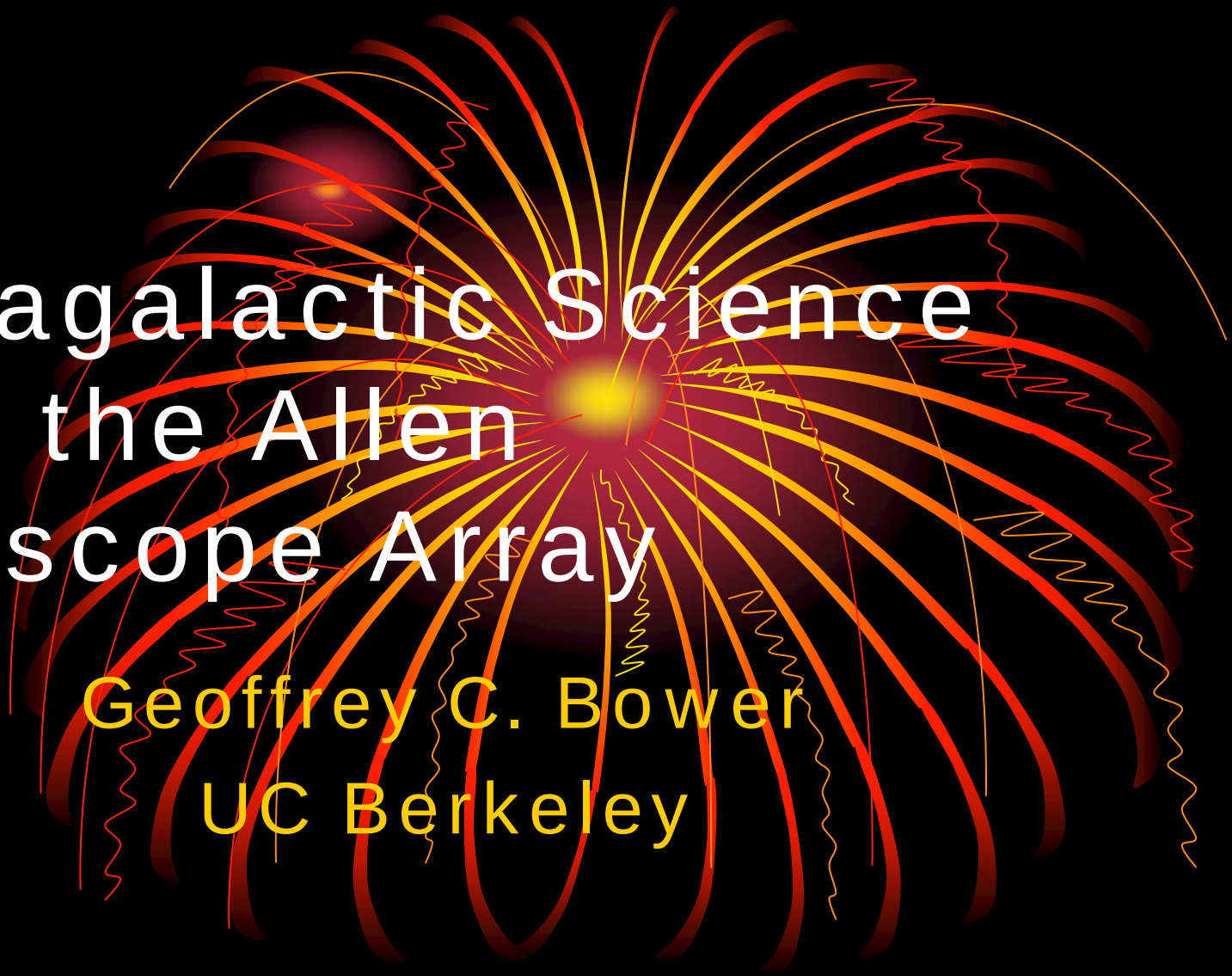
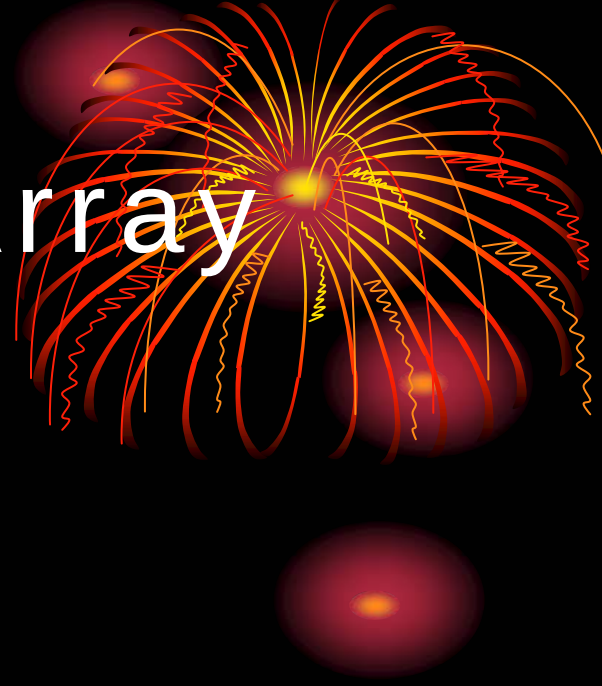


