

# The Future of High-Dimensional Data Visualization, and its Communication

Alyssa A. Goodman  
Professor of Astronomy  
Harvard University

# In this *Hour*??

(1) Why **VDQI**?

(2) “**Art of Numbers**” class at Harvard

(3) “**Astronomical Medicine**” Project, and the 

(4) Online Data & **Collaboratories**

(e.g. Many Eyes, Taste Testing, iSTEM, World Wide Telescope)

(5) **The Future**

The Evolution of Mashups & Customized/Homemade Applications (Gapminder, Google Docs Widgets)

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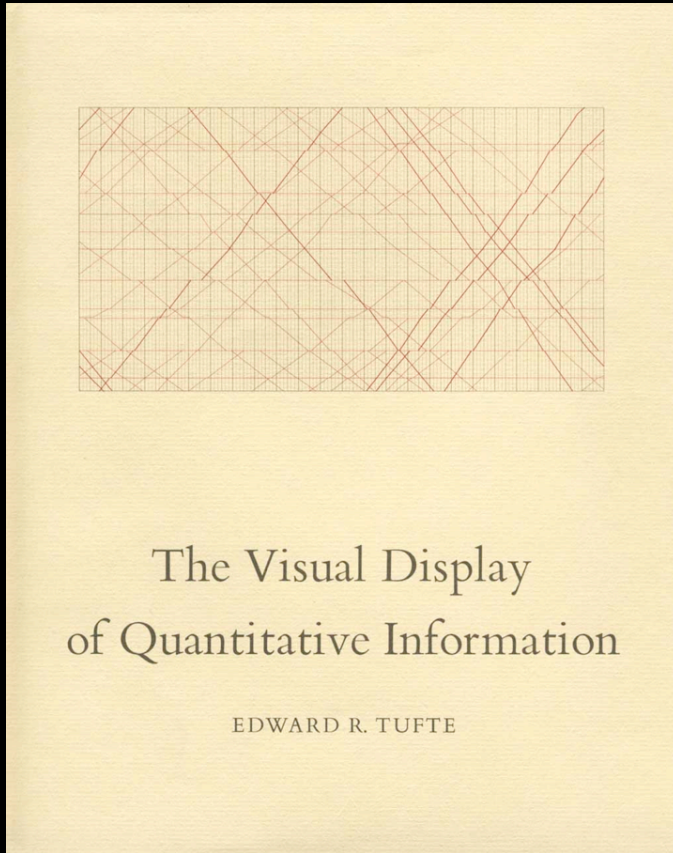
(3) “**Astronomical Medicine**” Project, and the 

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# VDQI=Visual Display of Quantitative Information=



Maps

Tables

Graphs

Charts

Illustrations

& Combinations Thereof

# What is VDQI for?

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Data **exploration**

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Hypothesis **testing**

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Hypothesis **testing**

Making a **point**



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**Demonstrating** a concept

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> 1 of the above (BEST)

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*Biggest test: Does it pass the “**interocular impact test**”?*

- ✓ Maps
- ✓ Tables
- ✗ Graphs
- ✓ Charts
- ✓ Illustrations
- ✓ Combinations

Live Scoreboard | Celtics.com

DEN 116 WAS 72 POR 97 PHI 46 MIL 34 DAL 26-11 LAL 25-11  
 CHA 119 BOS 79 NJN 70 SAS 52 UTA 34 SAC 14-21 SEA 9-27  
 FINAL 2:34 4th 6:50 4th Halftime 5:36 2nd 10:00 10:00

COURTSIDE LIVE

72 02:46 79

19-16 1 4 0 18 17 24 13 72 18 19 26 16 78 1 3 1 30-5

WAS SELECT: ALL ACTIVE 5

PLAYER NAME	PTS	REB	AST	F
Daniels, Antonio	7	2	8	0
Steuenson, DeSha	11	3	4	2
Jamison, Antawn	18	10	0	3
Butler, Caron	14	3	1	3
Haywood, Brenda	12	5	0	3
Blatche, Andray	3	5	0	3
Mason, Roger	3	1	1	5
Songaila, Darius	2	1	1	2
Young, Nick	2	0	0	0
Pecherov, Olesiy	0	1	0	0
Arenas, Gilbert				
McGuire, Dominic				

BOS SELECT: ALL ACTIVE 5

PLAYER NAME	PTS	REB	AST	F
Rondo, Rajon	4	2	2	2
Allen, Ray	16	6	3	2
Garnett, Kevin	21	6	6	3
Pierce, Paul	16	4	2	3
Perkins, Kendrick	9	3	1	3
House, Eddie	5	6	3	1
Allen, Tony	4	4	0	0
Davis, Glen	1	0	0	2
Posey, James	3	2	0	2
Pollard, Scot				
Scalabrino, Brian				
Powe, Leon				

TD Banknorth GARDEN

WIZARDS CELTICS

WAS show: ● made shots ✓ X missed shots ✓ BOS show: ● made shots ✓ X missed shots ✓

# Relative Strengths

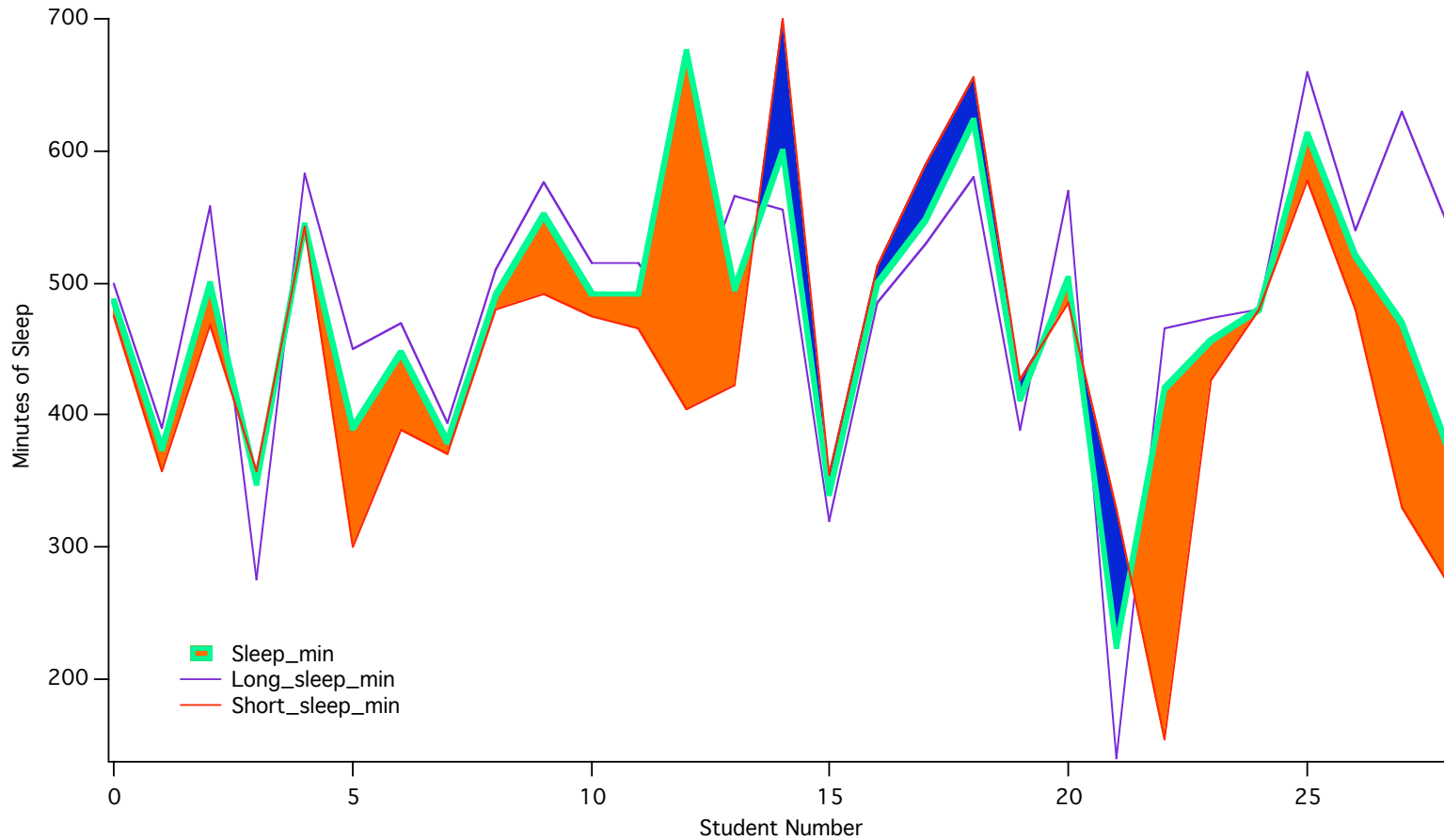


Pattern Recognition  
Creativity



Calculations

# Visualization's Value as a Reality Check





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# “Core” Principles for the Best Visual Displays (of Quantitative) Information

1. Clarity
2. Tailor to Audience
3. Optimize Display Design
4. Maximum Information, Minimum Mess
5. Consider Delivery Method (hardcopy, blackboard, web, PPT, movie vs. still)

QR46  
The Visual Display of  
Quantitative Information

Concluding Lecture:  
“Core Principles of QR46”

*Alyssa A. Goodman*  
*Professor of Astronomy*

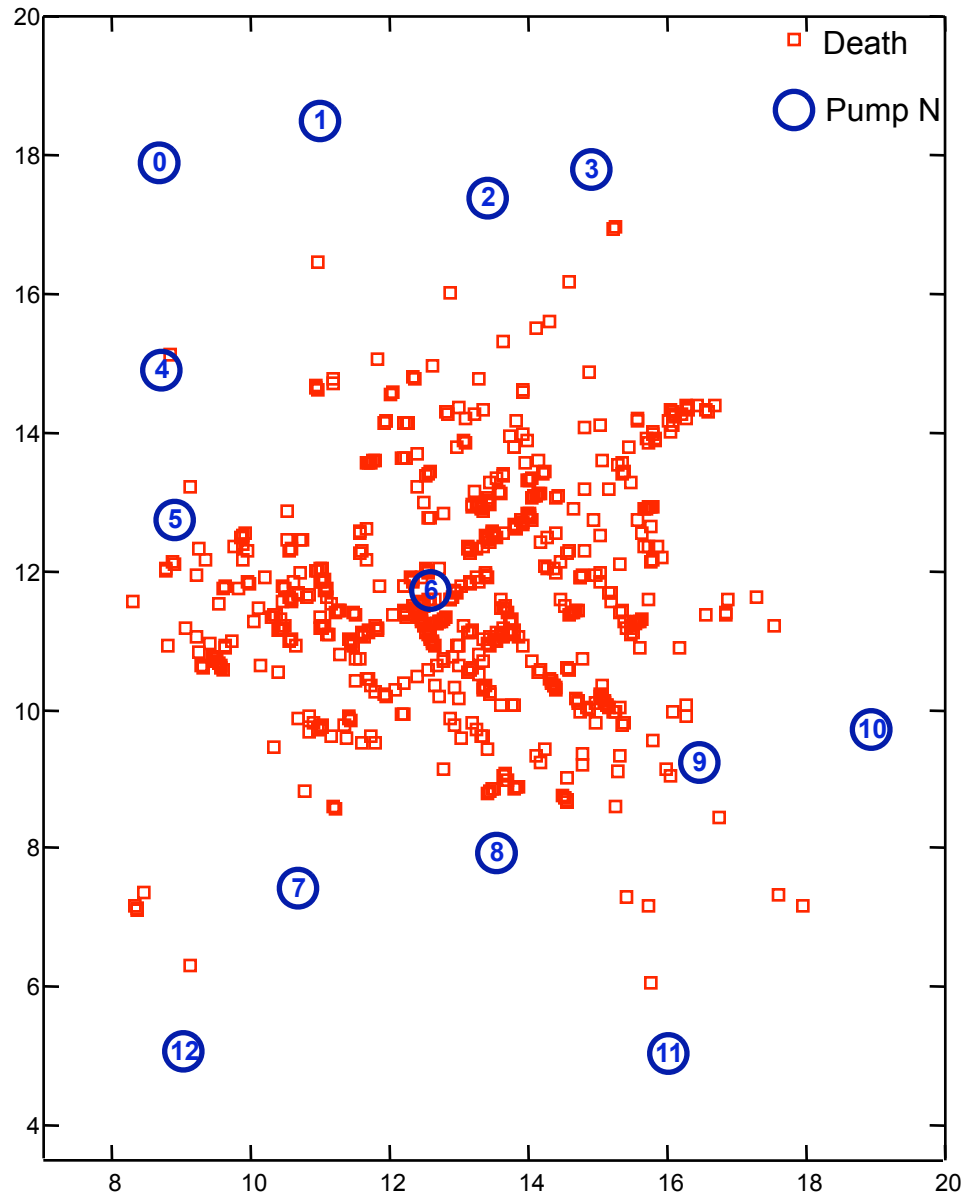
“Multifunctioning  
Graphical Elements”  
(more than one kind  
of display at once)



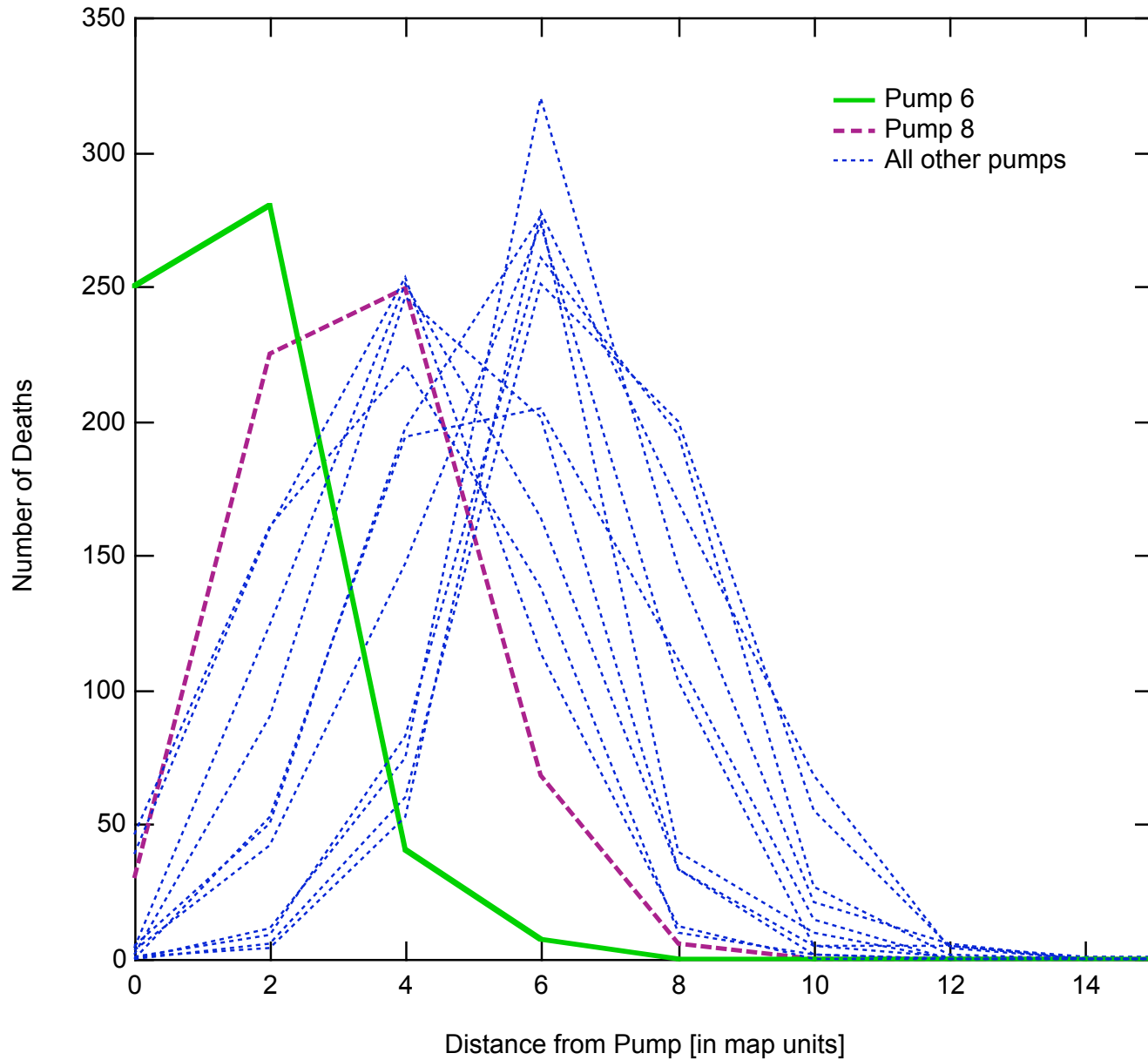
April 29, 2008

Reproduced from Visual and Statistical Thinking, ©E.R. Tufte 1997, based on Snow's drawing.

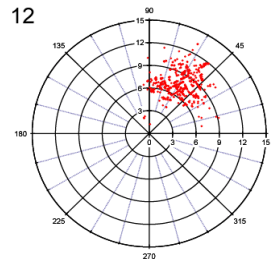
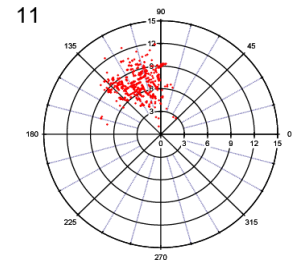
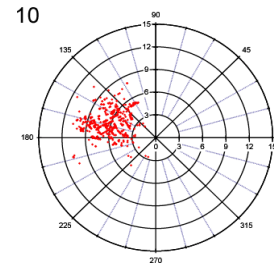
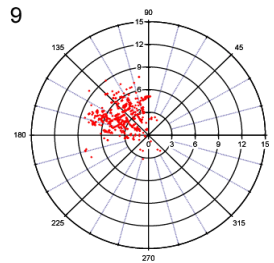
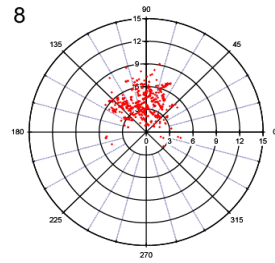
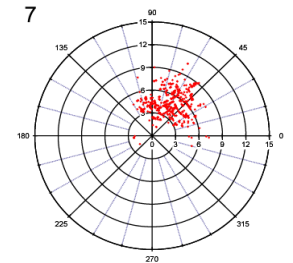
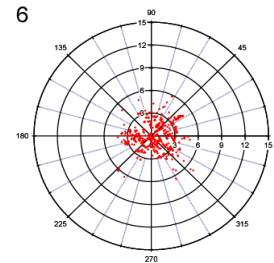
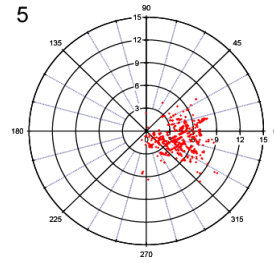
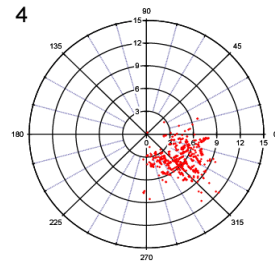
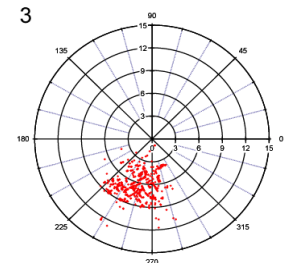
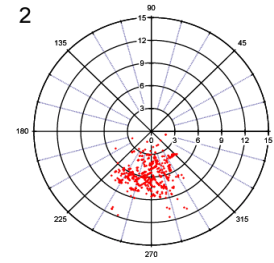
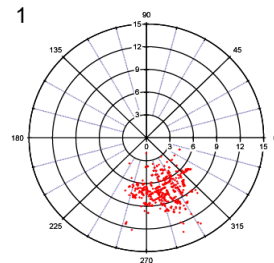
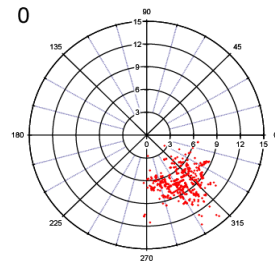
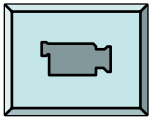
# (Graphing, Mapping & GIS



# Frequency Distributions



# Small Multiples vs. Movies

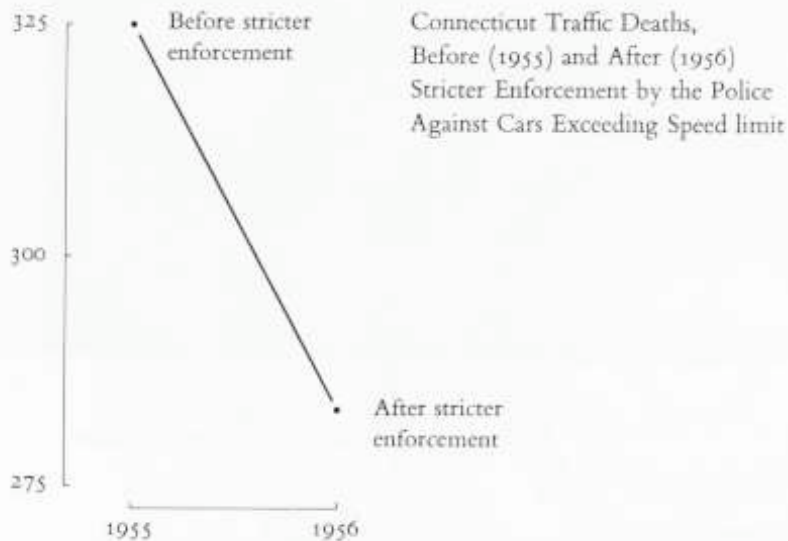


"Compared to What?"

# The Lie Factor

Graphics must not quote data out of context.

Nearly all the important questions are left unanswered by this display:



A few more data points add immensely to the account:



Tufte, 1970



# The Potential of Tables

CRIME	CARDINALE	LOPARO	MALONEY	POLISI	SENATORE	FORONJY	CURRO
MURDER	X	X					
ATTEMPTED MURDER		X	X				
HEROIN POSSESSION AND SALE	X	X		X			X
COCAINE POSSESSION AND SALE	X		X	X			
MARIJUANA POSSESSION AND SALE							X
GAMBLING BUSINESS		X		X		X	
ARMED ROBBERIES	X		X	X	X		X
LOANSHARKING		X		X			
KIDNAPPING			X	X			
EXTORTION			X	X			
ASSAULT	X		X	X			X
POSSESSION OF DANGEROUS WEAPONS	X	X	X	X	X		X
PERJURY		X				X	
COUNTERFEITING					X	X	
BANK ROBBERY			X	X			
ARMED HIJACKING				X	X		
STOLEN FINANCIAL DOCUMENTS			X	X	X		
TAX EVASION				X		X	
BURGLARIES	X	X		X	X		
BRIBERY		X		X			
THEFT: AUTO. MONEY, OTHER			X	X	X	X	X
BAIL JUMPING AND ESCAPE			X	X			
INSURANCE FRAUDS					X	X	
FORGERIES				X	X		
PISTOL WHIPPING A PRIEST	X						
SEXUAL ASSAULT ON MINOR							X
RECKLESS ENDANGERMENT							X

# Composite Table

**Table 1: Summary of VLA NH<sub>3</sub> Observations in Low-Mass Dense Cores as of 1994**  
(double-boxed sources to be observed in this proposal)

Source	Central Source	Outflow	Year of Obs'v'n.	Relationship of VLA NH <sub>3</sub> to Central Source	Comments (all observations are by the current proposers, unless otherwise indicated)
L1172	★		1984		
L1551	★		1989		Torrelles et al. 1985.
L1152	★		1988		improve sensitivity and extend map with proposed observations
TMC-1A (≡ L1534)	★		1988		improve sensitivity with proposed observations
B335	★		1990		Keene, Menten & Masson, in prep.
L1689N	NO	NO	1985		Wooten and Loren 1987. Star shown at left (w/outflow) not within primary beam of observation.
AQ13	NO	?	1988		noise higher in on-line channels, suggestive of signal
B217	NO	NO	1983		relatively poor sensitivity
L1582	★	?	1984		
L1498	NO	NO	1984		
B5	★		1985		relatively poor sensitivity
B1	★		1988		relatively poor sensitivity

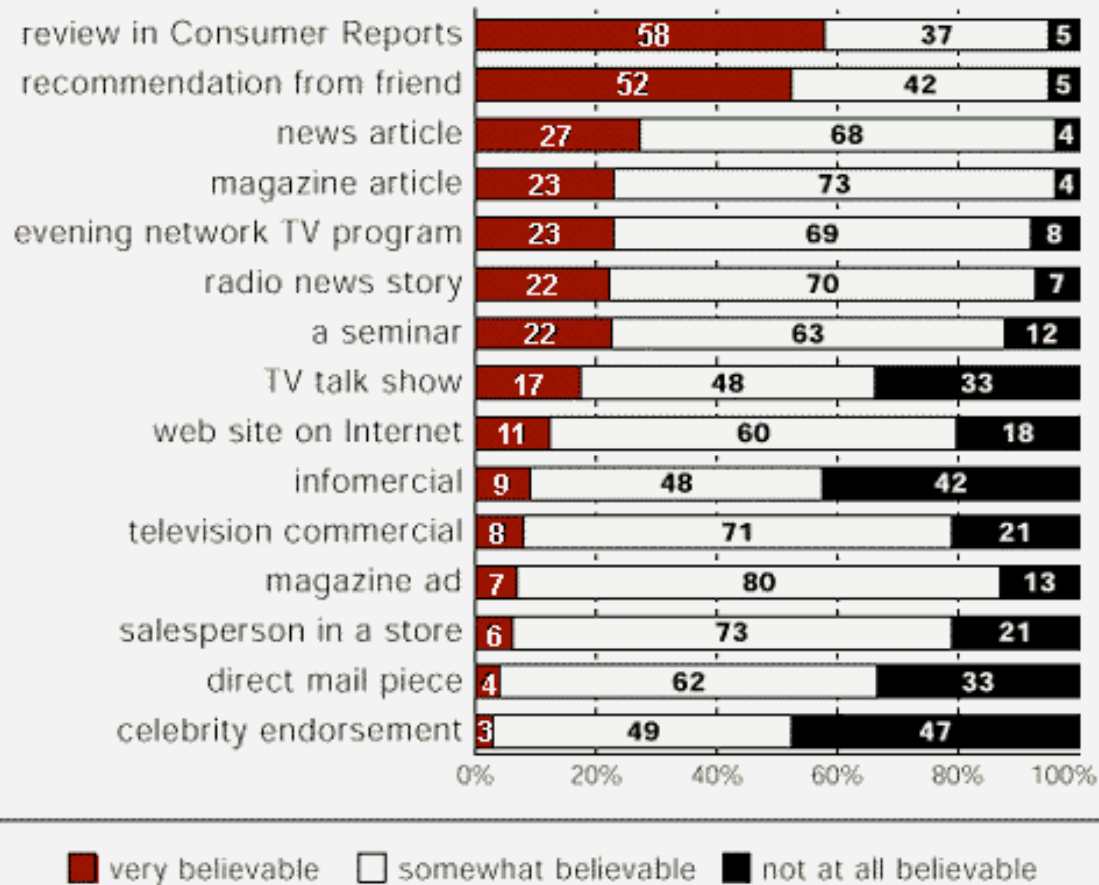
*New Sources to be Observed in this Proposal*

L1527	★		1995		infall candidate
L483	★		1995		infall candidate
B133	NO	NO	1995		strong extended sub-mm continuum, no known point source

\*determination is unclear from existing data

# Ranks & Distributions

**BELIEVABILITY OF SOURCES**  
FOR INFORMATION ABOUT PRODUCTS/SERVICES



Source: <http://wirthlin.webaxxs.com>

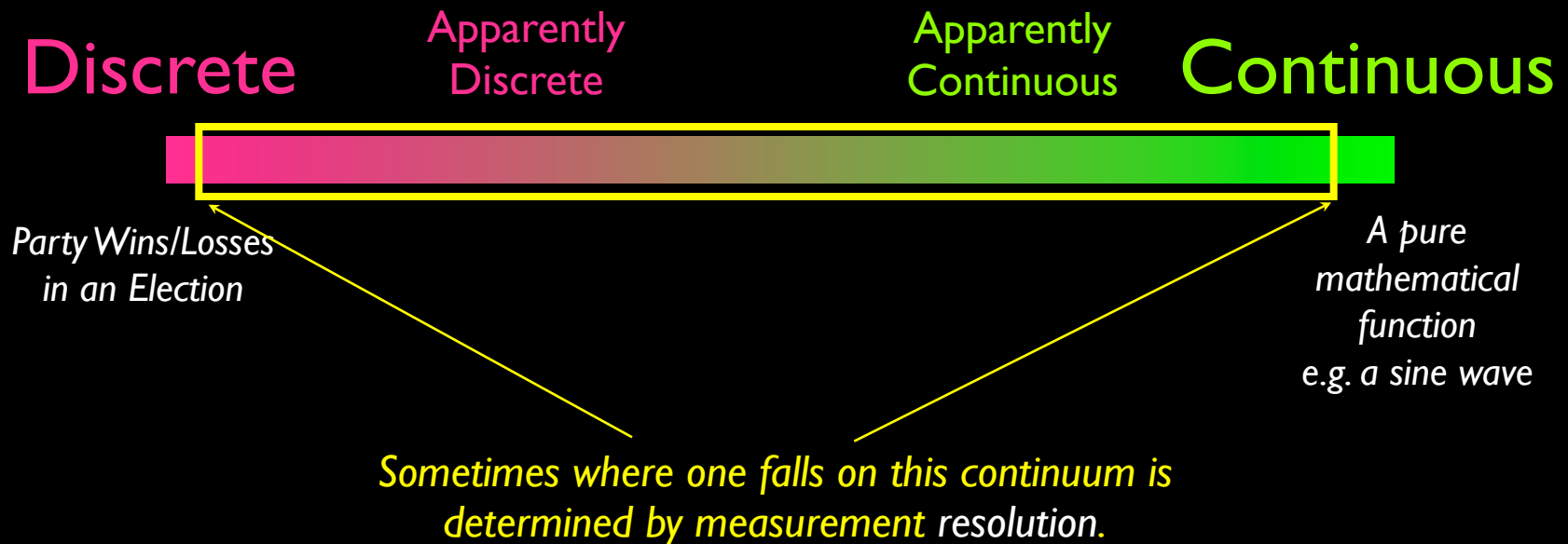
# Discrete & Continuous Quantities



*Party Wins/Losses  
in an Election*

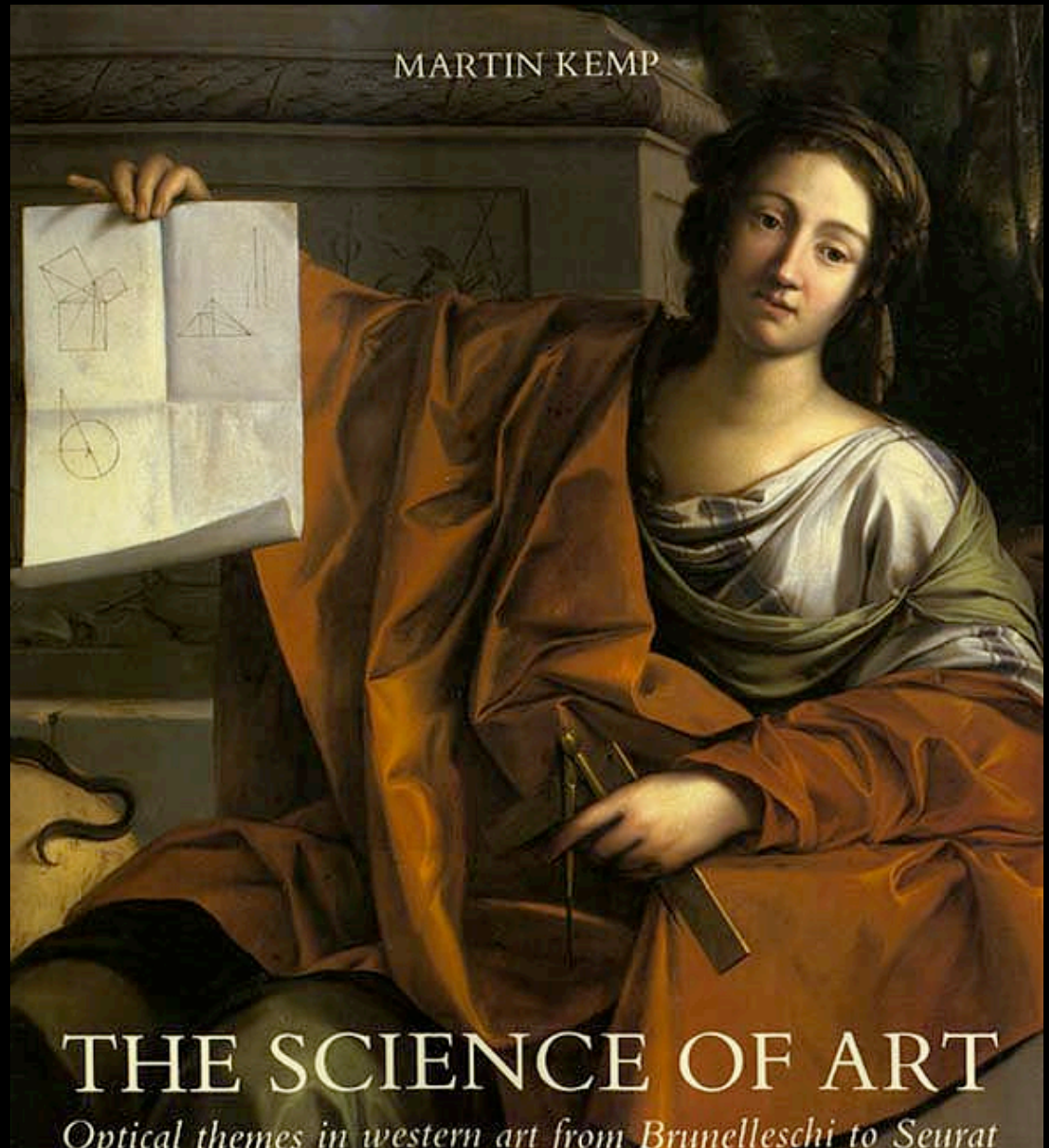
*A pure  
mathematical  
function  
e.g. a sine wave*

