The Virtual Observatory (and maybe some Astrophysics)

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National Virtual Observatory (NVO)

- 2000 NRC Astronomy Decadal Report – highest priority in the small program category.
- Given a total of $30 Million US split between NSF and NASA to develop a NVO.
- Several small grants oriented toward the NVO awarded through the OSS AISRP program.

Virtual Observatories, et al.

The idea of the Virtual Observatory is building rapidly and developing concurrently in many fields

- Astronomy: US NVO, CVO, UK AstroGrid, EC AVO, GAVO, VOIndia, RVO, eAstronomy Australia, ChinaVO, JapanVO; heritage from AstroBrowse, ISAIA, SkyView, DigitalSky, etc.
- Solar: US Virtual Solar Observatory (NSO, Stanford, Montana State Univ., NASA), European Grid for Solar Observations
- Atmospheric Science: National Virtual Aeronomical Observatory
- Space Physics: Space Physics VO, PhysiBrowse (CDPP, France, and NASA), SSDS initiatives
- Physics: GriPhyN, iVDGL
- Bioinformatics
- Digital Library

Grid computing, web services, and standards provide the technical underpinnings

- NASA Information Power Grid; NPACI; TeraGrid; Globus; SRB

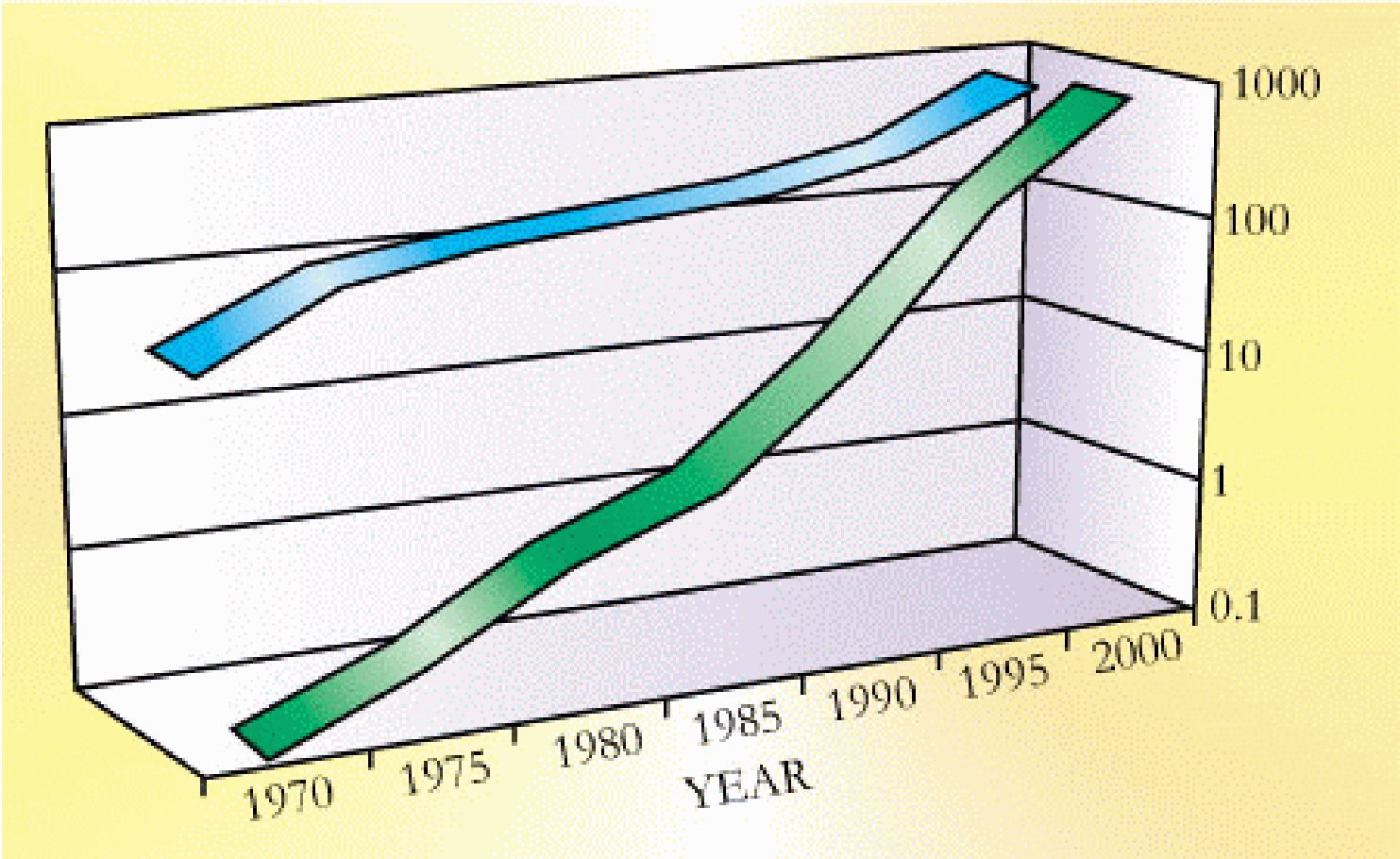
International Collaboration

- European initiatives underway
  - Astrophysical Virtual Observatory funded by European Commission (€3.3 million, three years)
  - AstroGrid, funded by UK e-science program (£5 million, three years)
- Other international efforts starting:
  - Canada (C$4M recently approved), India, Japan, Chile, Germany, Russia, Australia
- International VO roadmap developed and announced at Garching VO conference (June 2002)
- International VO Alliance formed; holding regular telecons
- Frequent technical contacts among partners

National Virtual Observatory (NVO)

- Growth in data sizes – Astronomy becomes photon rich the first time? Why?
- Community driven, built, accessible
- Catalogues of Astronomical Observations and Simulations and ***tools*** to work with the data.
- Data centers (NCSA) for archiving, viz, processing: Terra-bytes in size initially, Peta-bytes soon.
- Will provide transparent access to datasets and analysis tools using a web interface.
- XML emerging as the standard to used to structure the information.

