

Transient Sources

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‘‘Reports that say that something that has not happened is always interesting to me...

The message is that there are known knowns, there are things we know that we know.

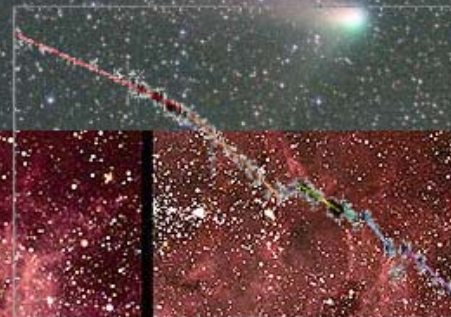
There are known unknowns, that is to say there are things that we now know we don't know.

But there are also unknown unknowns, there are things we do not know we don't know and each year we discover a few more of the unknown unknowns.’’

Mr. Donald Rumsfeld, Department of Defense new briefing

TRANSIENT UNIVERSE 2006: the Popular, the not so Popular and the Knowable Unknowns

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Eds. A. Rau & E. O. Ofek



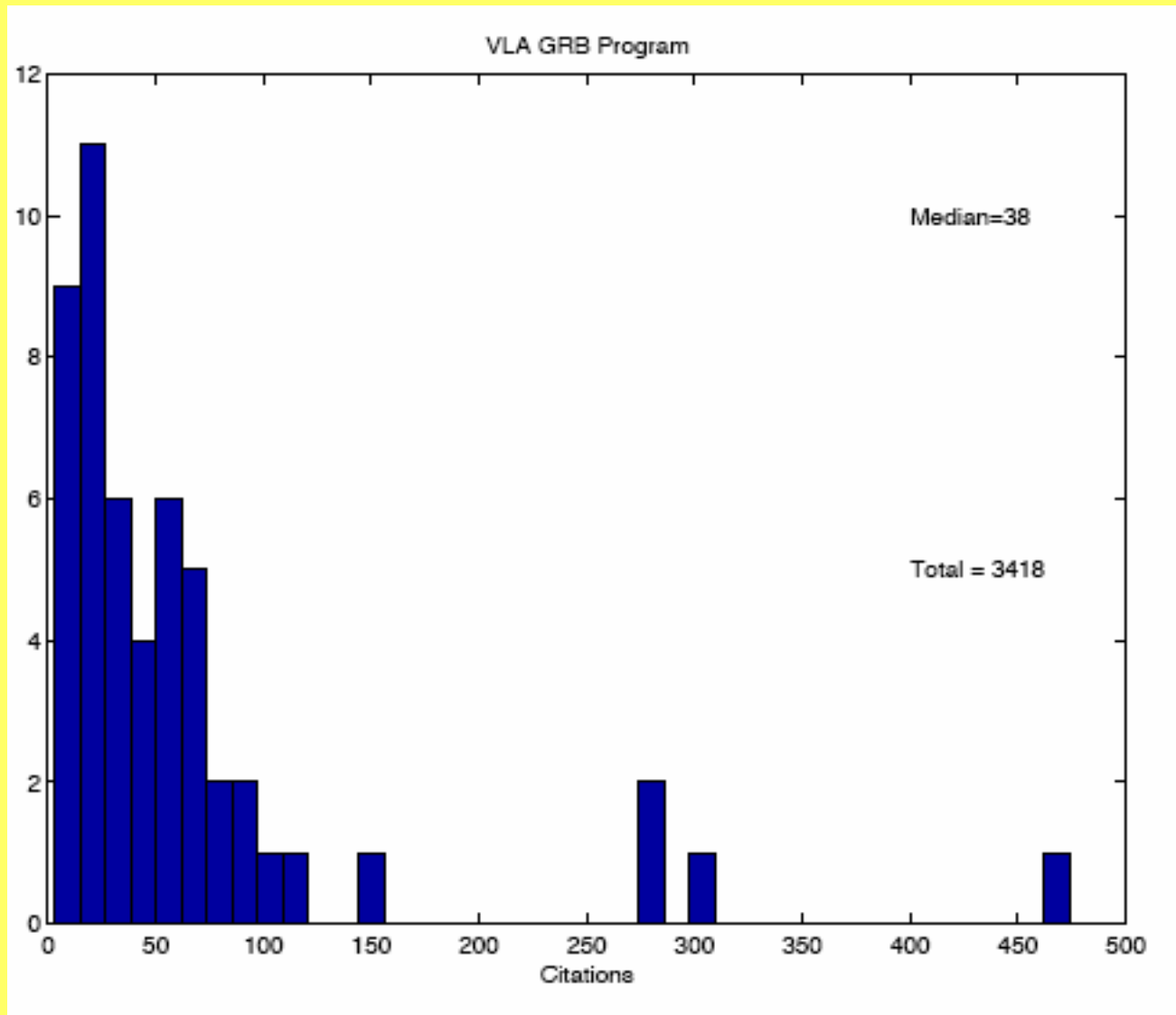
Los Alamos National Laboratory
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California Institute of Technology



