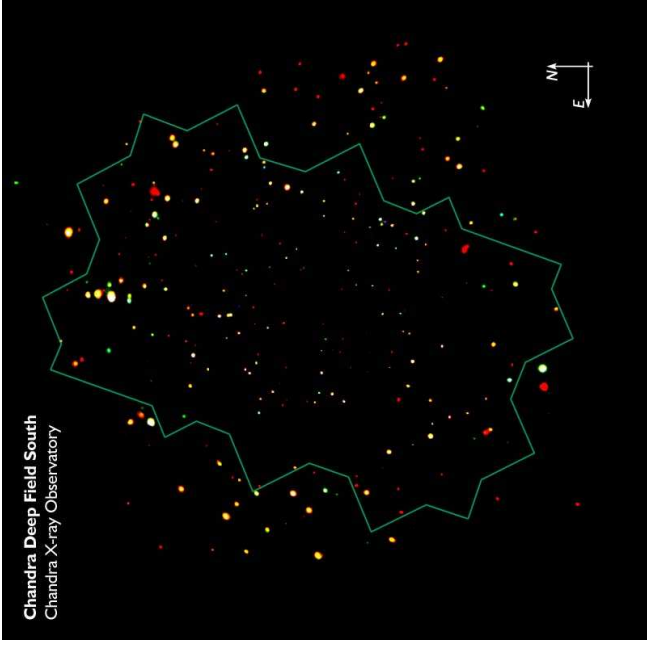
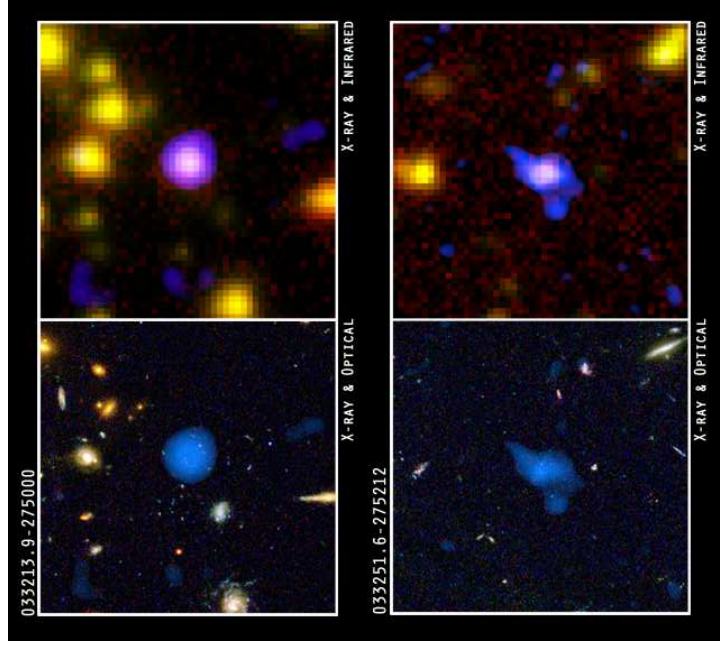


⇒ GOODS-Survey (Great Observatories Origins Deep Survey), centered on CDF-S
(same image as before, this time smoothed)

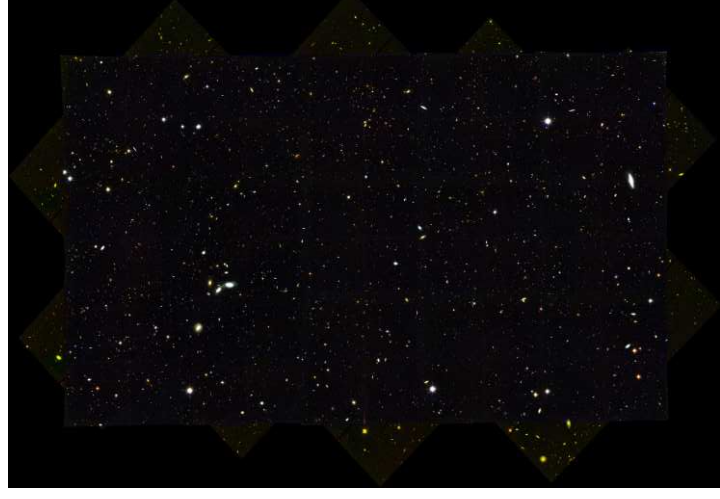


Chandra and HST fields aligned



IR, optical, and X-ray
image of small fraction of
GOODS

CXC/NASA



HST ACS observations of
whole area of CDF-S

CXC



2D/3D Surveys: Technology

Future for Large Scale Structure: 2D and 3D Surveys observing large part of sky with dedicated instruments.