Extragalactic Science with the Allen Telescope Array

Geoffrey C. Bower
UC Berkeley

Allen Telescope Array

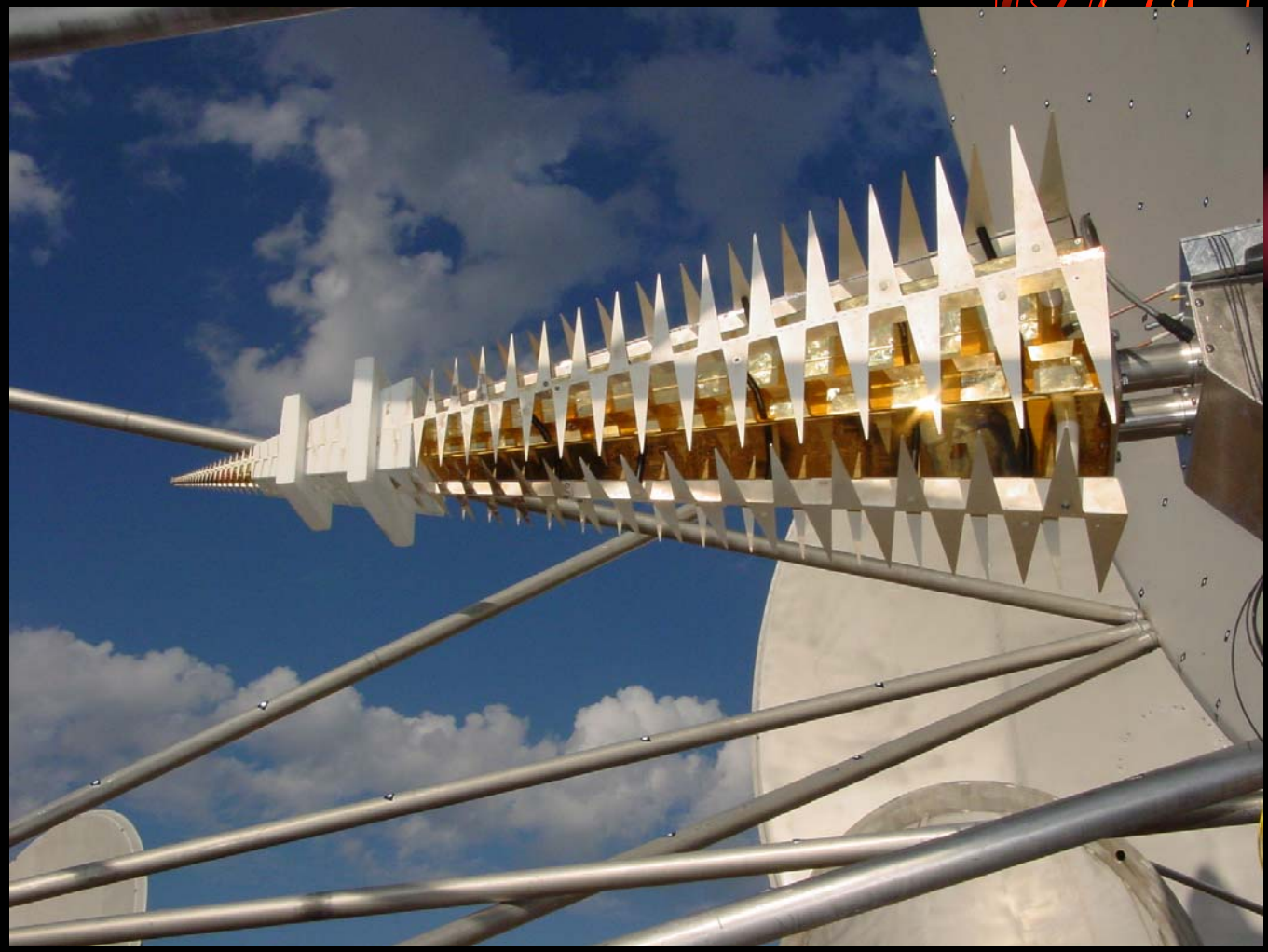


- Large N design
  - 350 x 6.1m antennas
  - Sensitivity of the VLA
- Continuous frequency coverage
  - 0.3 to 11.2 GHz
- Wide field of view
  - 3 degrees at 1 GHz
  - Excellent survey instrument
- Simultaneous observing with multiple backends
  - Correlator at 2 frequencies
  - 16 Phased array beams

- Joint project of UC Berkeley/SETI Inst.
- Prototype for US SKA proposal


Hat Creek, CA

Ultrawideband Log Periodic Feed




3 Now
32 under construction, due end 2004
350 by 2007

ATA Science

- SETI
- Deuterium detection
- Galactic Spectroscopy
- Pulsars
- Surveys, surveys, surveys

Extragalactic Science

- Dark galaxies
- Radio transients

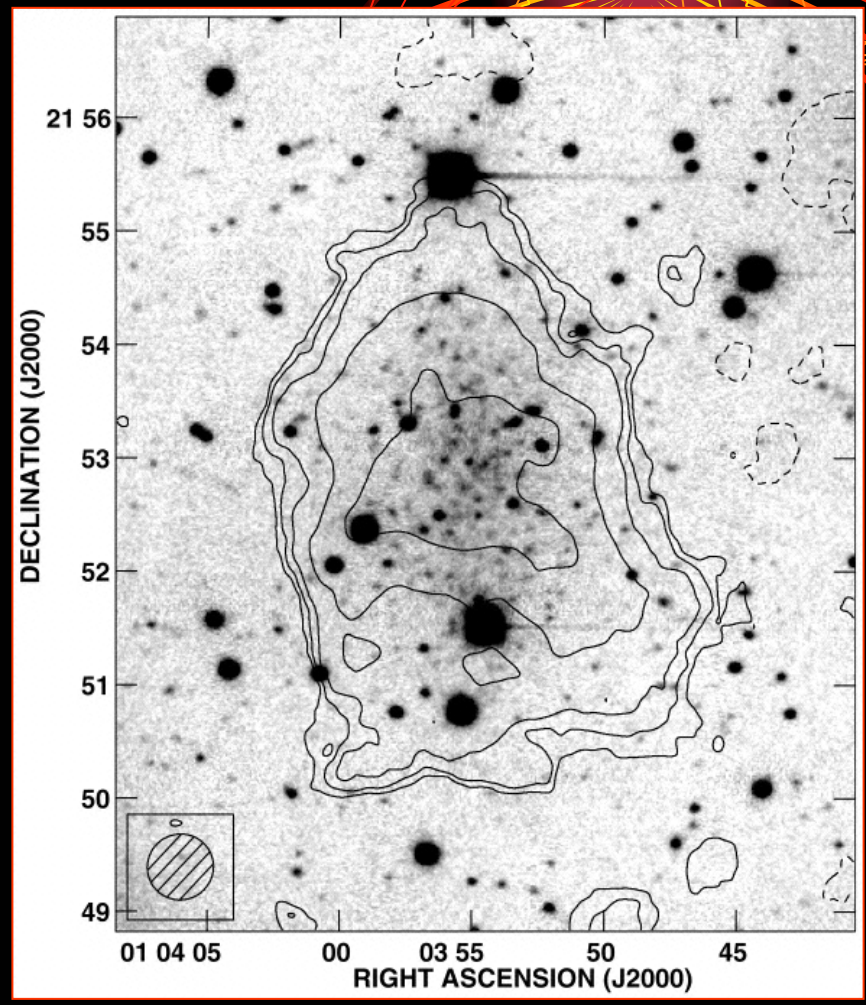
- Deep, high frequency AGN surveys
- High redshift atomic and molecular absorption