# Discrete & Continuous Quantities

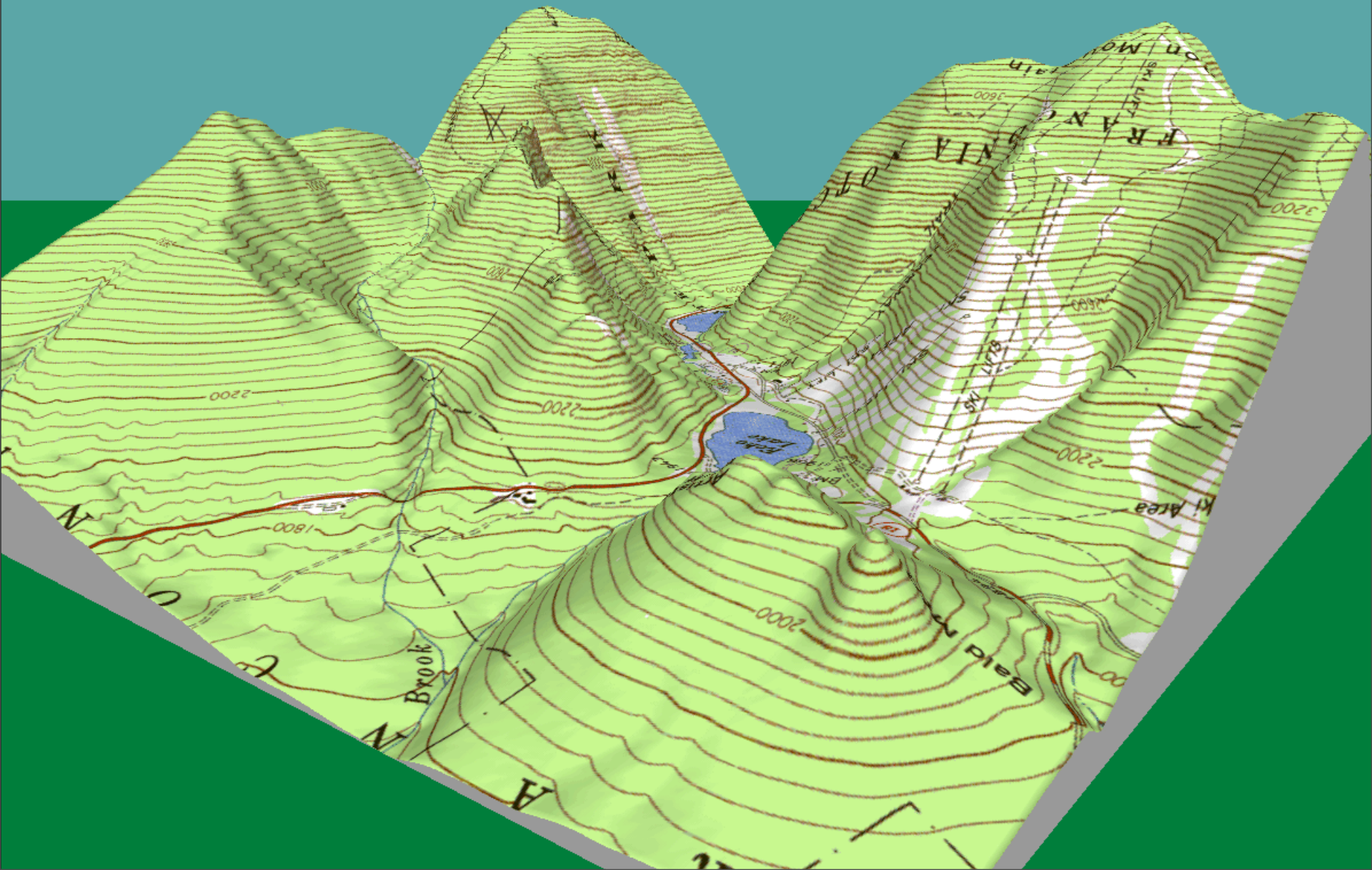


# Drawing 3D in 2D

## Perspective, Shading & Occlusion

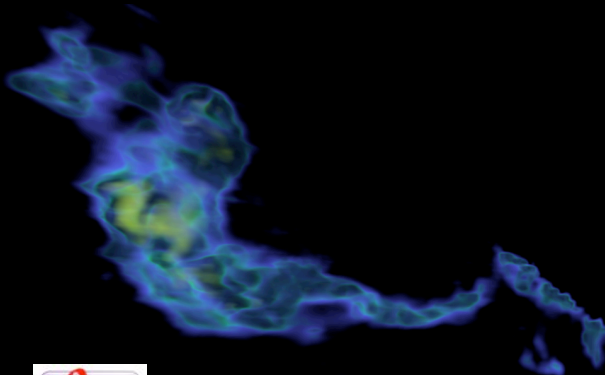


# Countour Map on Volumetric Rendering ...perspective, shading & occlusion...



# Modern Form Factor Options: Beyond Paper

3D rendering in 2D



3D in stereo 2D



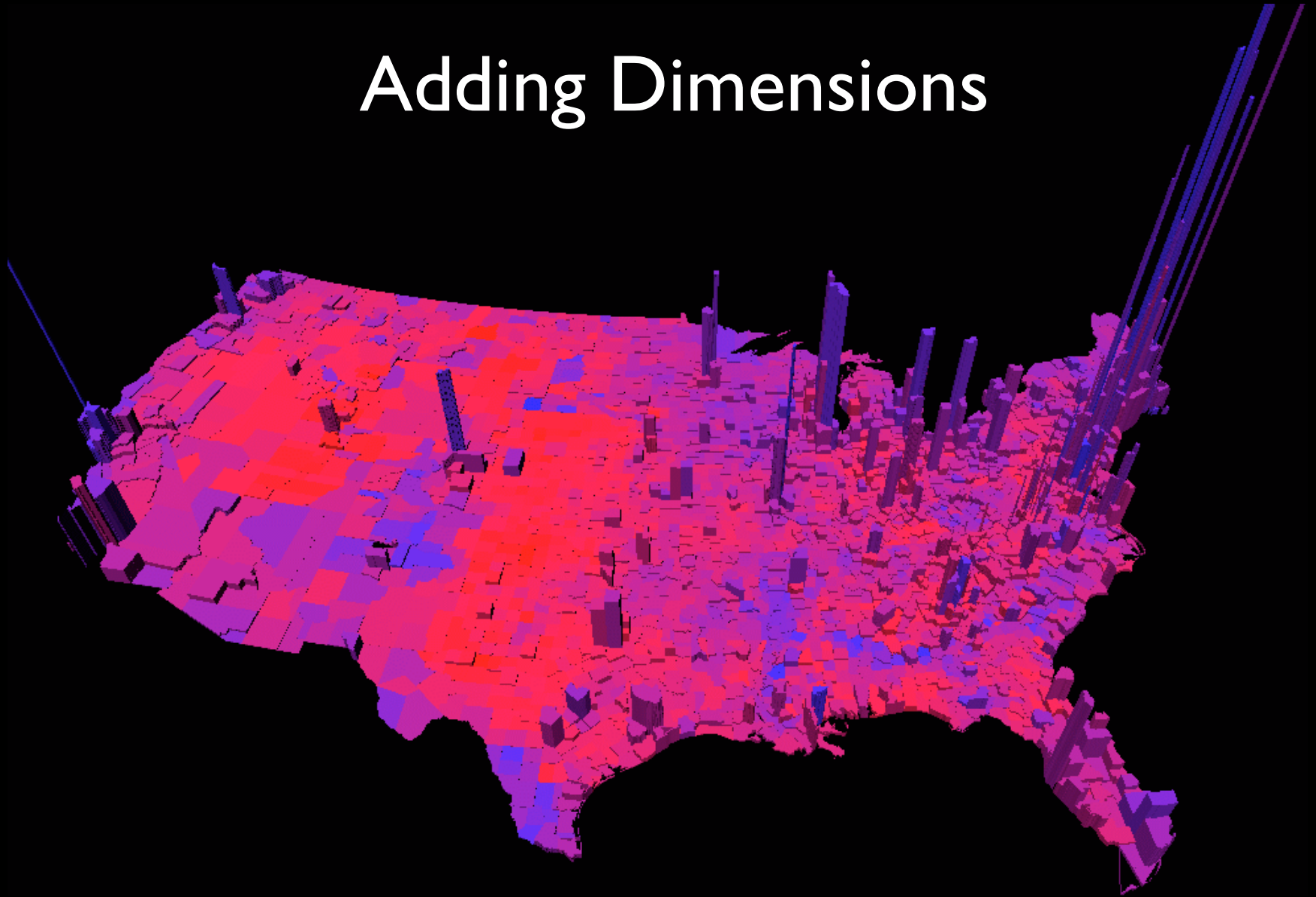
3D in 3D



+ choices about: moving vs. non-moving, interactive vs. non-interactive & interaction “devices”



# Adding Dimensions



April 29, 2008

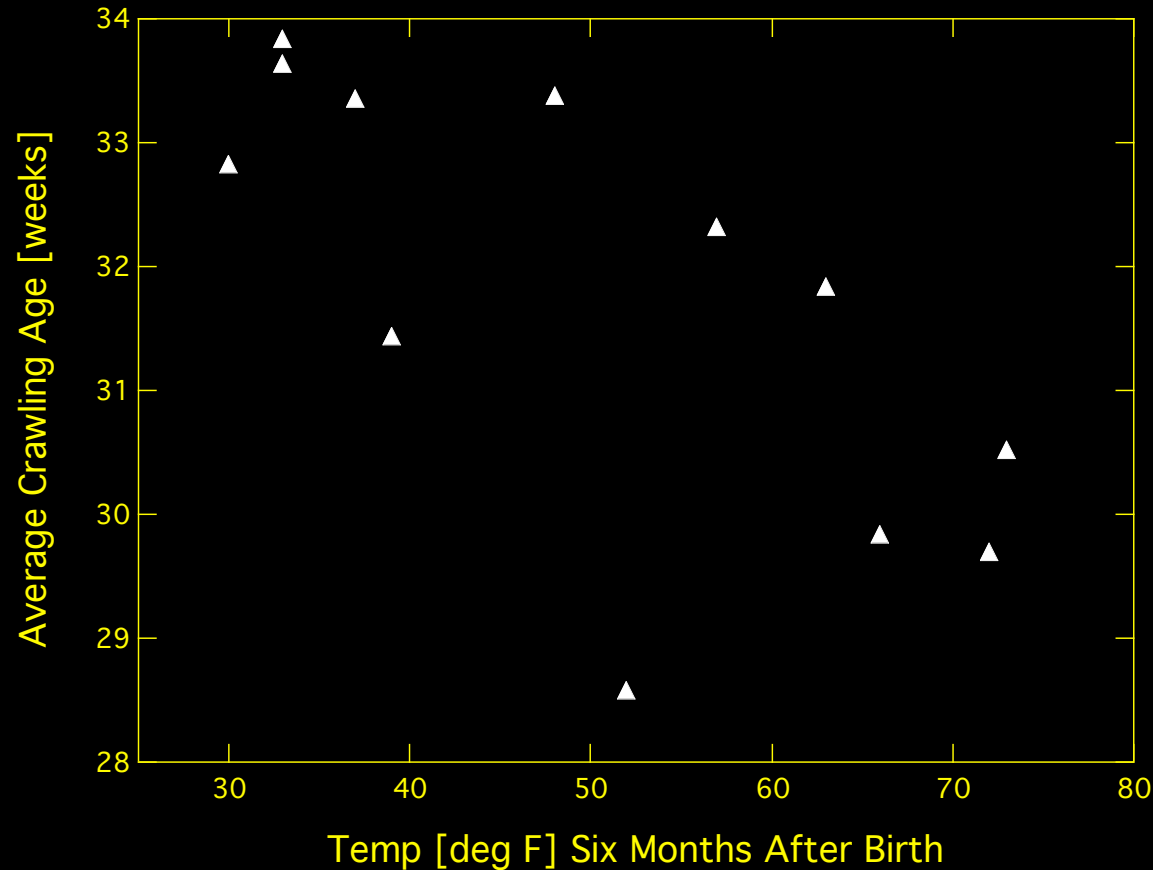
Harvard QR46

# How much is too much?

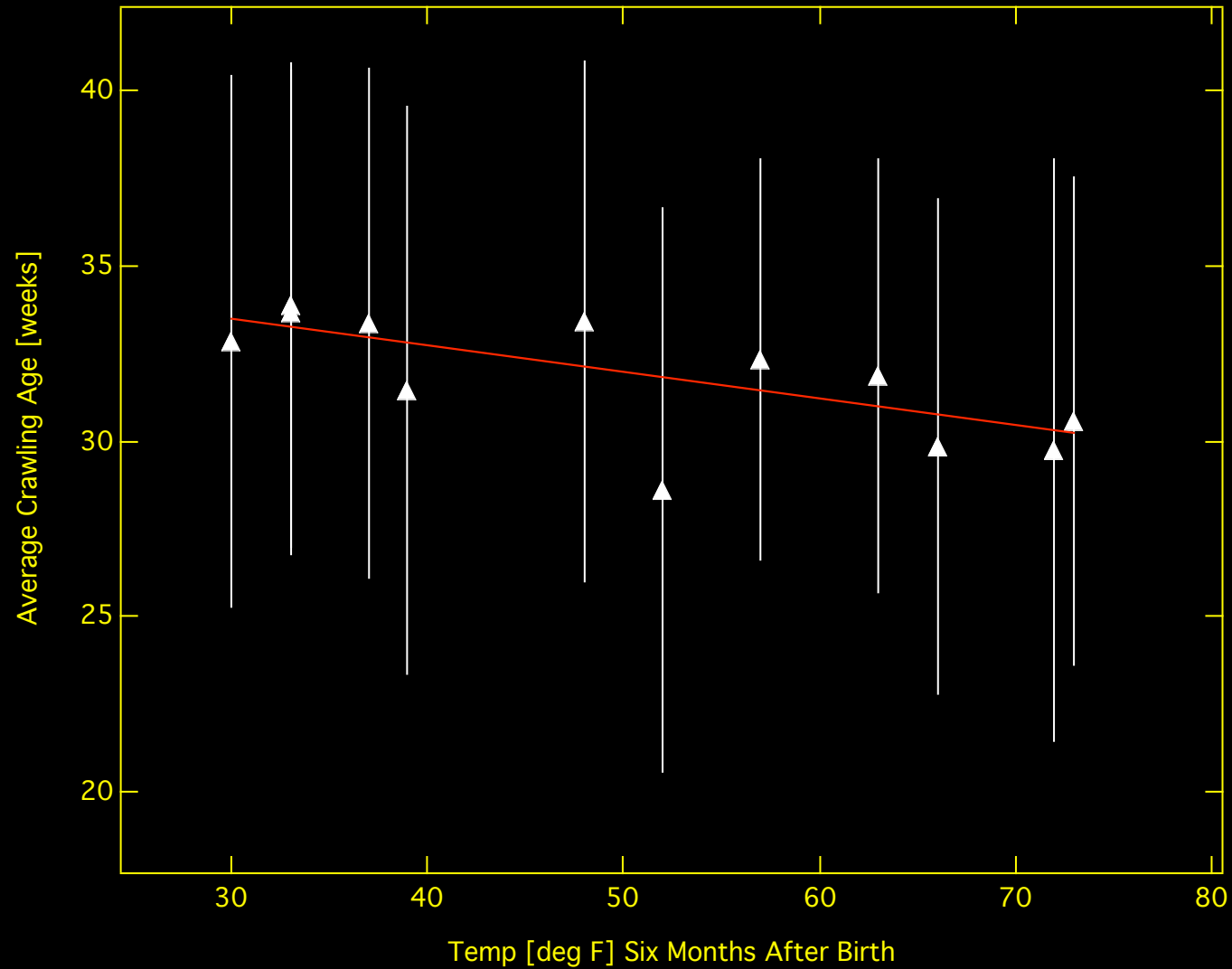


# A Trend?

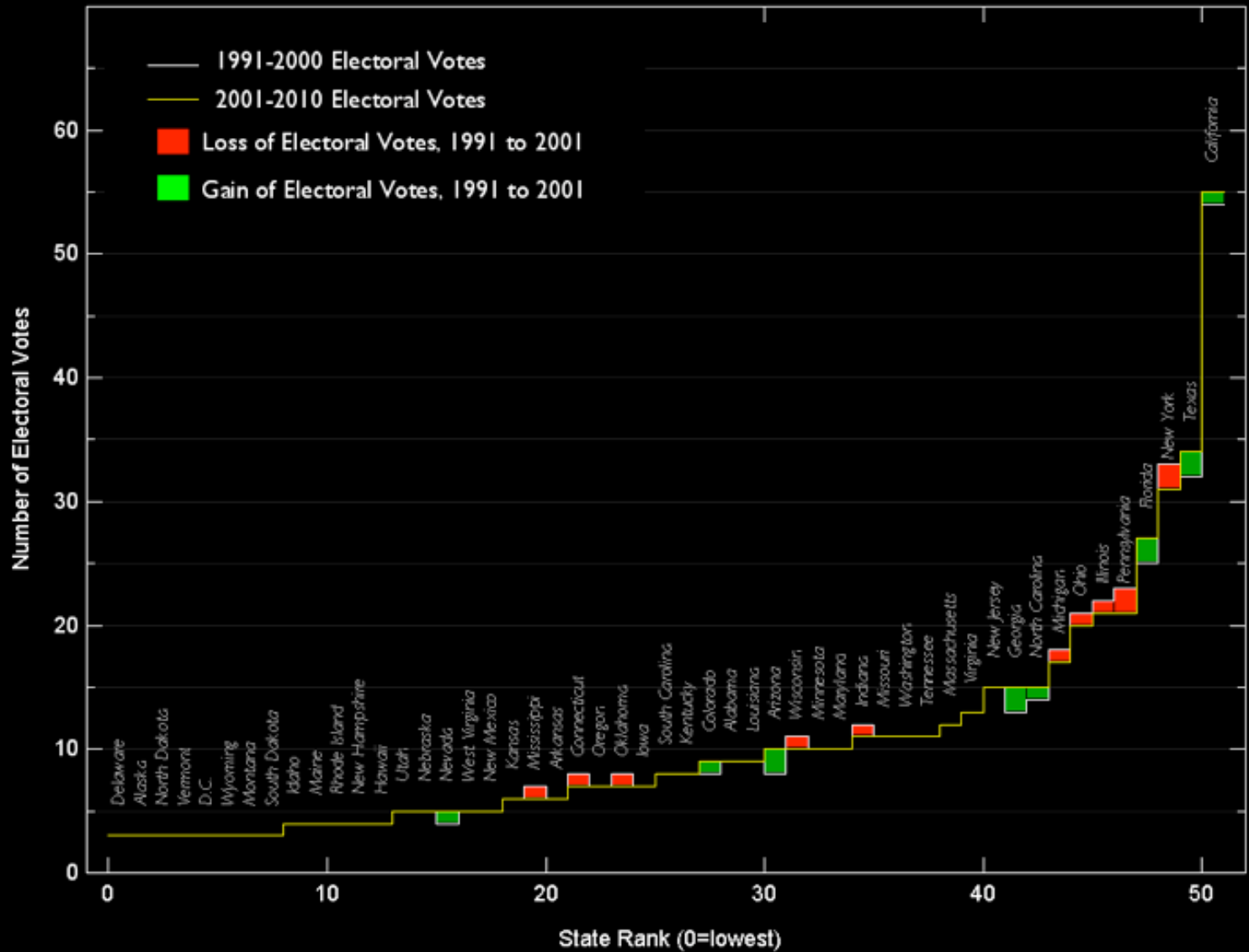
## What are the Uncertainties?

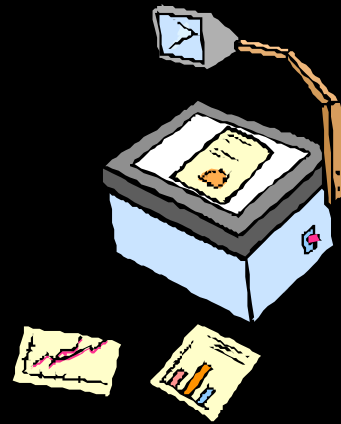
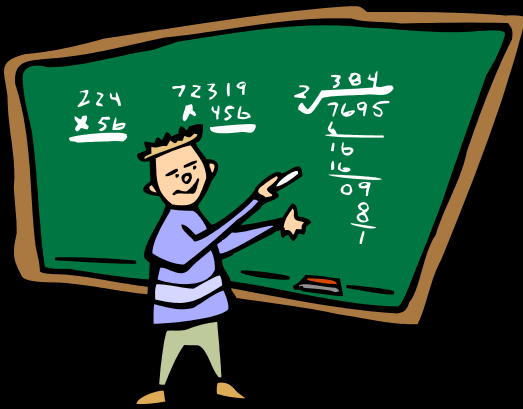


# The Value of Error Bars

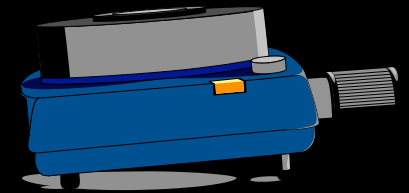


# The Value of Labeling





# Presentation Format Choices

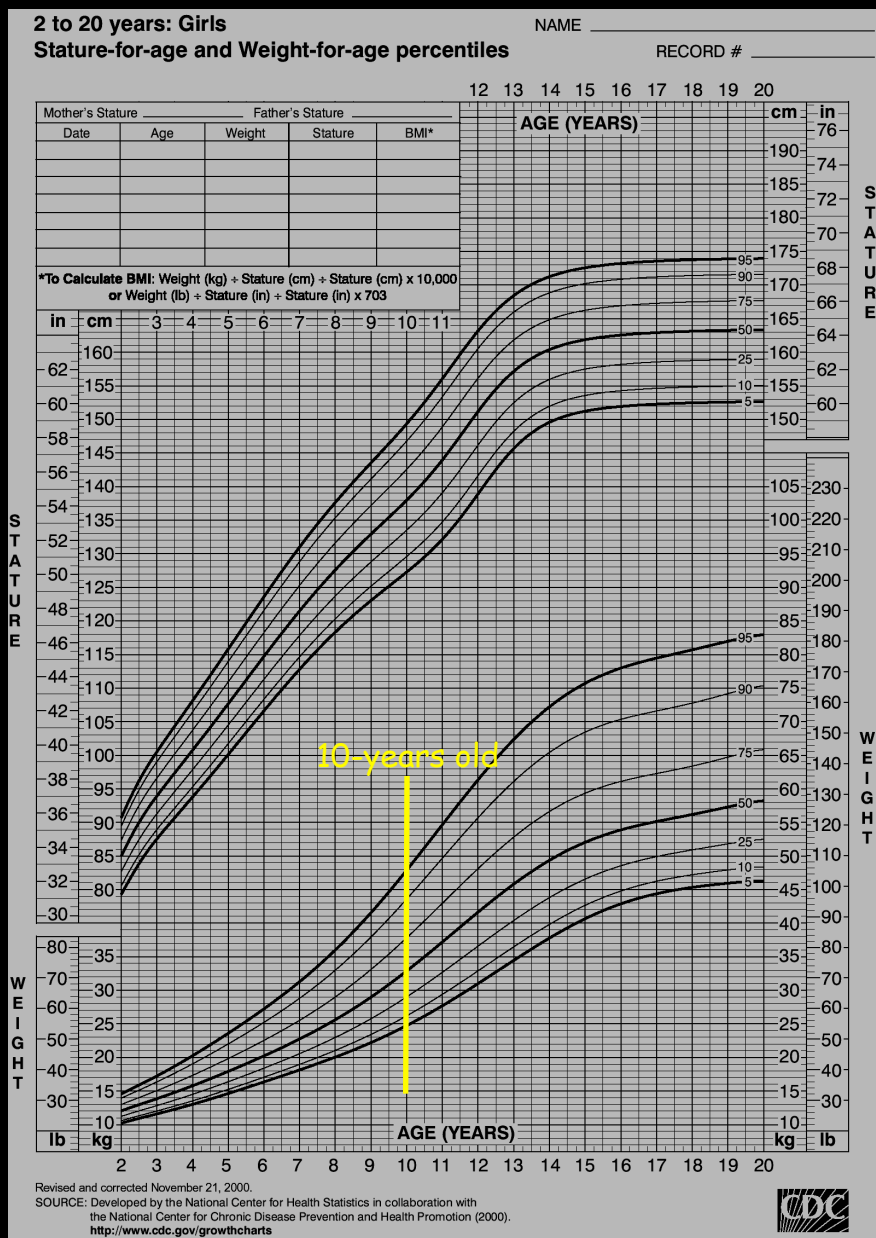


# PowerPoint Doesn't Kill Presentations, Bullets Do.

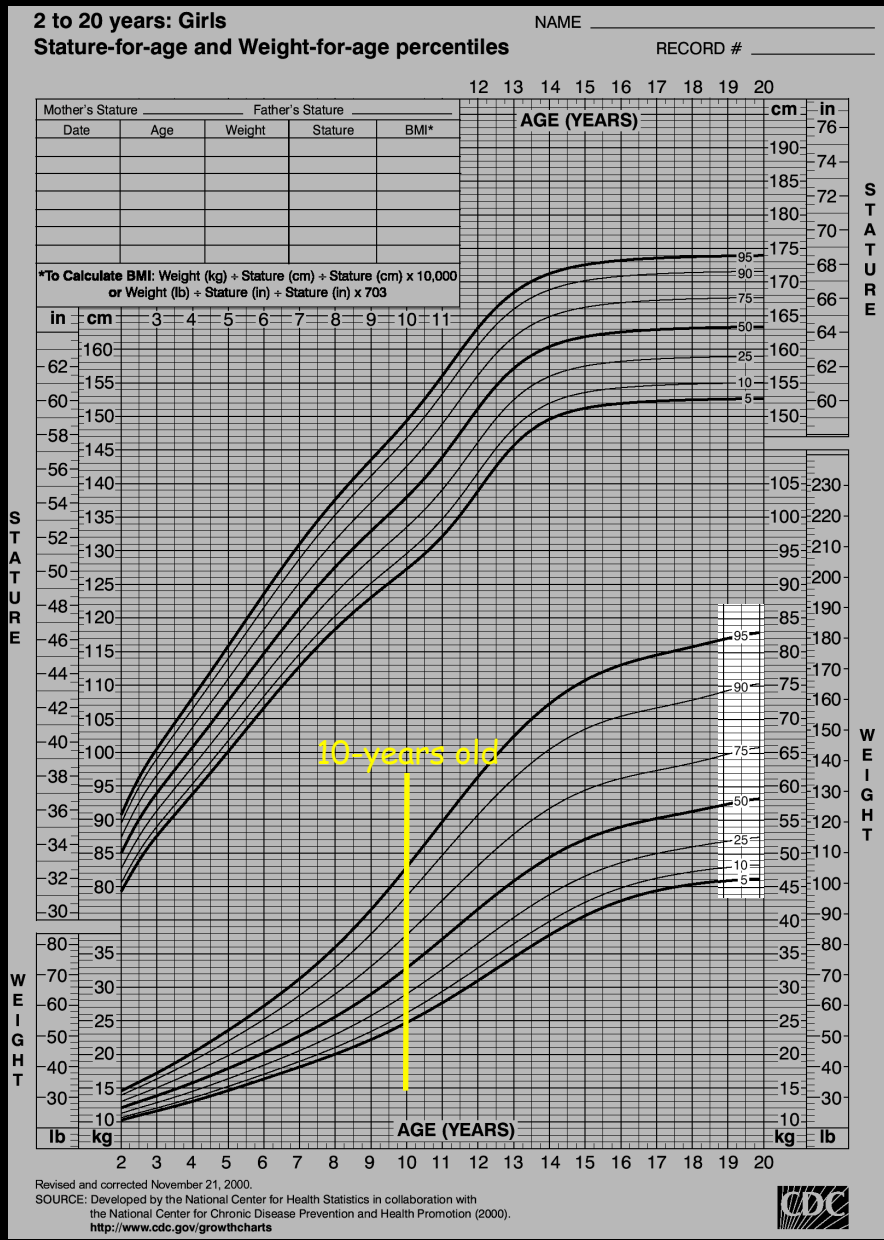




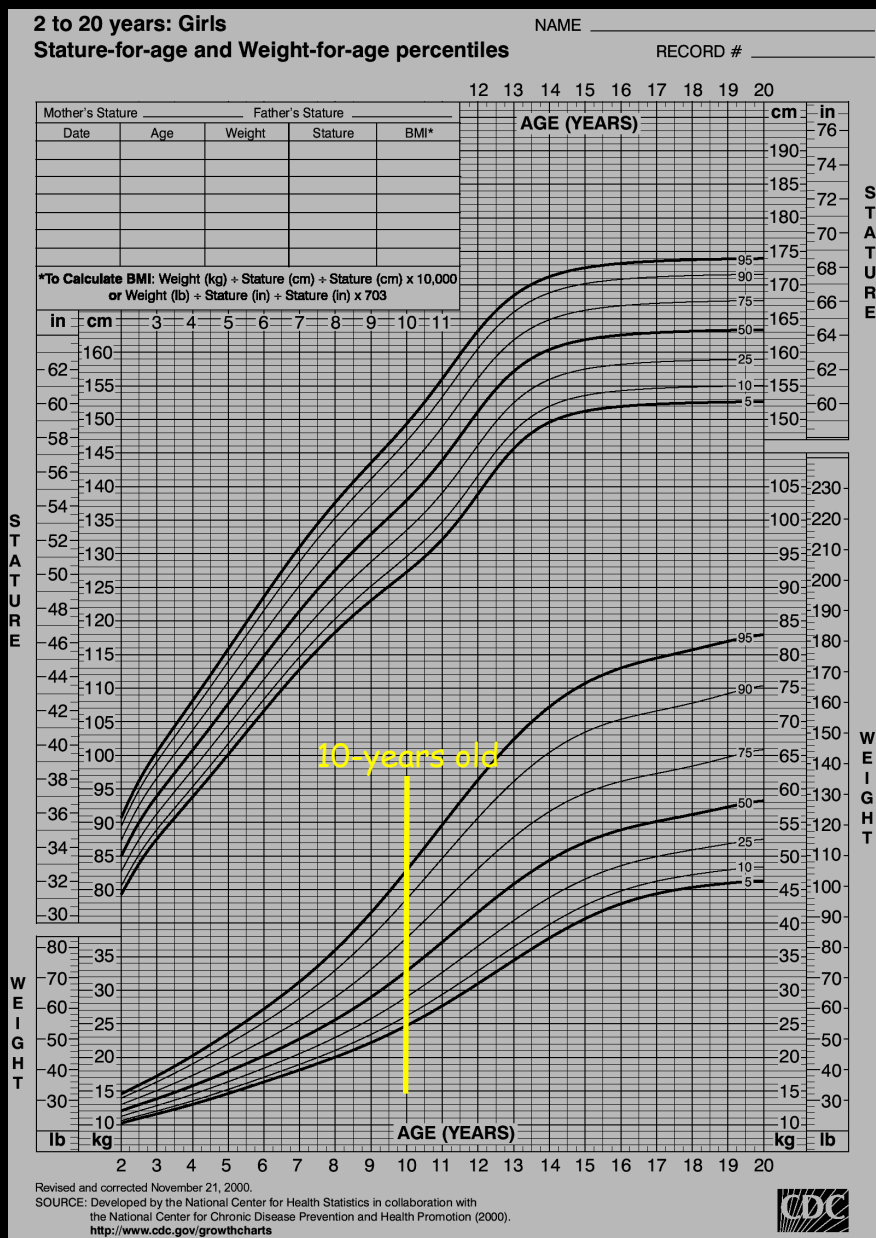
“General-Specific-General”



“General-Specific-General”



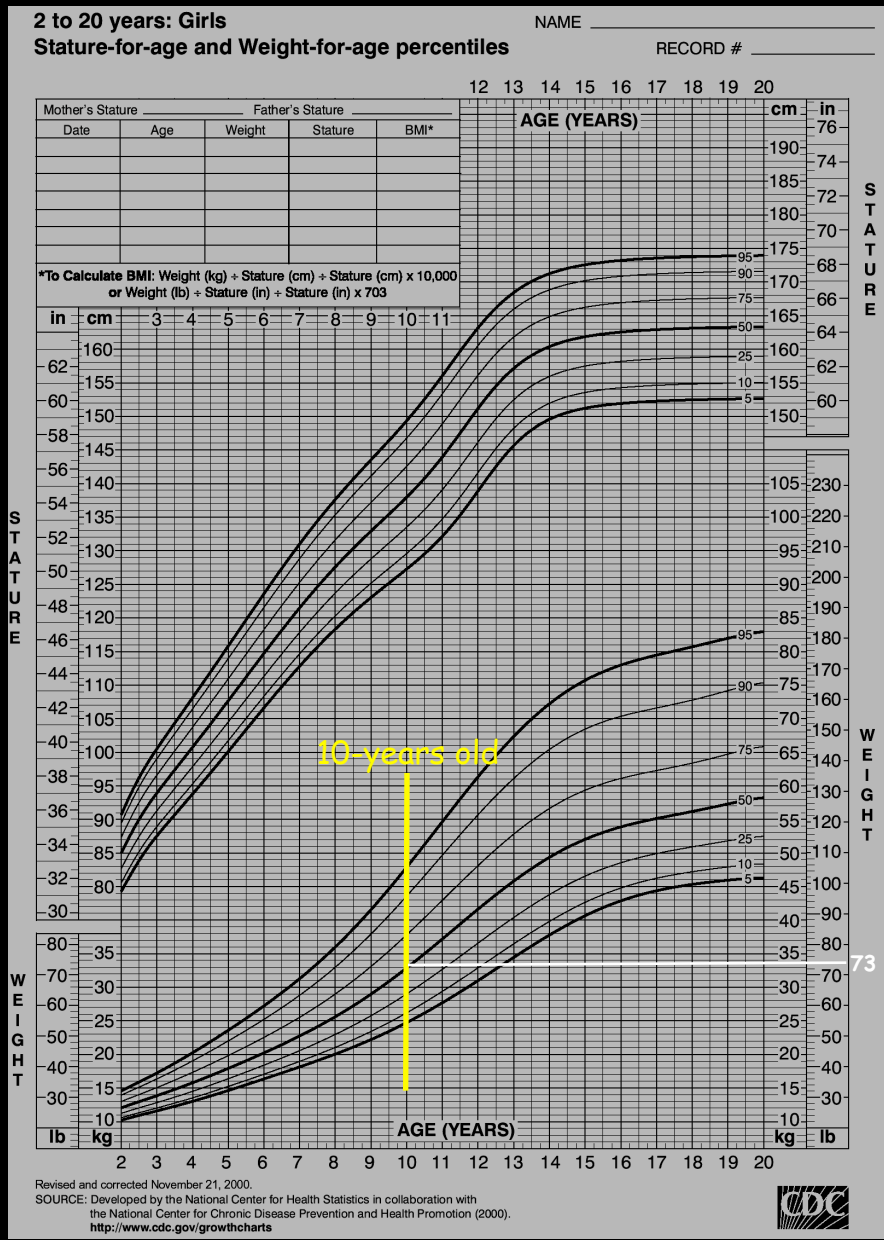
“General-Specific-General”



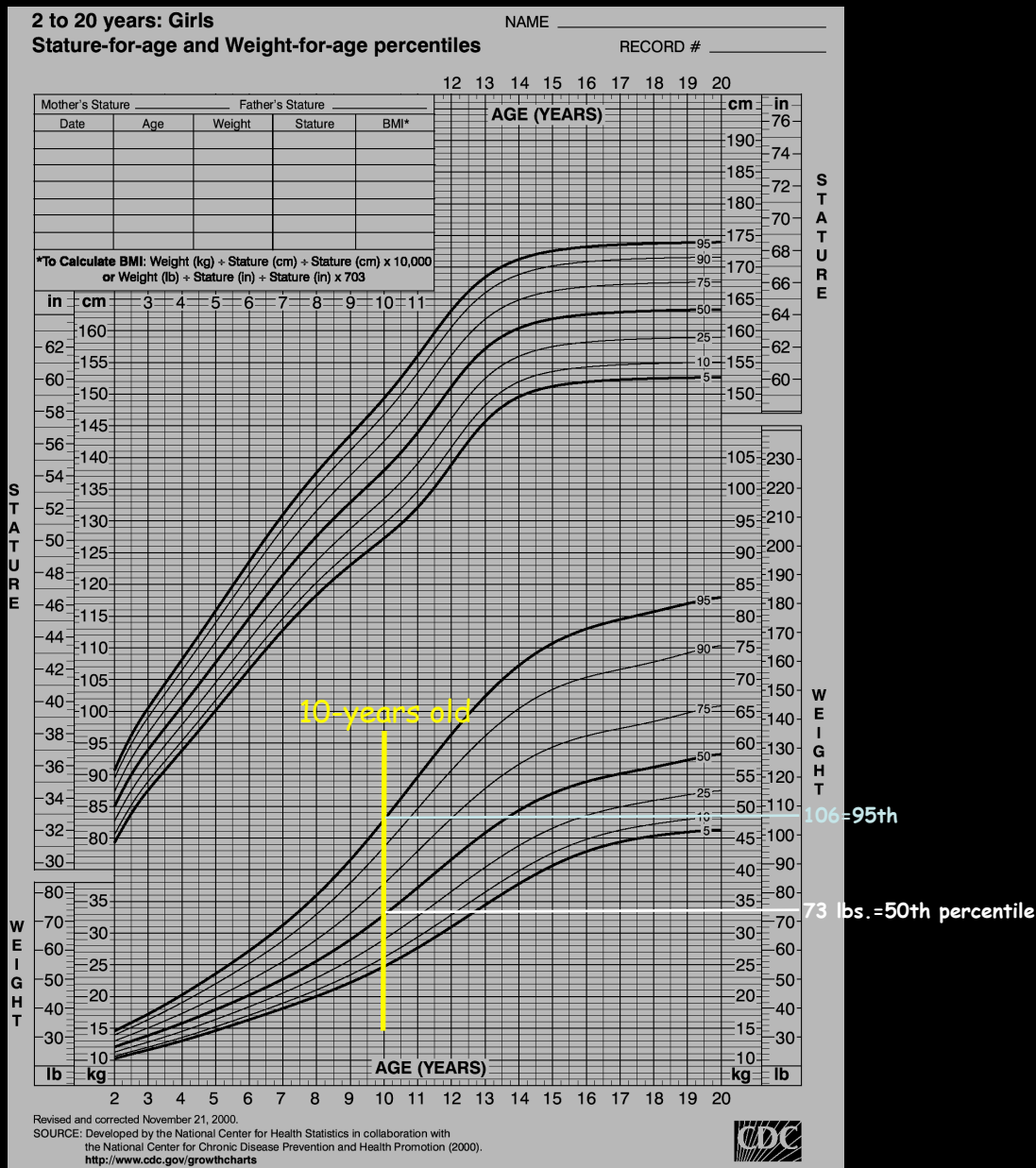
Revised and corrected November 21, 2000.  
SOURCE: Developed by the National Center for Health Statistics in collaboration with  
the National Center for Chronic Disease Prevention and Health Promotion (2000).  
<http://www.cdc.gov/growthcharts>



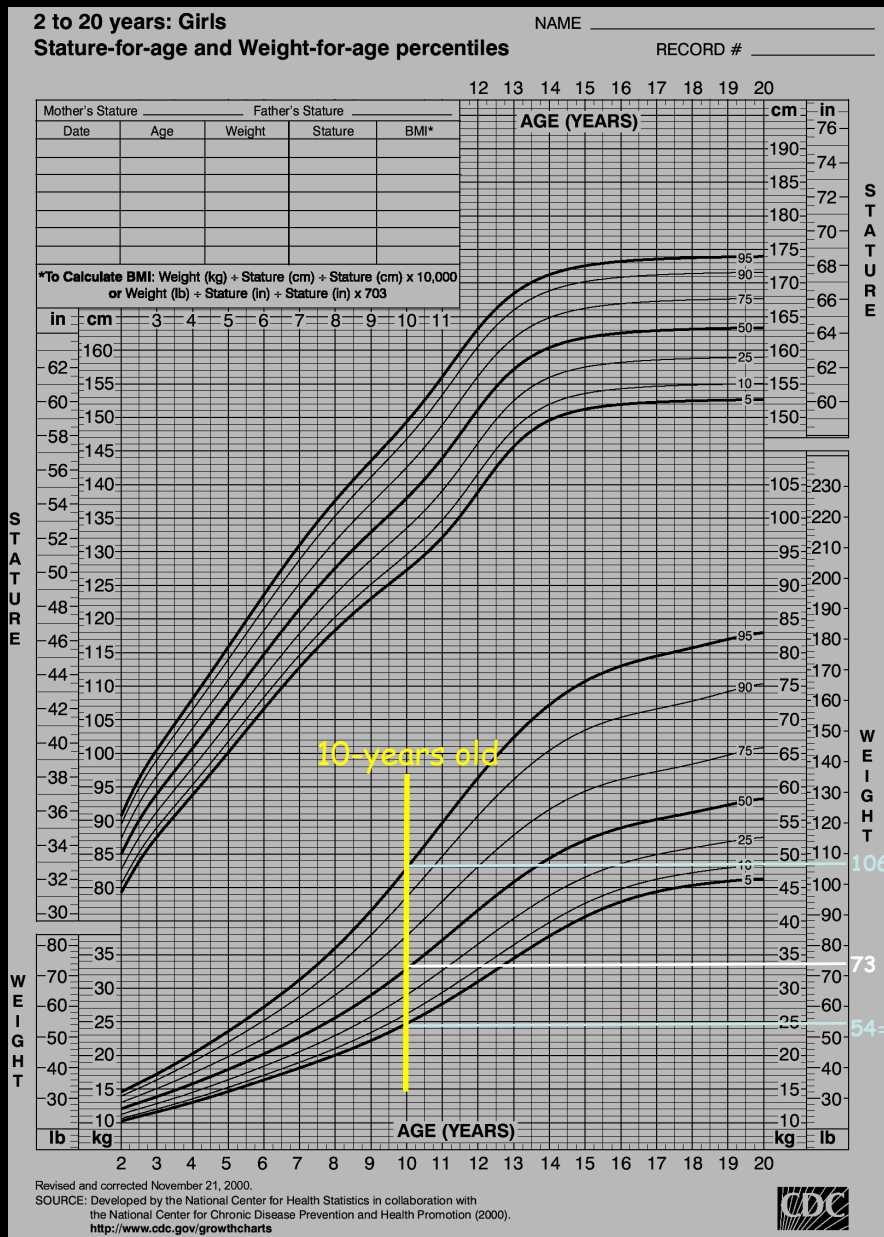
“General-Specific-General”