Why is the radio band important?

- Almost all non-thermal phenomena produce decimeter emission
- There are few (three) centimeter wave interferometers
 - VLA has (completely) dominated GRB science
 - Addition of ATA is fantastic
- High frequency (centimeter and millimeter) is fertile territory and largely unexplored
 - GBT and/or Bolometric Arrays
 - CARMA and ALMA
- Resurgence in meter and decameter astronomy

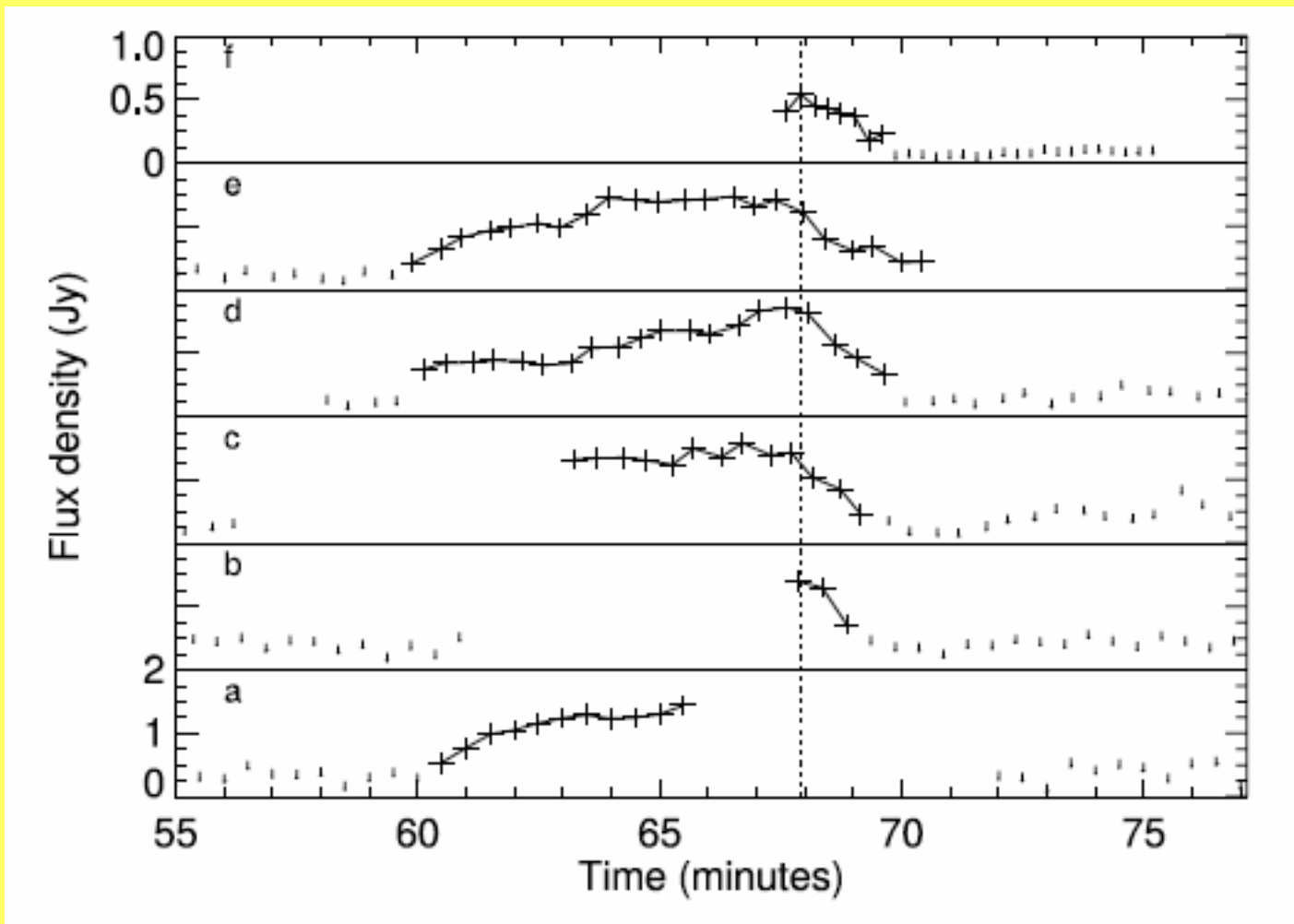
GRBs @ VLA



Overview: Low Frequency

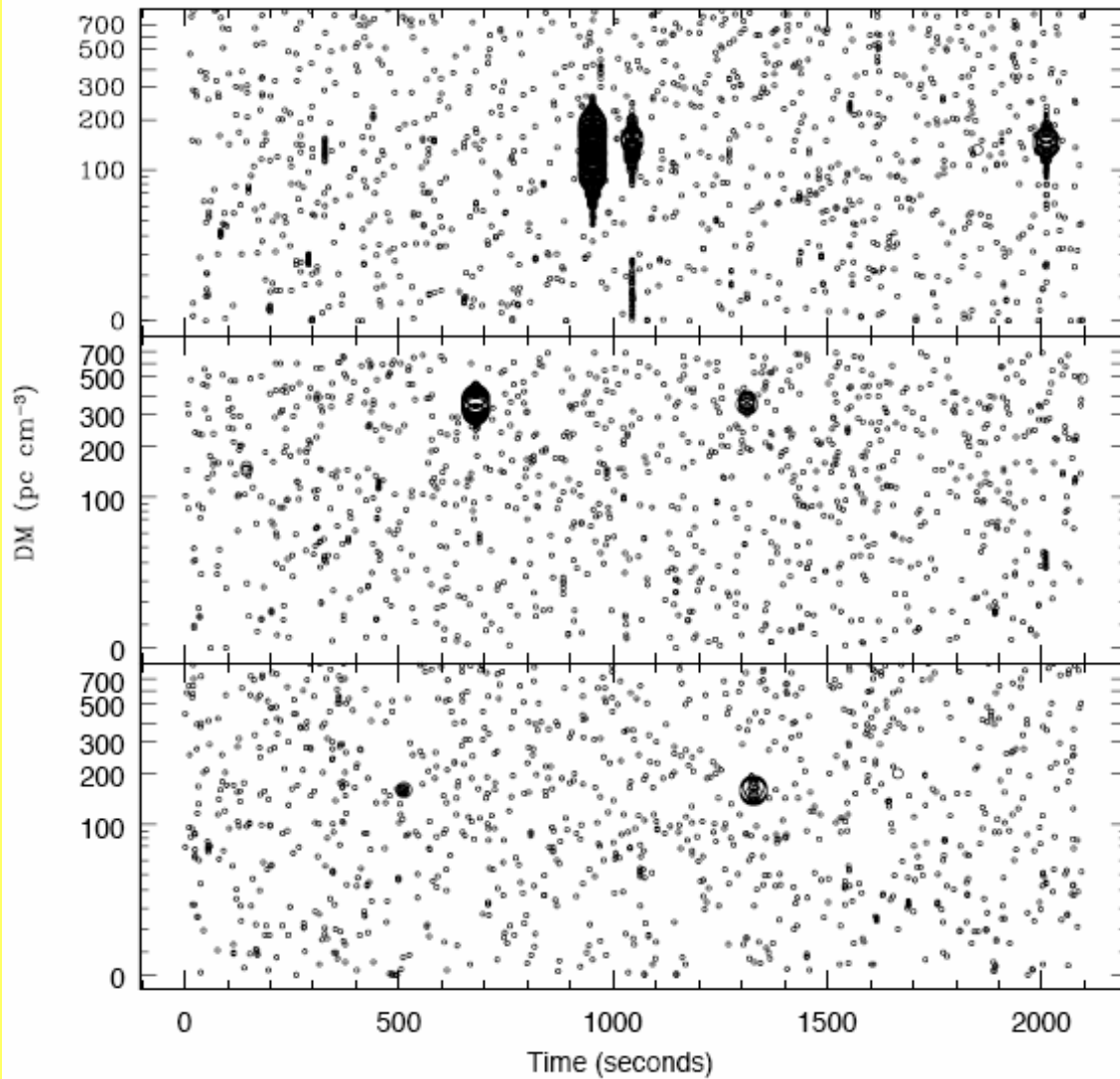
- Blind large field-of-view (FOV) searches are well suited to meter and decameter facilities
 - Multibeam Pulsar & Spike Searches (Parkes, Arecibo)
 - LOFAR, MWA, LWA
- Challenge:
 - Precise source localization
 - Rapid response at other wavelengths