The HI SDSS Complement

Dark Galaxies to redshift 0.2

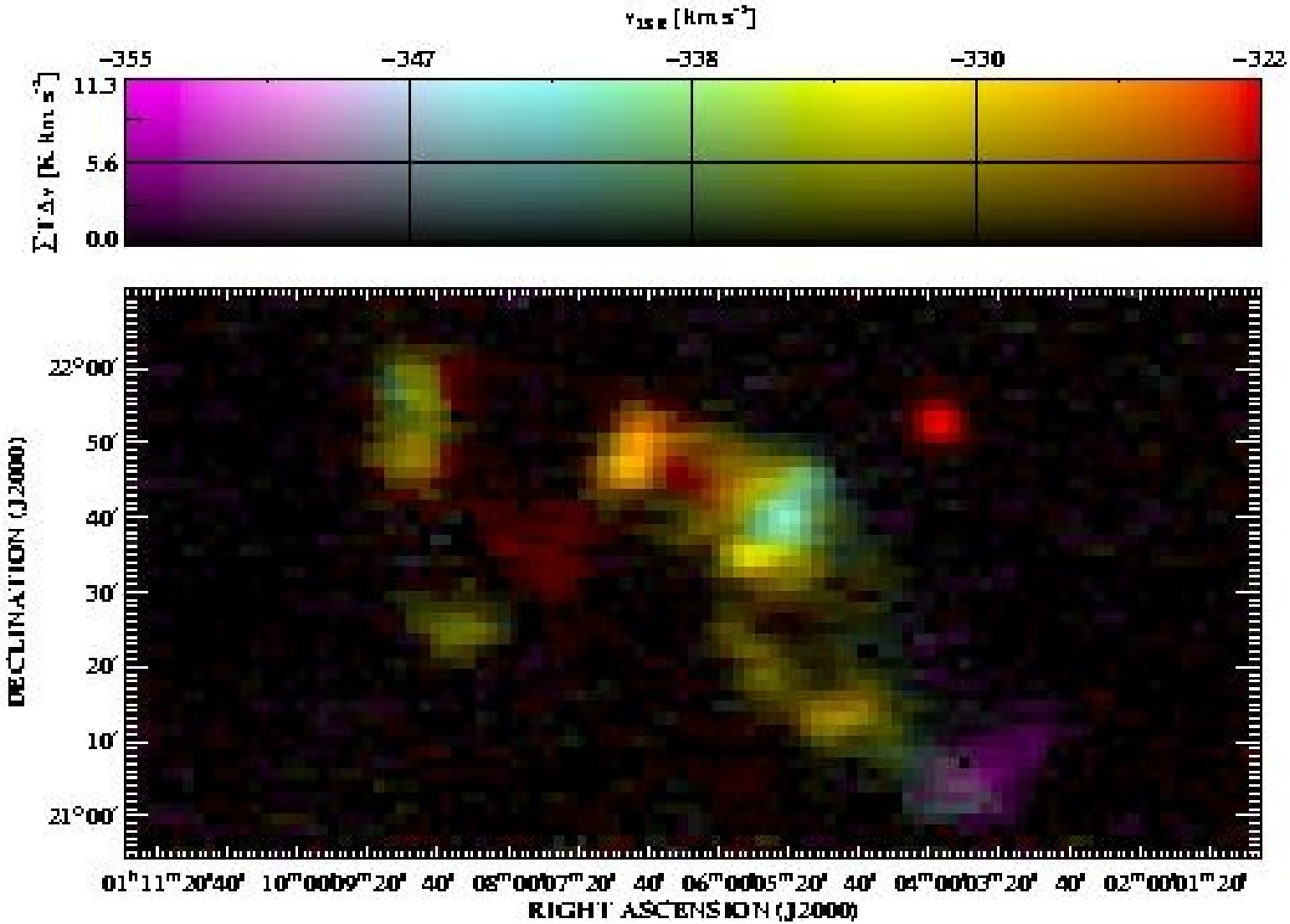
Dark Galaxies

LGS 3



Young & Lo 1997

Are there dark galaxies?