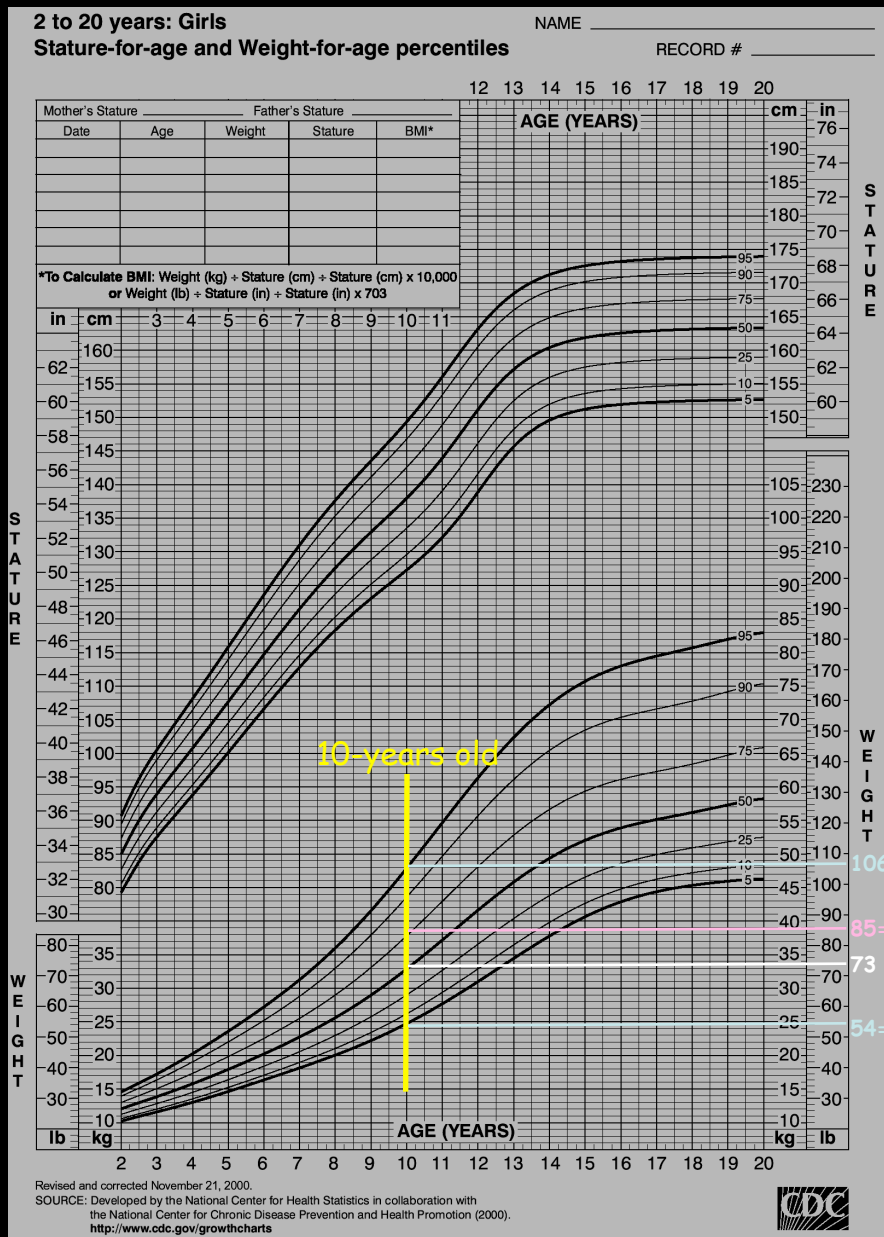
“General-Specific-General”



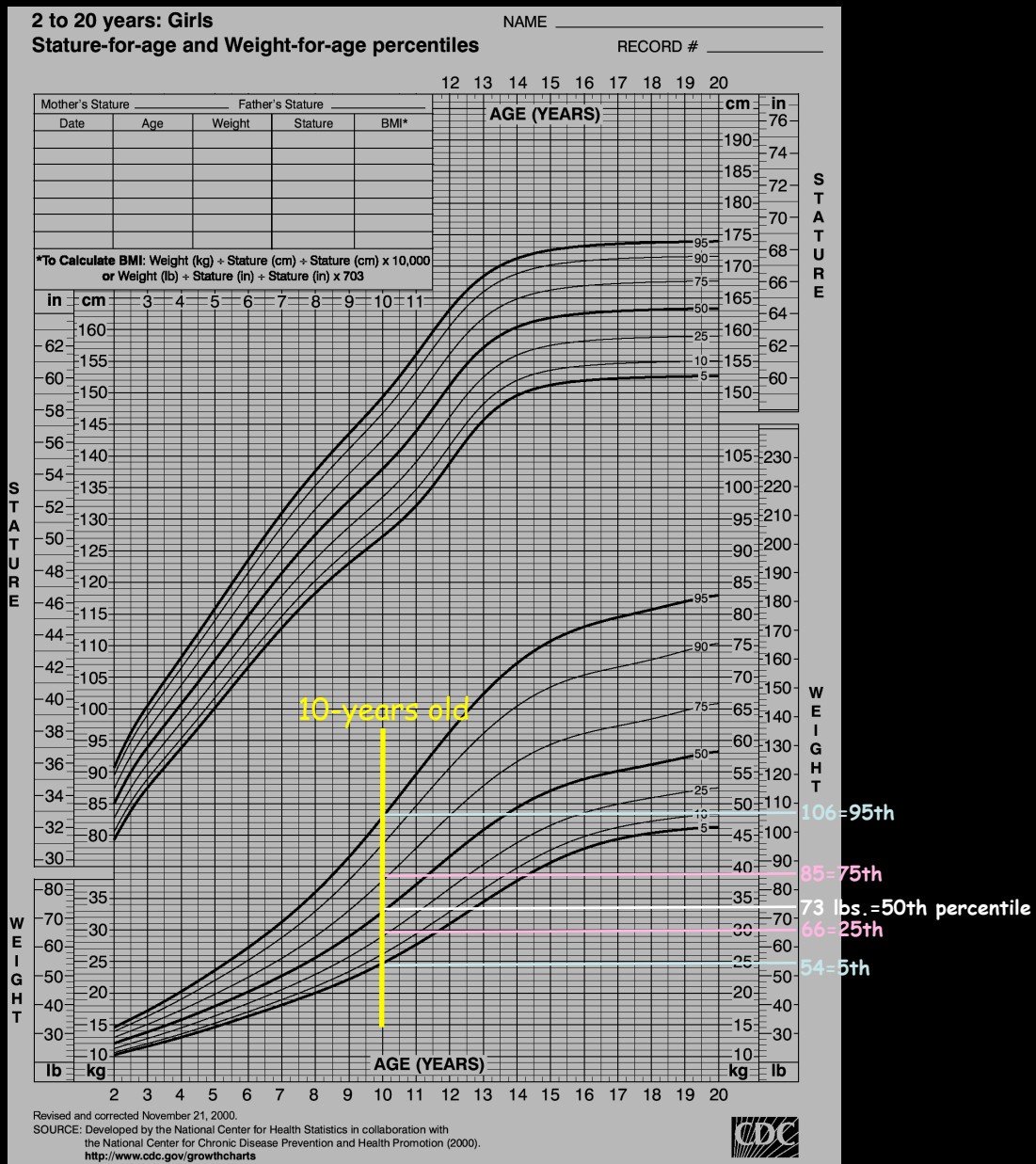
“General-Specific-General”



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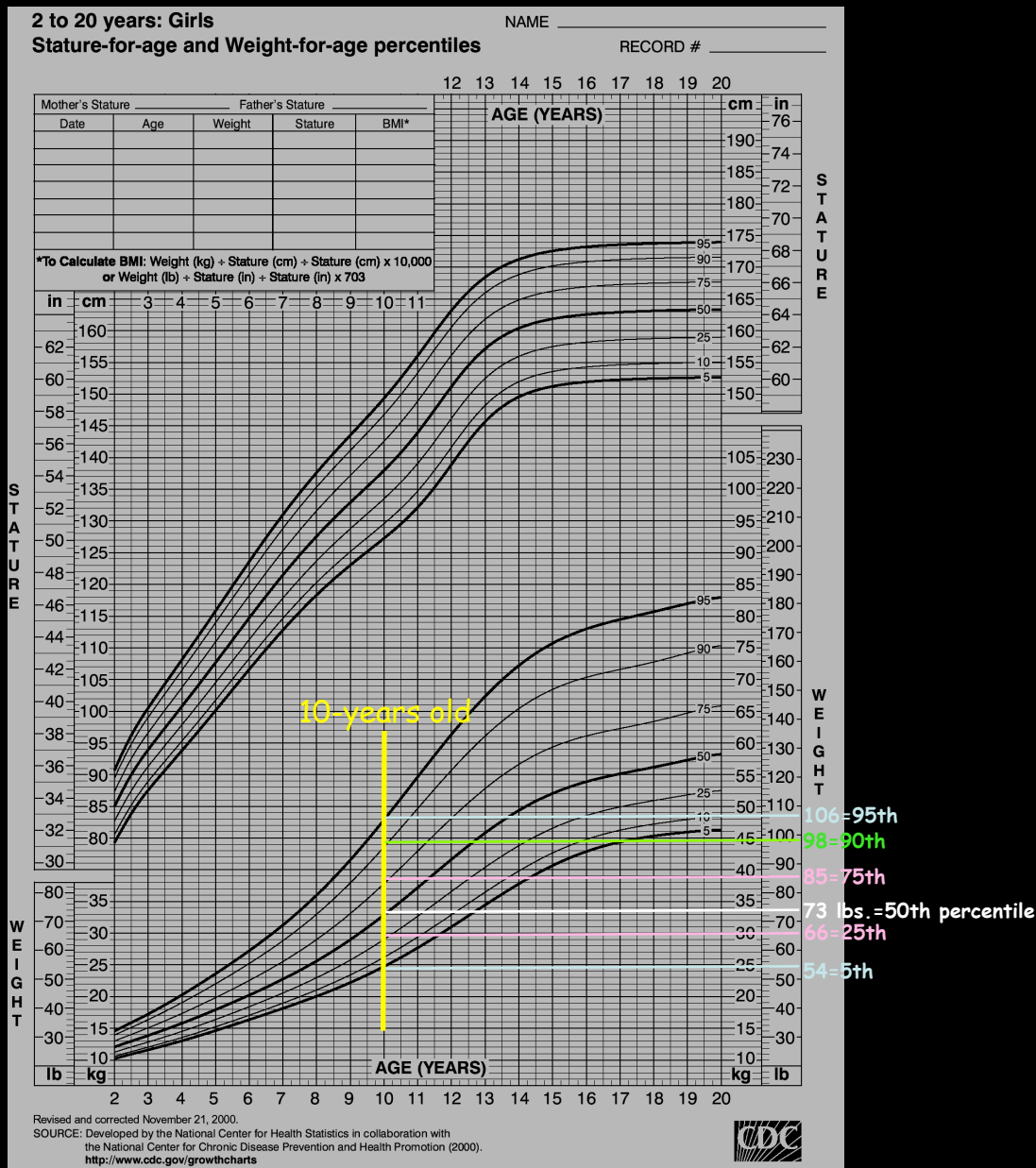


“General-Specific-General”

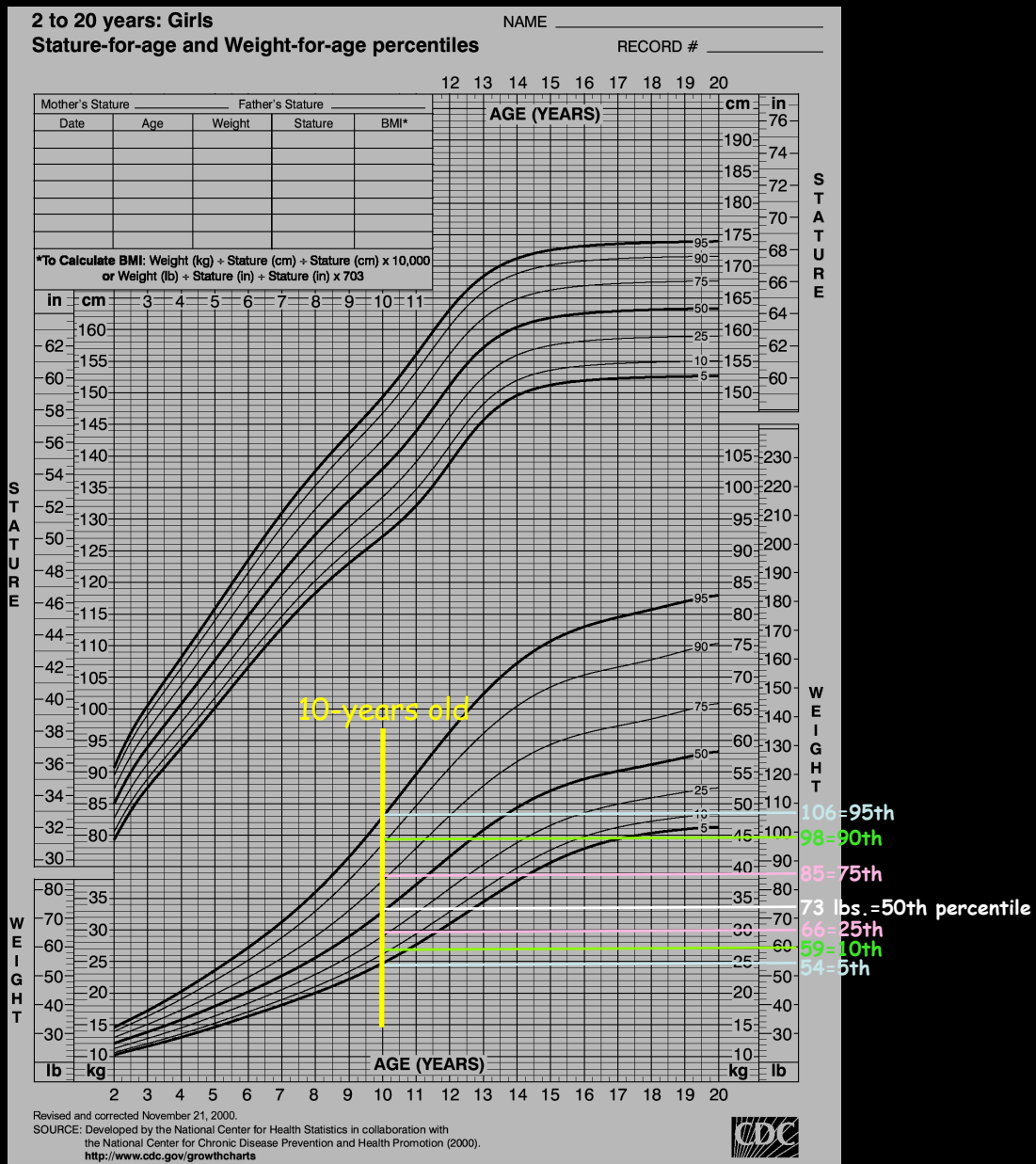




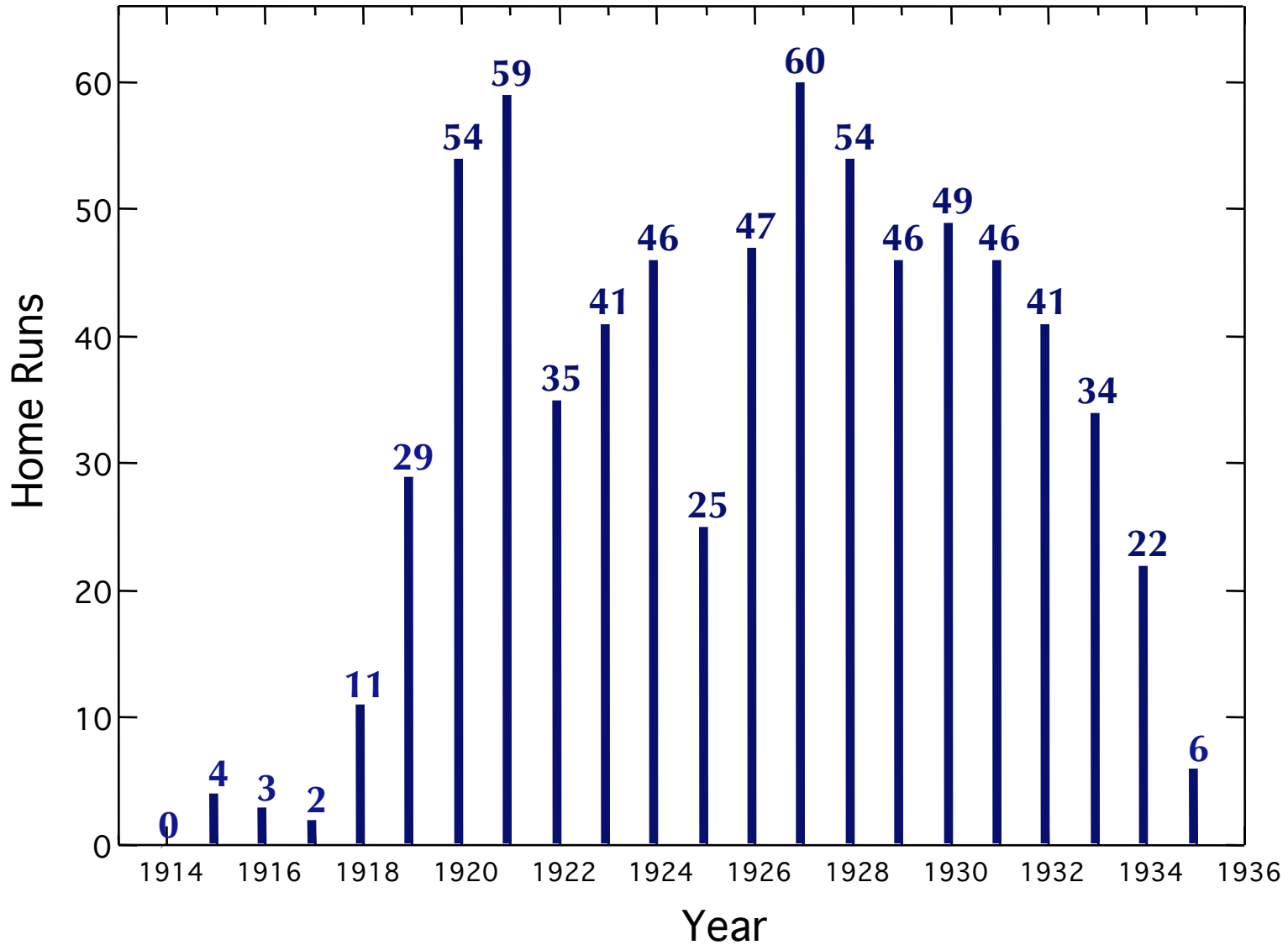
“General-Specific-General”



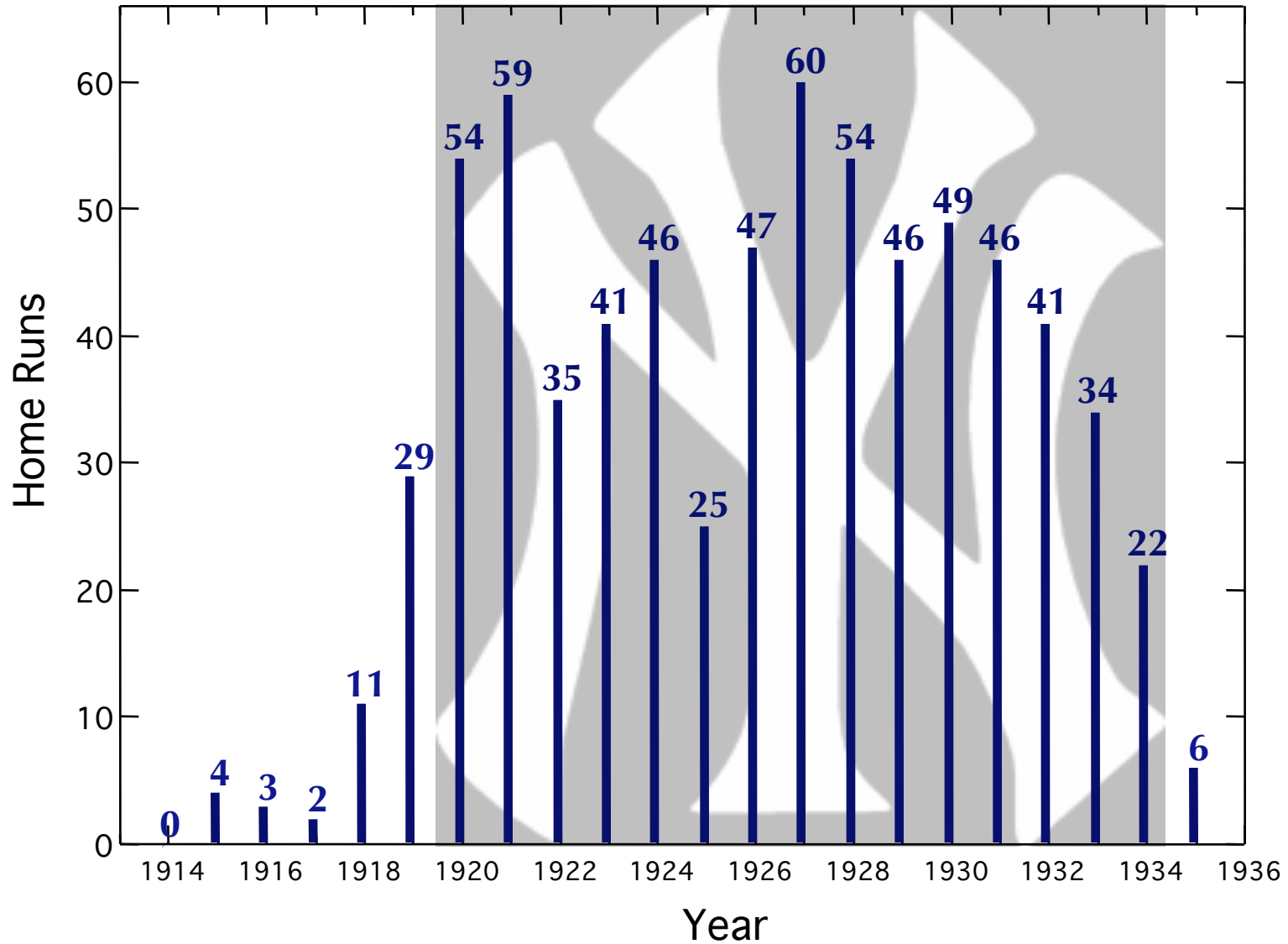
“General-Specific-General”



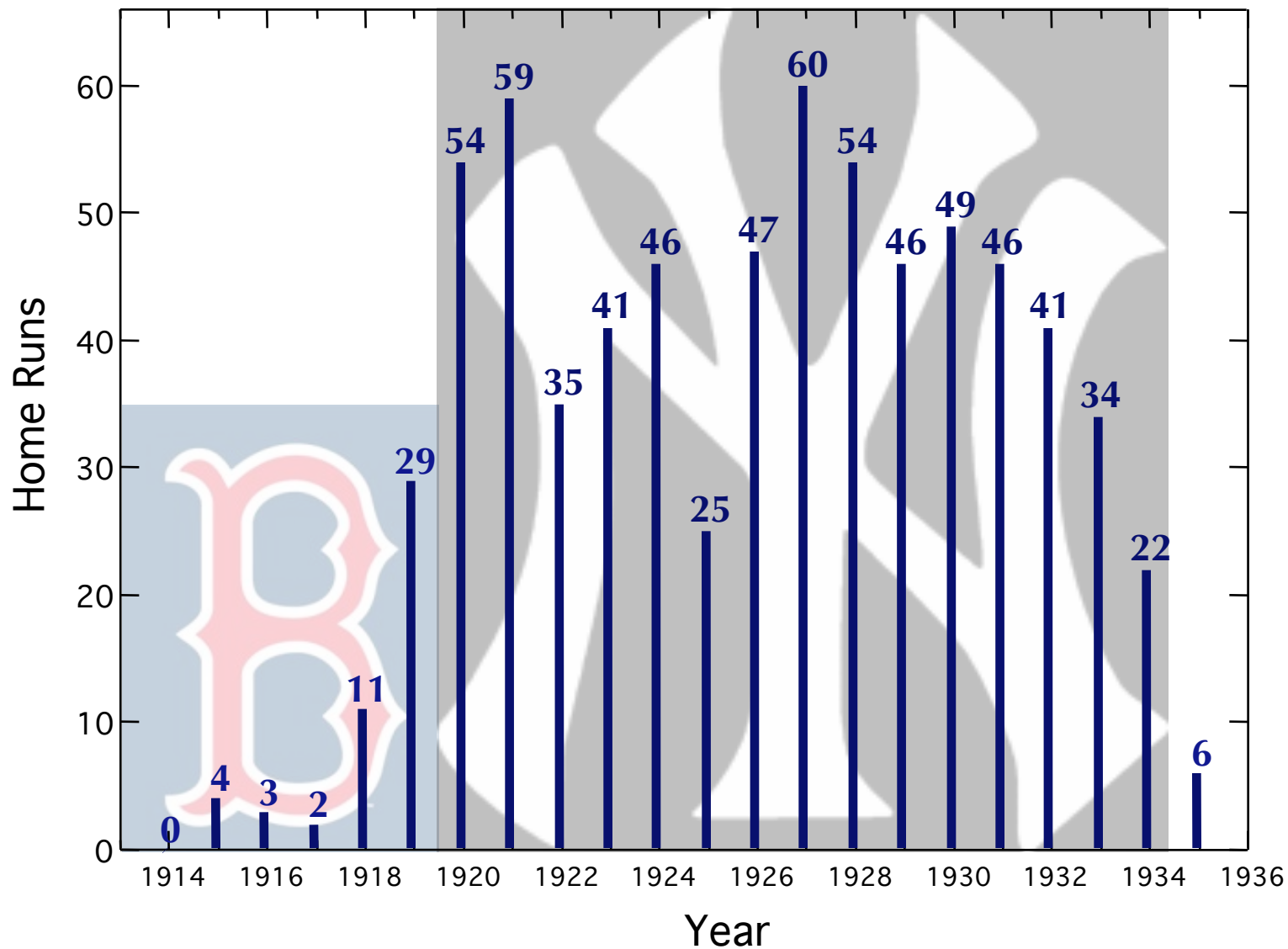
# The Whole Babe Ruth's Home Runs Story



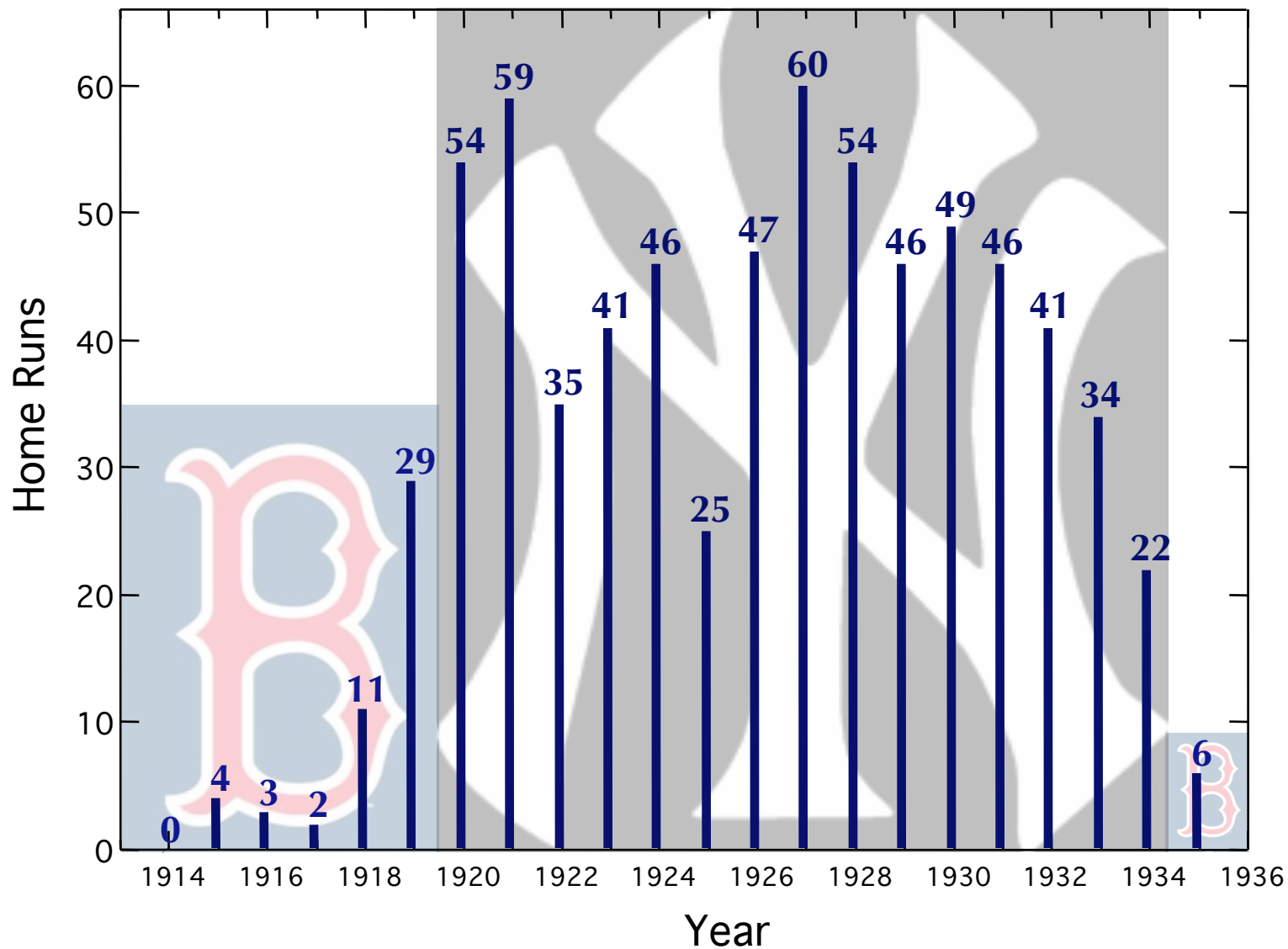
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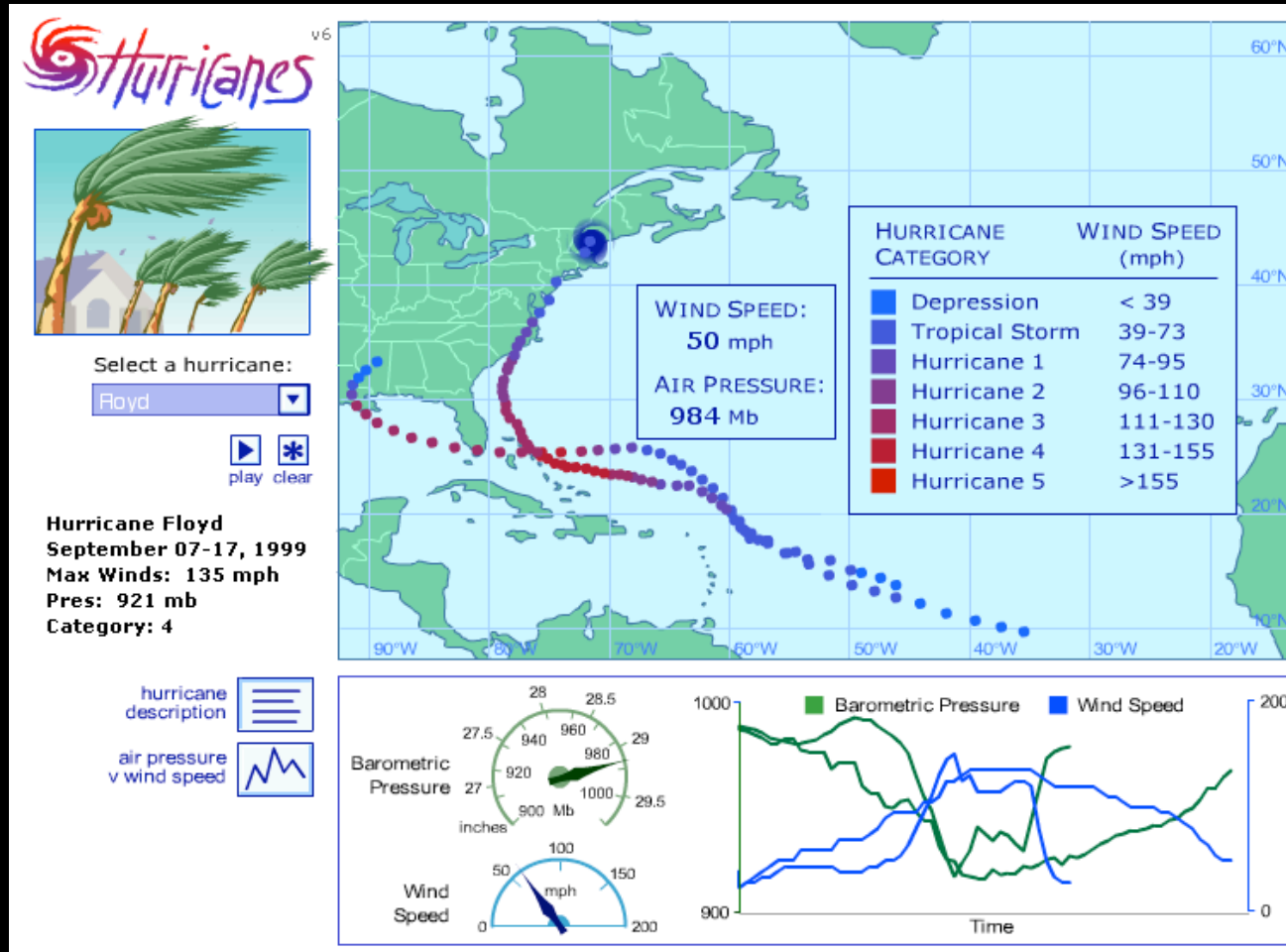
# The Whole Babe Ruth's Home Runs Story



# The Whole Babe Ruth's Home Runs Story



# (Dynamic) Web of Possibilities



<http://www.informmotion.biz/Database/Hurricane.html>

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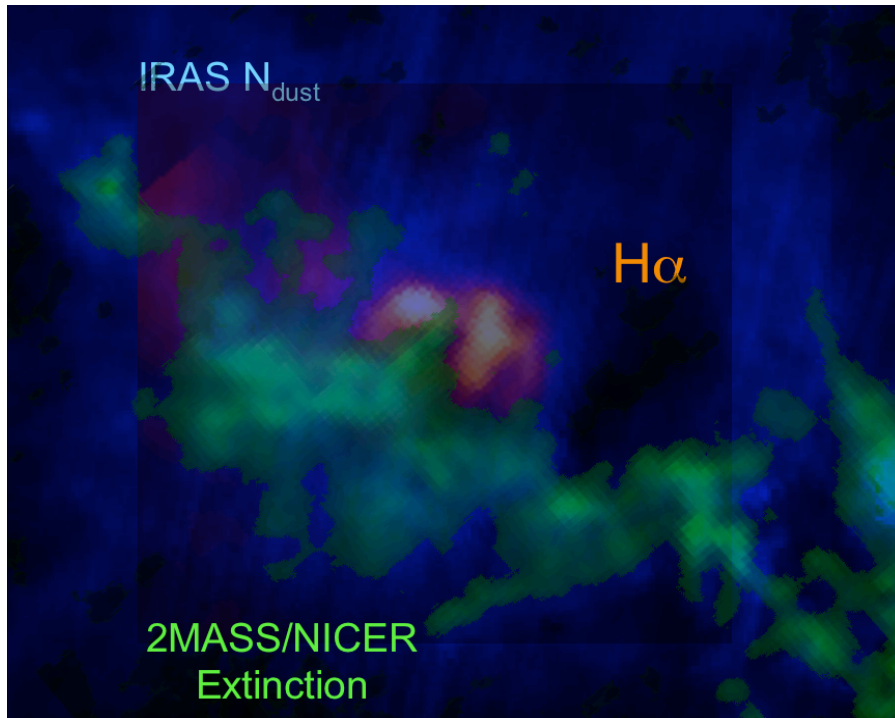
(5) **The Future**

The Evolution of Mashups & Customized/Homemade Applications (Gapminder, Google Docs Widgets)



# Astronomical Medicine

2D “multi-modal” imaging is fascinating, but “easy”



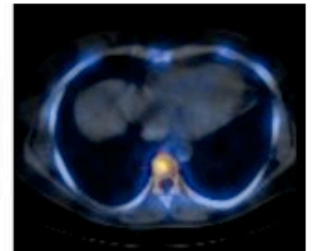
Lesion in the vertebral body (thoracic transverse slices, Infinia Hawkeye)