Data Growth?



The number of pixels in charge-coupled device cameras grew 3000-fold from 1975 to 2000 (green band, in megapixels). Over the same period, the total area of ground-based telescopes 3 meters in diameter or larger increased by a factor of 30 (blue band, in meters squared).(Courtesy of Alex Szalay, Johns Hopkins University.)

Content

- Digital and digitized Astronomical Surveys (FIRST, 2MASS, IRAS, SDSS, COBE, MAP, [DPOSS] ← photon poor example)
- Pointed Observations (HST, Chandra, ESO, NOAO, Private Observatories?)
- Simulation Data (N-body)
- Algorithms to analyze the data????

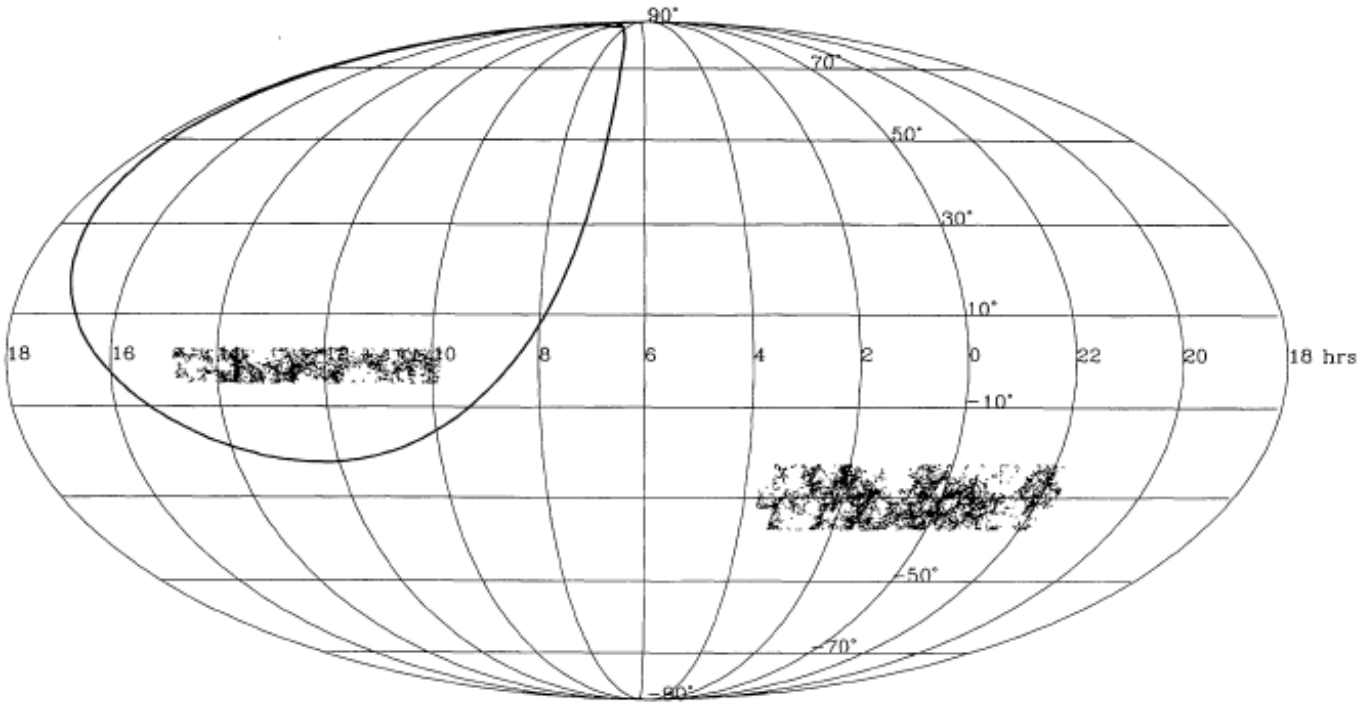
Sloan Digital Sky Survey (SDSS)

- 10000 sq deg imaging data in 5 broad bands centered at 3540,4770,6230,7630,9130A