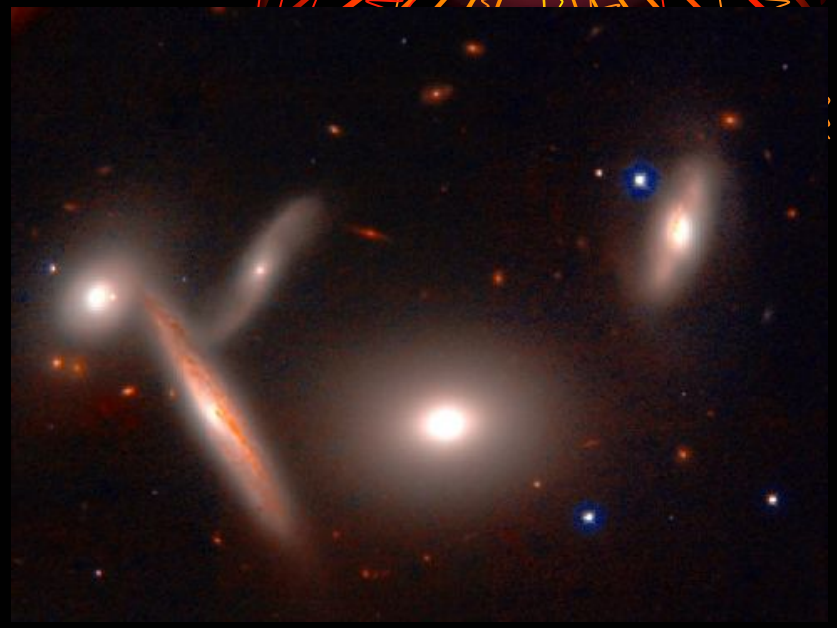


2 x 10^7 Solar Masses

Robishaw et al 2002

Consider some ATA sensitivities for HI

Assume: $\Delta V = 214$ km s^{-1}
$\Theta = 76''$
4 hour integration



Sensitivity:
70 μJy/beam (rms)
10 mK

HI Mass Sensitivity: *(5 sigma – 2 pols)*

1.9 x 10^9 ***$M_\odot$*** **@ 500 h_{70}** ***Mpc*** *(cz = 34,000 km s^{-1})*

can detect L_* to z ~ 0.16 over entire northern sky

well matched to Sloan DSS – can be part of HI survey

HI SDSS Complement Survey

- *HI Mass Sensitivity: (5 sigma)*
  - 1.9 x 10^9 $M_\odot$ @ 500 h_{70} *Mpc*
  - L* to z ~ 0.16 over entire northern sky
- rotation curves for all spatially resolved galaxies
- Ultimate zone of avoidance survey
- Structure of the universe at low z
- Detection of dark galaxies
- Confusion-limited AGN survey

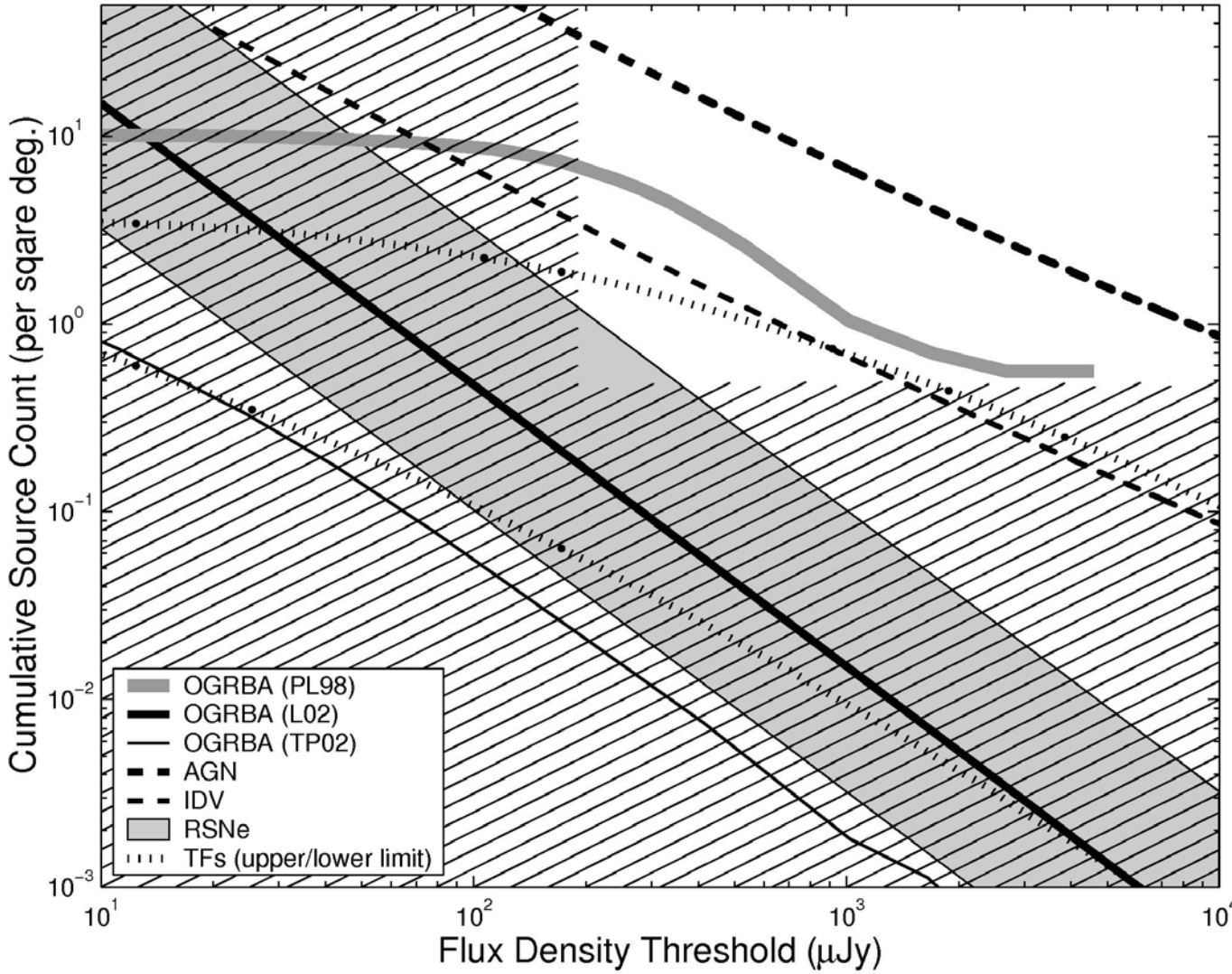
Transient Science with the ATA

- Targeted Monitoring
  - Exploits multiple beams
  - Pulsars
  - Gamma-ray burst afterglows
  - Black holes
  - Supernovae
  - Intraday variability
  - *Your Favorite Object Here*
- Blind Surveys
  - Exploit wide FOV
  - Low-Hanging Fruit
  - Orphan GRB afterglows
  - New Supernovae
  - Tidally disrupted stars around Massive BHs
  - The Twinkling Radio Sky
  - *Something New!*