CT Hawkeye

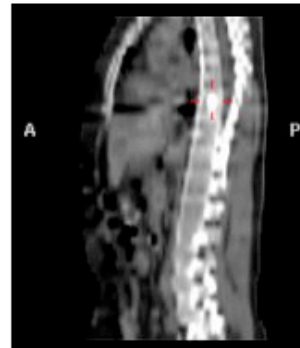


SPECT

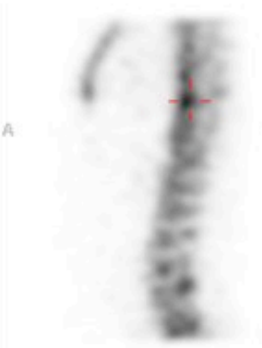


Fused Image

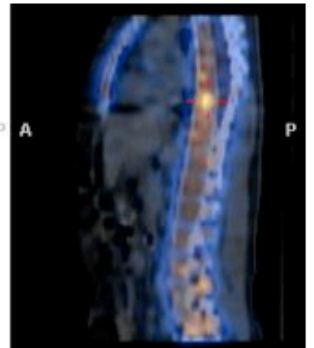
Lesion in the vertebral body (thoracic sagittal slices, Infinia Hawkeye)



CT Hawkeye



SPECT



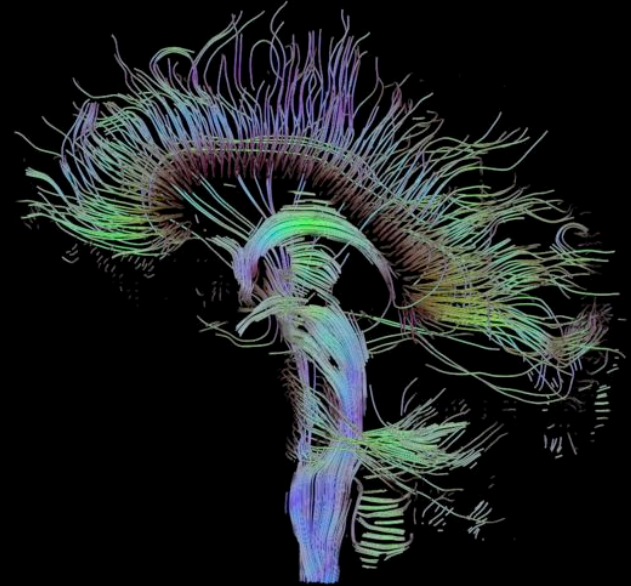
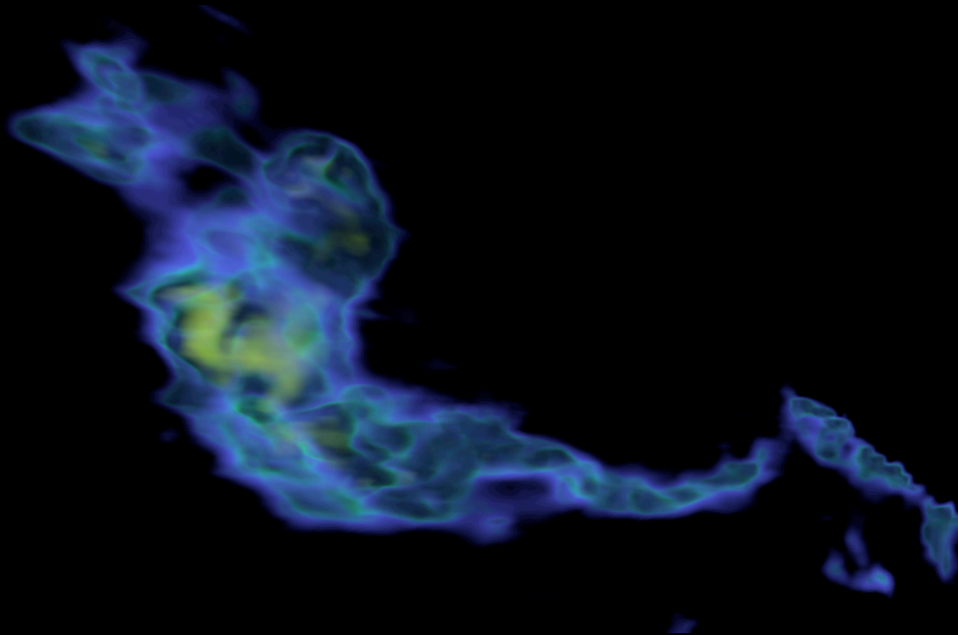
Fused Image

COMPLETE

GE Healthcare



# Astronomy + Medicine = Understanding



Alyssa A. Goodman  
Initiative in Innovative Computing @ Harvard  
and



Harvard-Smithsonian Center for Astrophysics

# Real 3D space



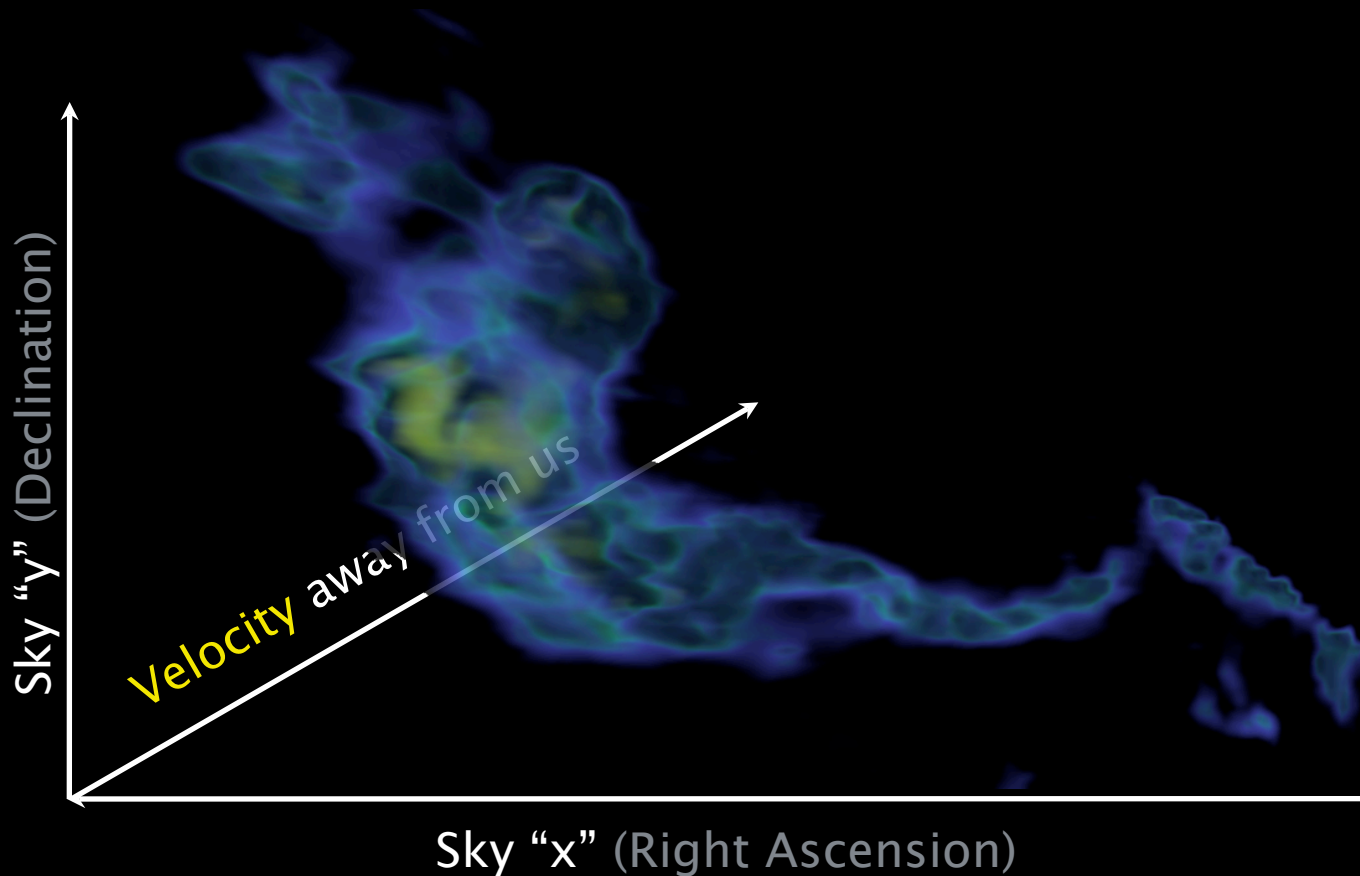
# Real 3D space



# “Position-Position-Velocity” Space

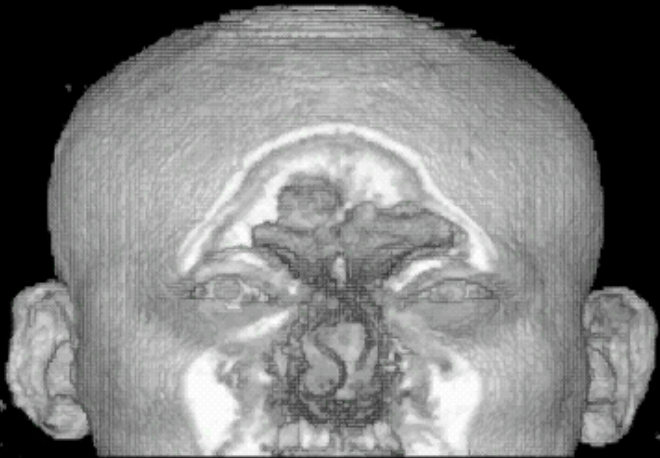


# “Position-Position-Velocity” Space



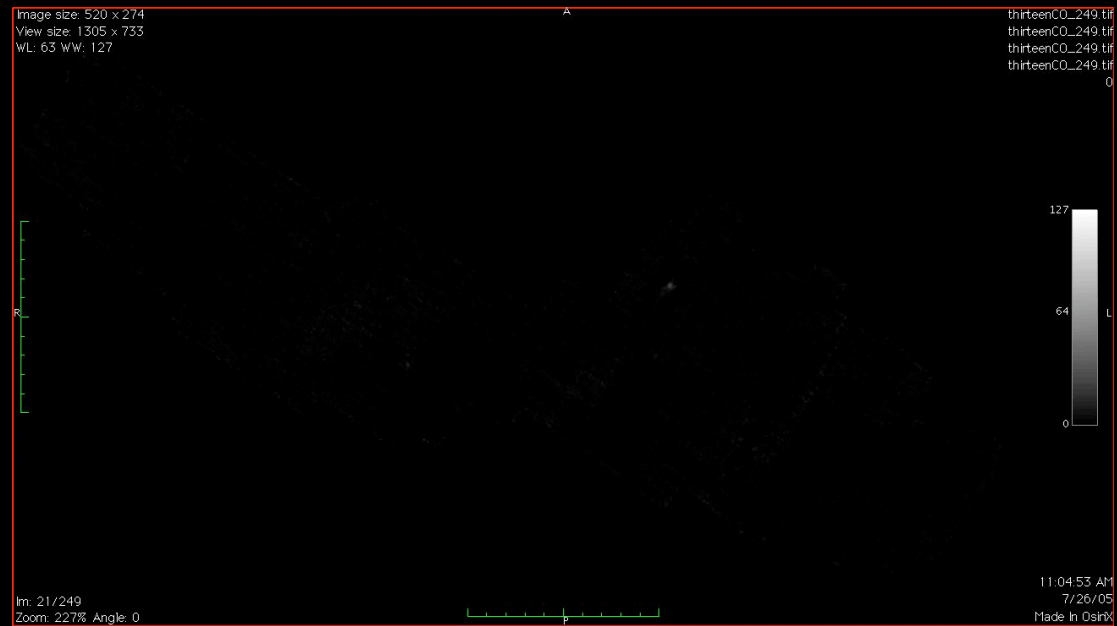
# “Slices”

“KEITH”



“z” is depth into head

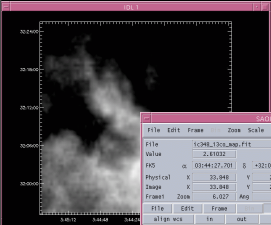
“PERSEUS”



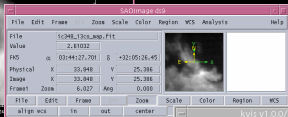
“z” is line-of-sight velocity

# Astronomical Visualization Tools are Traditionally 2D

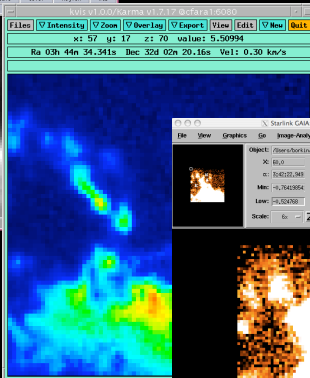
IDL



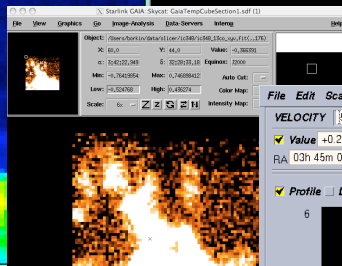
DS9



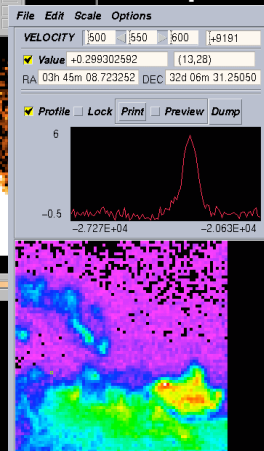
Karma\*



GAIA

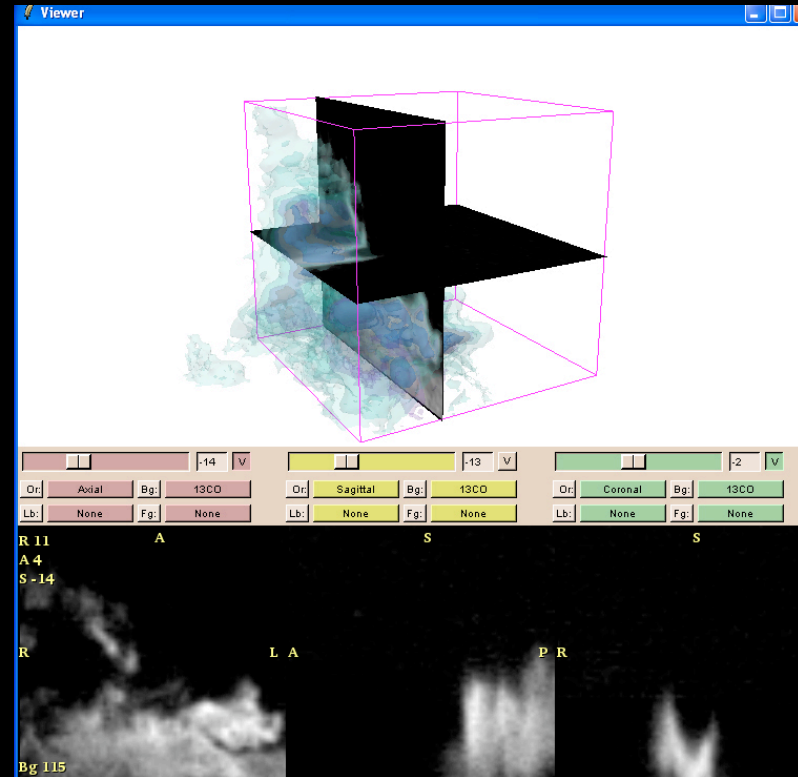


Aipsview








“3D”=movies

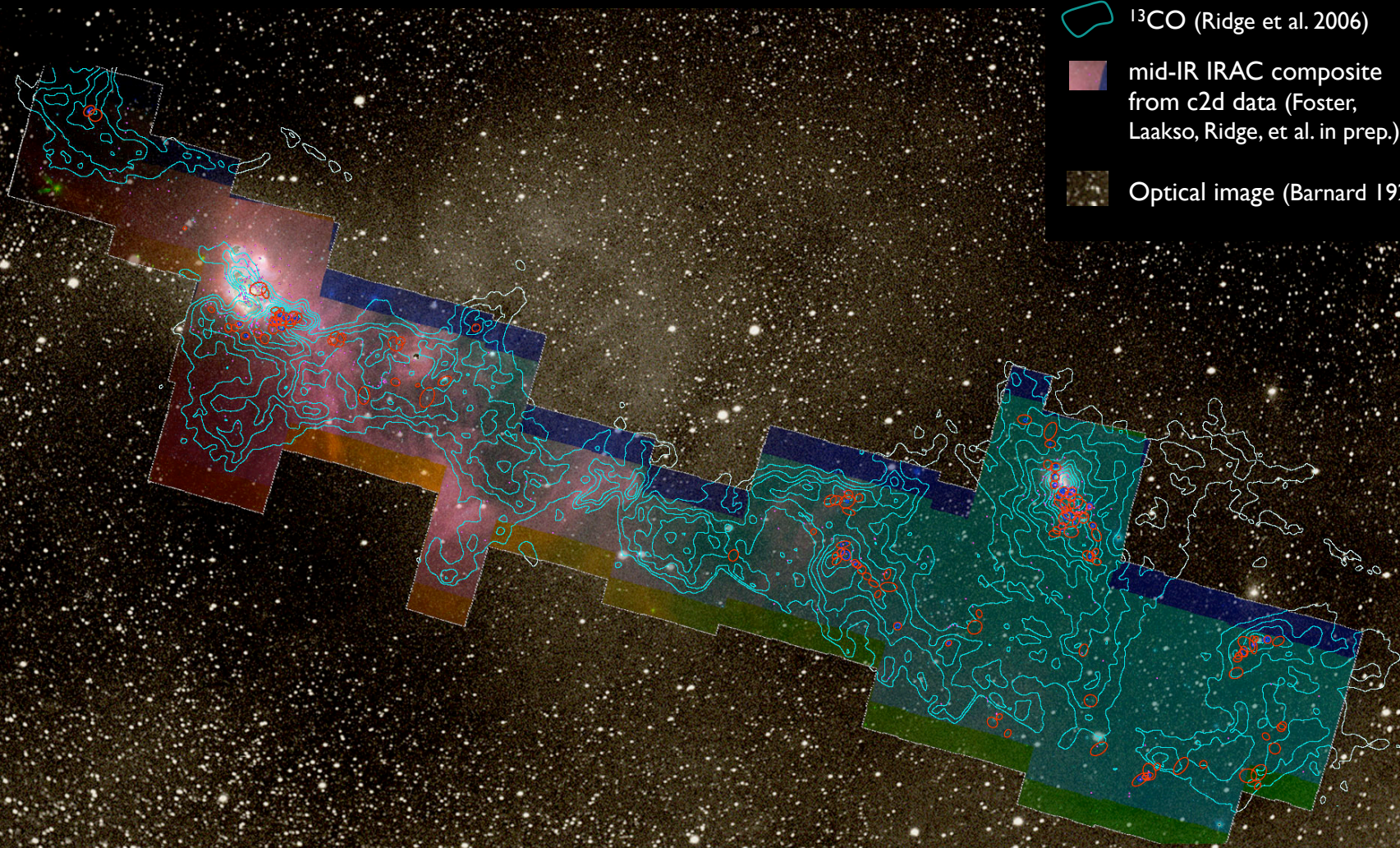
3D Slicer







# COMPLETE=COordinated Molecular Probe Line Exinction Thermal Emission

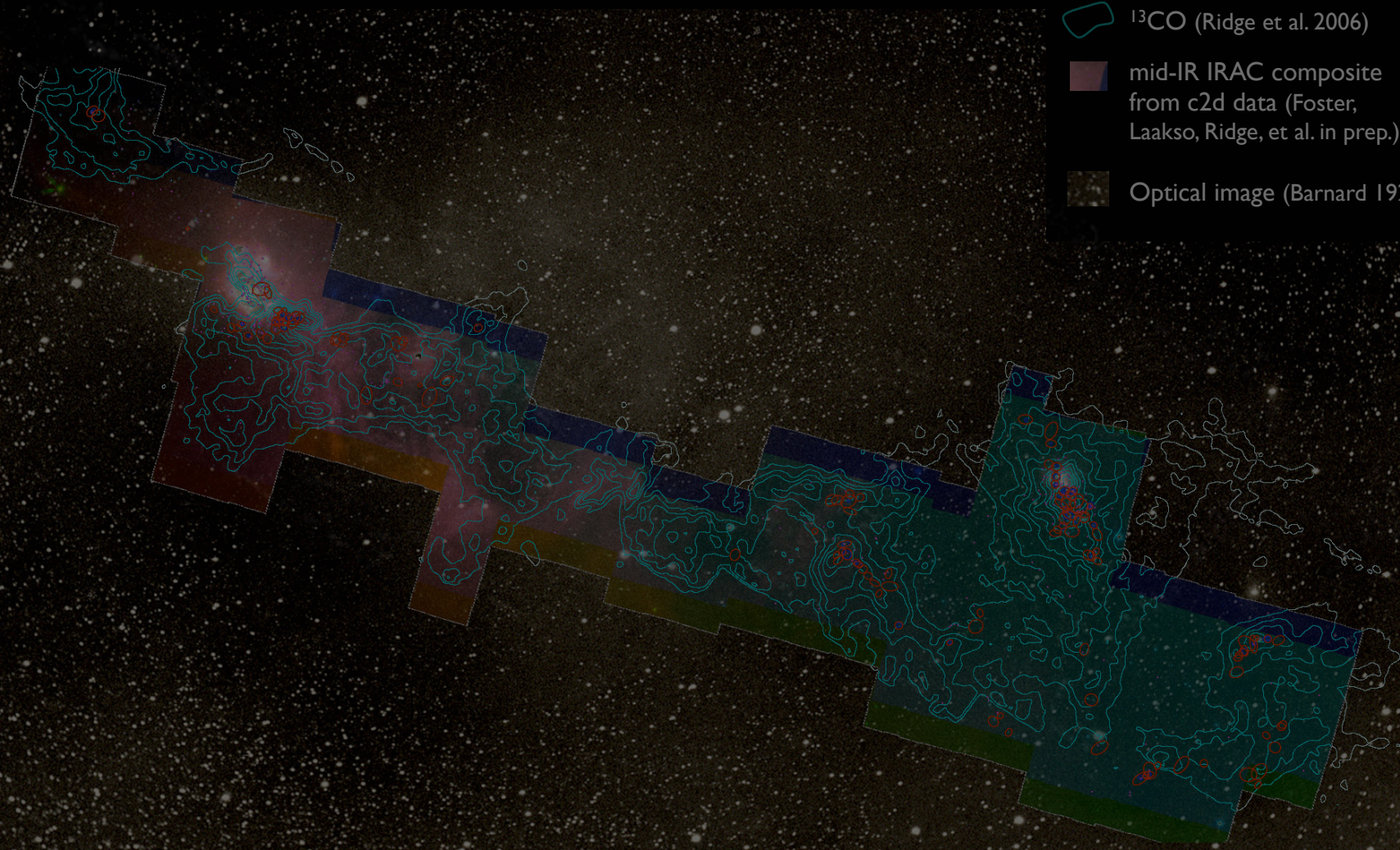
-  mm peak (Enoch et al. 2006)
-  sub-mm peak (Hatchell et al. 2005, Kirk et al. 2006)
-   $^{13}\text{CO}$  (Ridge et al. 2006)
-  mid-IR IRAC composite from c2d data (Foster, Laakso, Ridge, et al. in prep.)
-  Optical image (Barnard 1927)



# COMPLETE-COordinated Molecular Probe Line Exinction Thermal Emission

image size: 520 x 274  
view size: 1305 x 733  
VL: 63 WWF 127

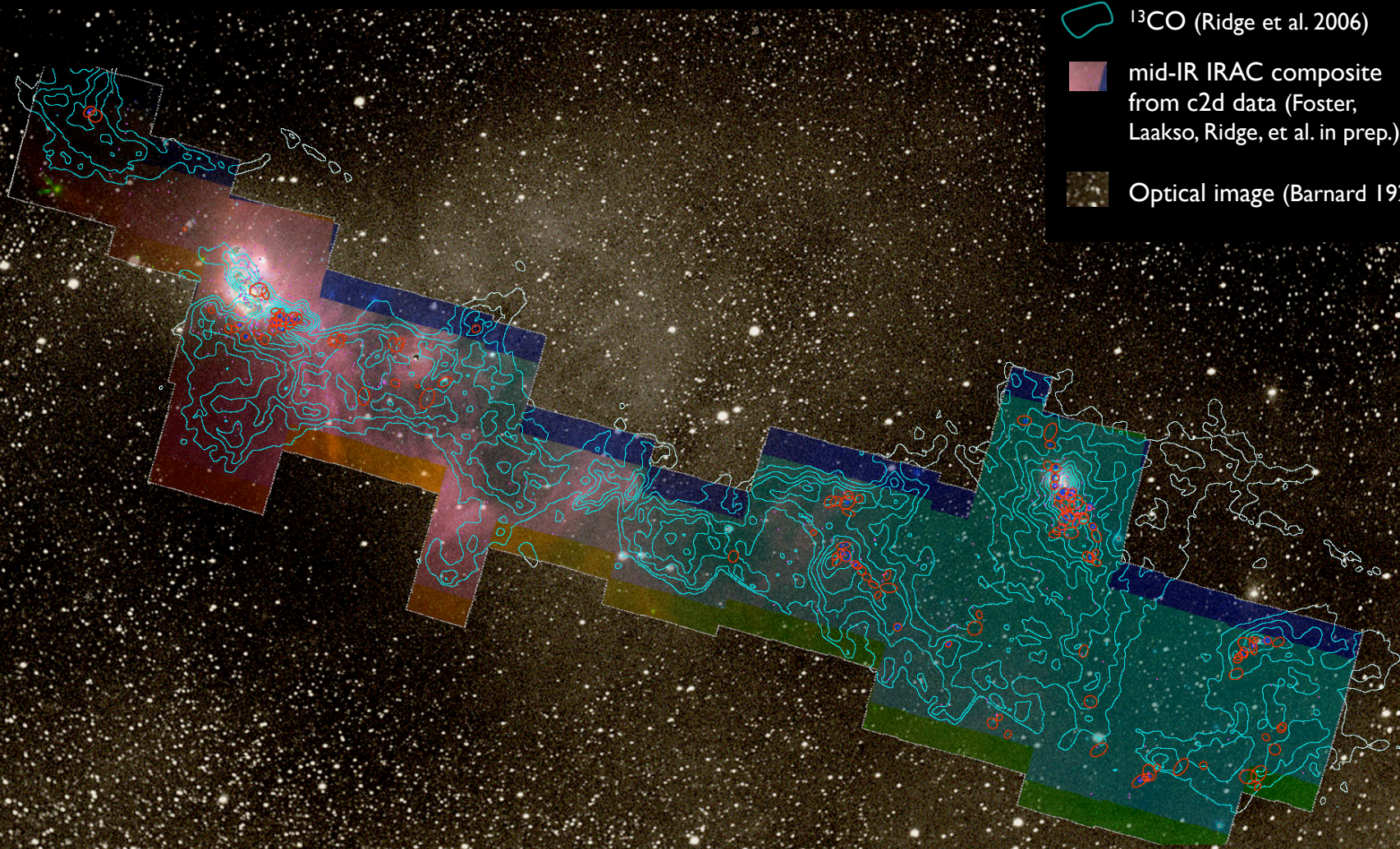
-  mm peak (Enoch et al. 2006)
-  sub-mm peak (Hatchell et al. 2005, Kirk et al. 2006)
-   $^{13}\text{CO}$  (Ridge et al. 2006)
-  mid-IR IRAC composite from c2d data (Foster, Laakso, Ridge, et al. in prep.)
-  Optical image (Barnard 1927)

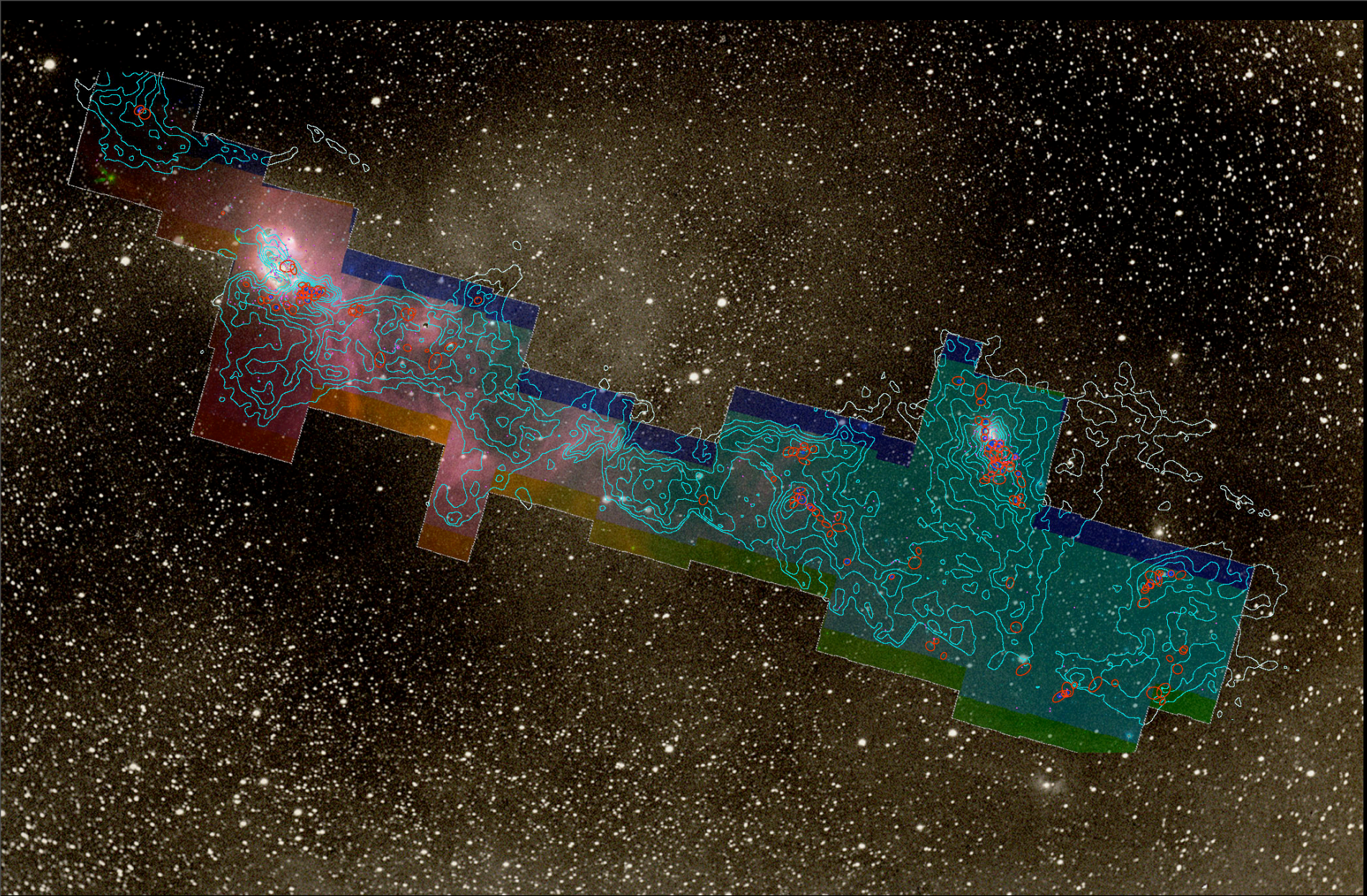


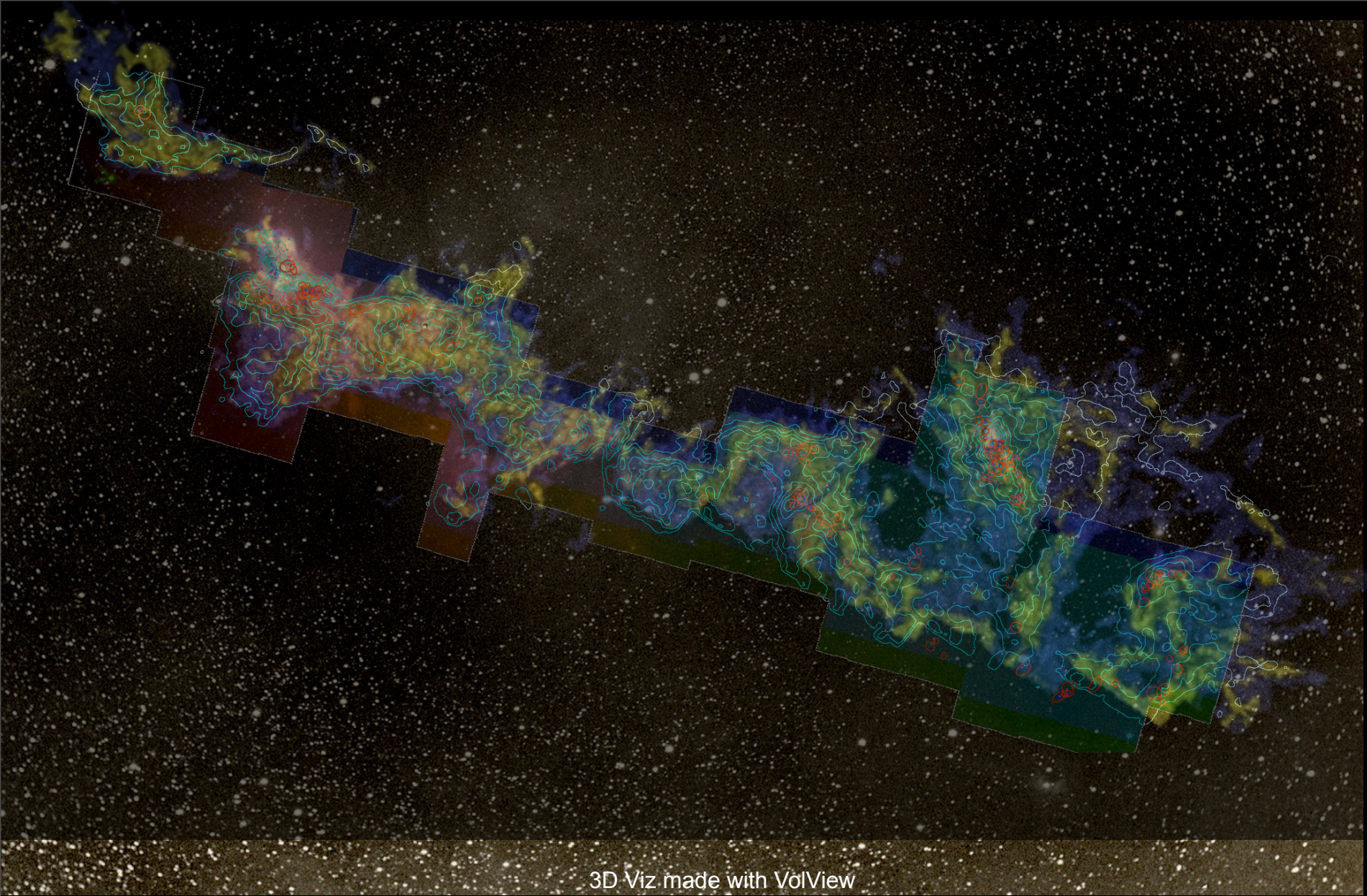
m: 1/249  
zoom: 227% Angle: 0

# COMPLETE=COordinated Molecular Probe Line Exinction Thermal Emission

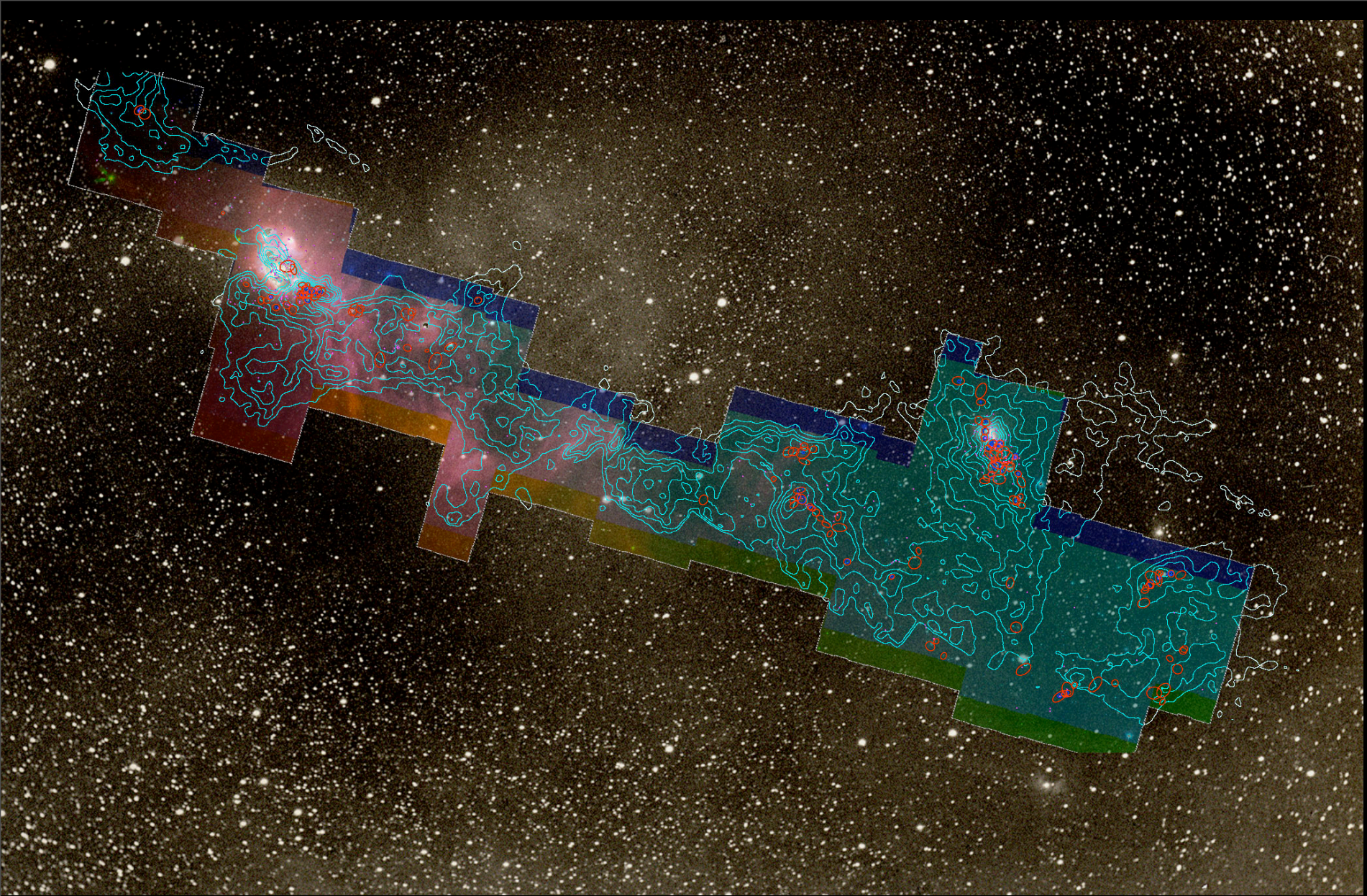
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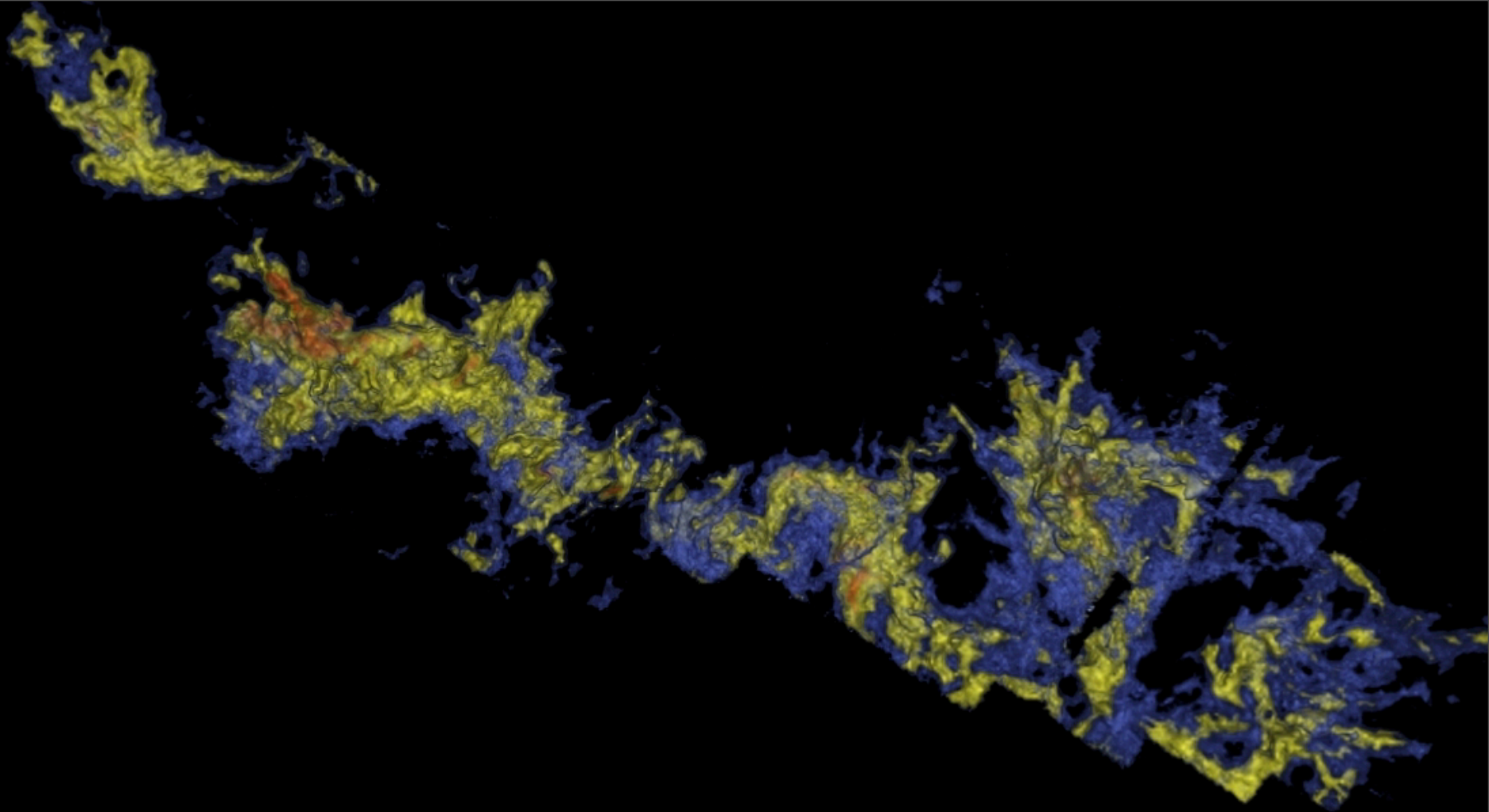