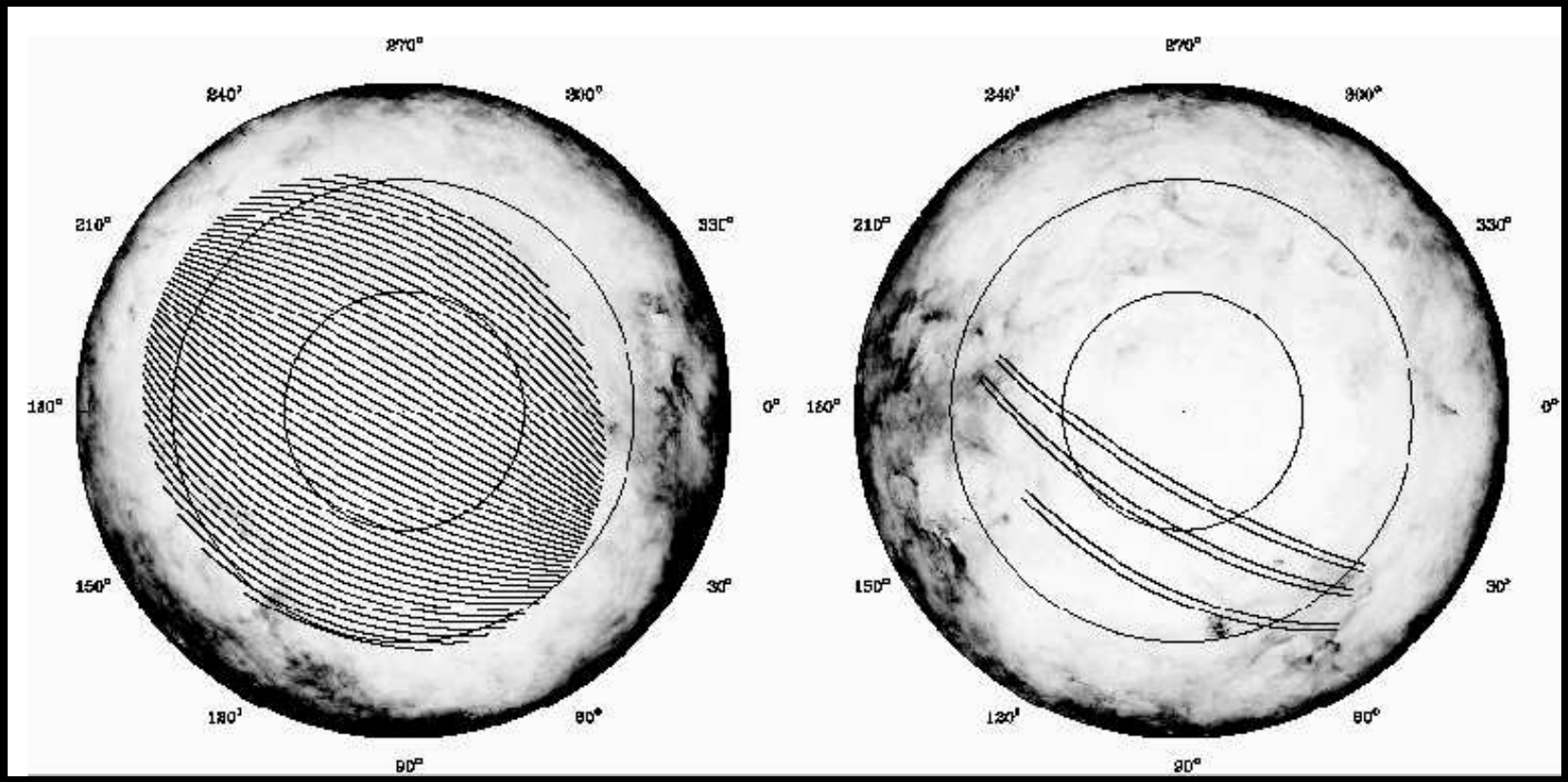
  stars=23rd mag B, gal=19th, QSO=20th
- 10^6 galaxy & 10^5 quasar spectra (<60km/s)
- Data rate 200 GB/night
- EDR (462 sq deg thus far)