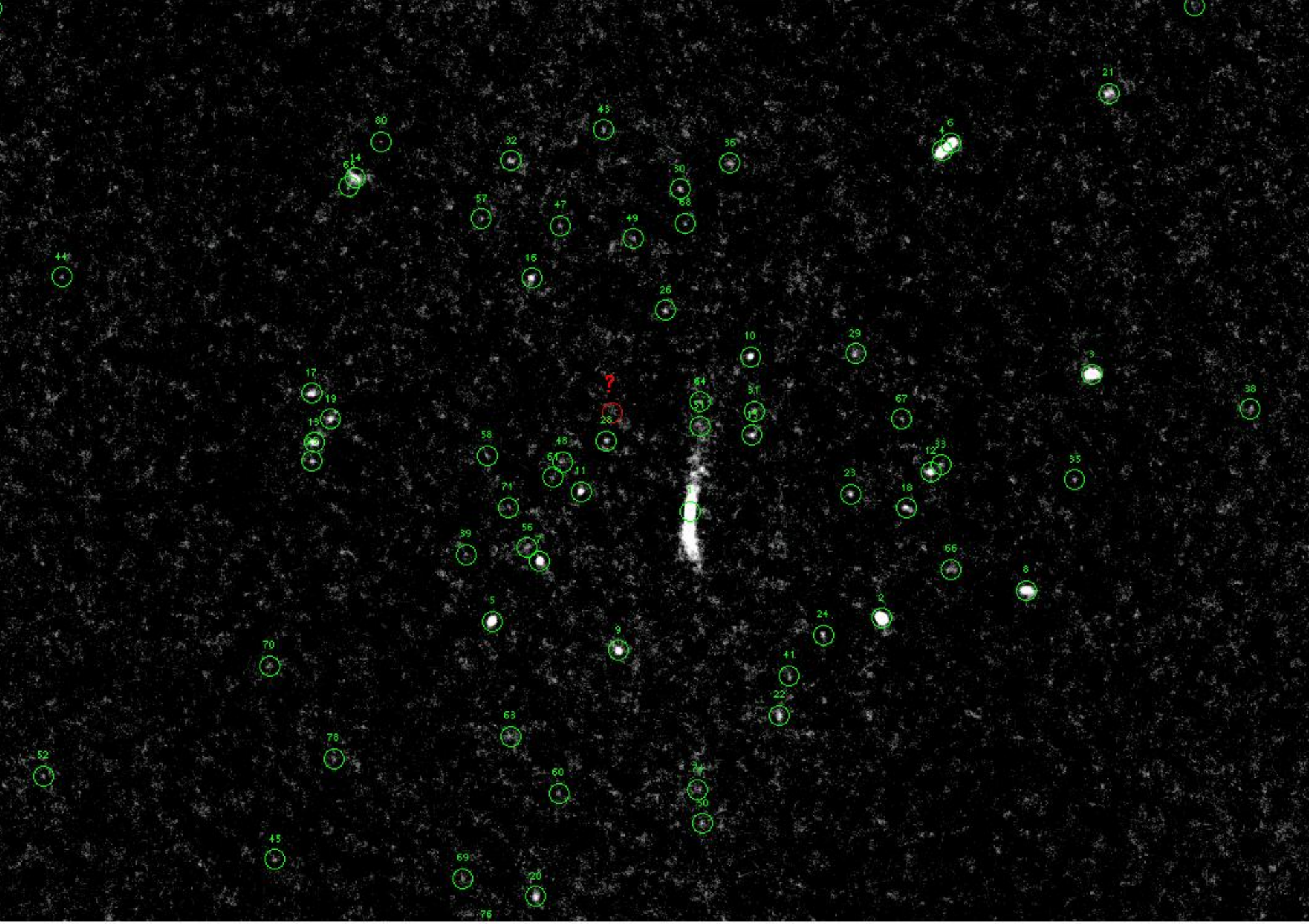
Orphan Gamma Ray Burst Afterglows

- γ- ray quiet, radio loud bursts
  - Not yet discovered
- Search tests basic GRB model
- Find the first stars and black holes (z~10-30)
- Identify the foreground for Square Kilometer Array