The Burping Source



Hyman et al.

RRATs, Sparkers ...



Overview: Centimeter Bands

- I. Byproduct of other legacy imaging projects
 - Overlap region
 - Repeated visits to the same position
- II. High Cadence Searches towards special regions
 - Galactic Center
 - Virgo Cluster
 - M31
- III. (e)VLA as a follow-up machine
 - Wide field imagers in the optical and X-ray will need radio follow up.
 - “There is only one VLA”

I. Traditional known unknowns from blind surveys

- AGN burps & flares
- Flares from stars
- Intra-day variables
- Obscured supernovae
- Rare and energetic supernovae (1998bw)
- Orphan afterglows

Results

- **First+NVSS (1/17 sky)** Gal-Yam et al
 - Known pulsar, known AGN
 - Obscured radio SN in nearby galaxy NGC 4216
 - Likely radio loud AGN (unusual Galactic object)
- **VLA calibration field** Bower et al.
 - Likely radio supernova in a resolved host galaxy
 - Suspect distant M dwarfs

What have these efforts taught us?

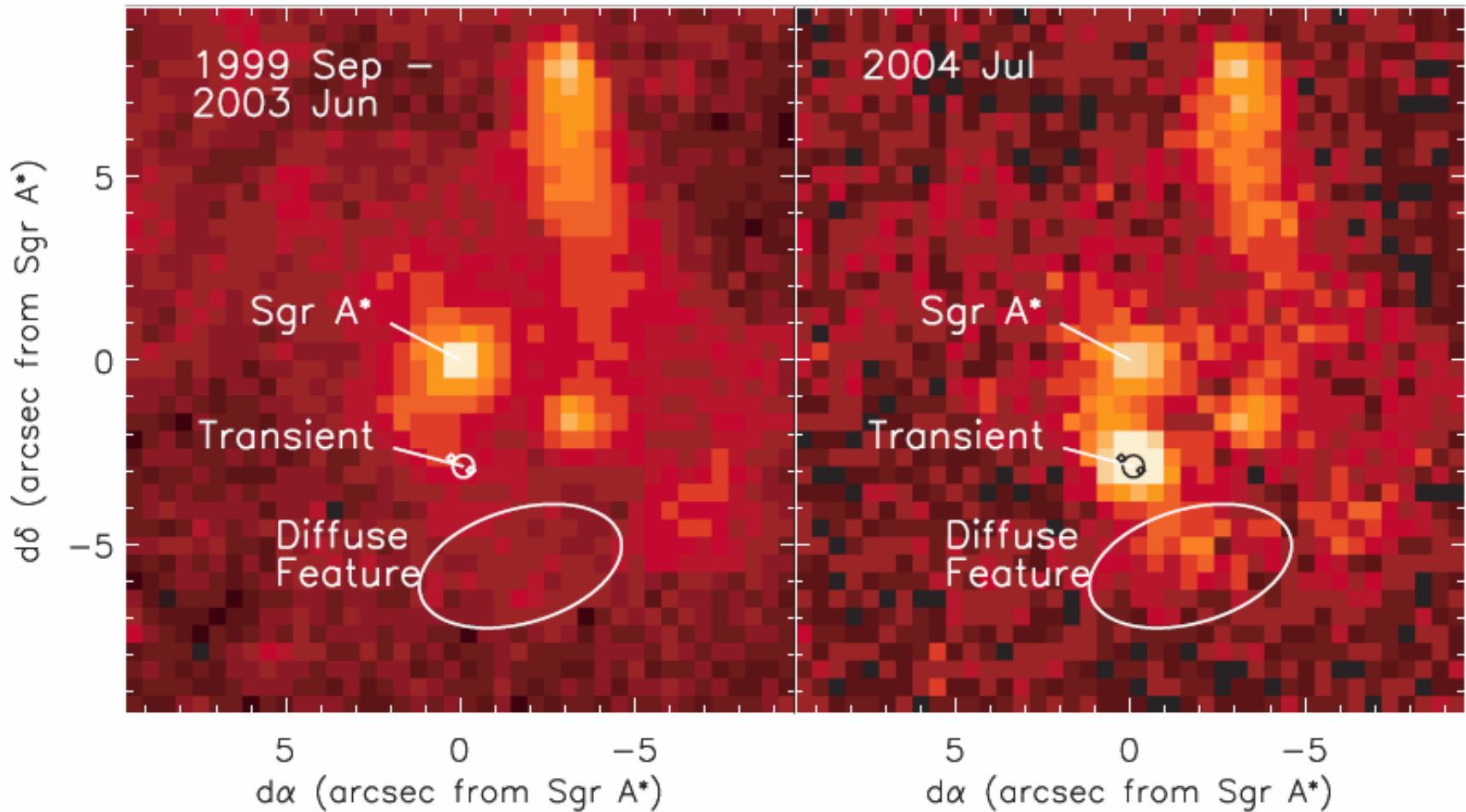
- Meaningful progress needs large coverage of sky or high cadence or both
 - > need dedicated program
 - > need dedicated instrument
- Rapid response is essential
 - Essential to study the transient (especially during outburst) at other wavelengths
- Optical investigation of the “precursor” object is critical.
 - Helps to have deep images in advance