- Total quantity of information produced:

  15 terrabytes
- Volume = 100 times that explored to date

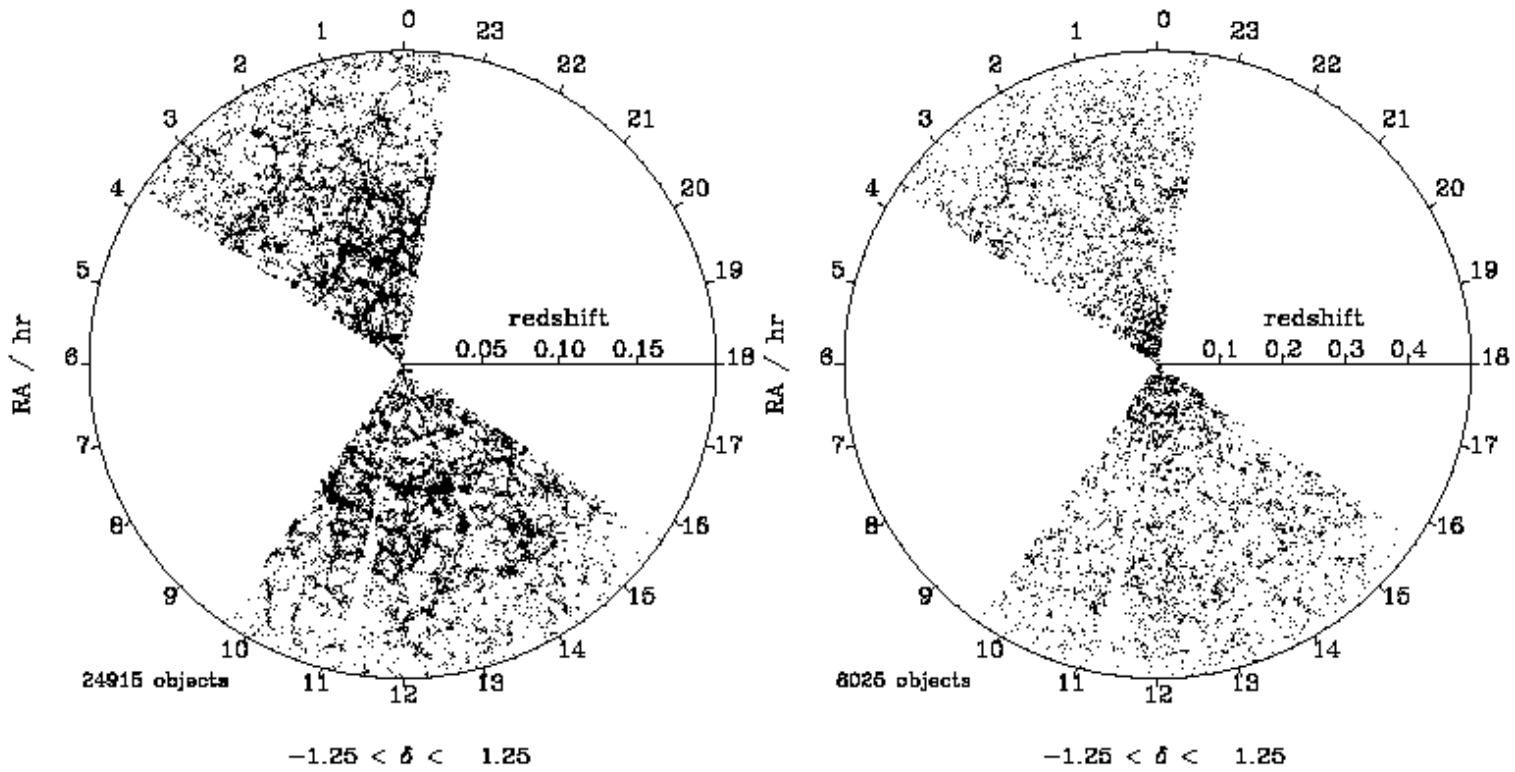
SDSS volume (2DF)