Radio Transient Source Counts



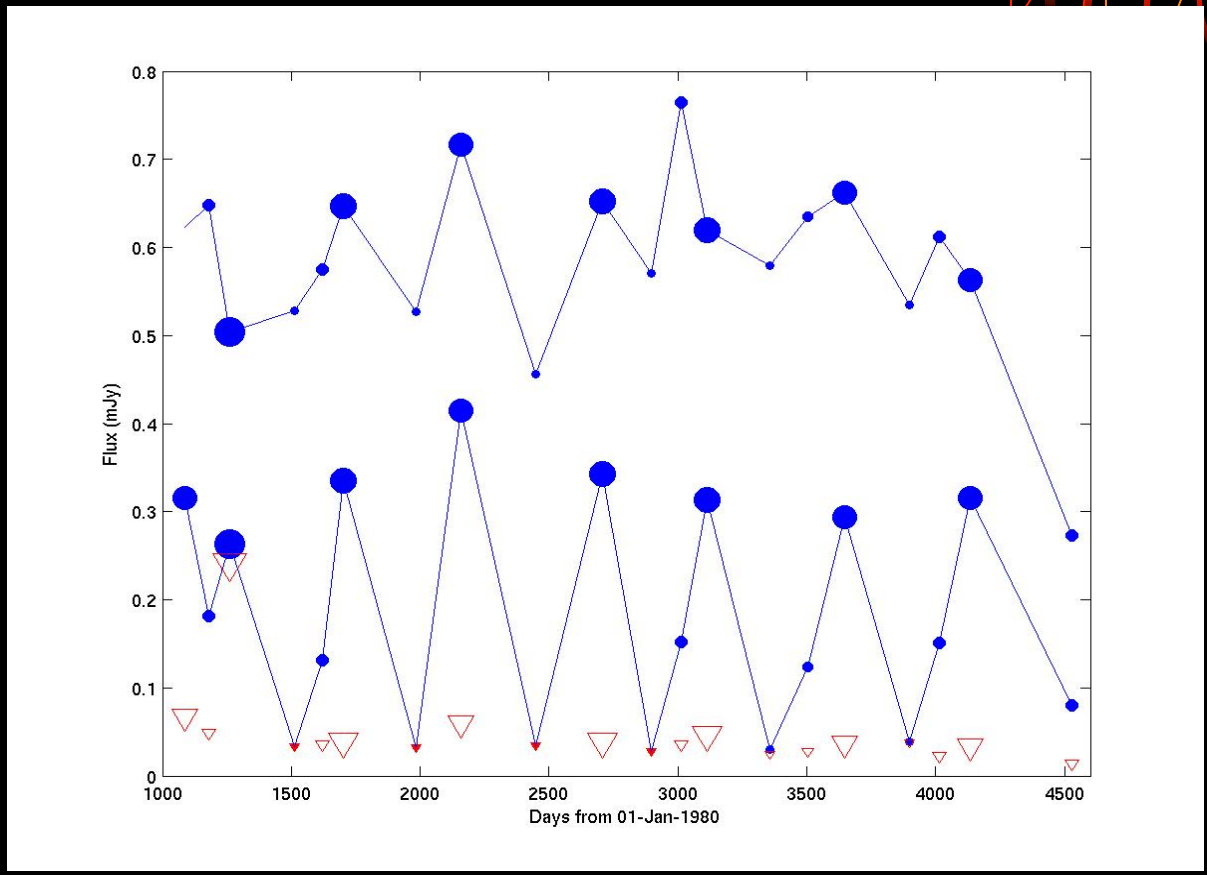
VLA
200
hours


4.5 microJansky rms

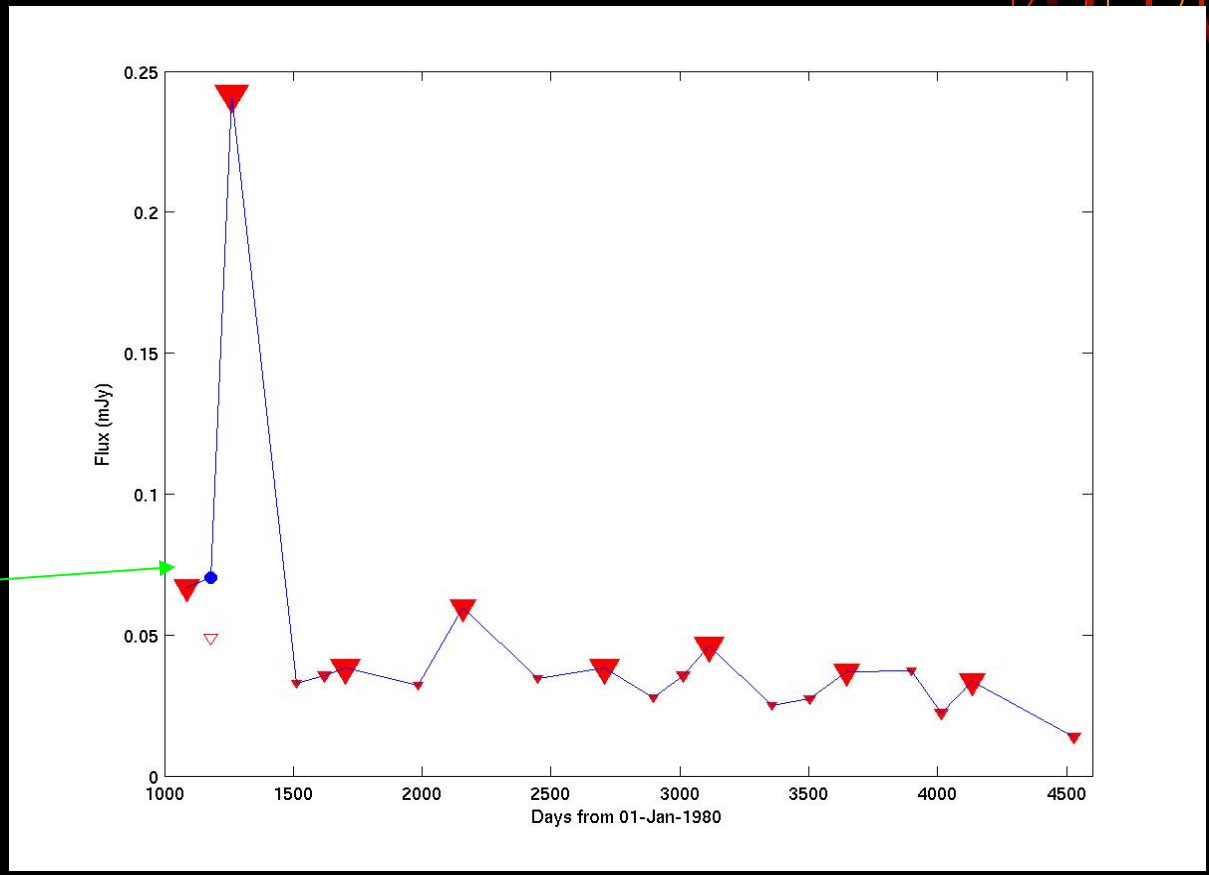
VLA Archive Transient Survey

- 10 years
- 20 epochs
- 5 GHz
- 20 microJansky rms/epoch
- 80 sources
  - 20 suitable for transient study

