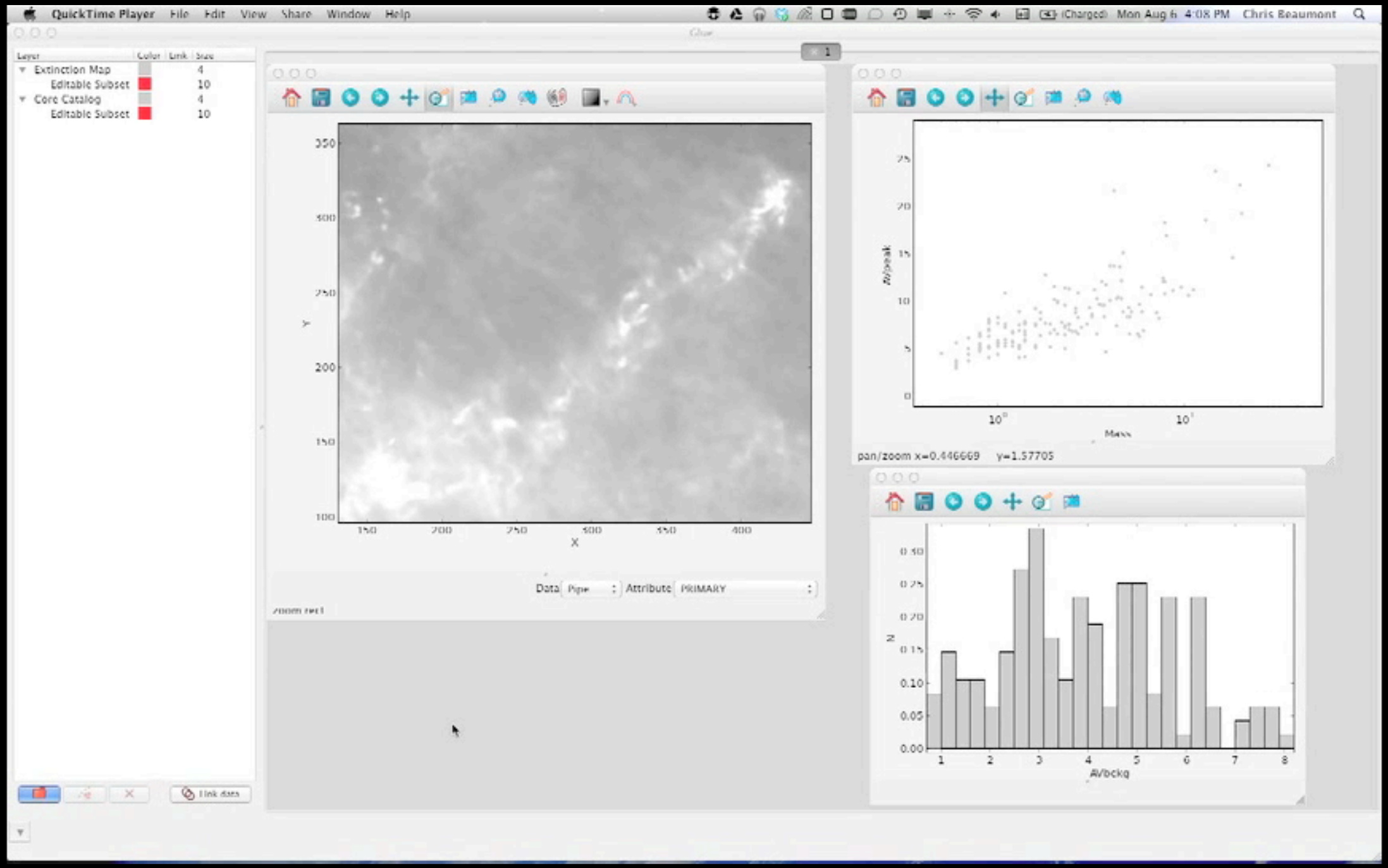
Astronomy



IDL "Dendroviz" screenshot, reproduced from Goodman 2012, "Principles of High-Dimensional Data Visualization in Astronomy" (Dendroviz, created by C. Beaumont, available for download)

GLUE

PROJECTS.IQ.HARVARD.EDU/SEAMLESSASTRONOMY/SOFTWARE/GLUE

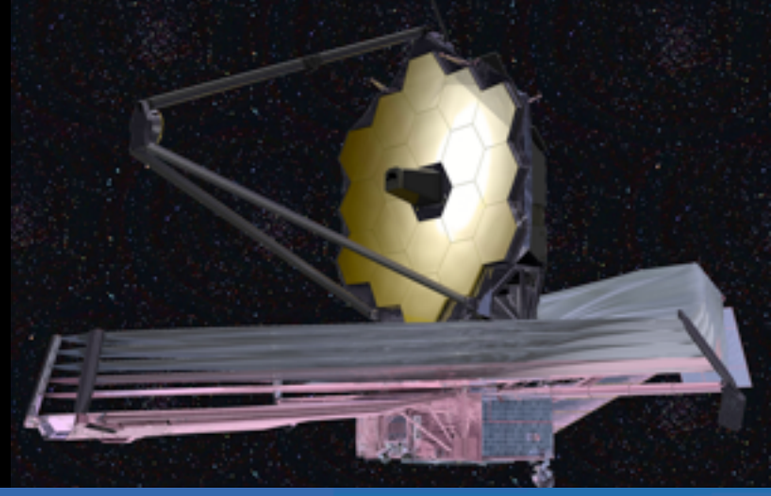


Open-source, python-based, linked view visualizaiton (currently 2D, 3D coming soon)