II. Known Unknowns from Special Places

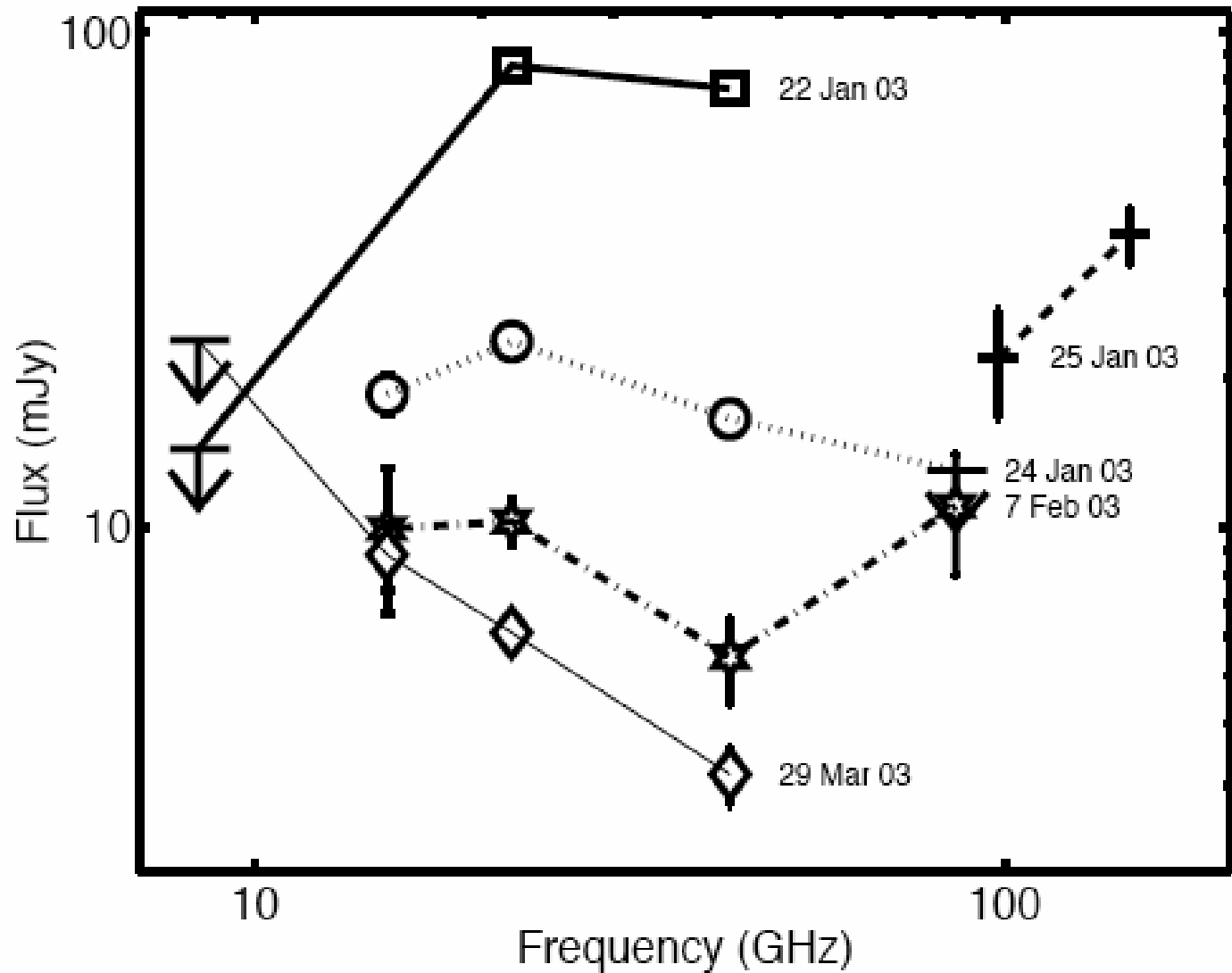
- Galactic center
- Orion Star forming Region
- M31
- Virgo Cluster