Sample Light Curves

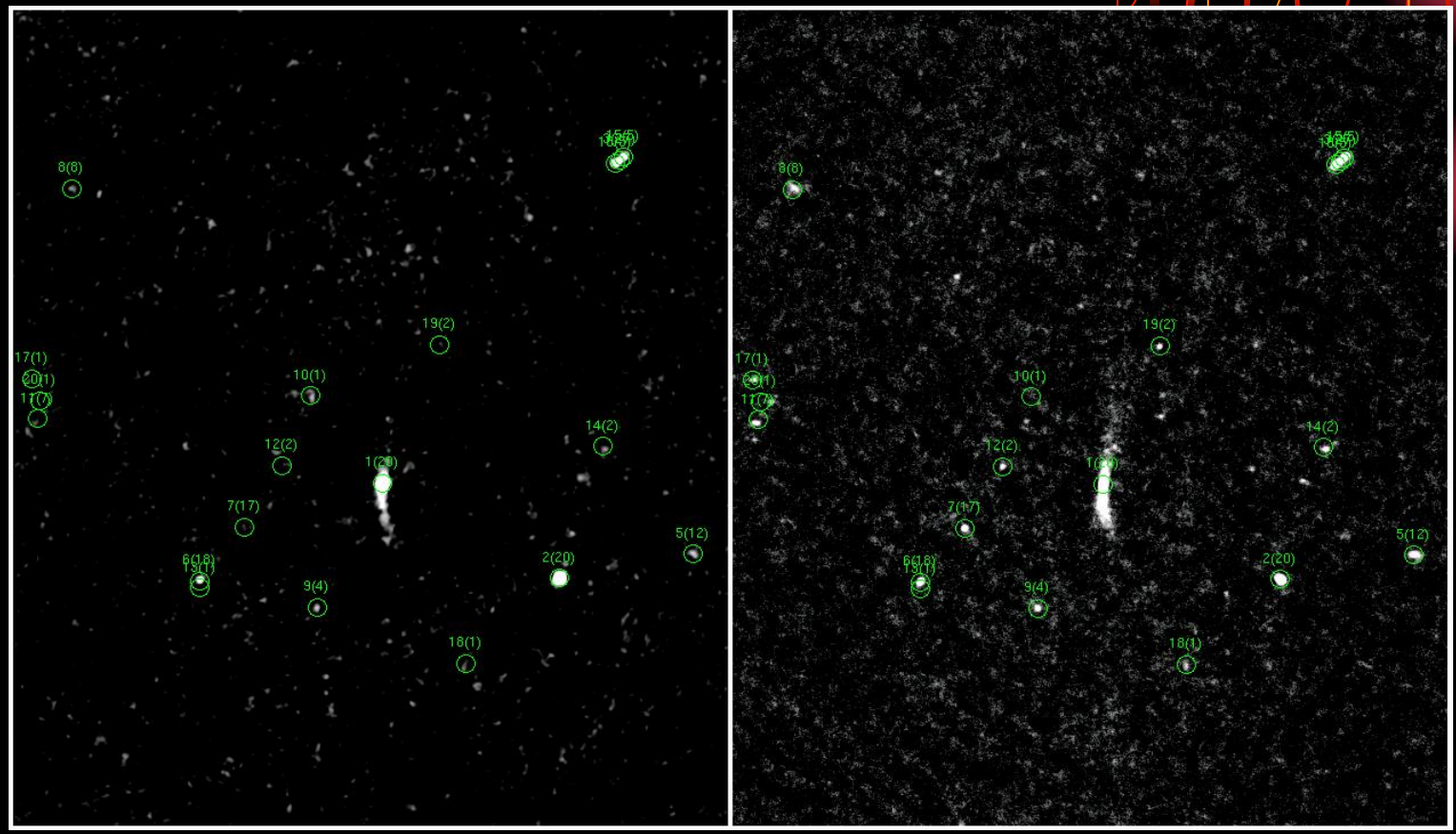


Transient?