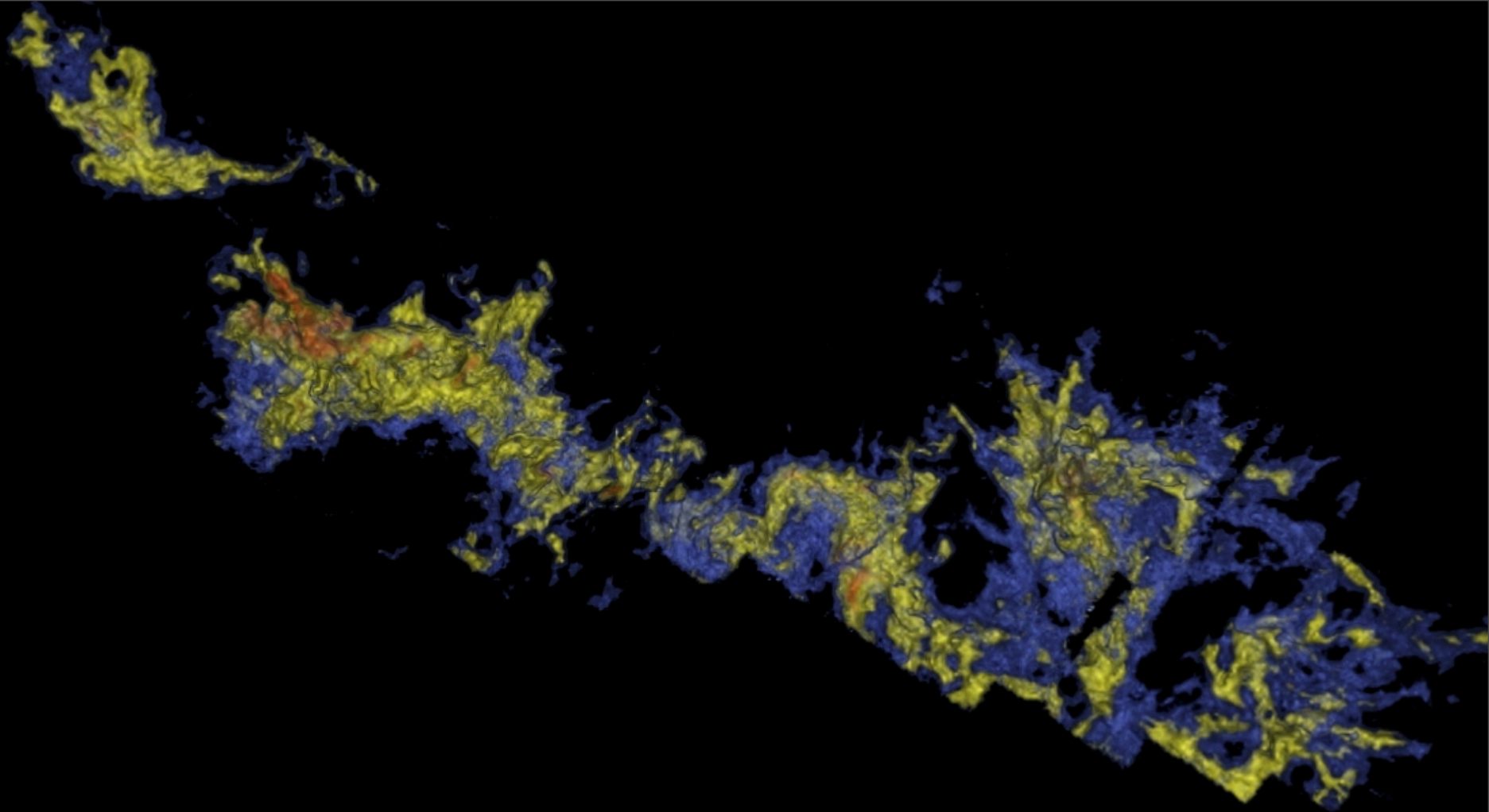




3D Viz made with VolView



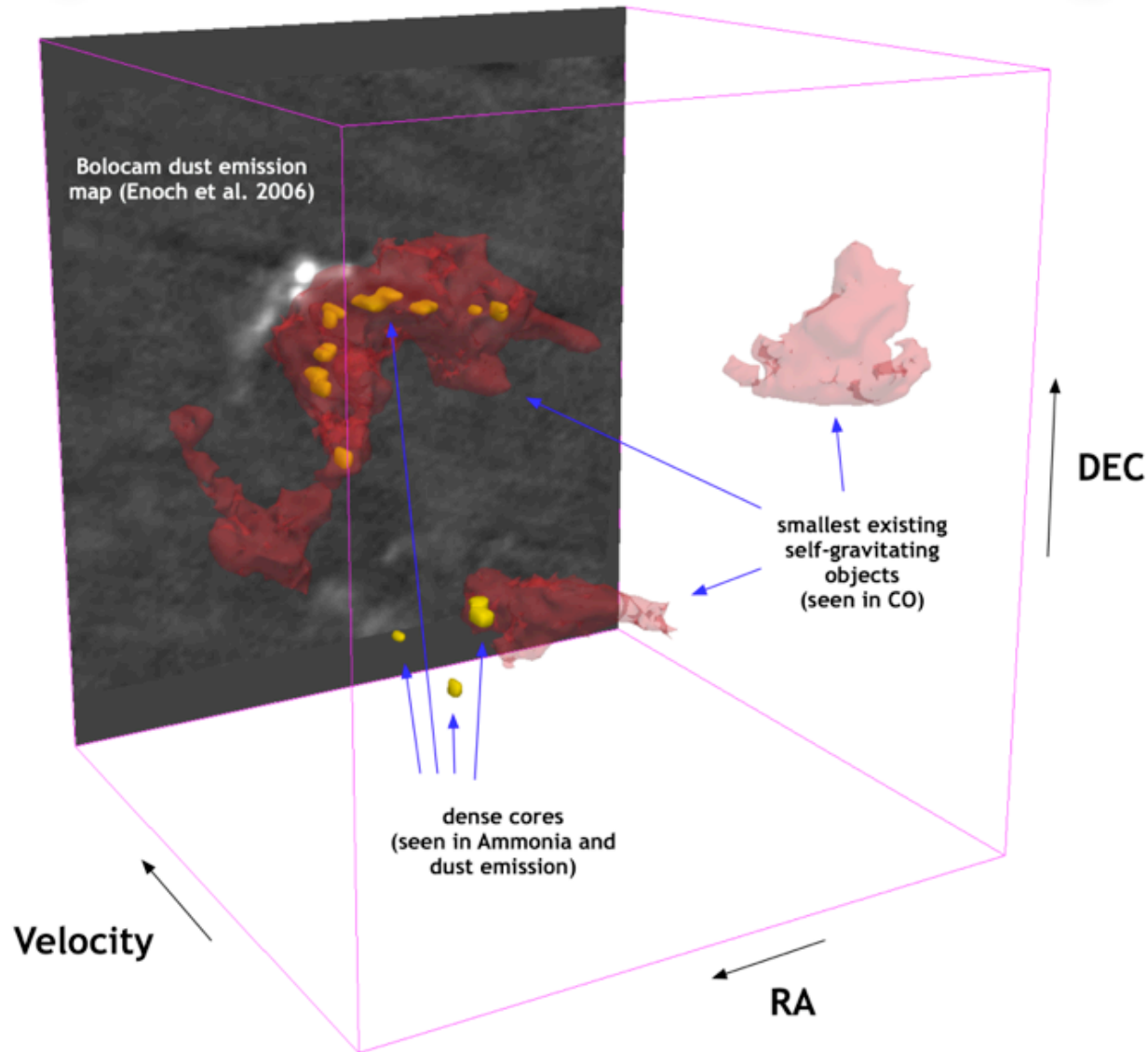




3D Viz made with VolView



# Astronomy + Medicine = Understanding



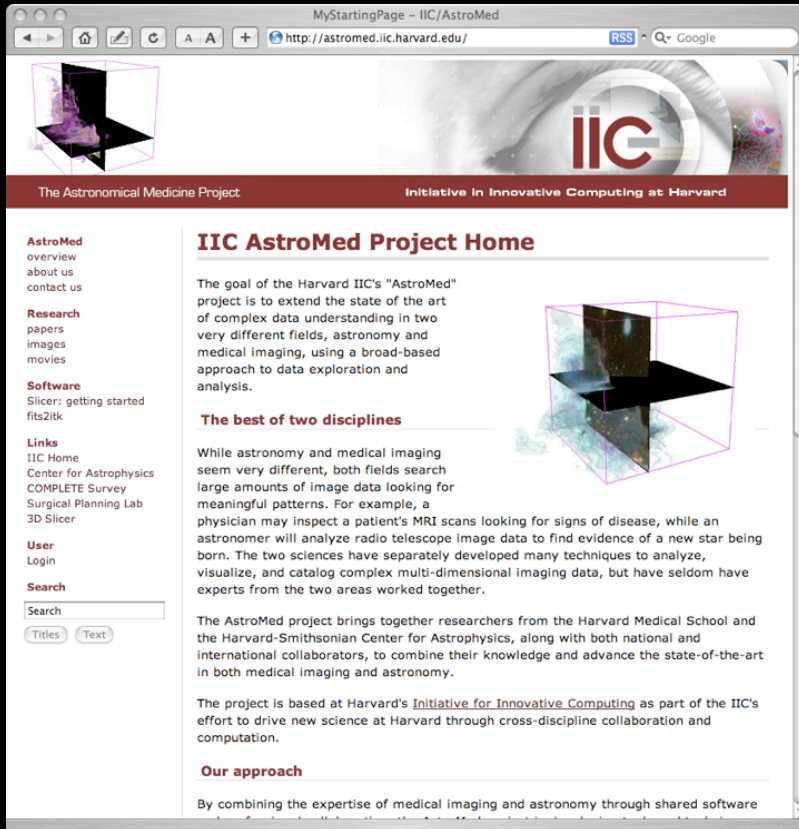
Visualization created by Jens Kauffmann (CfA/IIC) using 3D Slicer

# Generalizing & Sharing



# Generalizing & Sharing

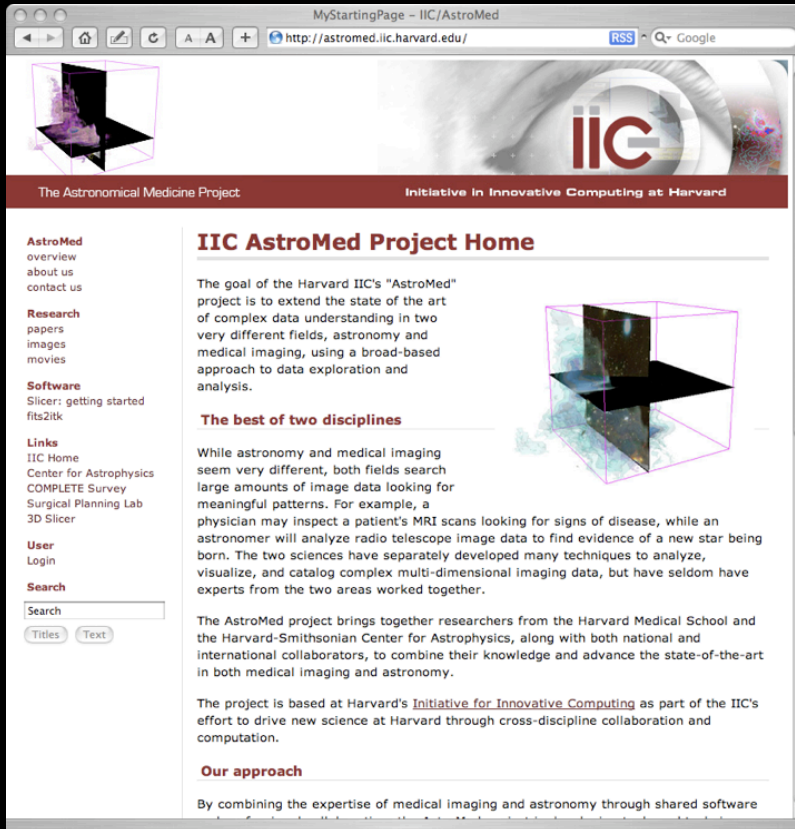
Open-Source code released, and explained, as it is developed.



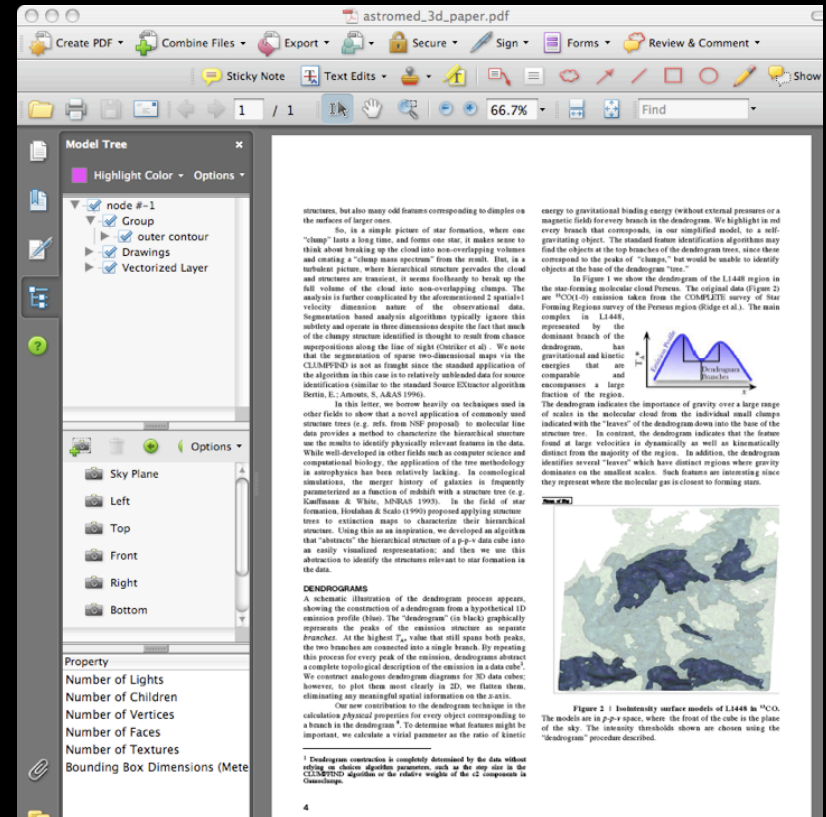
# Generalizing & Sharing

Open-Source code released, and explained, as it is developed.

Changing the future of scientific publishing.



The screenshot shows a web browser window with the URL `http://astromed.iic.harvard.edu/`. The page title is "MyStartingPage - IIC/AstroMed". The main content area features the "IIC AstroMed Project Home" header and a central image of a 3D cube with a black plane cutting through it. Below the header, there is a navigation menu with links for "AstroMed overview", "Research papers", "Software", "Links", "User", and "Search". The main text describes the project's goal: "The goal of the Harvard IIC's 'AstroMed' project is to extend the state of the art of complex data understanding in two very different fields, astronomy and medical imaging, using a broad-based approach to data exploration and analysis." It also mentions "The best of two disciplines" and "Our approach".



The screenshot shows a PDF viewer window displaying a scientific paper titled "astromed\_3d\_paper.pdf". The left sidebar contains a "Model Tree" with a hierarchical structure: "node #-1" (expanded) containing "outer contour", "Drawings", and "Vectorized Layer". Below the tree is a "Property" panel with fields for "Number of Lights", "Number of Children", "Number of Vertices", "Number of Faces", "Number of Textures", and "Bounding Box Dimensions (Mete)". The main content area shows a 3D visualization of a dendrogram structure, a graph with nodes and edges, and a 3D map of a region. The text on the page discusses "structures, but also many odd features corresponding to dimples on the surfaces of larger ones." and "DENDROGRAMS".



# In this Hour??

(1) Why **VDQI?**

(2) “**Art of Numbers**” class at Harvard

(3) “**Astronomical Medicine**” Project, and the 

(4) **Online Data & Collaboratories**

(e.g. Many Eyes, Taste Testing, iSTEM, World Wide Telescope)

(5) **The Future**

The Evolution of Mashups & Customized/Homemade Applications (Gapminder, Google Docs Widgets)

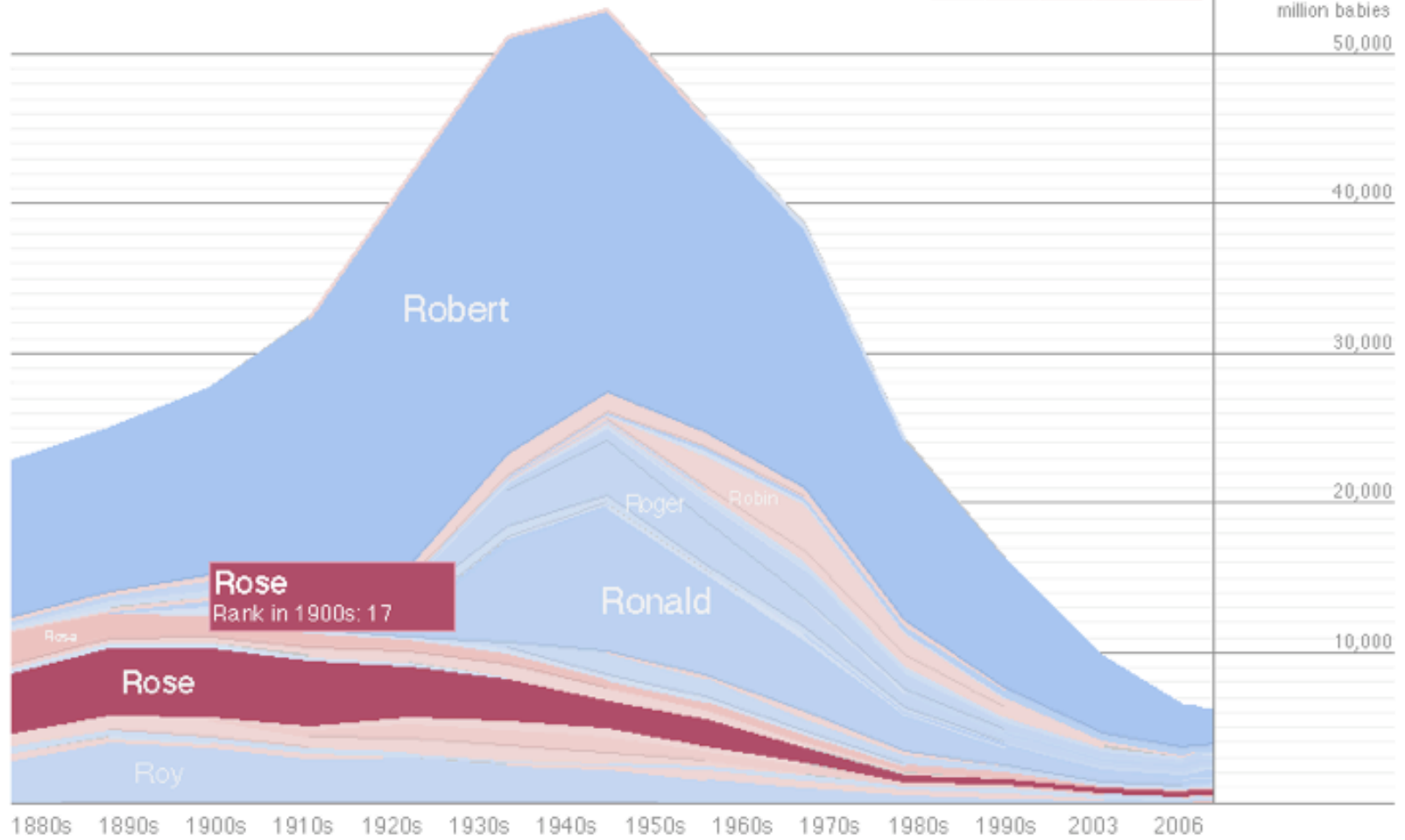


> RO

boys  girls  both

2005 rank, boys	1000	500	100	25	1
girls	1000	500	100	25	1

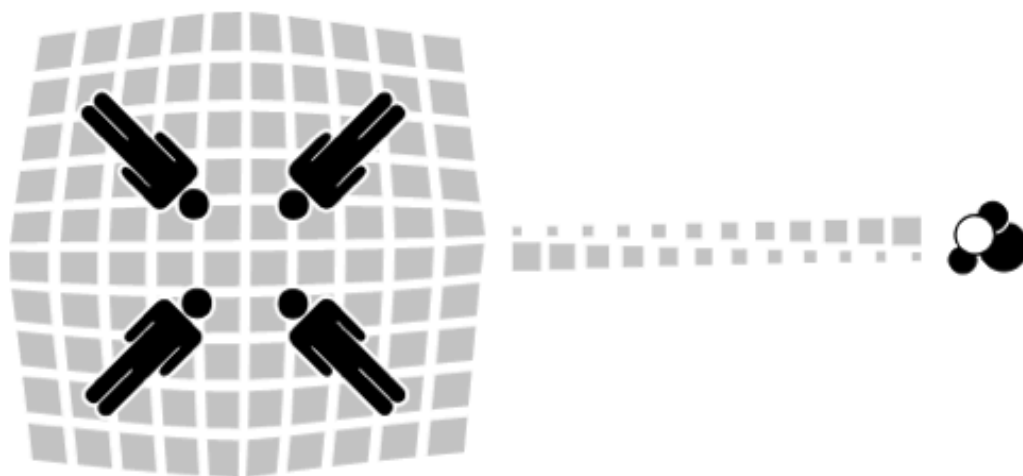
Names starting with  
"RO", per  
million babies



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research »

## Scientific Collaboration Framework



### Lead investigators

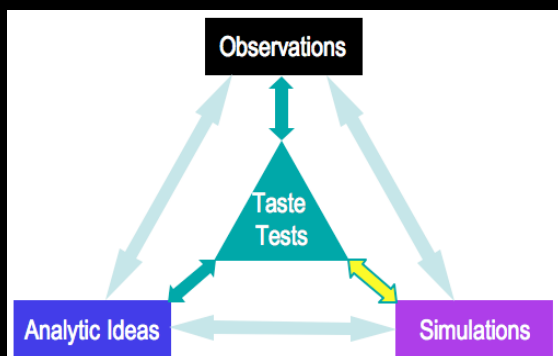
Brock Reeve (HMS/HSCI), [Tim Clark](#) (HMS/Neurology and IIC), [Sudeshna Das](#) (IIC)

### Description

Interdisciplinary research programs at Harvard and elsewhere naturally tend to be distributed geographically, across campuses and departments. Effective collaboration for these programs requires the ability to bridge distance, which in turn implies digital collaboration, and therefore abilities:

- to publish and discuss on-line content such as articles, news, and perspectives;
- to share, annotate, archive and retrieve digital content;
- to search, browse and annotate joint resources such as laboratory reagents and protocols;
- to provide semantic context to on-line content for more powerful interactions within multiple sub-disciplines;
- to integrate as well as distinguish the individual contributions of many scientific workers

# “Taste Tests”: Simulations, Observations, and Delicious Insight



Star Formation Taste Tests > Overview

https://iic.grouphub.com/projects/700257/pr

Google Calendar Wikis Etc. Directories Delicious RSS (1423) ADS Best BeyondADS Image Search Weather

Dashboard | Choose a project Settings | Permissions | My account | Log-out HELP


## Star Formation Taste Tests CfA

Overview Messages To-Do Milestones Writeboards Chat Time Files People Search

### Project overview

[Add message](#) | [Add to-do list](#) | [Add milestone](#) | [Add file](#)

#### Welcome to the Tasting Room



This is the collaborative space for those who do simulations of star forming regions, and those who observe them. It was inspired, in the Fall of 2006, by the NSF proposal entitled “Star Formation Taste Tests,” by A. Goodman & E. Rosolowsky. Today, it is used to host conversations about and short descriptions of simulatons, along with links to longer descriptions (e.g. Journal articles & web sites). In the future, we are planning to connect more enhanced descriptions of those simulations directly to online code bases and sample outputs (likely with help from our friends at NCSA). So, stay tuned.

#### What's fresh?

##### Today

No activity today


##### Yesterday

**MESSAGE** [General Remarks and Suggestions](#)  
by Jürgen S. in [Full Group Communications](#), 23 Nov

##### Before Yesterday

**FILE** [GoodmanNSF1106Basecamp.pdf](#)  
(PDF, 3151K) uploaded by Alyssa G., 17 Nov

**MESSAGE** ["Taste Test" NSF Proposal Uploaded](#)



#### Subscribe to project's RSS feed

Want to be notified any time someone posts a message, comment or file, or adds or completes a to-do item or milestone in this project? Just [subscribe to your project RSS feed](#) **RSS** ([What is RSS?](#))

#### People on this project

[iic](#)

- Alyssa Goodman
- Douglas Alan  
Last login about 22 hours ago
- Michelle Borkin  
Last login 2 days ago
- Jens Kauffmann  
Last login 18 days ago
- Tim Clark  
Last login 105 days ago

#### American Museum of Natural History

Mordecai-Mark Mac Low  
Last login 28 days ago

#### Cardiff University

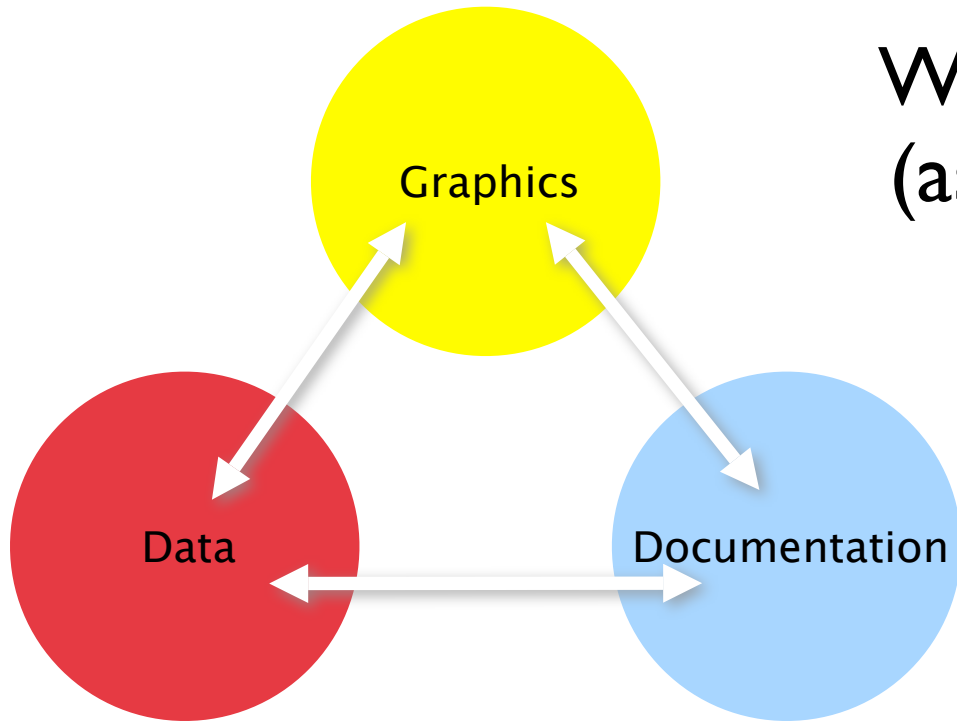
Anthony Whitworth  
No login yet

CfA

Go to "https://iic.grouphub.com/P4080344"



# World Wide Telescope (ask for a demo, later)



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# The Current & Future “Web”

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Now (“Web 1.5”)

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- I. (Automated) Dynamic Content Creation  
(suffixes .php, .asp, .cfm, .cgi, .shtml, etc.) ([Amazon.com](http://Amazon.com))

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- The “Semantic Web” (See [SciAm article](#), 2001)

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## The Future (“Web 2.5”)

1. The Web *without the Browser*  
(Google Earth, [World Wide Telescope](#))
  - The “Semantic Web” (See [SciAm article](#), 2001)
  - “Services” in “The Cloud” (e.g. [Amazon s3](#), ec2)

UFO Maps Sighting reports, as they happen. [Comments?](#) Month: July Year: 2006

Map Satellite Hybrid

Norfolk, MA • Jul 1st 2006 12:00:00 AM

It was a ball of opal or white with a little pink and green sheen to it. Not metal....

[Read full report](#)

UFO Sighting Report Form

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an excerpt of interest from Wikipedia's [Unidentified flying object](#) article...

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Google Maps' "kml" format (GIS)

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Massive online data repository

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Seamless dataset integration

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Easy information contribution



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Norfolk, MA • Jul 1st 2006 12:00:00 AM

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Map Satellite Hybrid

Norfolk, MA • Jul 1st 2006 12:00:00 AM

“Social” (community) tags & data

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UFO Sighting Report Form Powered by Google Maps UFO data from [National UFO Reporting Center](#), UFO icon by [Tom7](#), 241 project by [Poly9](#)

Wikipedia is all “social”

an excerpt of interest from Wikipedia's [Unidentified flying object](#) article...

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Norfolk, MA • Jul 1st 2006 12:00:00 AM

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Commercial, but open-source, "API's"



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Legal issues addressed openly

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Portals to deeper information

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Wikipedia!

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UFO Maps Sighting reports, as they happen. [Comments?](#) Month: July Year: 2006

Map Satellite Hybrid

Norfolk, MA • Jul 1st 2006 12:00:00 AM

It was a ball of opal or white with a little pink and green sheen to it. Not metal....

[Read full report](#)

UFO Sighting Report Form

Powered by Google Maps UFO data from [National UFO Reporting Center](#), UFO icon by [Tom7](#), 241 project by [Poly9](#)

an excerpt of interest from Wikipedia's [Unidentified flying object](#) article...

“Provenance” Information

The “Web 2.0” Model



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# The "Web 2.0" Model



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Re-usable, standard interaction tools

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UFO Maps Sighting reports, as they happen. [Comments?](#) Month: July Year: 2006

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UFO Maps Sighting reports, as they happen. [Comments?](#) Month: July Year: 2006

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Norfolk, MA • Jul 1st 2006 12:00:00 AM

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[Read full report](#)

Interactive Data Exploration

POWERED BY Google

UFO Sighting Report Form Powered by Google Maps UFO data from [National UFO Reporting Center](#), UFO icon by [Tom7](#), 241 project by [Poly9](#)

an excerpt of interest from Wikipedia's [Unidentified flying object](#) article...

The  
 “Web 2.0”  
 Model



# Google Gadgets

## Add a Gadget

### Featured

[All](#)

[Charts](#)

[Tables](#)

[Maps](#)

[Web](#)

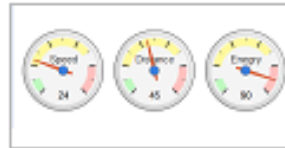
[Diagrams](#)

[Finance](#)

[Custom...](#)

### Have a better idea?

[Write your own gadget](#) to display data in cool new ways. Want to see your gadget on this list? Submit it to us using the [submission form](#).



### Gauges

By Google

Each numeric value is shown as a gauge.

[Add to spreadsheet](#)

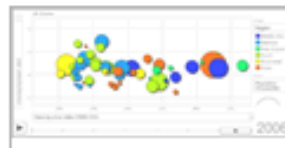


### Interactive Time Series Chart

By Google

An interactive time series line chart like the one used in Google Finance. The first column contains dates and the second column contains values.

[Add to spreadsheet](#)



### Motion Chart

By Google

A dynamic flash based chart to explore several indicators over time. Required columns: bubble name, time and 2 columns of numeric values. Optional columns: Numeric values or categories.

[Add to spreadsheet](#)

“PLASTIC”

Plastic Central Plastic – the Platform for Astronomical Tool InterConnection.

http://plastic.sourceforge.net/ plastic astronomy virtual o

Google Calendar Wikis Etc. Directories Delicious RSS (1126) ADS Best BeyondADS Image Search Weather

**EURO VO**  
TECHNOLOGY CENTRE

Last Published: 17 Nov 2006 06:37:45 AstroGrid | VOTech | Plastic


**Documentation**  
Home  
Plasticized applications  
Five minute intro  
▶ Plastic in...  
Plastic Specification  
Message Definitions  
Mailing Lists  
Presentations on Plastic  
Demos

**Downloads and API**  
▶ API  
▶ Downloads

**Related Projects**  
Aladin  
Astro Runtime  
Diagnostic Tools  
Mirage  
Octet  
Plaskit  
Plastic Con Manager  
Topcat  
VisIVO  
VOEvent  
VORuby  
xmdv  
YOUR PROJECT HERE

**Project Documentation**  
▶ Project Information

**Admin**  
Page views  
SourceForge page

built by:  maven

## Welcome to PLASTIC Central

PLASTIC (Platform for Astronomical Tool InterConnection) is a collaboration between the teams behind Aladin, Topcat, VisIVO, AstroGrid and others to develop interoperability standards for client-side virtual observatory tools.

**NEW!** Download an example plastic client written in Java to get you started. This client uses the Plastic Connection Manager library.