Currently largest surveys:

Las Campanas Redshift Survey (LCRS): 26418 redshifts in six $1.5 \times 80^\circ$ slices around NGP and SGP, out to $z = 0.2$.

CfA Redshift Survey: 30000 galaxies

APM: (Oxford University) $2 \sim 10^6$ galaxies, 10^7 stars around SGP, 10% of sky, through $B = 21$ mag.

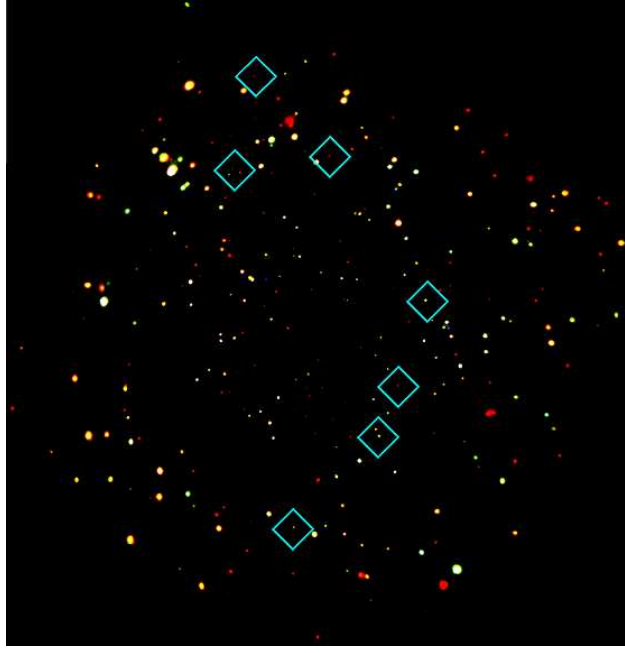
2MASS: IR Survey of complete sky (Mt. Hopkins/CTIO) completed

2000 October 25), 3 bands, $\sim 2 \times 10^6$ galaxies, accompanying redshift survey (8dF, CfA)

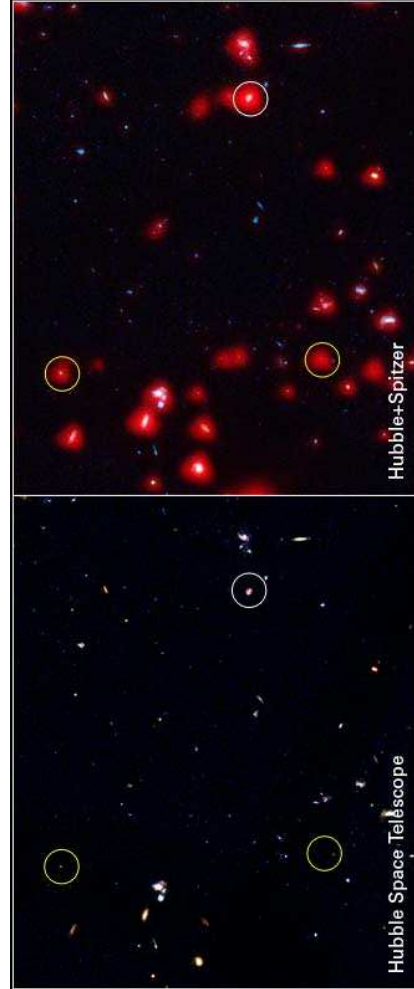
Sloan Digital Sky Survey (SDSS): dedicated 2000 October 5, Apache Point Obs., NM, 25% of whole sky, $\sim 10^8$ objects, now in Google Earth

And many more (e.g., Keck, ESO, LSST, . . .).