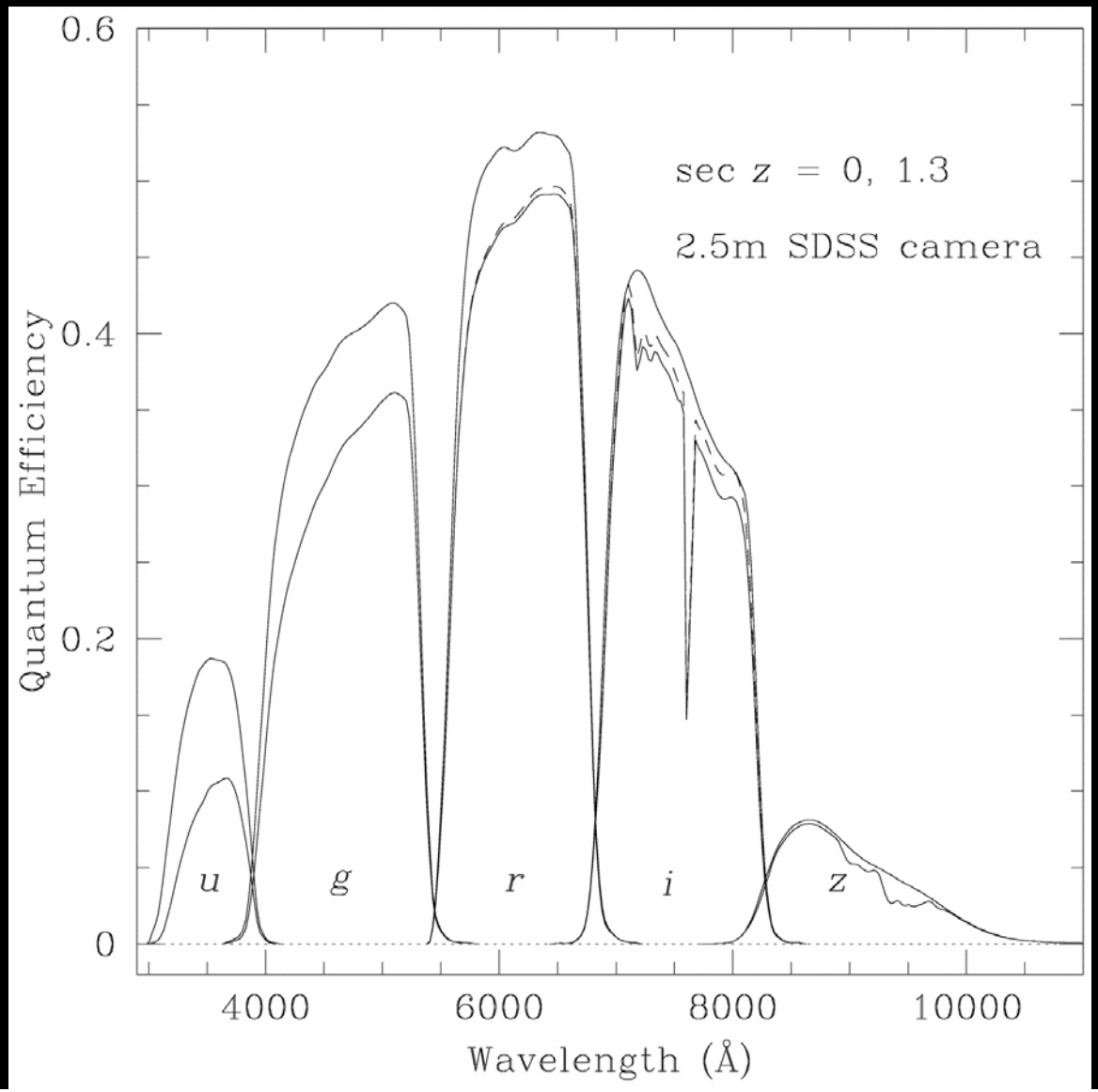
SDSS Volume v2



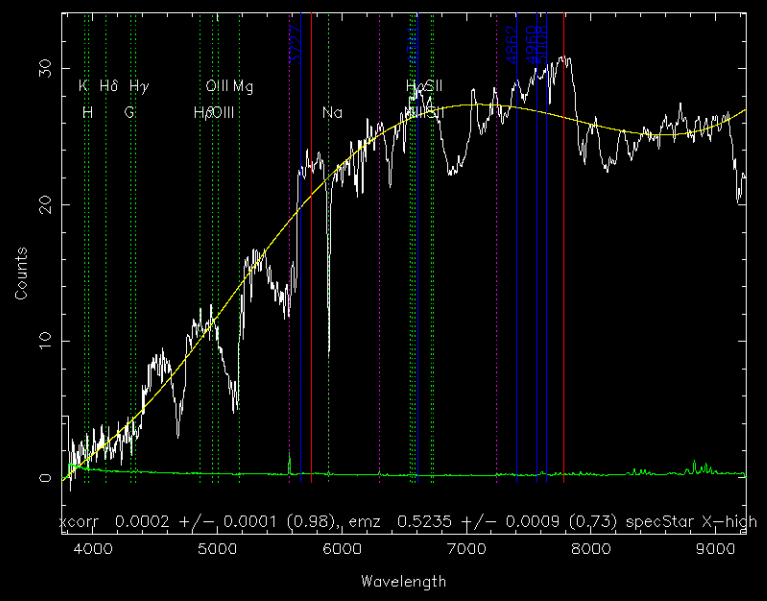
SDSS EDR Results

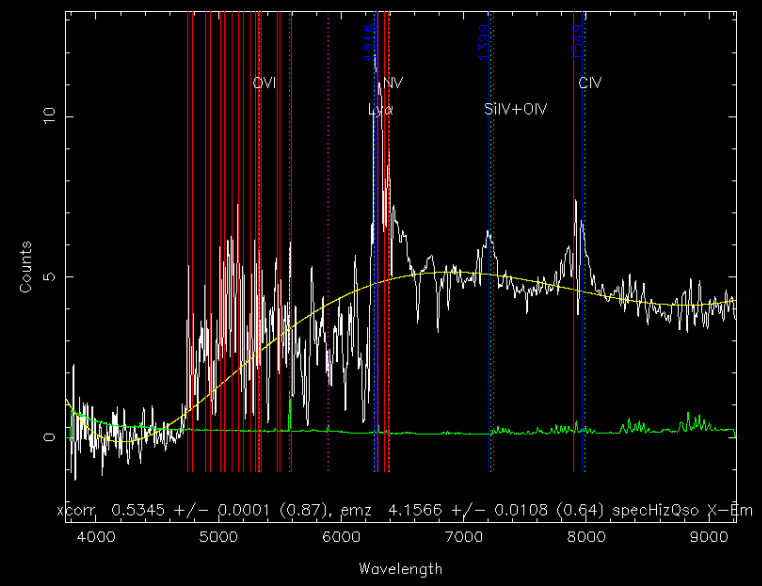