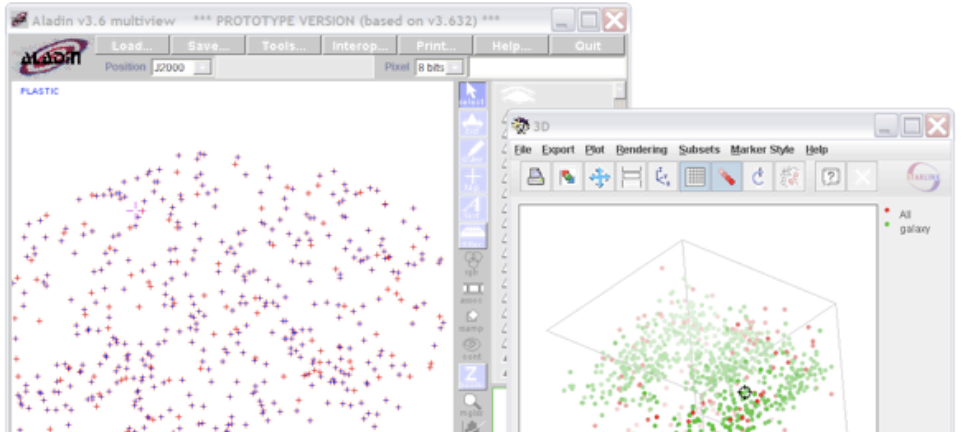
Movies of Plastic demos are now available.

Presentations on PLASTIC at the recent IVOA meeting are now available.

## About PLASTIC

### Elevator pitch

PLASTIC is a protocol for communication between client-side astronomy applications. It is very simple for application developers to adopt and is easily extended. Through PLASTIC applications can do tasks such as instruct each other to load VOTables, highlight a subset of rows or load an image of a particular area of sky. Although such operations are quite simple, they enable powerful collaborations between tools. The philosophy is that the astronomer should have a suite of interoperating tools at his disposal, each of which does *one thing well* and which can be composed according to his particular needs.



Aladin v3.6 multiview \*\*\* PROTOTYPE VERSION (based on v3.632) \*\*\*

3D

Go to "http://plastic.sourceforge.net/images/topcat\_aladin\_scrn.gif"



“PLASTIC”

Plastic Central Plastic – the Platform for Astronomical Tool InterConnection.

http://plastic.sourceforge.net/ plastic astronomy virtual o

Google Calendar Wikis Etc. Directories Delicious RSS (1126) ADS Best BeyondADS Image Search Weather

**EURO VO**  
TECHNOLOGY CENTRE

Last Published: 17 Nov 2006 06:37:45 AstroGrid | VOTech | Plastic


**Documentation**  
Home  
Plasticized applications  
Five minute intro  
▶ Plastic in...  
Plastic Specification  
Message Definitions  
Mailing Lists  
Presentations on Plastic  
Demos

**Downloads and API**  
▶ API  
▶ Downloads

**Related Projects**  
Aladin  
Astro Runtime  
Diagnostic Tools  
Mirage  
Octet  
Plaskit  
Plastic Con Manager  
Topcat  
VisIVO  
VOEvent  
VORuby  
xmdv  
YOUR PROJECT HERE

**Project Documentation**  
▶ Project Information

**Admin**  
Page views  
SourceForge page

built by:  maven

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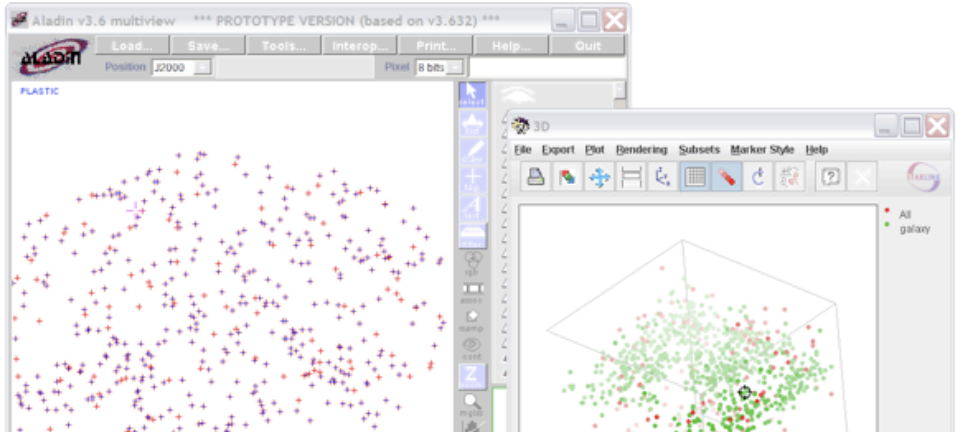
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Aladin v3.6 multiview \*\*\* PROTOTYPE VERSION (based on v3.632) \*\*\*

Load... Save... Tools... Interop... Print... Help... Quit

Position J2000 Pixel 8 bits

PLASTIC

3D

File Export Plot Rendering Subsets Marker Style Help

All galaxy

Go to "http://plastic.sourceforge.net/images/topcat\_aladin\_scrn.gif"





# “PLASTIC”

Plastic Central Plastic – the Platform for Astronomical Tool InterConnection.

http://plastic.sourceforge.net/ plastic astronomy virtual o

Google Calendar Wikis Etc. Directories Delicious RSS (1126) ADS Best BeyondADS Image Search Weather

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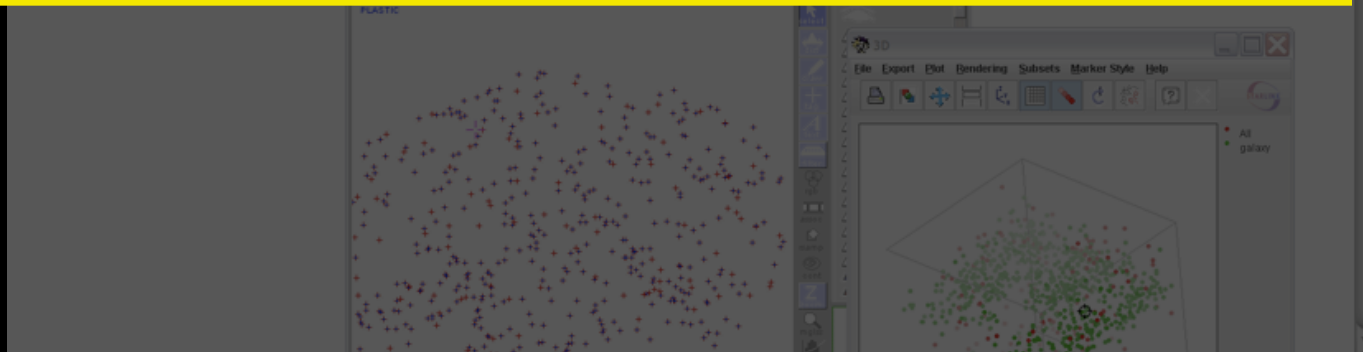
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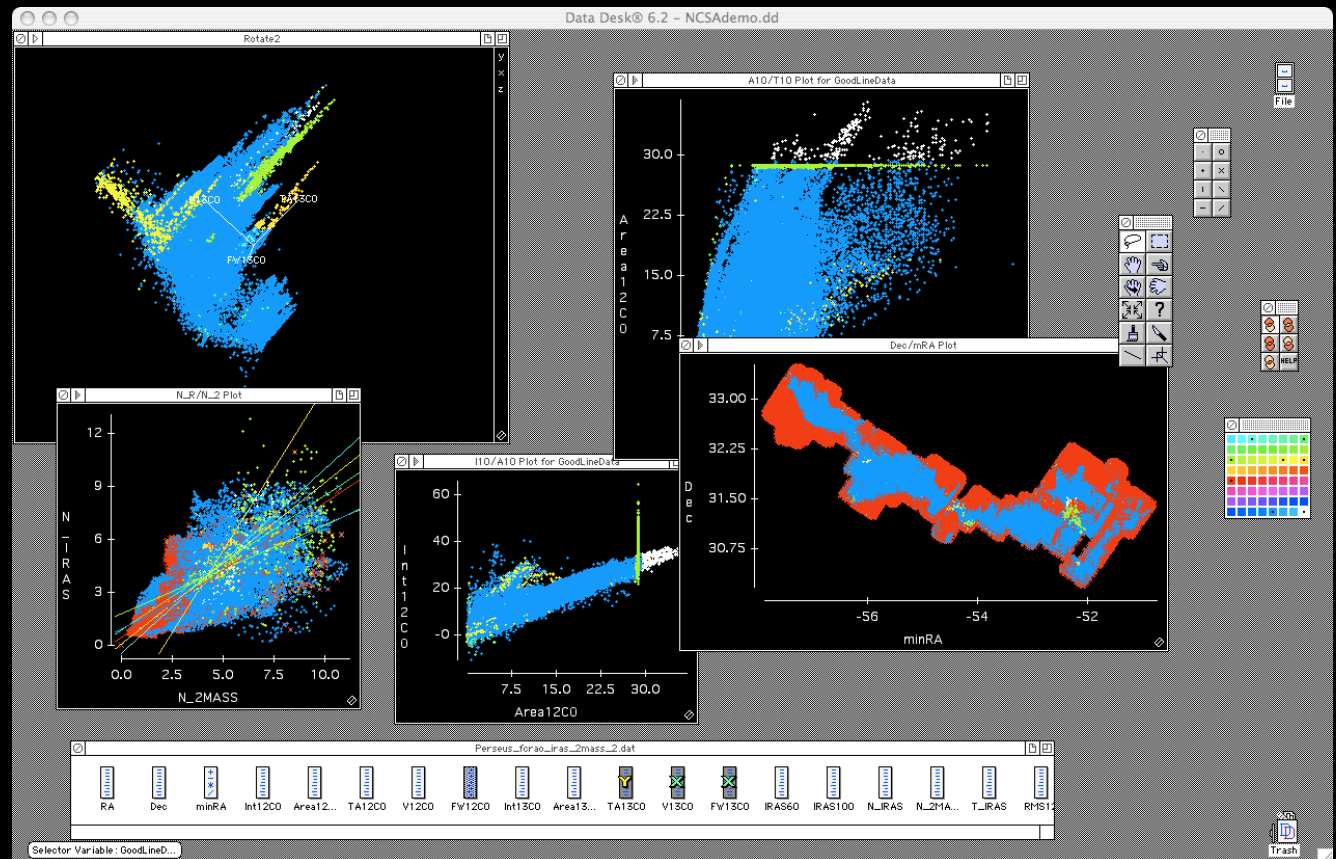
between tools. The philosophy is that the astronomer should have a suite of interoperating tools at his disposal, each of which does **one thing well** and which can be composed according to his particular needs



# Generalized nD Analysis, e.g. DataDesk

“3D Data Desk”

Demo, Perseus file



# The Future of High-Dimensional Data Visualization, and its Communication

Alyssa A. Goodman  
Professor of Astronomy  
Harvard University



# Visual Displays of Quantitative Information

Maps

Tables

Graphs

Charts

Illustrations

& Combinations Thereof

# Questions to Always Ask

# Questions to Always Ask

What's this "VDQI" for?

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What's this “VDQI” for?

- Data **exploration**



# Questions to Always Ask

What's this "VDQI" for?

- Data **exploration**
- Hypothesis **testing**

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- >1 of the above (best answer)

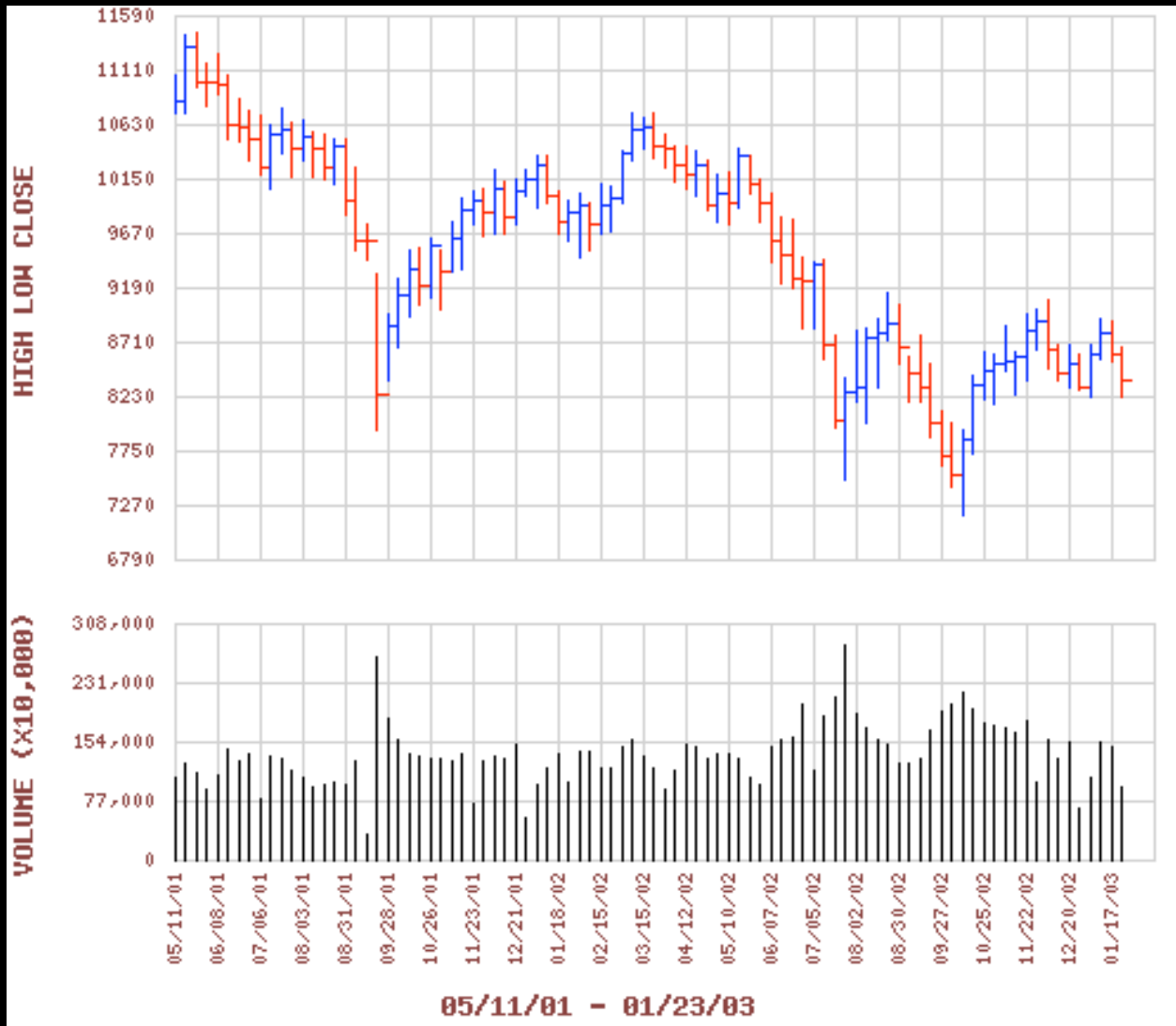
# Questions to Always Ask

What's this “VDQI” for?

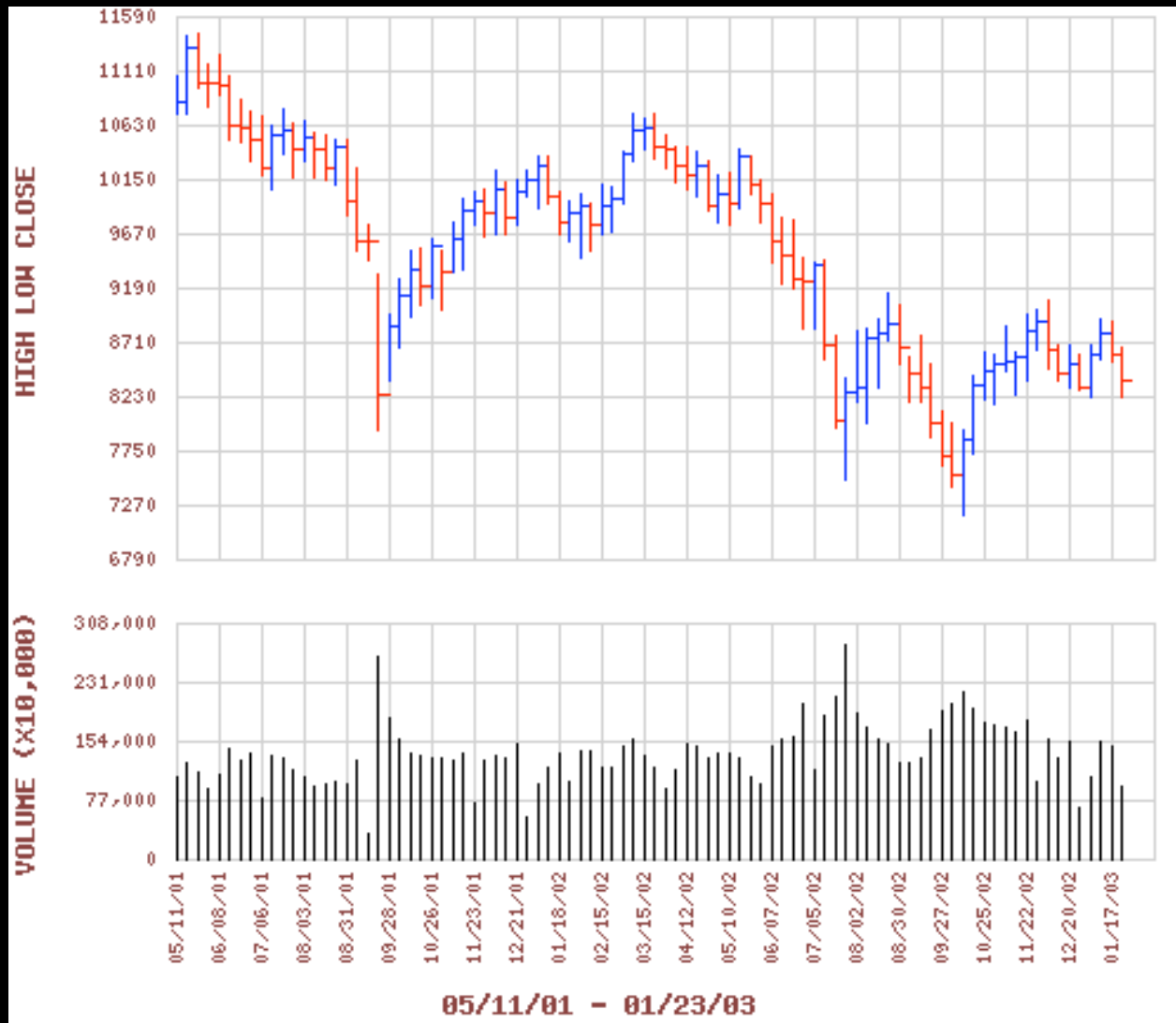
- Data **exploration**
- Hypothesis **testing**
- Making a **point**
- **Illustrating/demonstrating** an idea
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Does my display pass the “**interocular impact test**”?