Redshift Surveys



CDFS: blue boxes contain objects not visible in HST
⇒ farthest black holes known



1/200th of the whole GOODS field in optical and IR

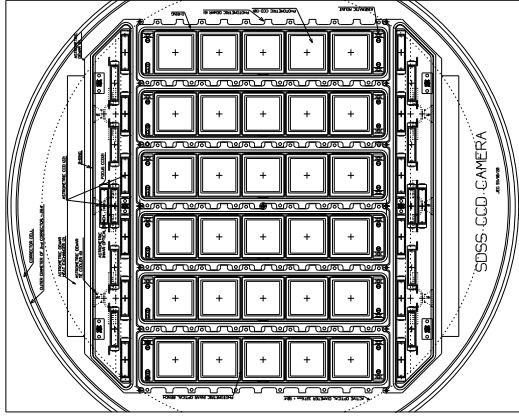


SDSS 2.5 m telescope at Apache Point Observatory

courtesy SDSS



2D/3D Surveys: Technology



CCD alignment of SDSS:

- focal plane: 2.5° ,
- 5 rows of 2048×2048 CCDs with r, i, u, z, g filters, saturation at $r = 14$
- 22 2048×400 CCD, saturation at $r = 6.6$ for astrometry

Imaging by slewing over CCD Array

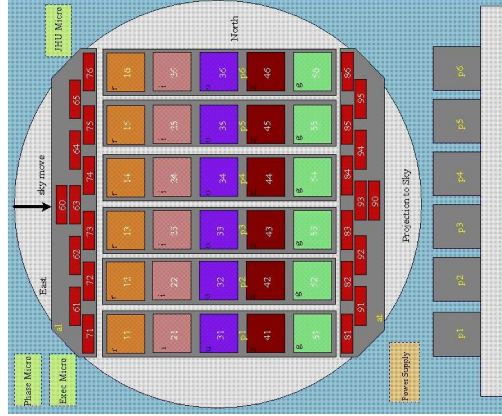
(Strauss, 1999, Fig. 5)

Redshift Surveys

26



2D/3D Surveys: Technology



CCD alignment of SDSS:

- focal plane: 2.5° ,
- 5 rows of 2048×2048 CCDs with r, i, u, z, g filters, saturation at $r = 14$
- 22 2048×400 CCD, saturation at $r = 6.6$ for astrometry