Core team:

Chris Beaumont, Michelle Borkin, Tom Robitaille, Alyssa Goodman & Hanspeter Pfister

GLUEY PLANS AGILE, OPEN



(NASA) JWST/IFU collaboration

(NSF) 2012 ALMA development grant to Rosolowsky et al., leveraging CyberSKA

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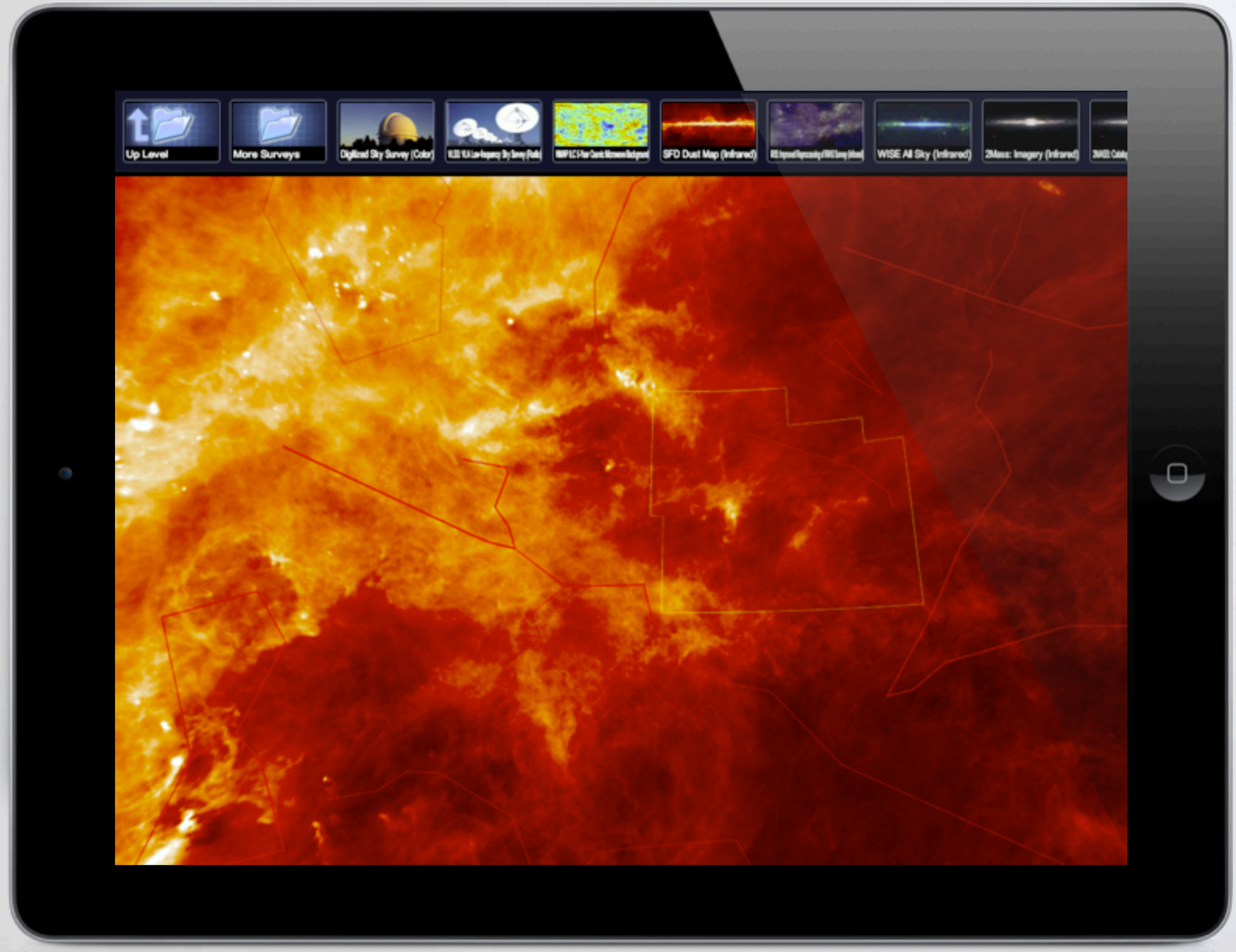

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