# Data Exploration

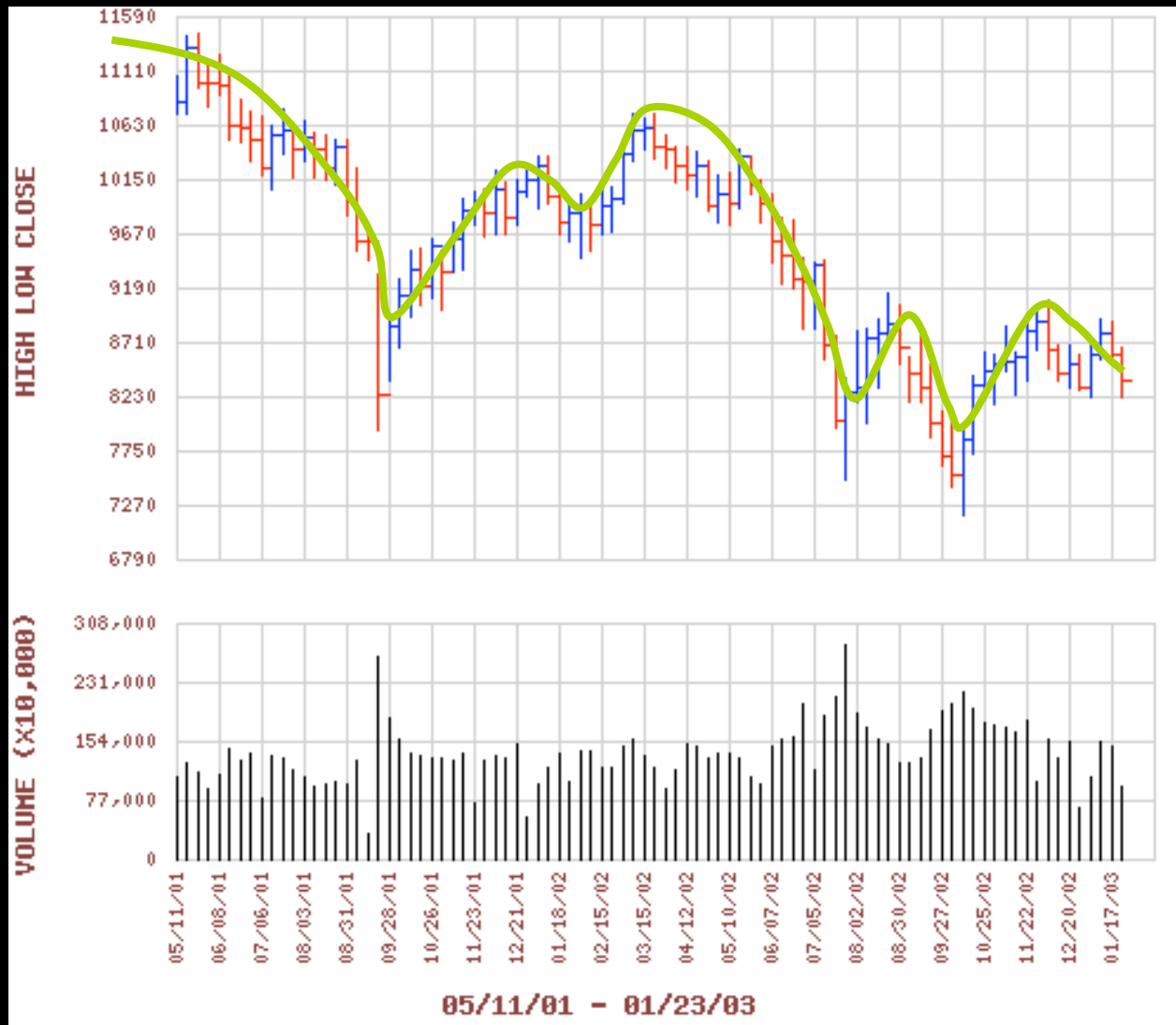


# Hypothesis (or “Model”) Testing

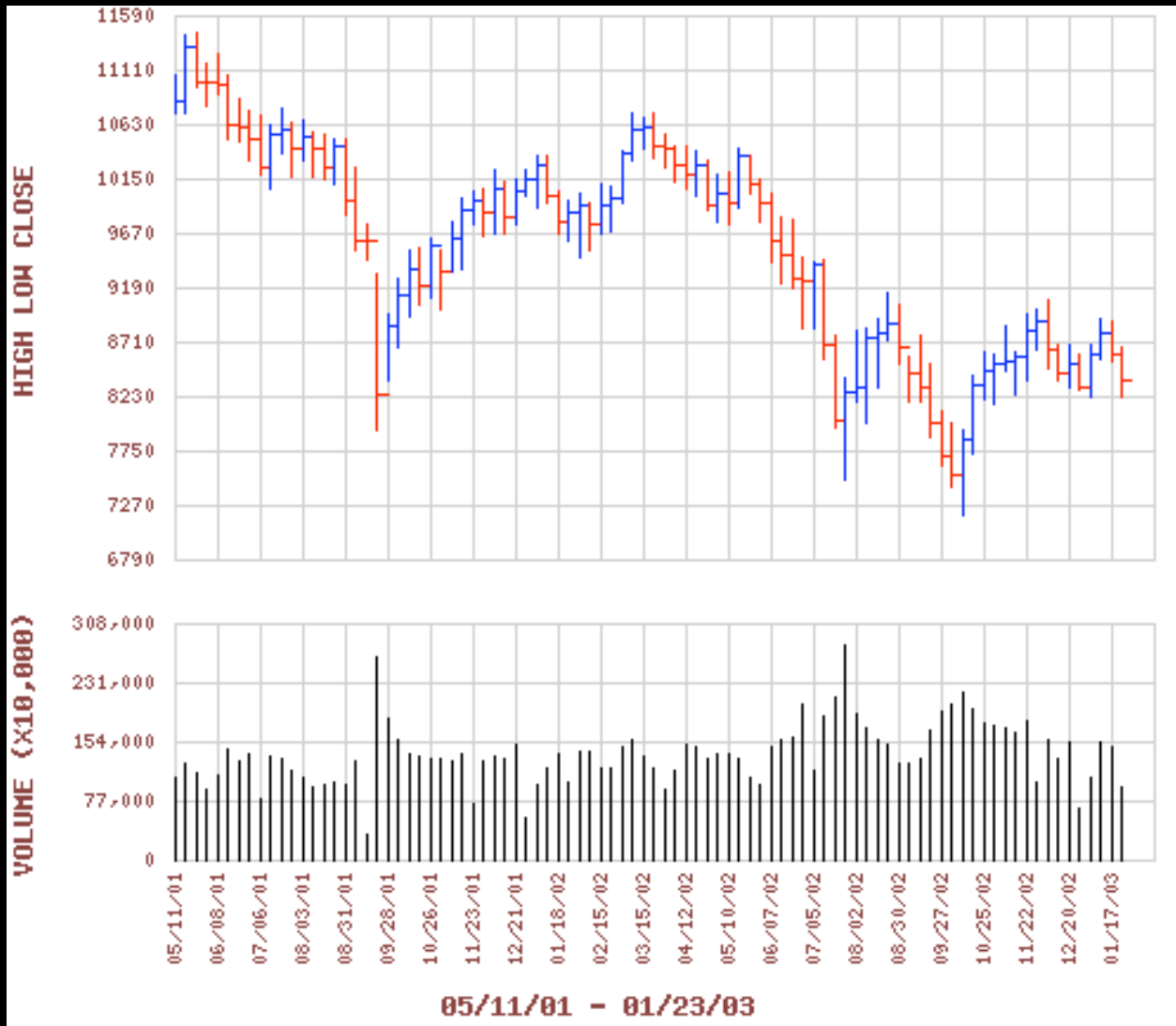




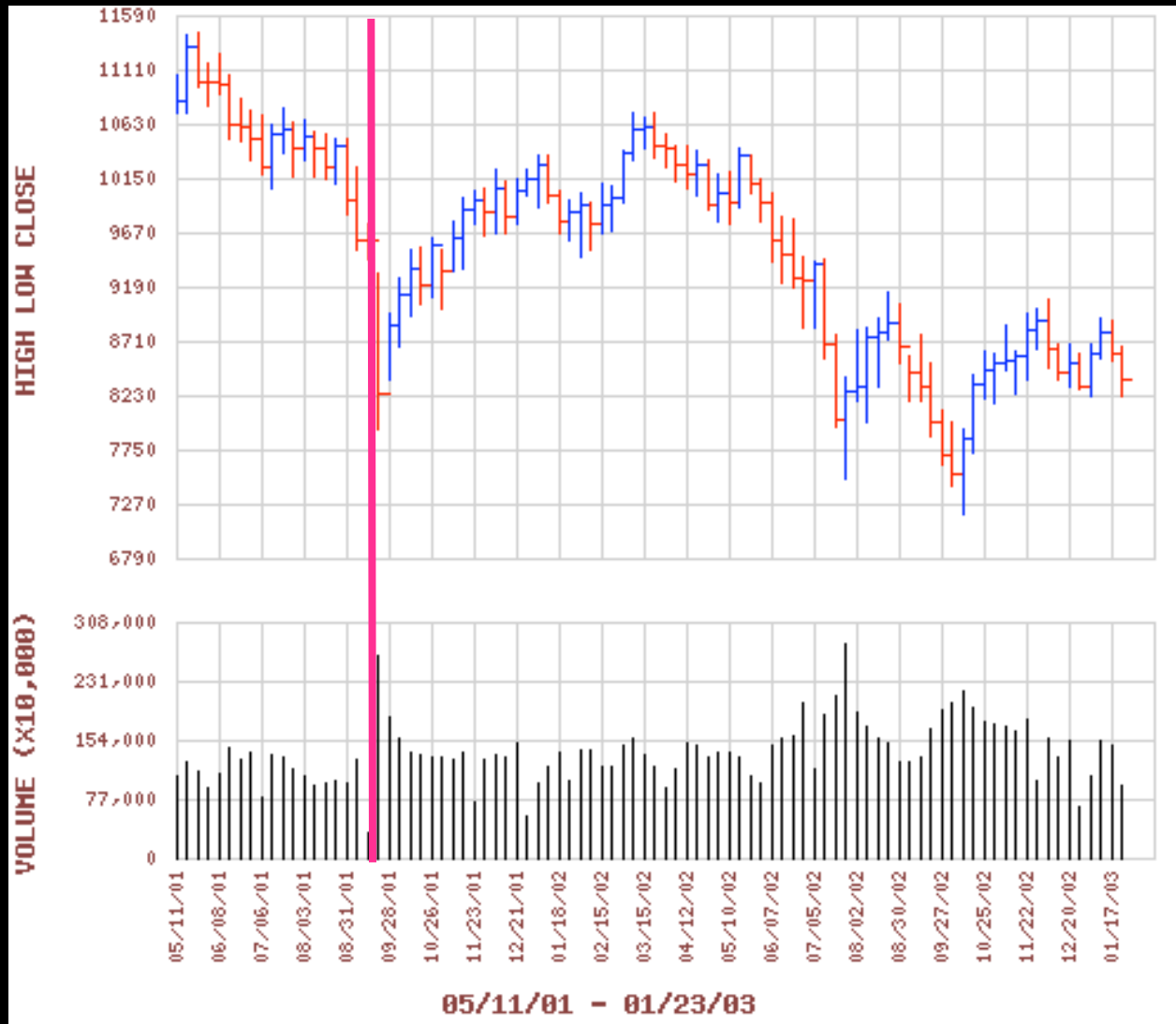
# Hypothesis (or “Model”) Testing



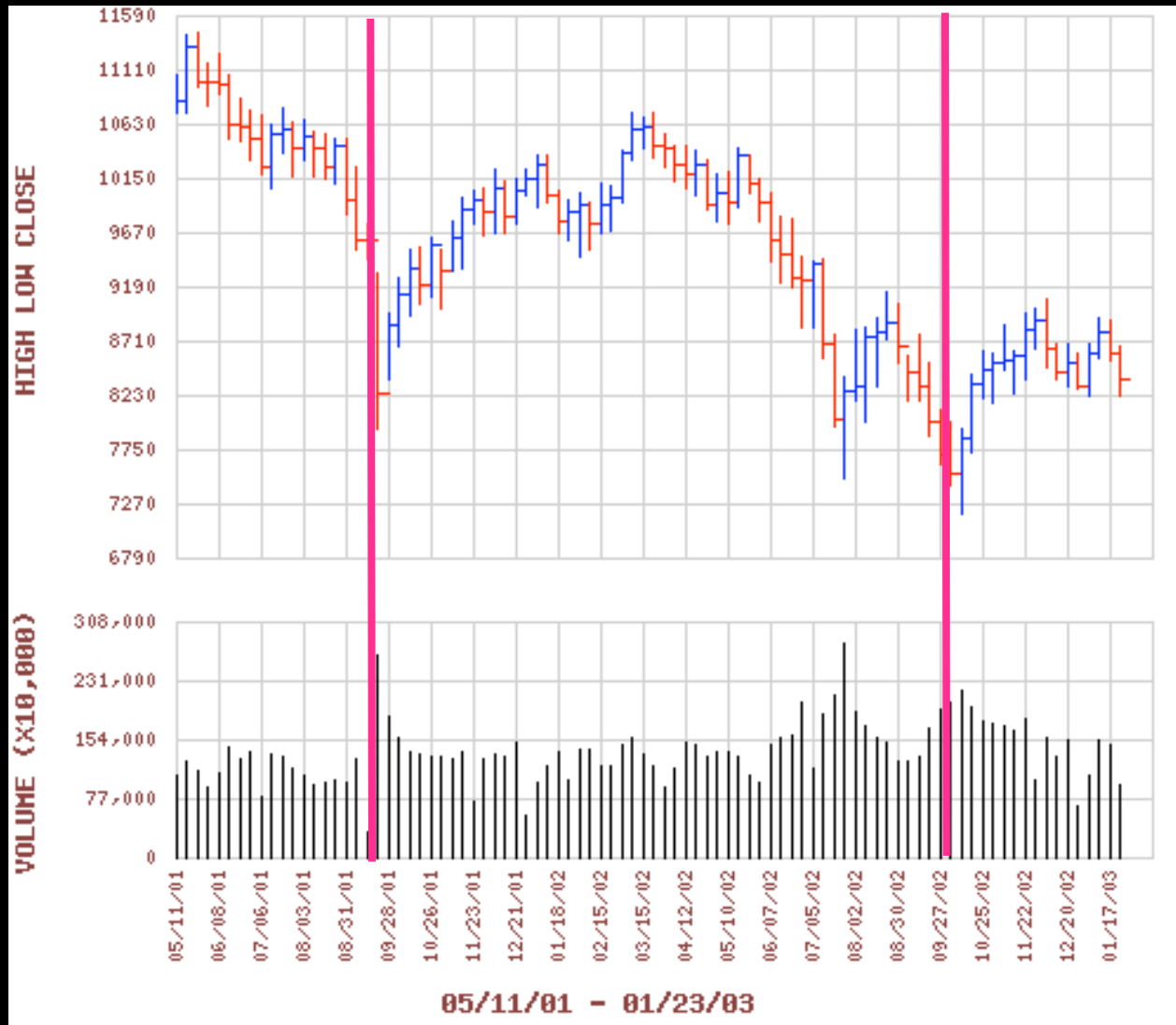
# Making a Point



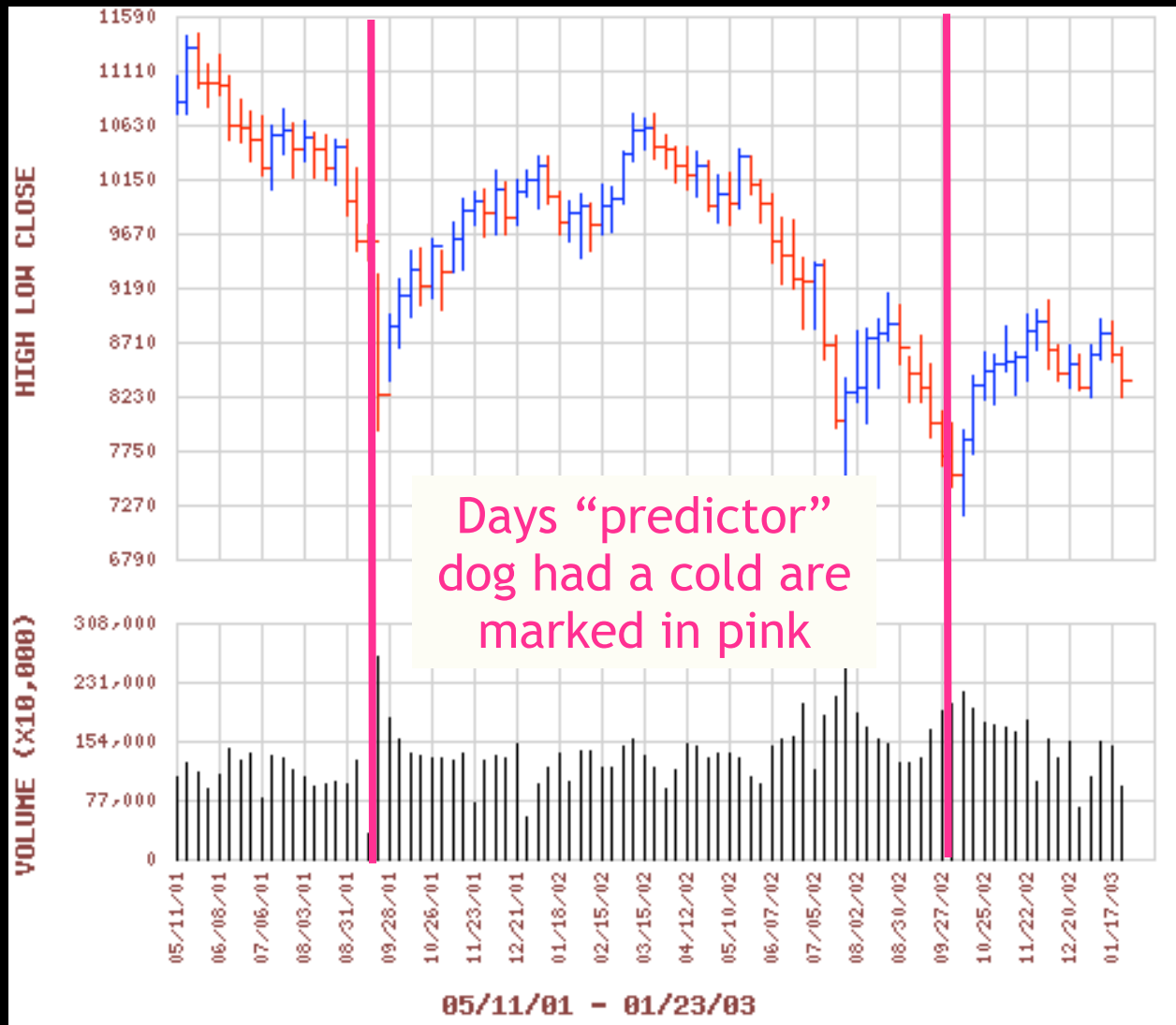
# Making a Point



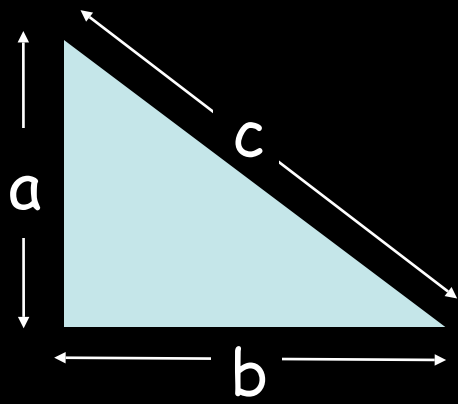
# Making a Point



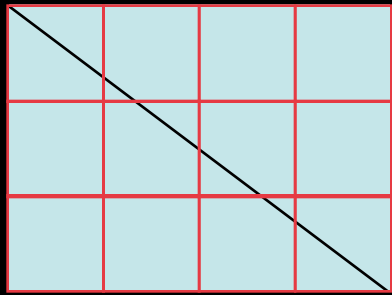
# Making a Point



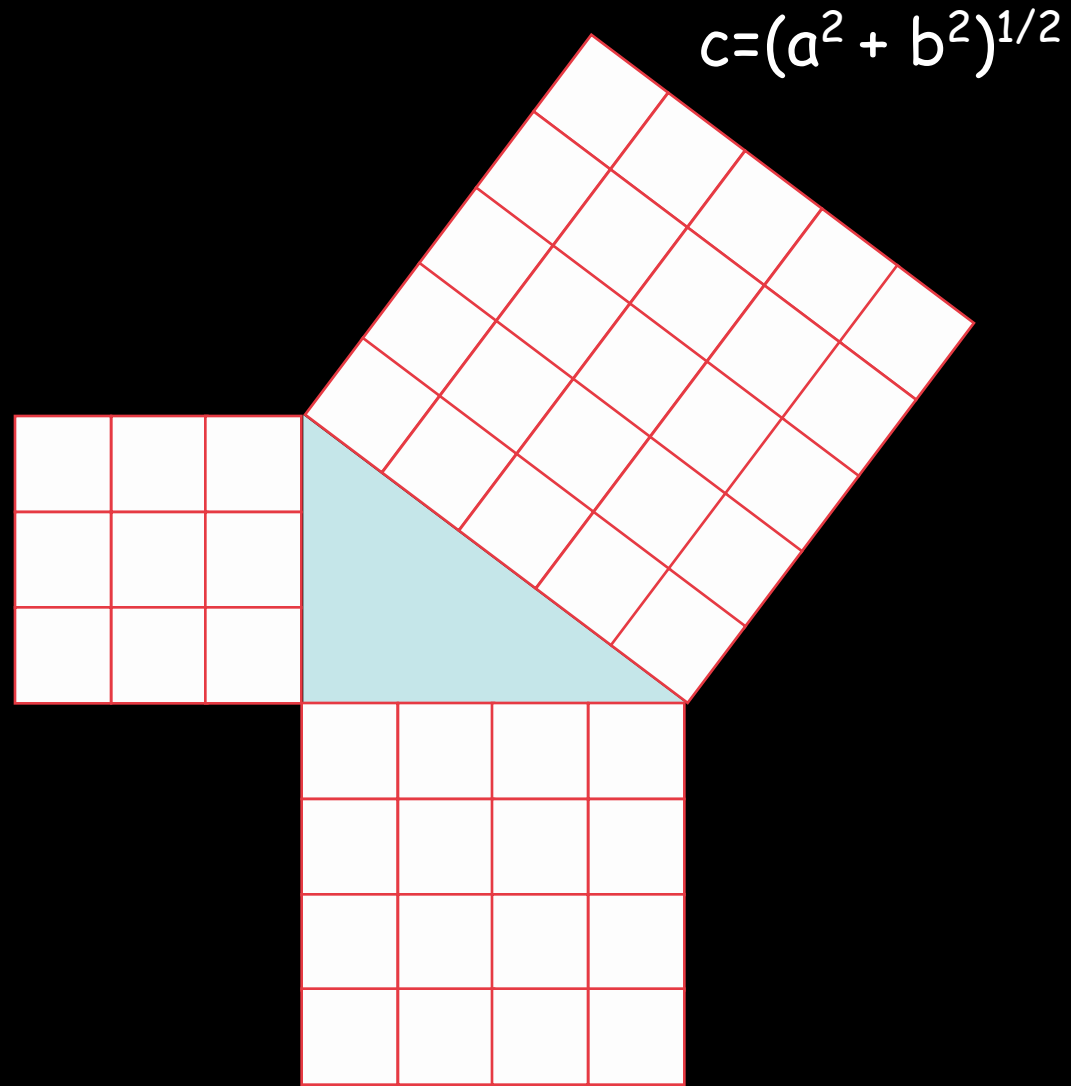
# Illustration



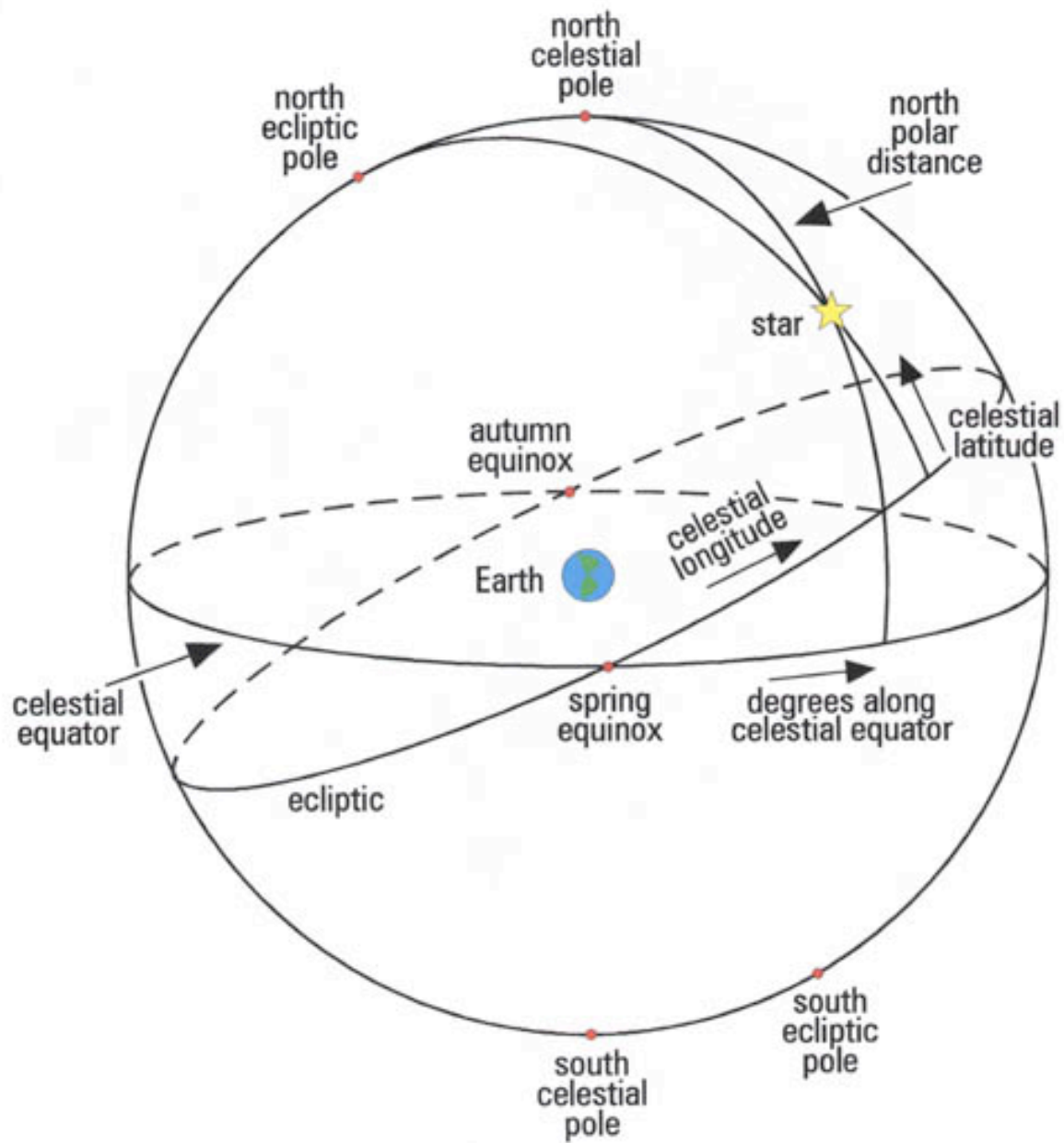
$$\text{Perimeter} = a + b + c$$



$$\text{Area} = (a \times b) / 2$$



# Illustration



# Condensing Information

## Periodic Table of the Elements

1		New										Original						18									
IA																		VIIIA									
1	<b>H</b> Hydrogen 1.00794																	2	<b>He</b> Helium 4.002602								
2	<b>Li</b> Lithium 6.941																	2	<b>Be</b> Beryllium 9.012182								
3	<b>Na</b> Sodium 22.989770																	2	<b>Mg</b> Magnesium 24.3050								
4	<b>K</b> Potassium 39.0983	<b>Ca</b> Calcium 40.078	<b>Sc</b> Scandium 44.955910	<b>Ti</b> Titanium 47.867	<b>V</b> Vanadium 50.9415	<b>Cr</b> Chromium 51.9961	<b>Mn</b> Manganese 54.938049	<b>Fe</b> Iron 55.8457	<b>Co</b> Cobalt 58.933200	<b>Ni</b> Nickel 58.6934	<b>Cu</b> Copper 63.546	<b>Zn</b> Zinc 65.39	<b>Ga</b> Gallium 69.723	<b>Ge</b> Germanium 72.61	<b>As</b> Arsenic 74.92160	<b>Se</b> Selenium 78.96	<b>Br</b> Bromine 79.904	<b>Kr</b> Krypton 83.80									
5	<b>Rb</b> Rubidium 85.4678	<b>Sr</b> Strontium 87.62	<b>Y</b> Yttrium 88.90585	<b>Zr</b> Zirconium 91.224	<b>Nb</b> Niobium 92.90638	<b>Mo</b> Molybdenum 95.94	<b>Tc</b> Technetium (98)	<b>Ru</b> Ruthenium 101.07	<b>Rh</b> Rhodium 102.90550	<b>Pd</b> Palladium 106.42	<b>Ag</b> Silver 107.8682	<b>Cd</b> Cadmium 112.411	<b>In</b> Indium 114.818	<b>Sn</b> Tin 118.710	<b>Sb</b> Antimony 121.760	<b>Te</b> Tellurium 127.60	<b>I</b> Iodine 126.90447	<b>Xe</b> Xenon 131.29									
6	<b>Cs</b> Cesium 132.90545	<b>Ba</b> Barium 137.327	57 to 71										<b>Hf</b> Hafnium 178.49	<b>Ta</b> Tantalum 180.9479	<b>W</b> Tungsten 183.84	<b>Re</b> Rhenium 186.207	<b>Os</b> Osmium 190.23	<b>Ir</b> Iridium 192.217	<b>Pt</b> Platinum 195.078	<b>Au</b> Gold 196.96655	<b>Hg</b> Mercury 200.59	<b>Tl</b> Thallium 204.3833	<b>Pb</b> Lead 207.2	<b>Bi</b> Bismuth 208.98038	<b>Po</b> Polonium (209)	<b>At</b> Astatine (210)	<b>Rn</b> Radon (222)
7	<b>Fr</b> Francium (223)	<b>Ra</b> Radium (226)	89 to 103										<b>Rf</b> Rutherfordium (261)	<b>Db</b> Dubnium (262)	<b>Sg</b> Seaborgium (263)	<b>Bh</b> Bohrium (264)	<b>Hs</b> Hassium (265)	<b>Mt</b> Meitnerium (266)	<b>Uun</b> Ununnilium (269)	<b>Uuu</b> Ununnilium (272)	<b>Uub</b> Ununbium (277)	<b>113</b>	<b>Uuq</b> Ununquadium (285)	<b>115</b>	<b>Uuh</b> Ununhexium (289)	<b>117</b>	<b>Uuo</b> Ununoctium (293)

Atomic masses in parentheses are those of the most stable or common isotope.

Web Page Design Copyright © 1997-1999 Michael Dayah <http://www.dayah.com/periodic/>

Note: The subgroup numbers 1-18 were adopted in 1984 by the International Union of Pure and Applied Chemistry. The names of elements 110-118 are the Latin equivalents of those numbers.

<b>57</b> Lanthanum 138.9055	<b>58</b> Ce 140.116	<b>59</b> Pr 140.90765	<b>60</b> Nd 144.24	<b>61</b> Pm (145)	<b>62</b> Sm 150.36	<b>63</b> Eu 151.964	<b>64</b> Gd 157.25	<b>65</b> Tb 158.92534	<b>66</b> Dy 162.50	<b>67</b> Ho 164.93032	<b>68</b> Er 167.26	<b>69</b> Tm 168.93421	<b>70</b> Yb 173.04	<b>71</b> Lu 174.967
<b>89</b> Ac (227)	<b>90</b> Th 232.0381	<b>91</b> Pa 231.03588	<b>92</b> U 238.0289	<b>93</b> Np (237)	<b>94</b> Pu (244)	<b>95</b> Am (243)	<b>96</b> Cm (247)	<b>97</b> Bk (247)	<b>98</b> Cf (251)	<b>99</b> Es (252)	<b>100</b> Fm (257)	<b>101</b> Md (258)	<b>102</b> No (259)	<b>103</b> Lr (262)



# Questions to Always Ask

What's this “VDQI” for?

- Data **exploration**
- Hypothesis **testing**
- Making a **point**
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- >1 of the above (best answer)

Does my display pass the “**interocular impact test**”?

# Tables

- When is a **table better** than a graph or chart?
- How many **independent quantities** are listed in a table?
  - Are any of the entries “**correlated**”? Should they be?
- Is the numerical **accuracy** shown appropriate (# of “significant figures”)?

# Tables

## Lake Pend Oreille Weather: Current Conditions

Last Measurement: **23 Jan 2003 at 19:21:11 PST** Updated every 10 Minutes

Sensor Measurement	Value	Daily Max / Ave / Min	Units
Wind Speed	5.4	16.7 / 7.3 / 0.1	Mph
Wind Gust	8.5	29.7 / 11.3 / 2.2	Mph
Wind Direction Magnetic North	223	359 / 178.0 / 1	Deg
Significant Wave, Peak-to-Trough	0.2	1.2 / 0.7 / 0.2	Ft
Barometric Pressure	30.44	30.49 / 30.4 / 30.29	InHg
Relative Humidity	85	98 / 86.4 / 69	%
Dew Point	38.3	38.3 / 34.1 / 28.2	Deg F
Air Temp	42.5	45.0 / 38.0 / 29.5	Deg F
Water Surface Temp	40.4	40.5 / 40.4 / 40.3	Deg F
Water Temp 50 ft	40.3	40.4 / 40.3 / 40.1	Deg F
Water Temp 100 ft	40.5	40.5 / 40.4 / 40.4	Deg F
Water Temp 200 ft	40.3	40.5 / 40.4 / 40.3	Deg F
Water Temp 400 ft	39.7	40.0 / 39.7 / 39.5	Deg F

[Measurement Description Notes.](#)

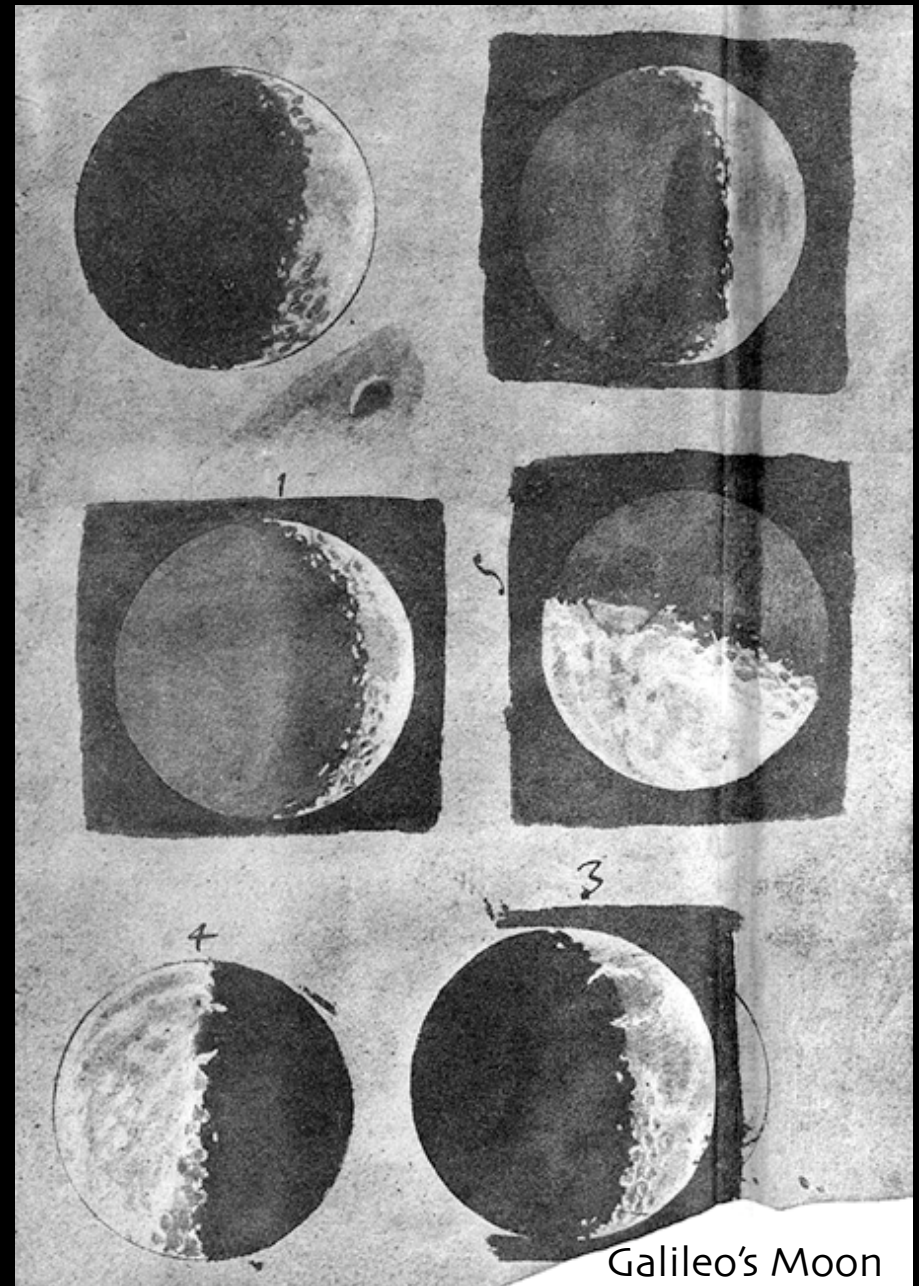
[http://lpo.dt.navy.mil/ems/weatherman/std\\_tbl/?rnd=](http://lpo.dt.navy.mil/ems/weatherman/std_tbl/?rnd=)

# Tables

CRIME	CARDINALE	LOFARO	MALONEY	POLISI	SENATORE	FORONJY	CURRO
MURDER	X	X					
ATTEMPTED MURDER		X	X				
HEROIN POSSESSION AND SALE	X	X		X			X
COCAINE POSSESSION AND SALE	X		X	X			
MARIJUANA POSSESSION AND SALE							X
GAMBLING BUSINESS		X		X		X	
ARMED ROBBERIES	X		X	X	X		X
LOANSHARKING		X		X			
KIDNAPPING			X	X			
EXTORTION			X	X			
ASSAULT	X		X	X			X
POSSESSION OF DANGEROUS WEAPONS	X	X	X	X	X		X
PERJURY		X				X	
COUNTERFEITING					X	X	
BANK ROBBERY			X	X			
ARMED HIJACKING				X	X		
STOLEN FINANCIAL DOCUMENTS			X	X	X		
TAX EVASION				X		X	
BURGLARIES	X	X		X	X		
BRIBERY		X		X			
THEFT: AUTO. MONEY, OTHER			X	X	X	X	X
BAIL JUMPING AND ESCAPE			X	X			
INSURANCE FRAUDS					X	X	
FORGERIES				X	X		
PISTOL WHIPPING A PRIEST	X						
SEXUAL ASSAULT ON MINOR							X
RECKLESS ENDANGERMENT							X

More Sample Graphics

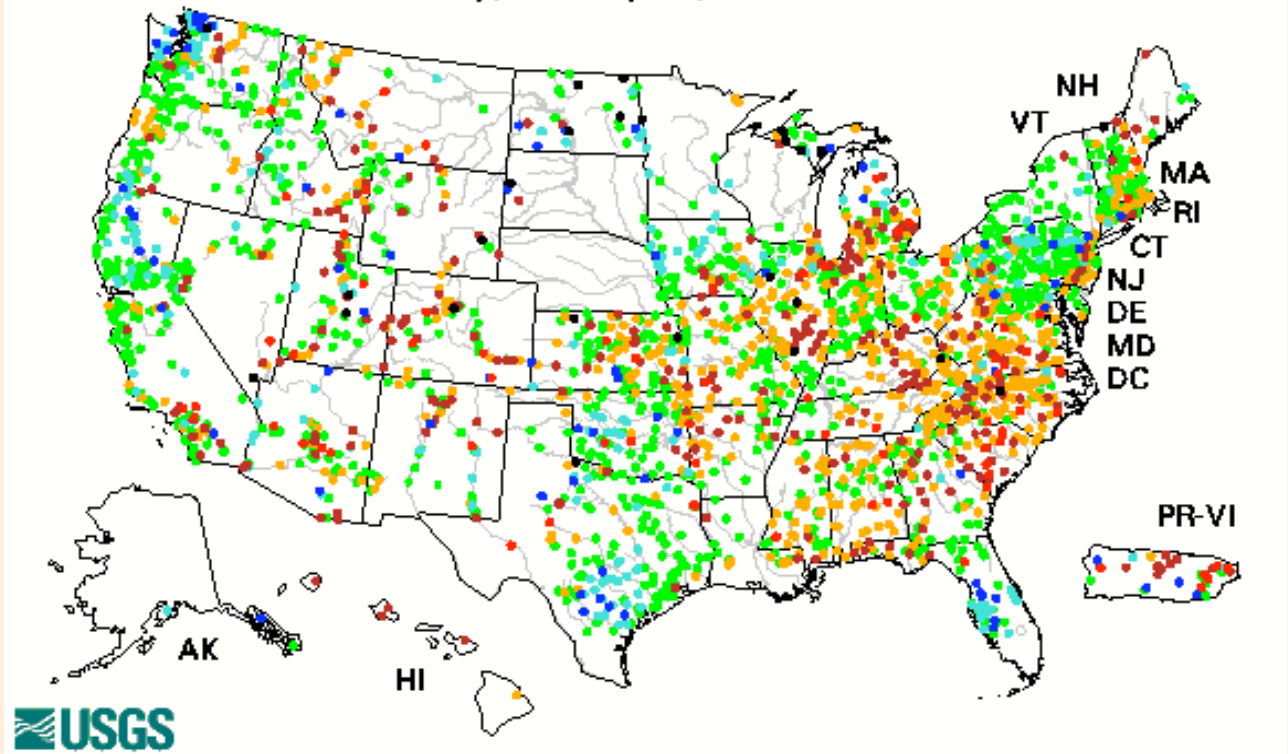
# “Small Multiples”



Galileo's Moon

# Map of real-time streamflow compared to historical streamflow for the day of the year (United States)

Thursday, January 23, 2003 22:20ET



Dry Normal Wet

Choose a data retrieval option and select a location on the map  
 List of all stations in state,  State map, or  Nearest stations

Explanation - Percentile classes						
New low	< 10	10 - 24	25 - 74	75 - 89	≥ 90	New high

Data  
Exploration

# Hypothesis Testing

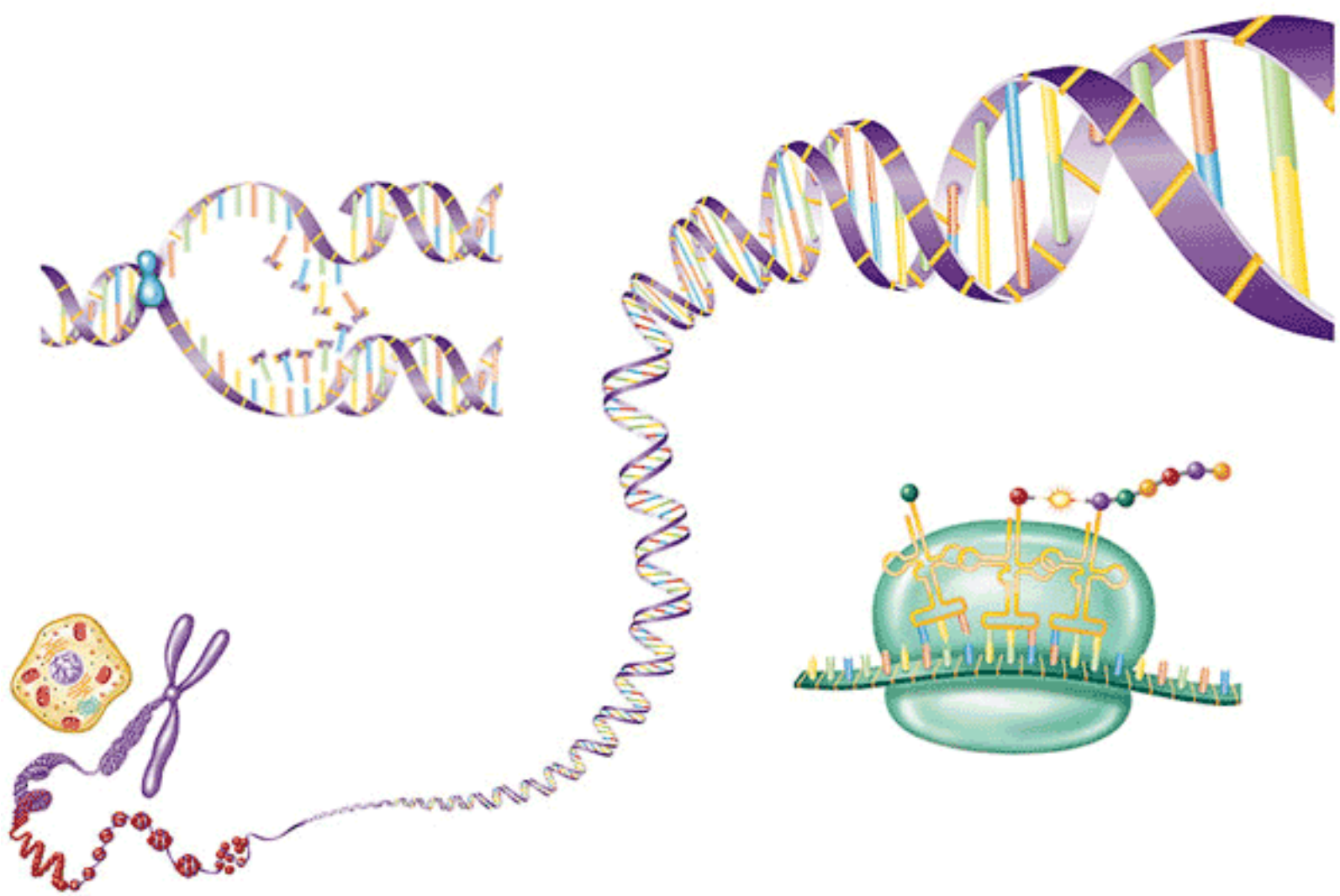
## John Snow & the London Cholera Epidemic 1854

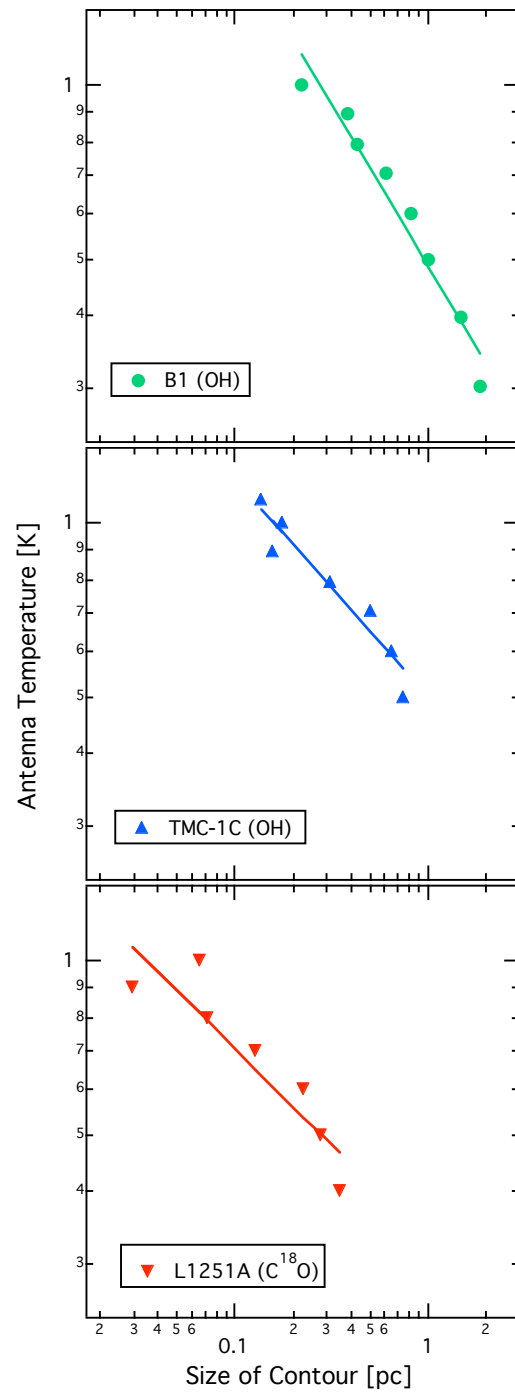
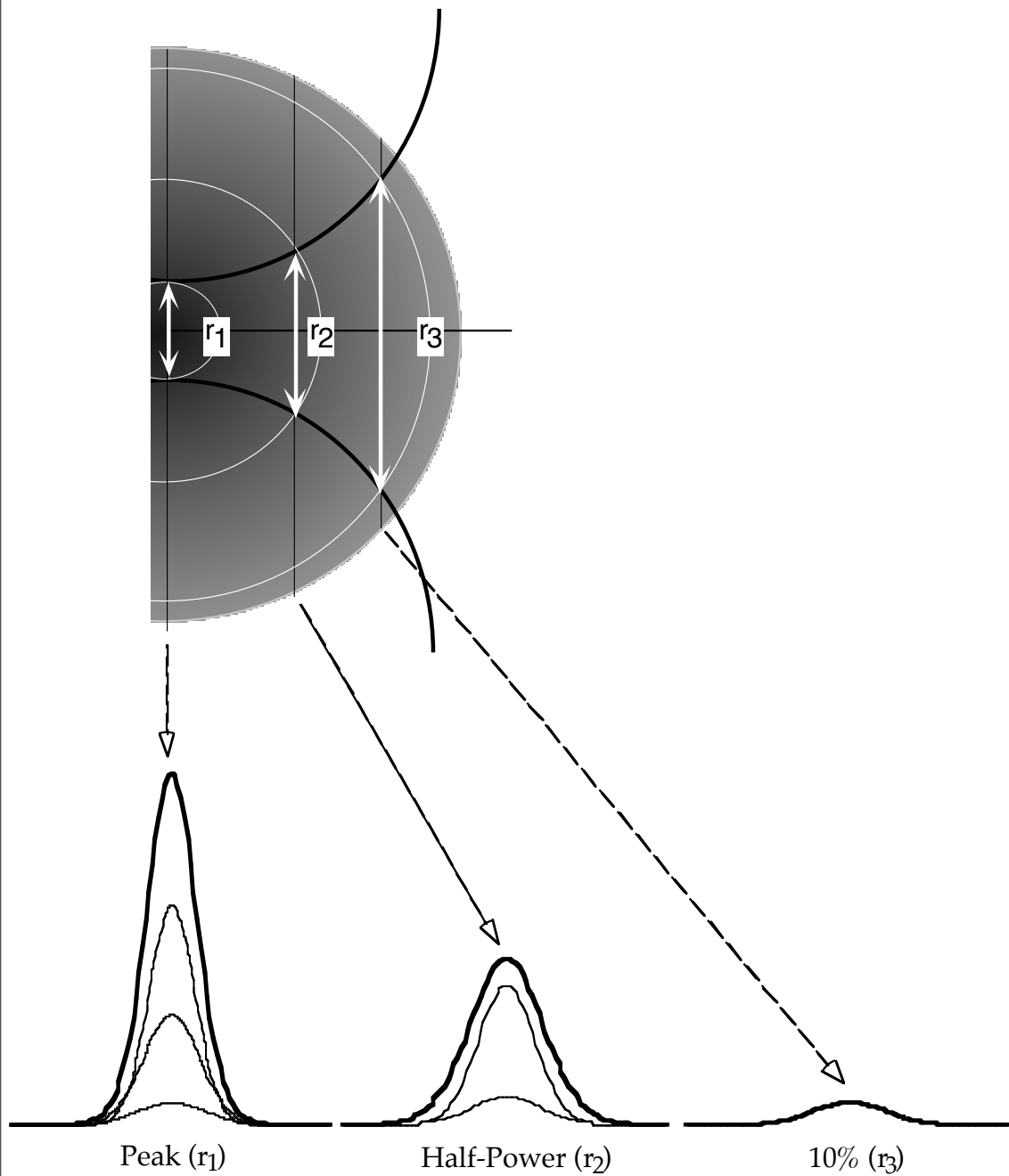


Reproduced from Visual and Statistical Thinking, ©E.R. Tufte 1997, based on Snow's drawing.