*Great Attraction: Meaningful VLA campaigns
can be mounted towards these regions*

LMXB in Galactic Center Region



Flaring source in Orion



III. (e)VLA as a follow up machine

“There is one Caltech but really only
one VLA”

(ergo, eVLA > 2\$B)

All sky capabilities in space

- Swift (beyond prime phase)
 - BAT is unique, XRT is an excellent camera
- Integral/IBIS
- GLAST and SuperAGILE (2007?)
- Astrosat (India, 2008?)
- (Chandra, XMM, Astro-E2)

Known Unknowns from X-ray Missions

- Magnetars
- Microquasars
- Be X-ray binaries
- Flare Stars
- AGN (of all sorts)
- GRBs (of all sorts)

Optical Astronomy: Time Domain

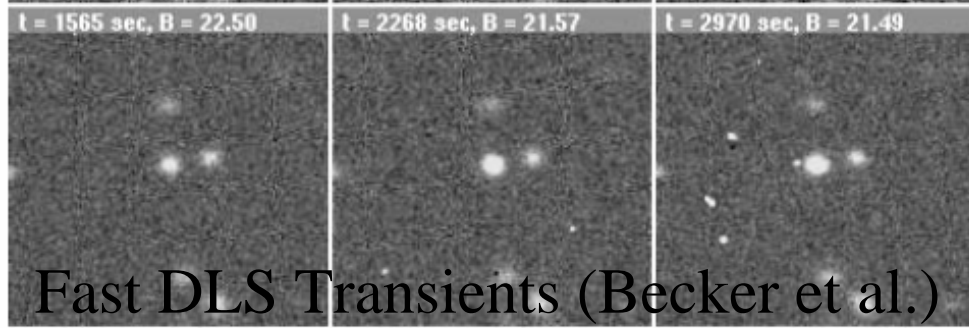
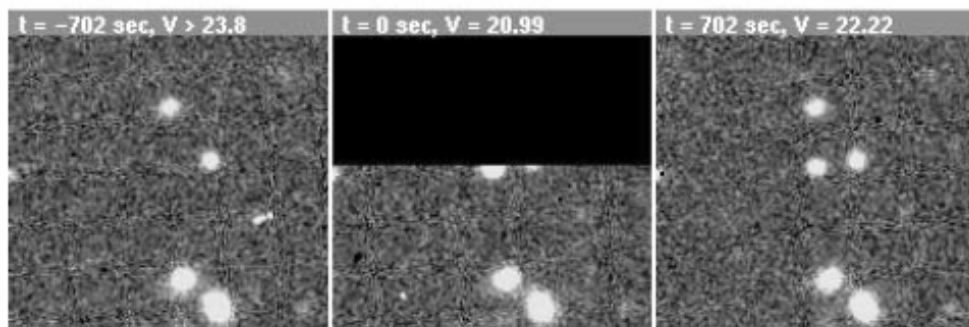
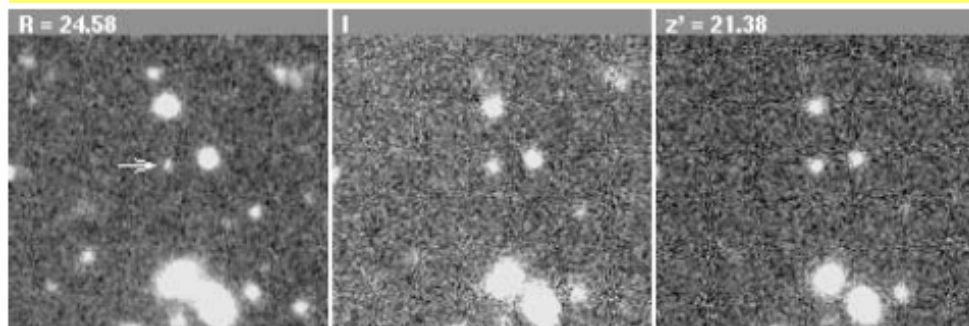
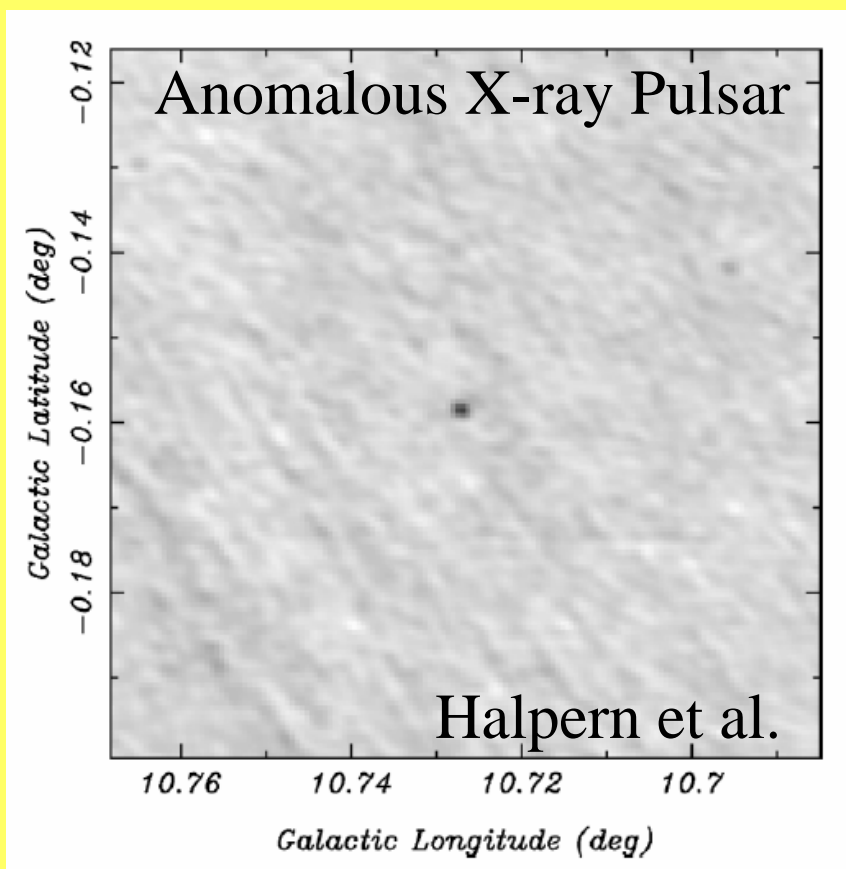
Astronomy is back in Fashion

- Moore's law applies to computing, sensors, storage and bandwidth
- Optical astronomy on the verge of a revolution
 - Large field imagers (CFHT, Quest...)
 - Dedicated wide field imagers (PanSTARRS, LSST)