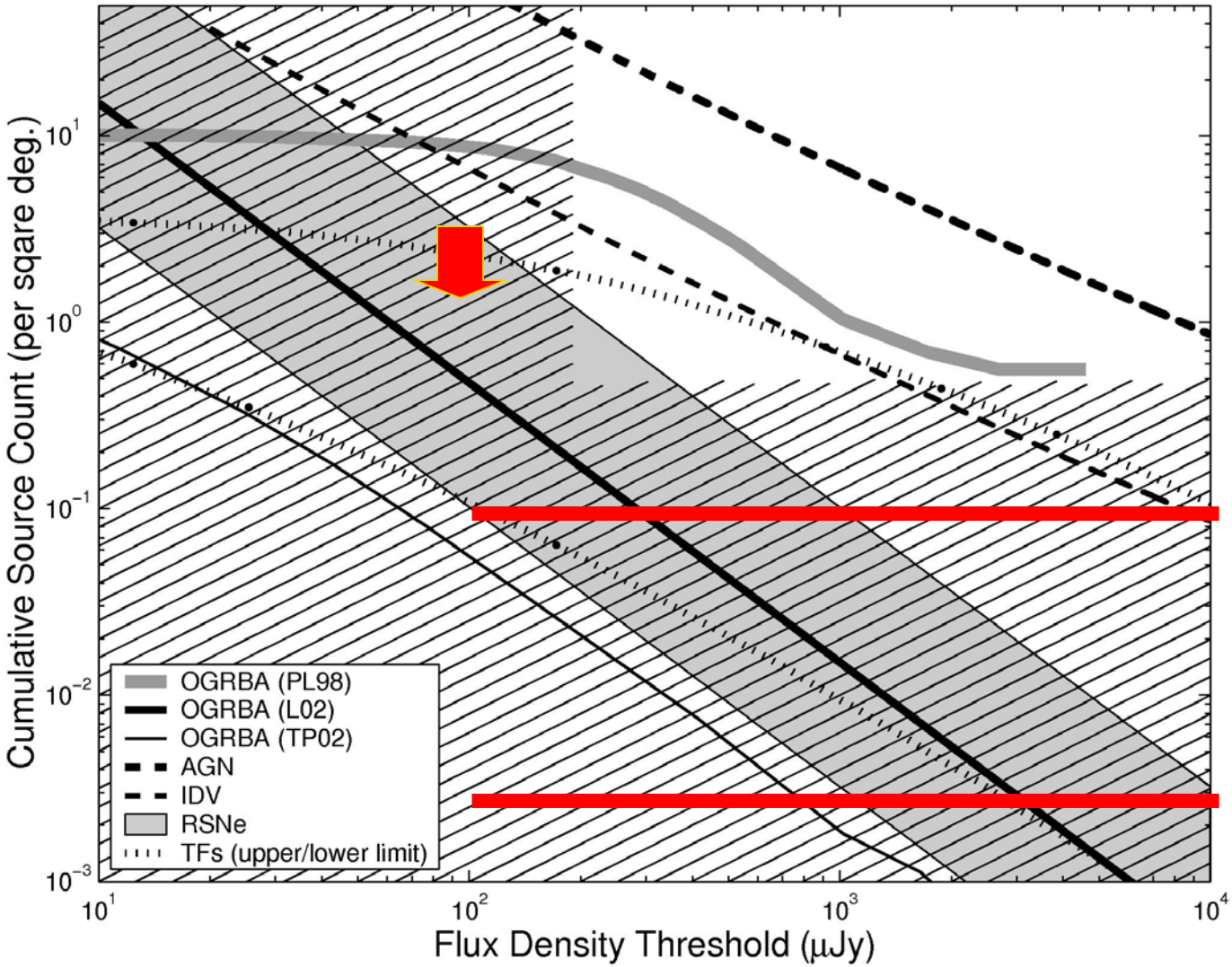


5 Sigma Detection

Transient?

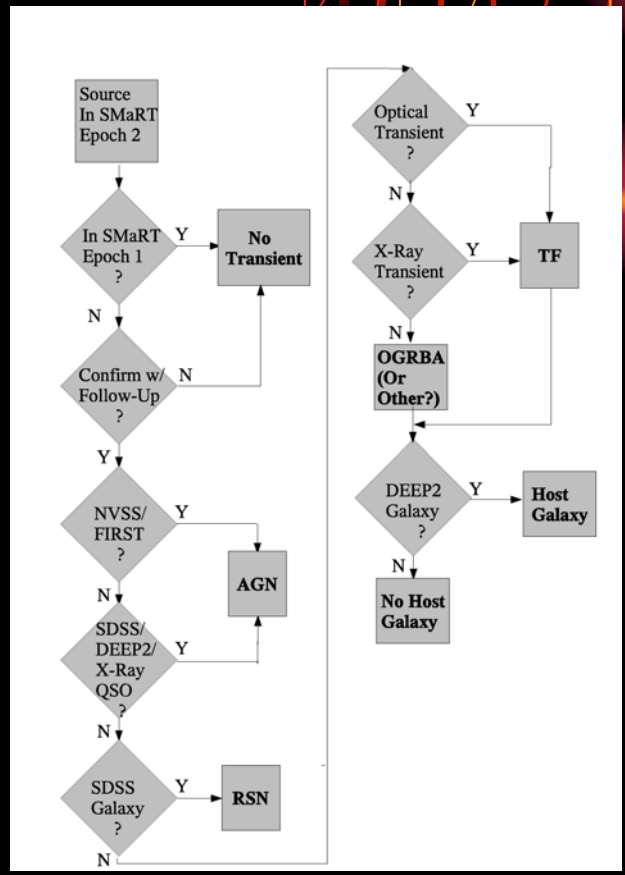


Radio Transient Source Counts



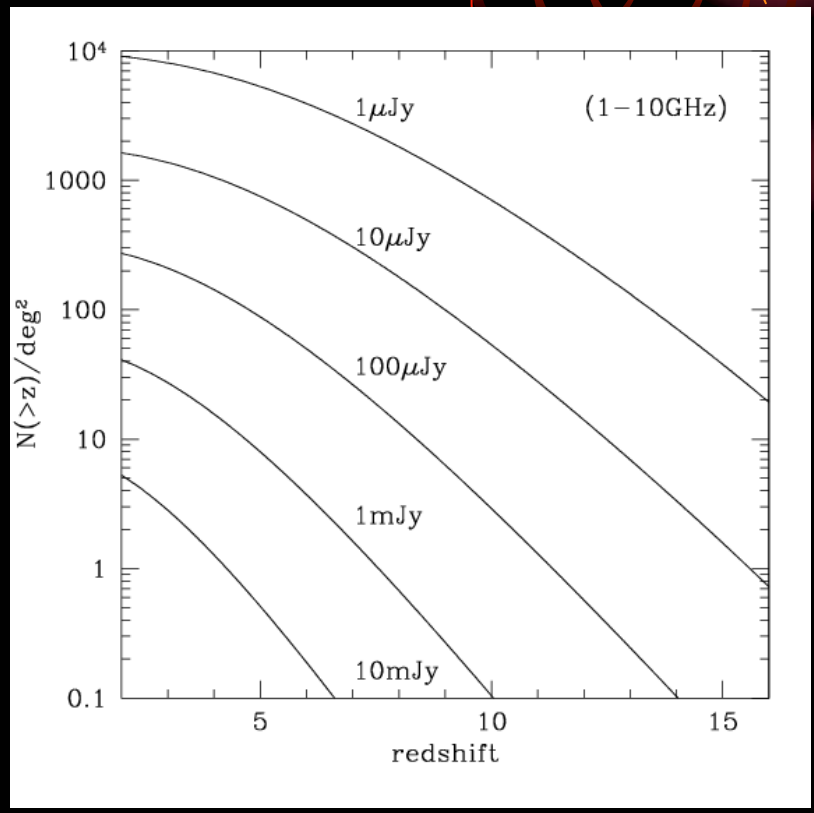
Multi-wavelength Approach Necessary

- Many types of sources are transient
- Multi-lambda necessary to determine type



High Redshift AGN Surveys

- ~10^4 FIRST sources (~1%) at z>8
- ATA can conduct deep & wide area survey
  - 6 GHz, 10^4 square degree in the same time



Haiman, Quataert & Bower 2004

ATA will be a powerful instrument for extragalactic surveys

- HI SDSS complement
  - Dark galaxies
  - Structure of the local universe
- Transients
  - Terra incognita
  - Potentially very high redshift science