Broad band filters

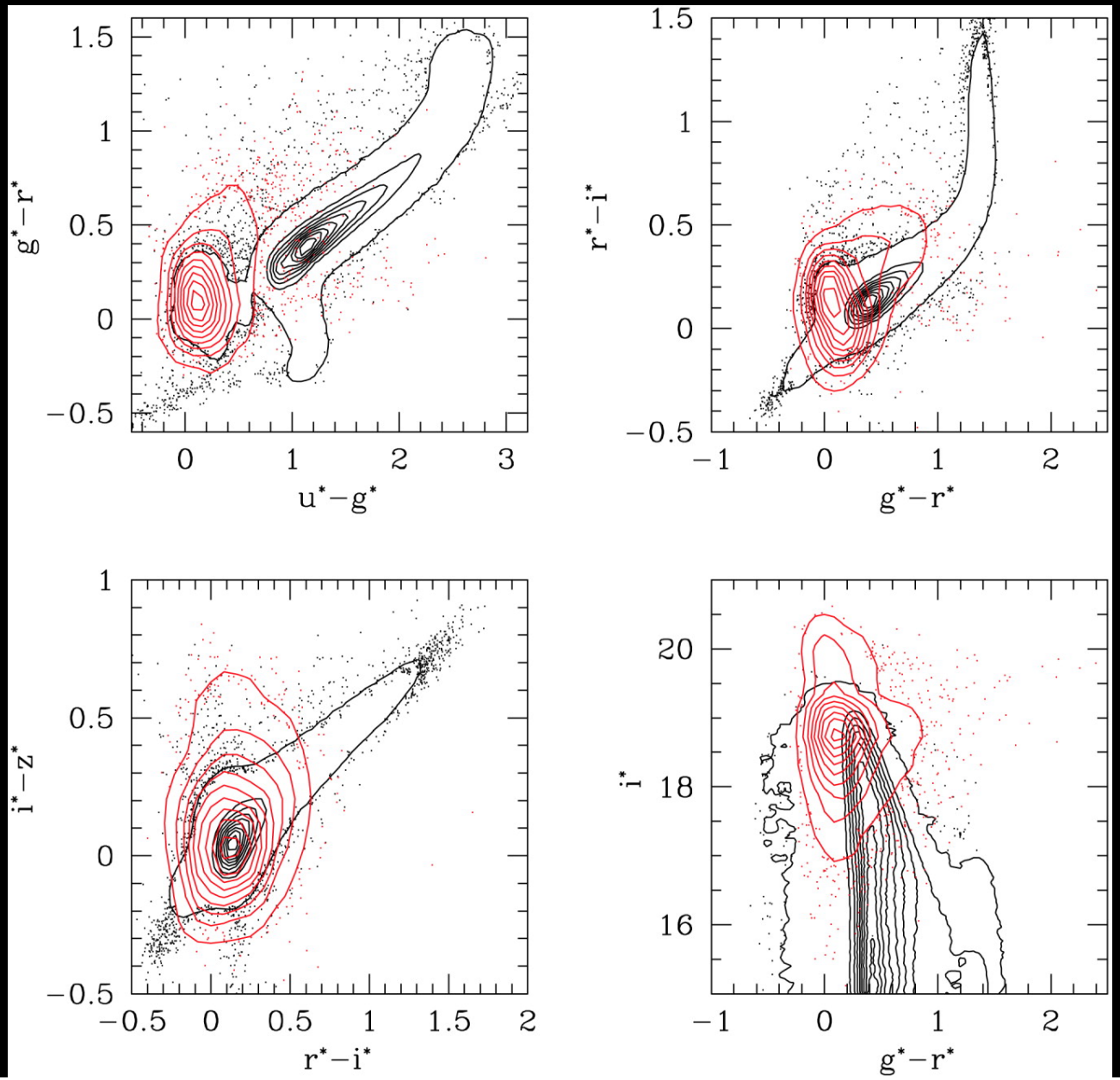


Differing Spectra (carbon star vs z=4.2 QSO) [broad band filters]