Imaging by slewing over CCD Array

SDSS

Redshift Surveys

27



2D/3D Surveys: Technology

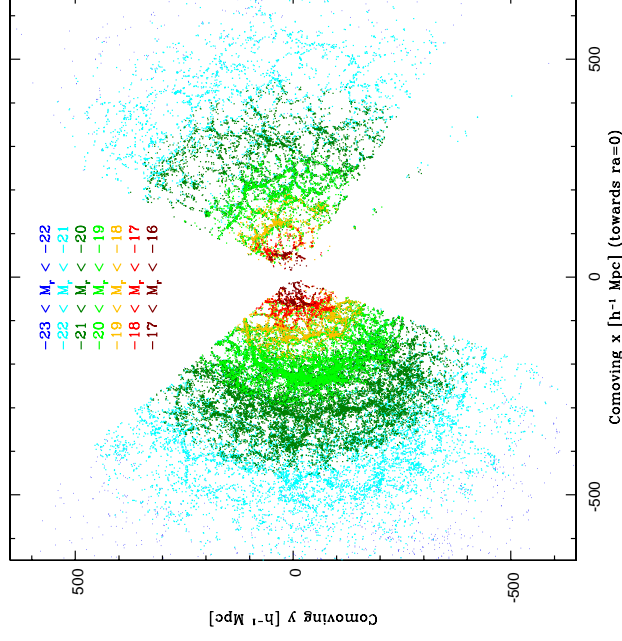


courtesy SDSS

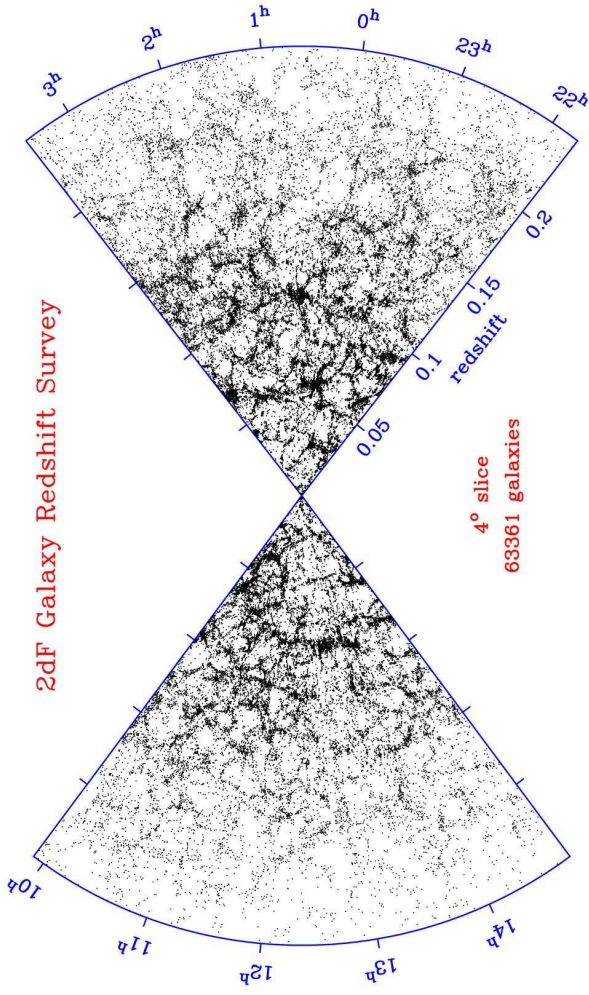
Spectroscopy with grism (combination of prism and grating), light from objects via optical fibers and plug plate.

Redshift Surveys

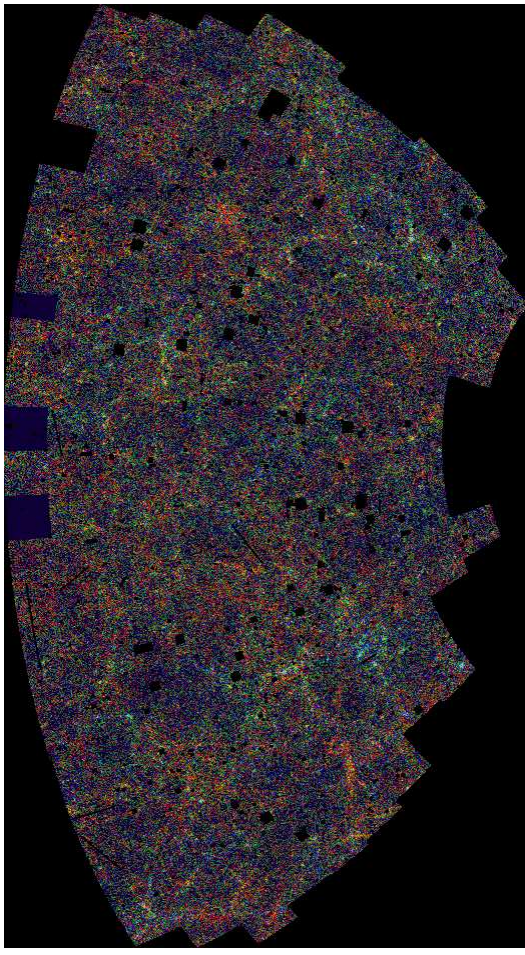
28



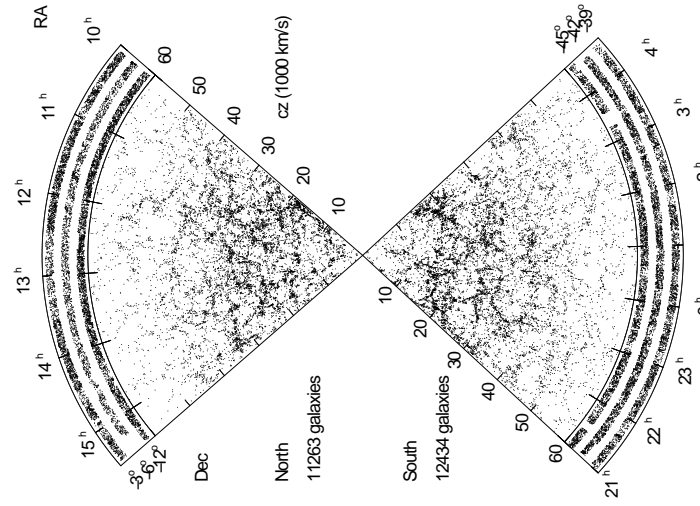
(Tegmark et al., 2004, Fig. 4)