# Critiques





# PowerPoint for Good & Evil

# PowerPoint for Good & Evil

Good

# PowerPoint for Good & Evil

## Good

- Forces good handwriting

# PowerPoint for Good & Evil

## Good

- Forces good handwriting
- Animation/overlays

# PowerPoint for Good & Evil

## Good

- Forces good handwriting
- Animation/overlays
- Clear record of presentations



# PowerPoint for Good & Evil

## Good

- Forces good handwriting
- Animation/overlays
- Clear record of presentations
- Color

# PowerPoint for Good & Evil

## Good

- Forces good handwriting
- Animation/overlays
- Clear record of presentations
- Color
- Good graphics import

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- Random access Difficult



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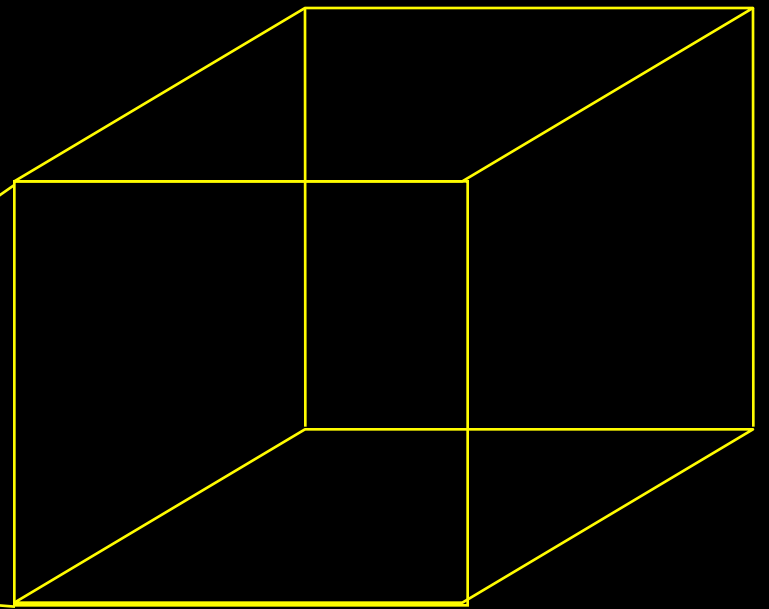
## Evil

- Gratuitous Graphics--too much glitz, no substance
- Bulleted list after bulleted list
- Poor graphics import (e.g. EPS)
- Random access Difficult
- Spinning things

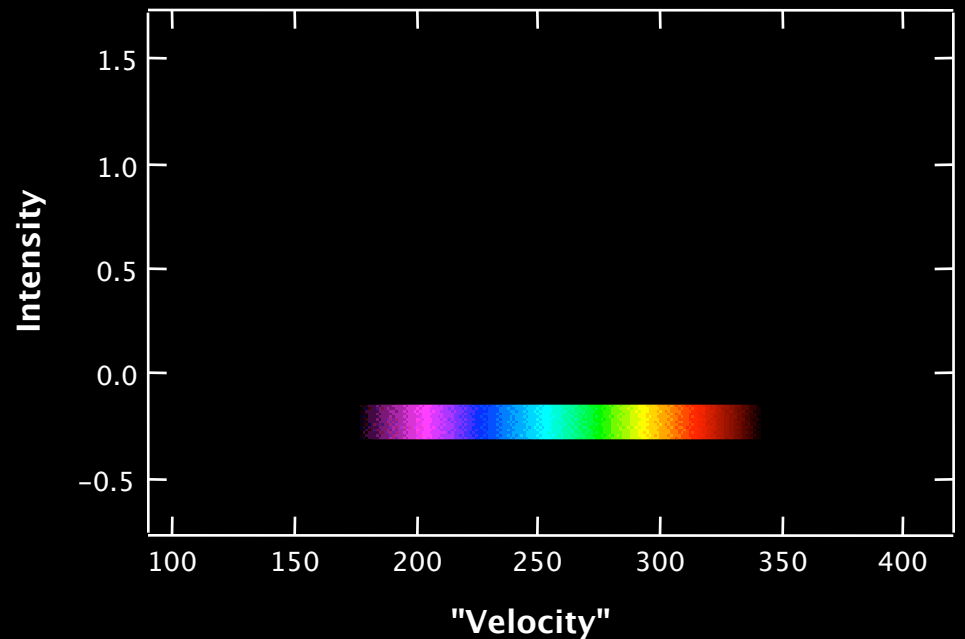
# Velocity from Spectroscopy



Telescope +  
Spectrometer



Observed Spectrum

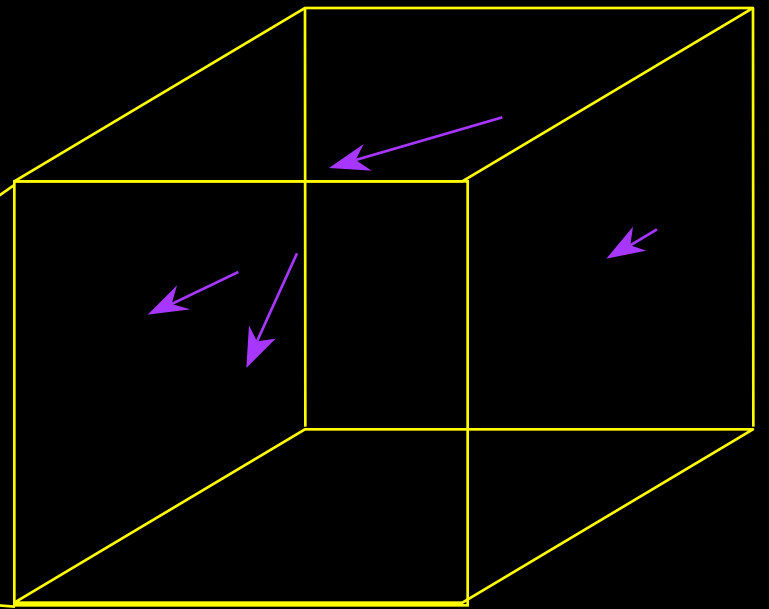


*All thanks to Doppler*

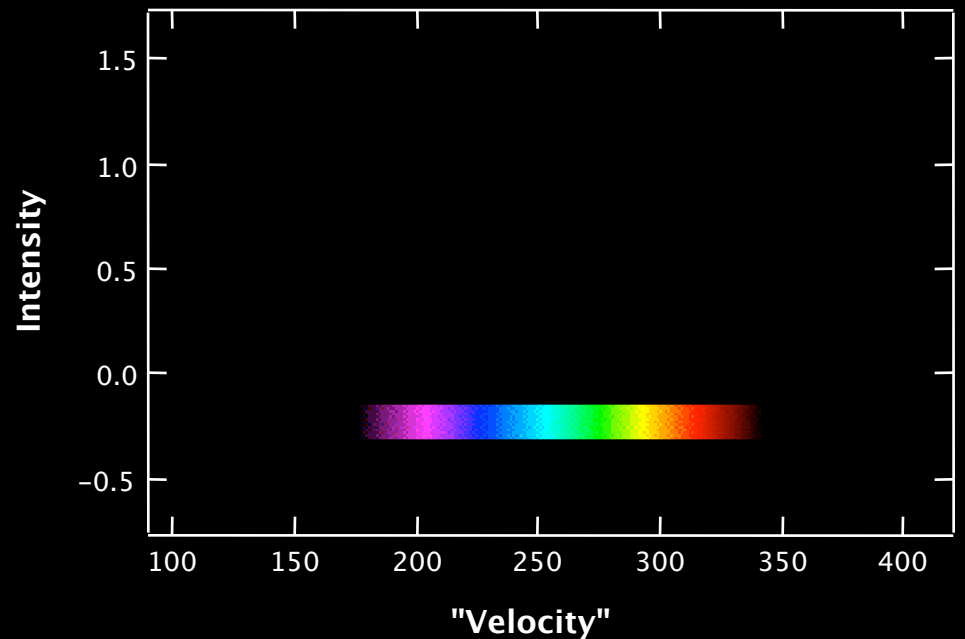
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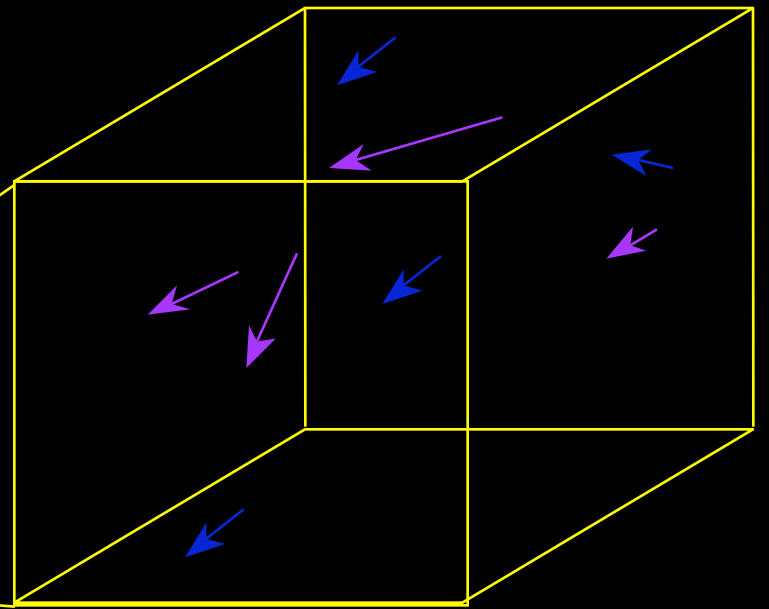


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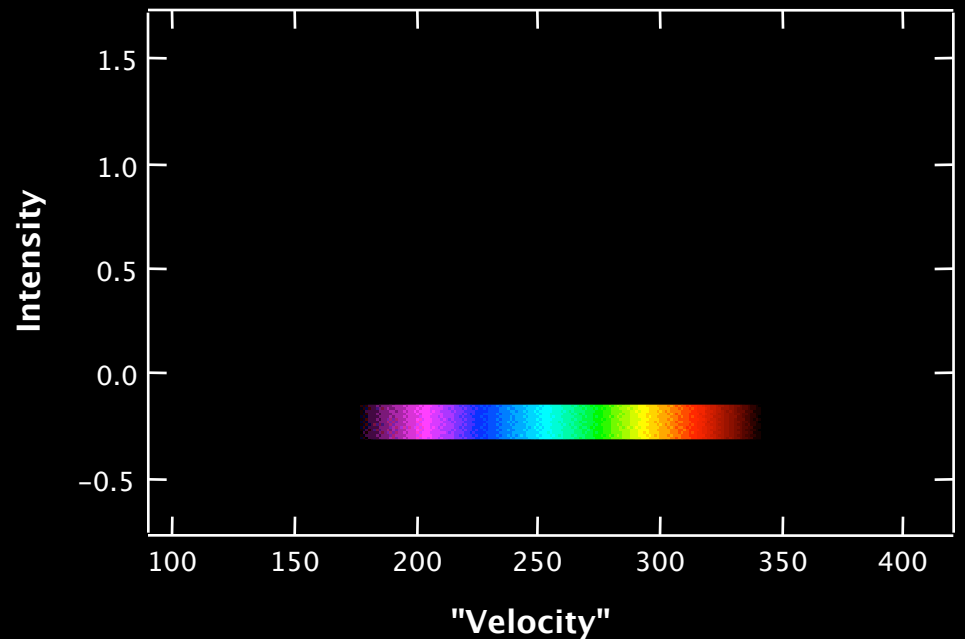
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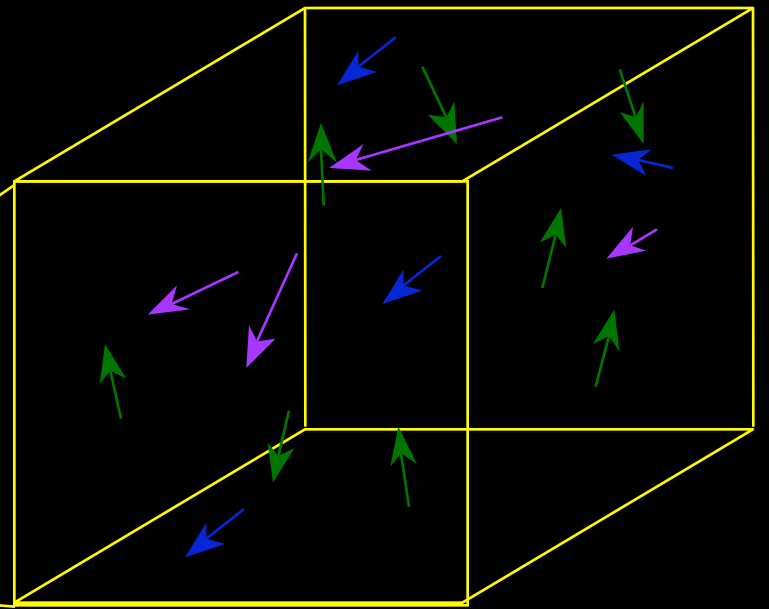


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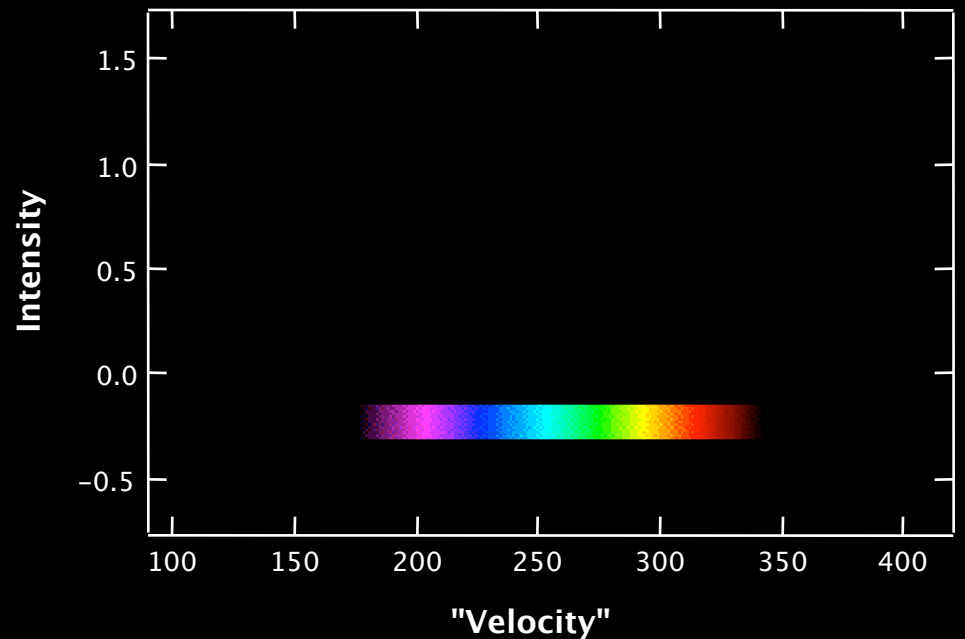
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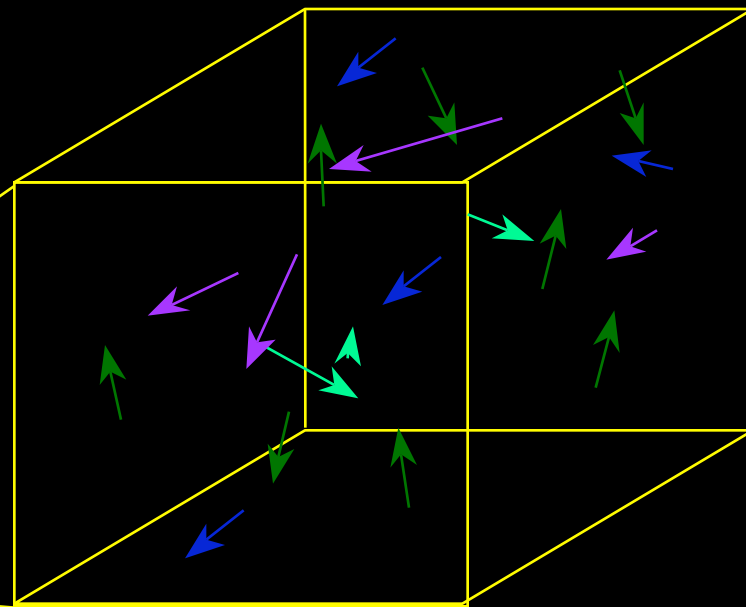


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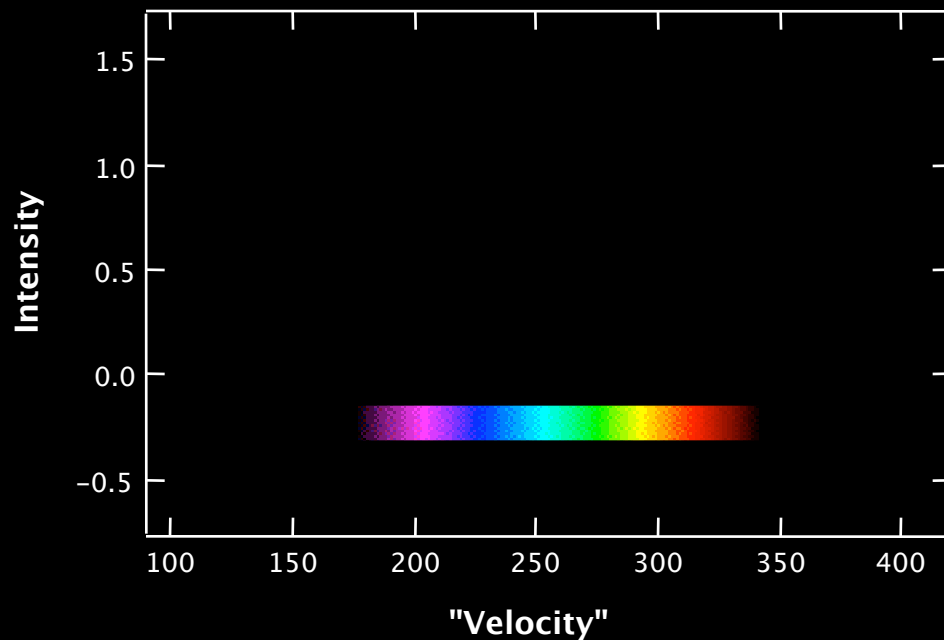
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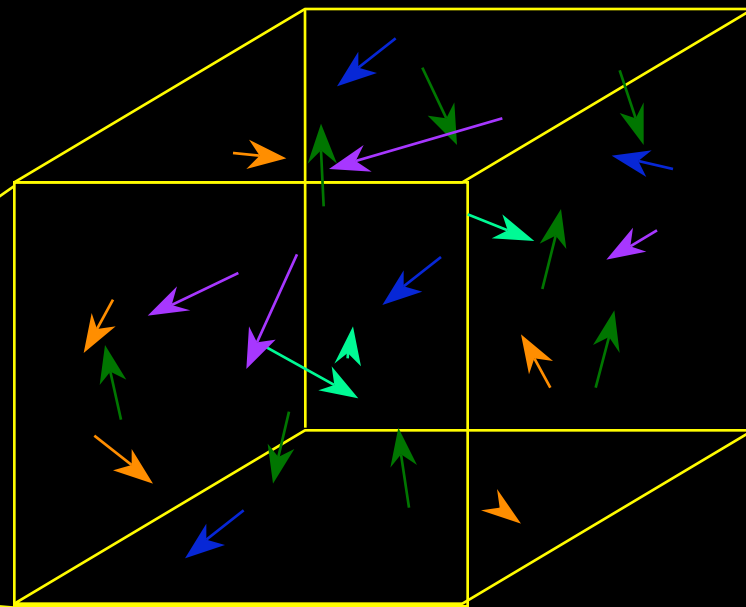


All thanks to *Doppler*

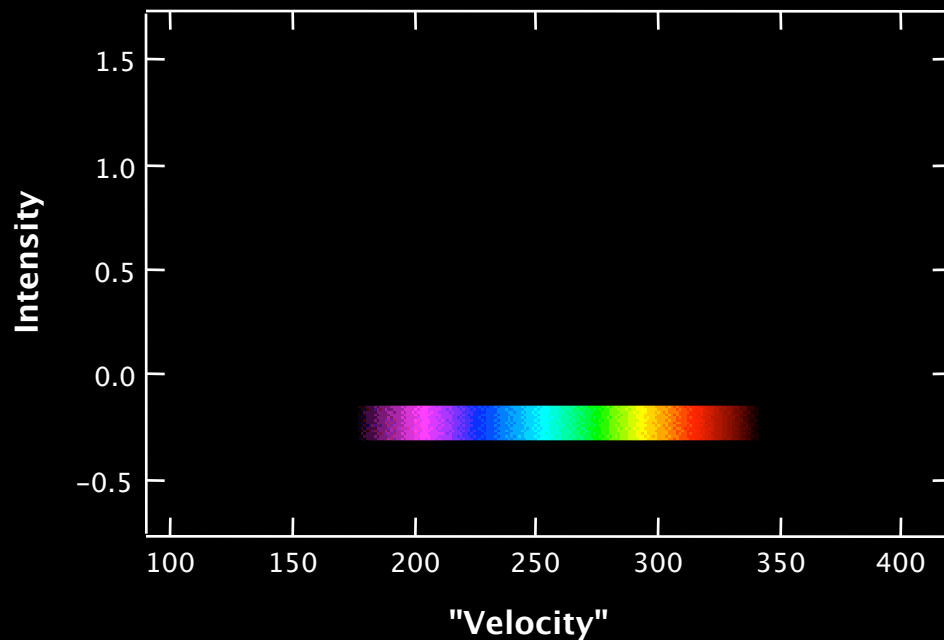
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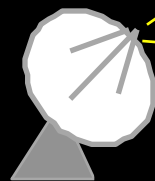


Observed Spectrum

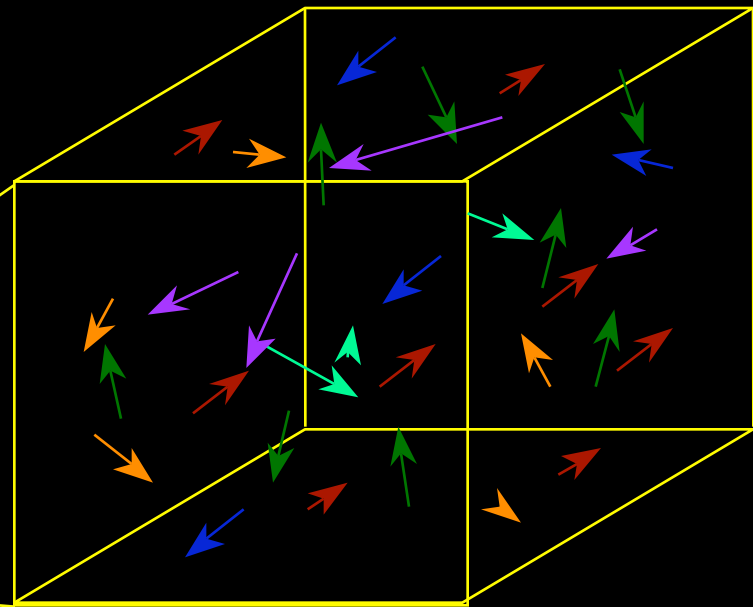


All thanks to *Doppler*

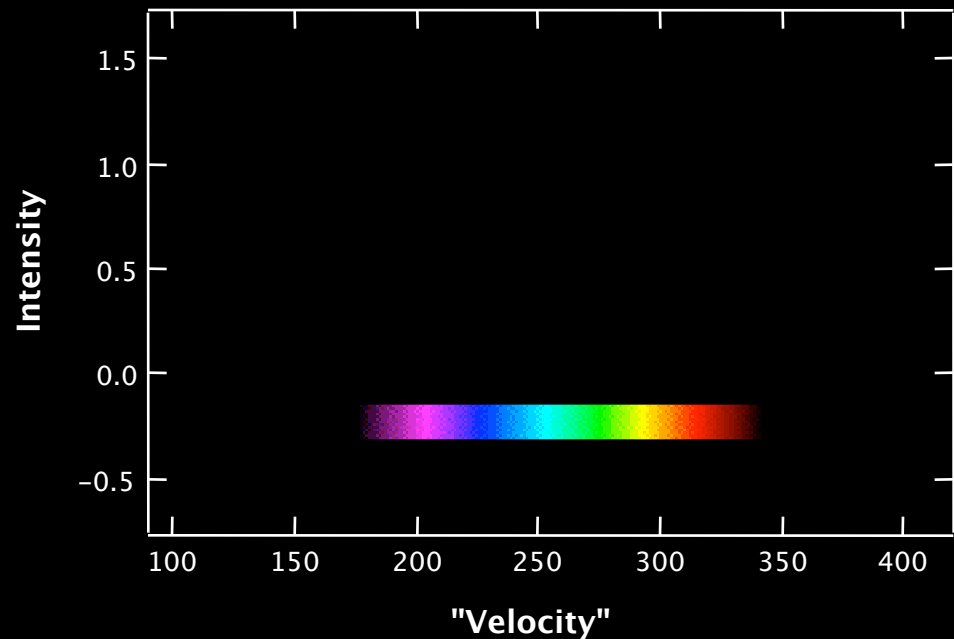
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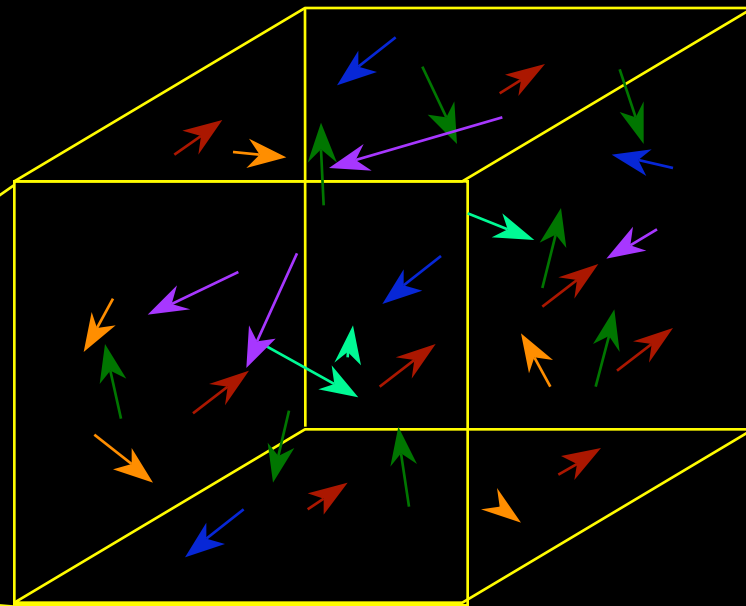
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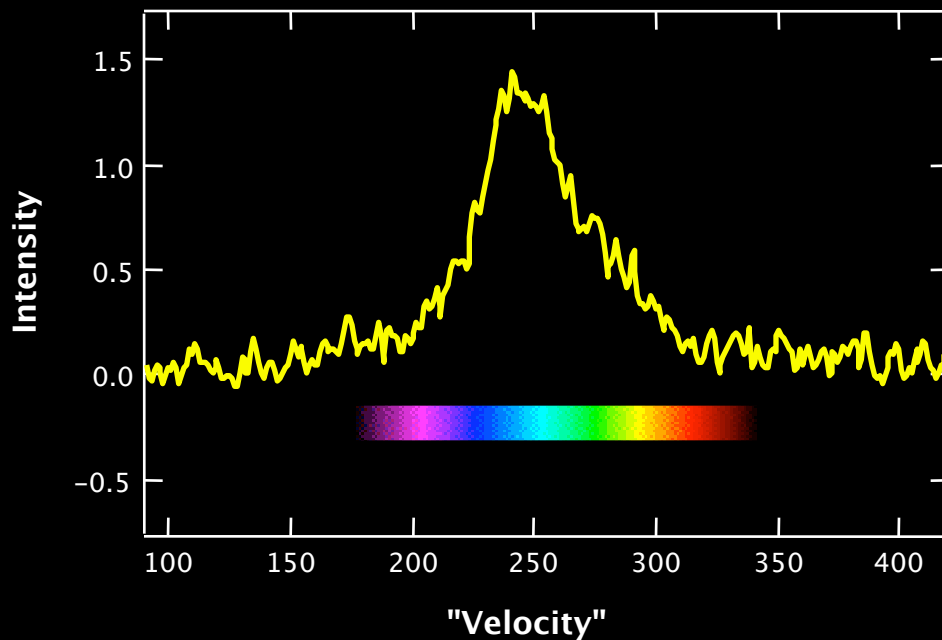
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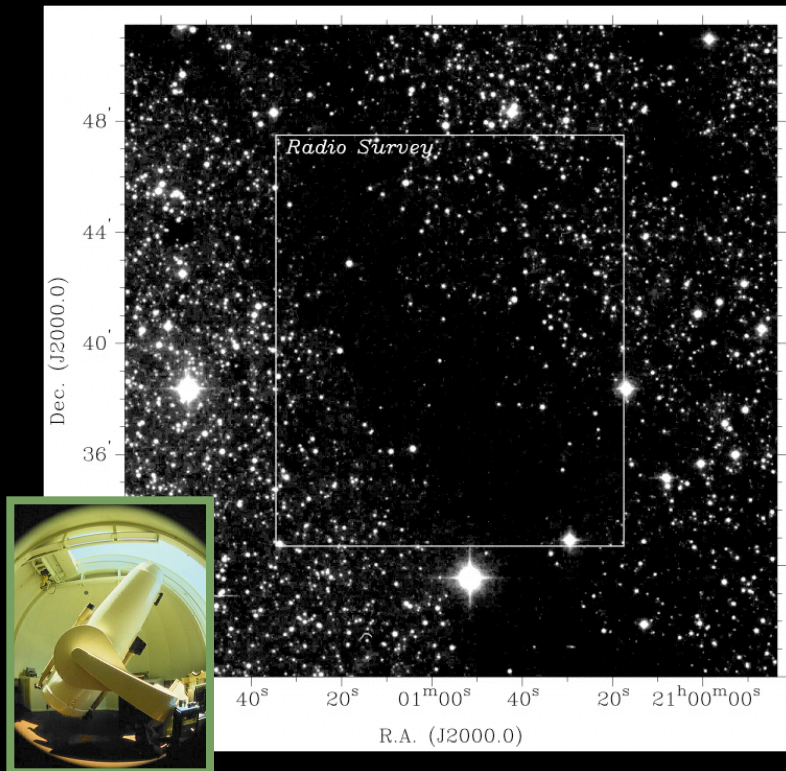
Observed Spectrum



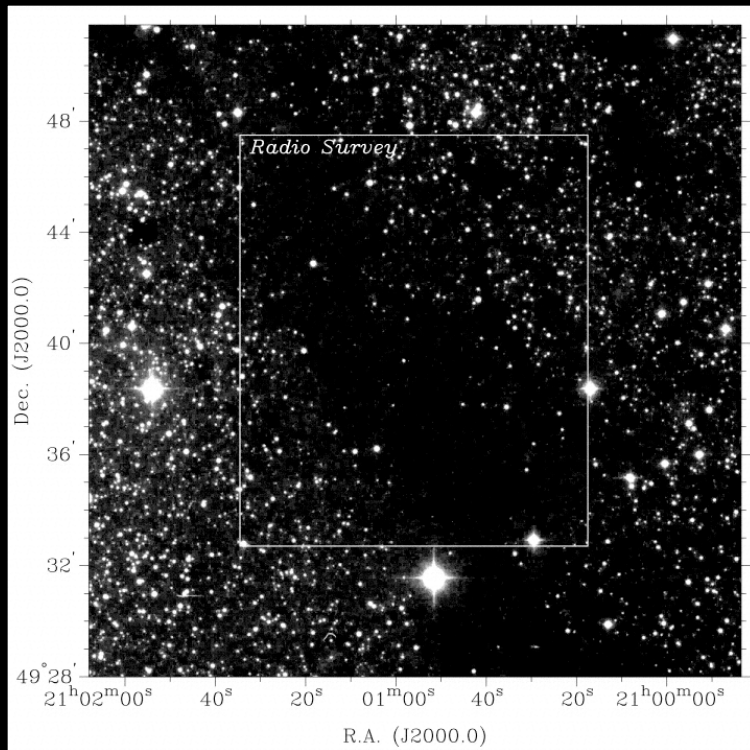
All thanks to **Doppler**

# Radio Spectral-line Observations of Interstellar Clouds

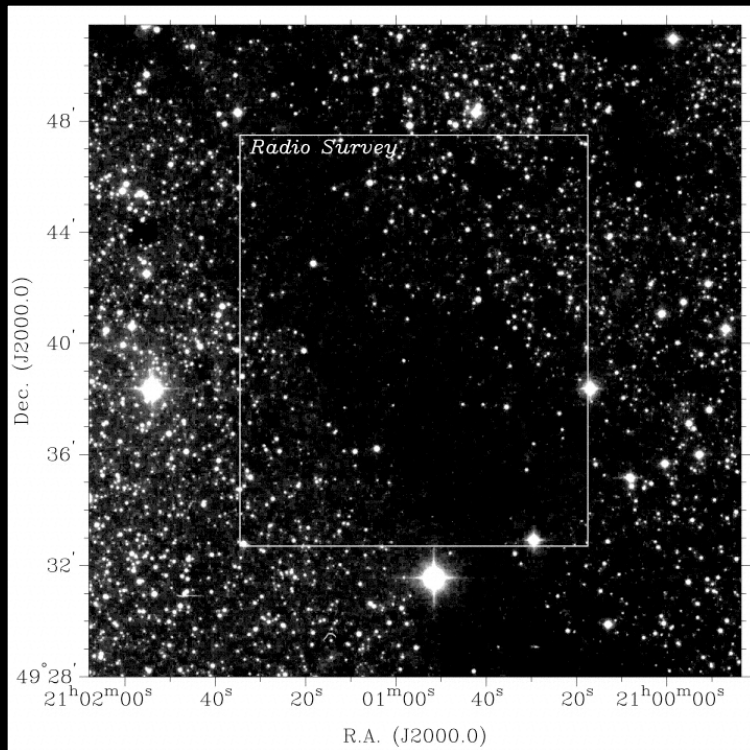
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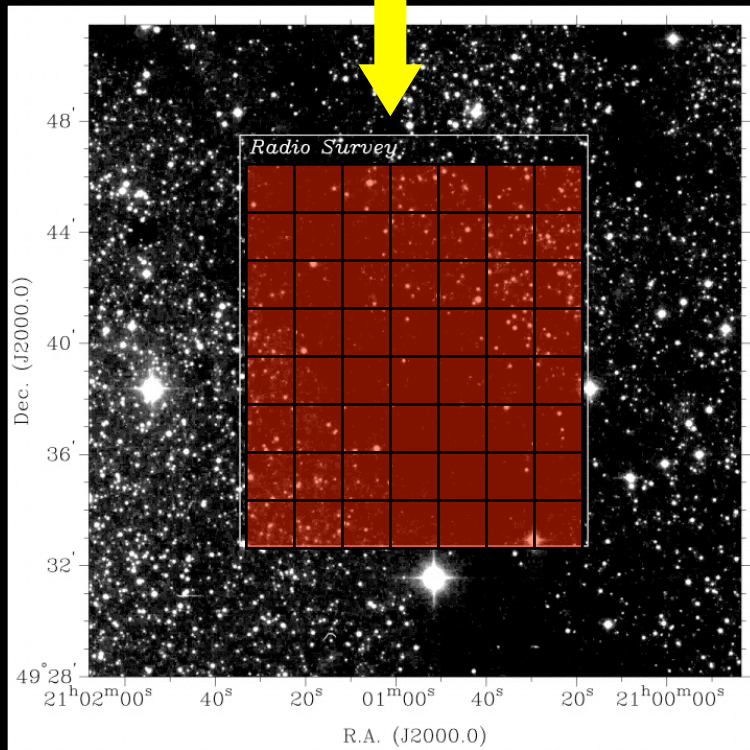
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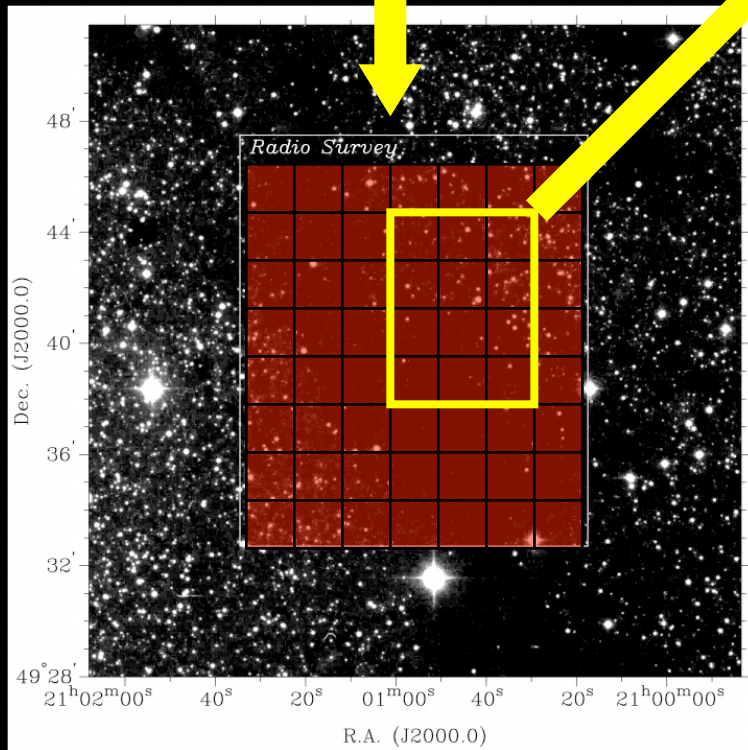
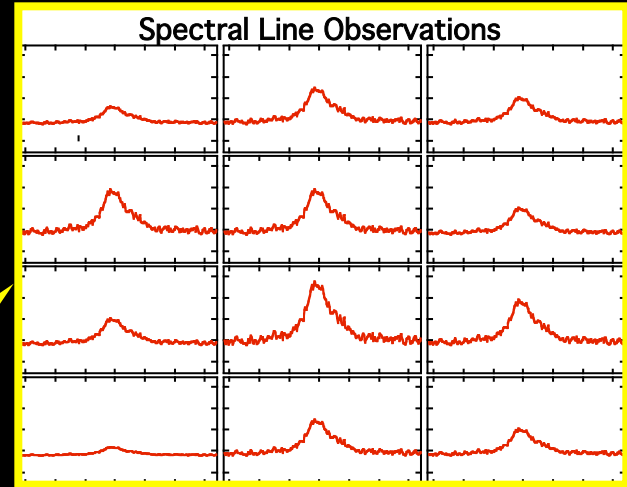
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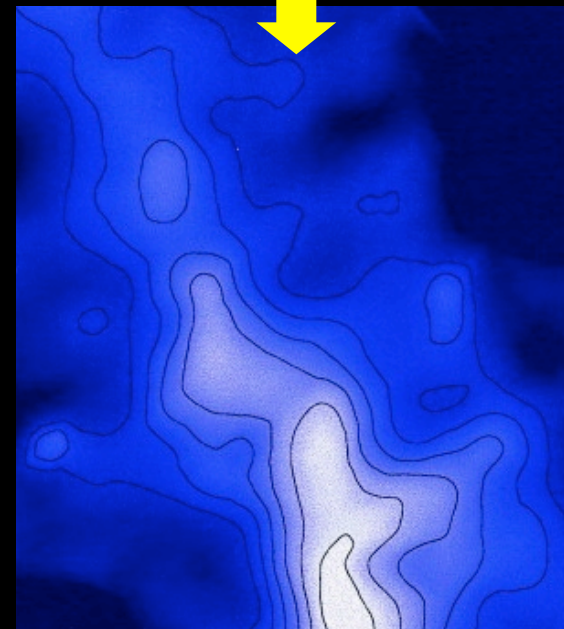
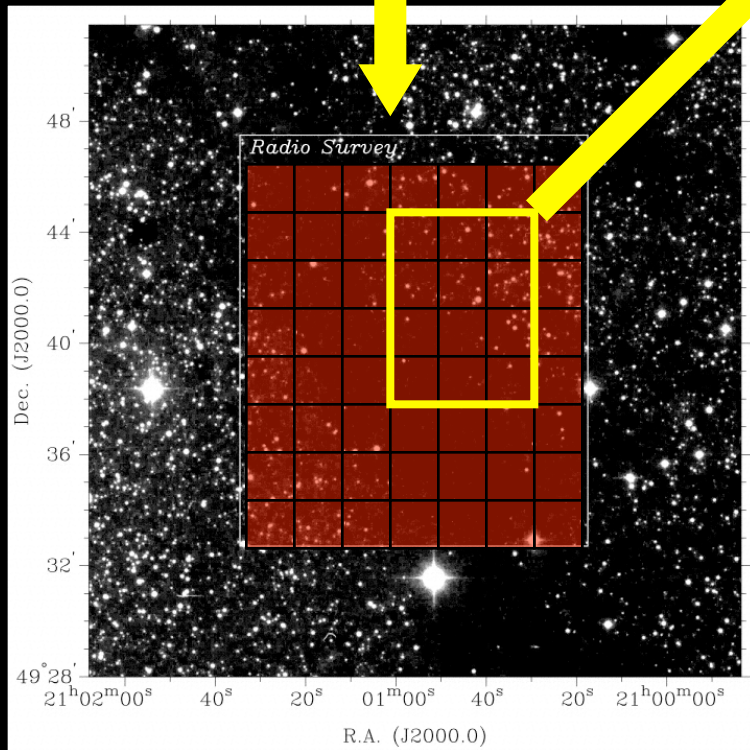
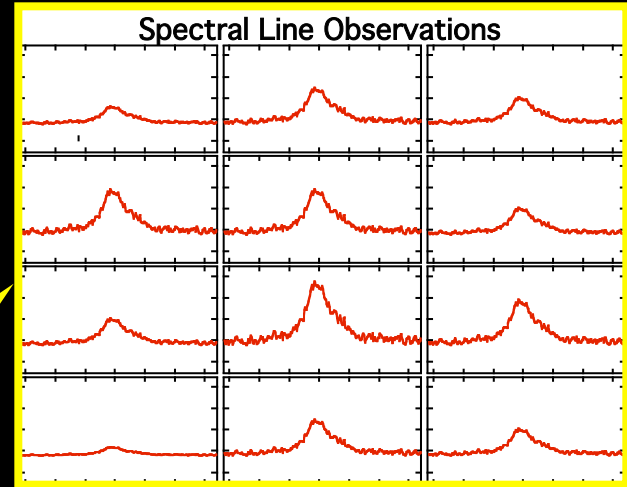
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# “Core” Principals for the Best Visual Displays (of Quantitative) Information

1. Clarity
2. Tailor to Audience
3. Optimize Display Design
4. Maximum Information, Minimum Mess
5. Consider Delivery Method (hardcopy, blackboard, web, PPT, movie vs. still)