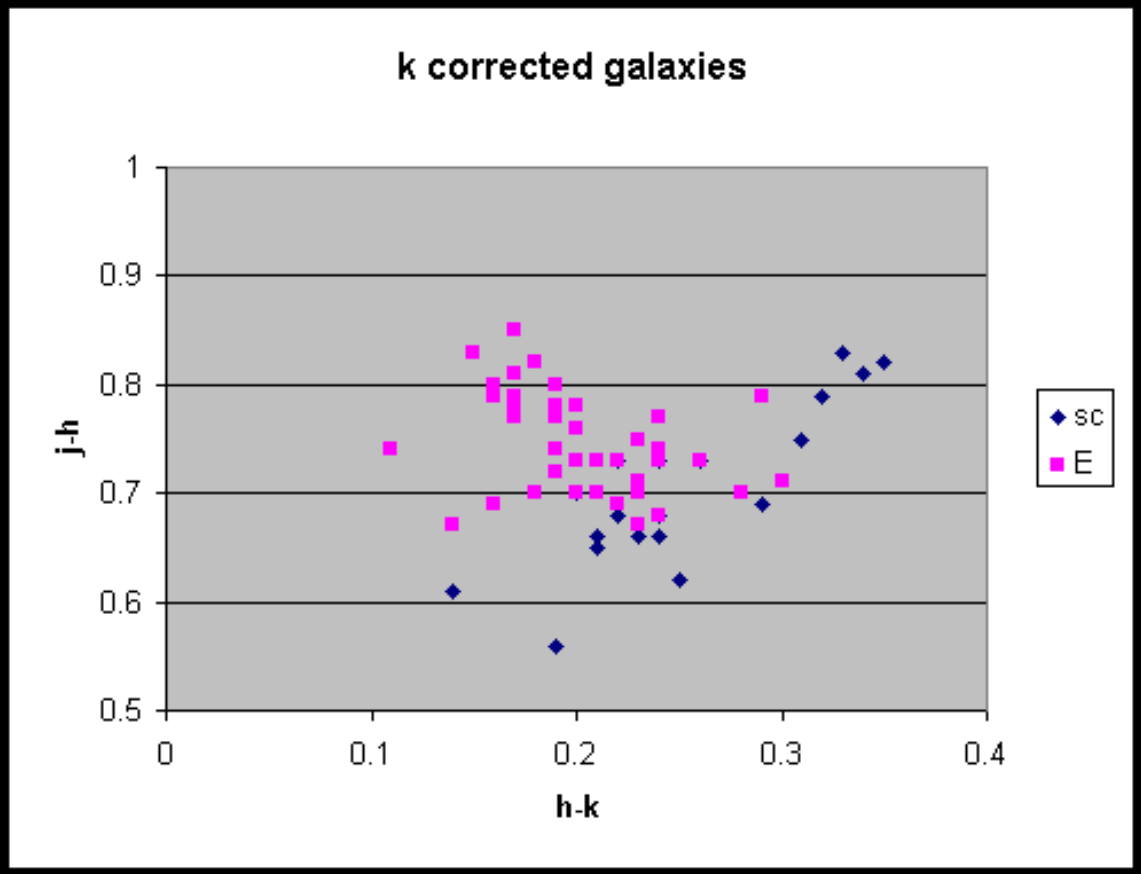




Red=stars, black=QSOs



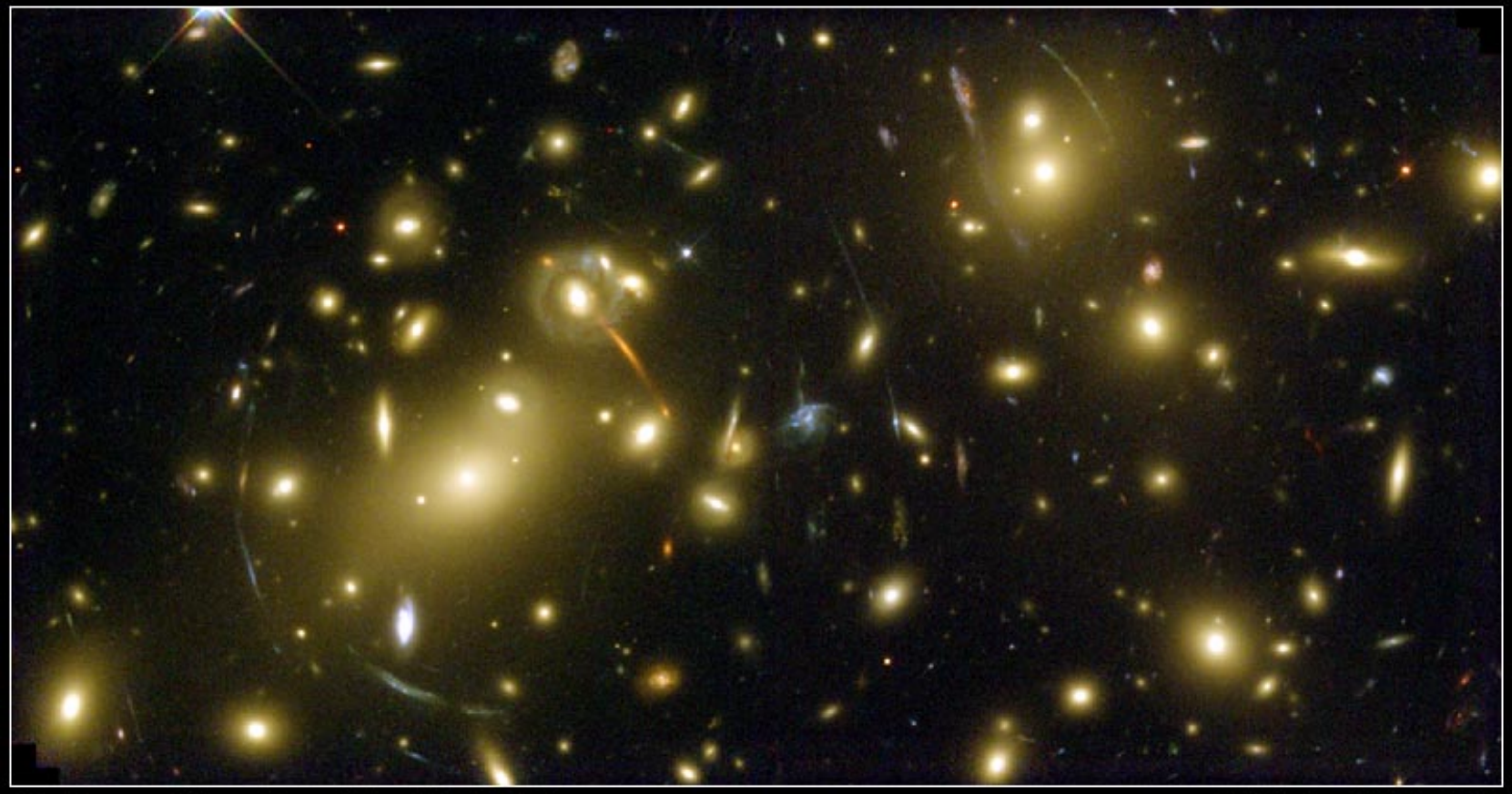
Color – Color diagrams



Example: Clusters of Galaxies

- Studied for many years in multiple wavebands from space and earth (Radio to Gamma Rays!)
- Complex Systems (dynamically evolving)
- Cosmological Probes
- Related to structure formation in the Universe