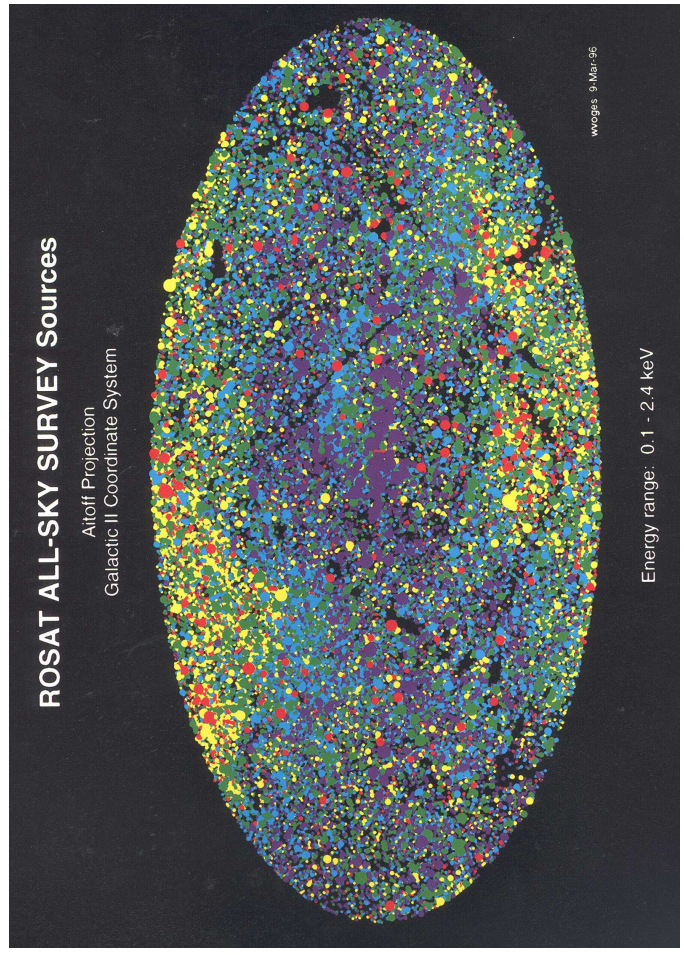
courtesy 2dF collaboration



Galaxies in APM catalogue, color: avg. B in pixel: blue (18) - green (19) - red (20)

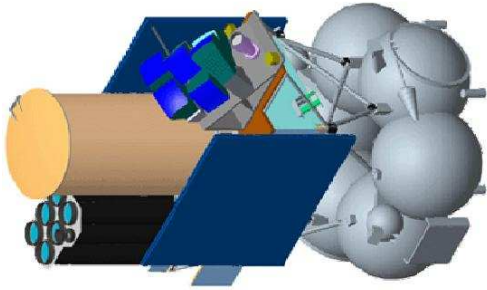


The complete LCRS survey (at cz large: reach mag. limit)



www.gas.9.mar.96

X-Ray Surveys



Spectrum-X- Γ in Yamal-Configuration (outdated)

Cosmology: Black Holes play a significant role in structure formation.

"Structures": Galaxies and galaxy clusters

⇒ **Spectrum-Roentgen-Gamma:**

- X-ray survey of the whole sky (3 years)
- most sensitive survey of black holes ever
- russian satellite bus, experiments:
 - **eROSITA** (CCDs): MPE, IAA Tübingen, FAU, Potsdam, Hamburg, industry (~50 Mio €)
 - **SXC** (Calorimeter): SRON/ISAS/GSFC (?)
 - **ART-XC** (CZT): Roscosmos (??)
- Launch: 2012, Operations at least until 2016