Galaxy cluster lensing

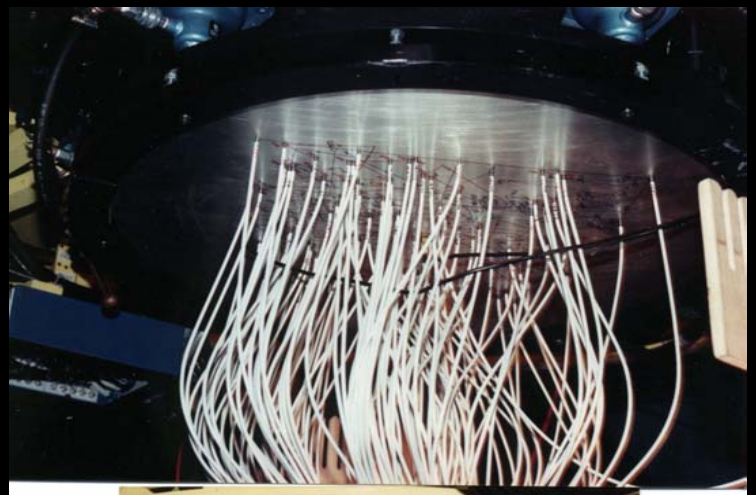


Galaxy Cluster Abell 2218 **HST • WFPC2**

NASA, A. Fruchter and the ERO Team (STScI, ST-ECF) • STScI-PRC00-08

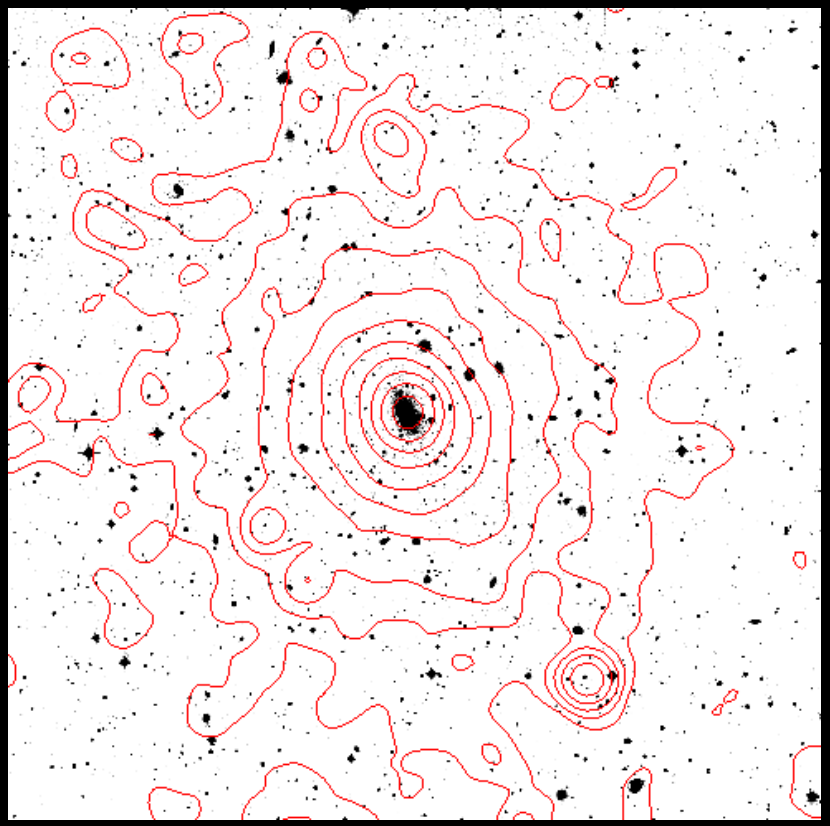
Galaxy Cluster – Available Data

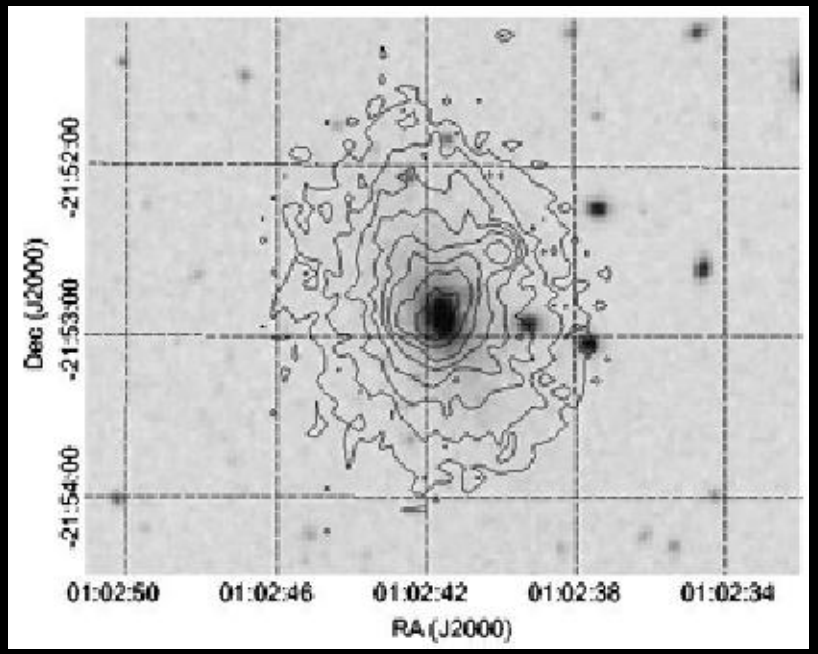
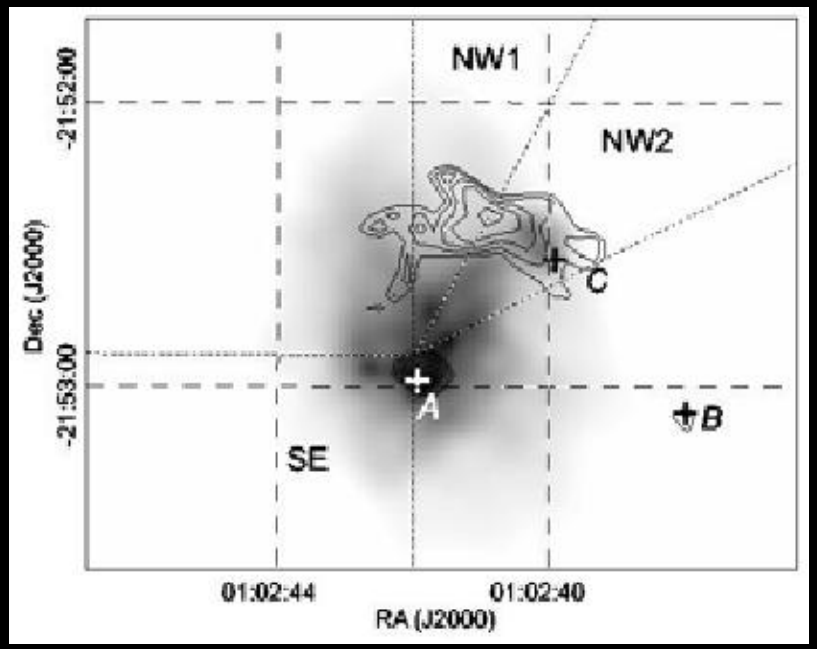
- Multi-color Photometry (star ages)
- Positional Data (merging?)
- Redshift (location/age?)
- X-Rays (local Matter density)



Xray data (ROSAT/Chandra)

- X-Ray temperature is proportional to the square of the local matter density
- Less subject to fore-ground/background contamination



Radio Data (1.4Ghz VLA)

- Radio lobe(s) associated with cD (displaced)