Known Unknowns from Optical Astronomy

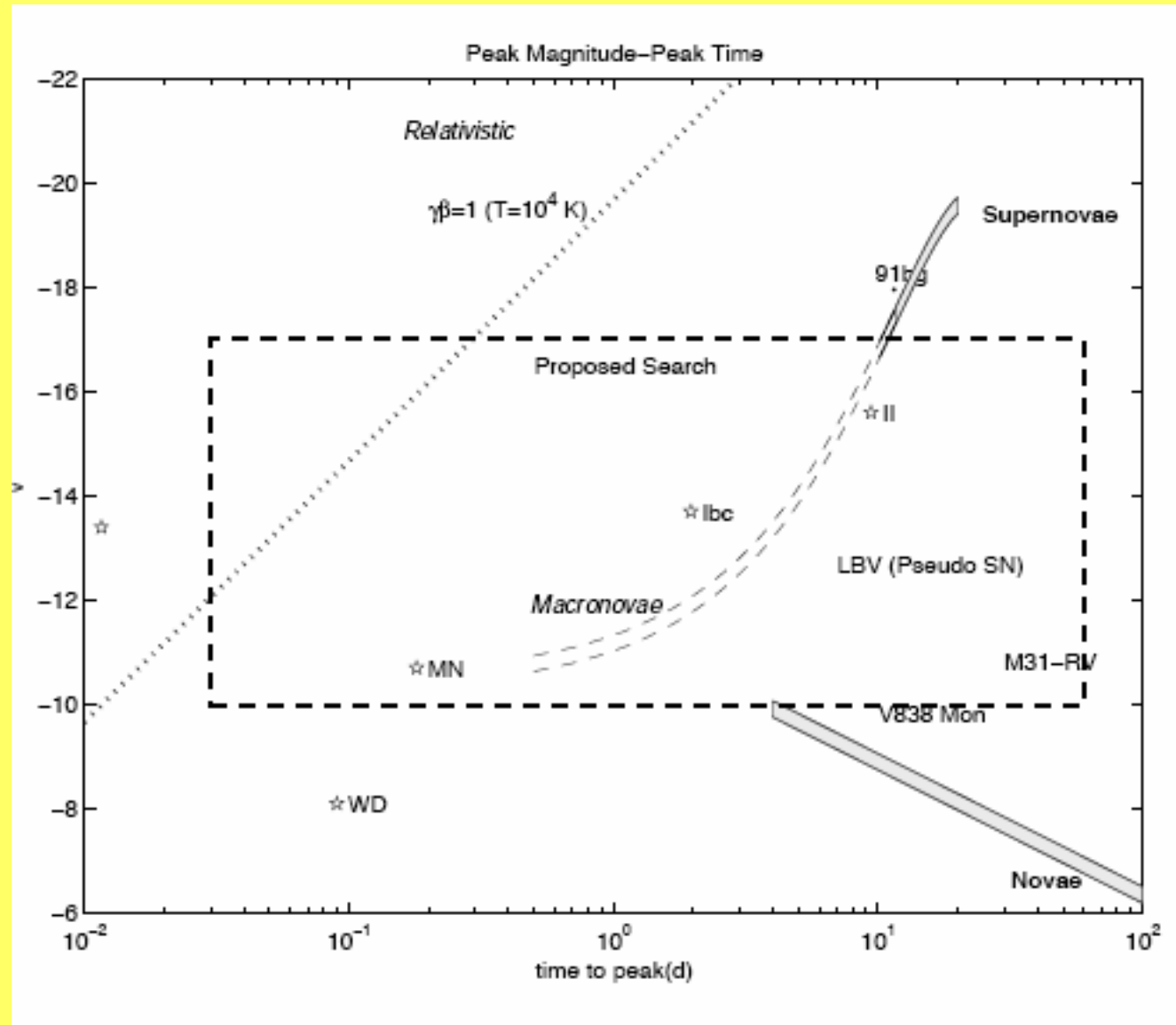
- Flare stars (3 per second, over entire sky)
- Supernovae
- Nova
- Macronova (Brachynova, Dolichonova)
- Unusual versions of CVs, interacting binaries etc.

Flares, Flares, Flares



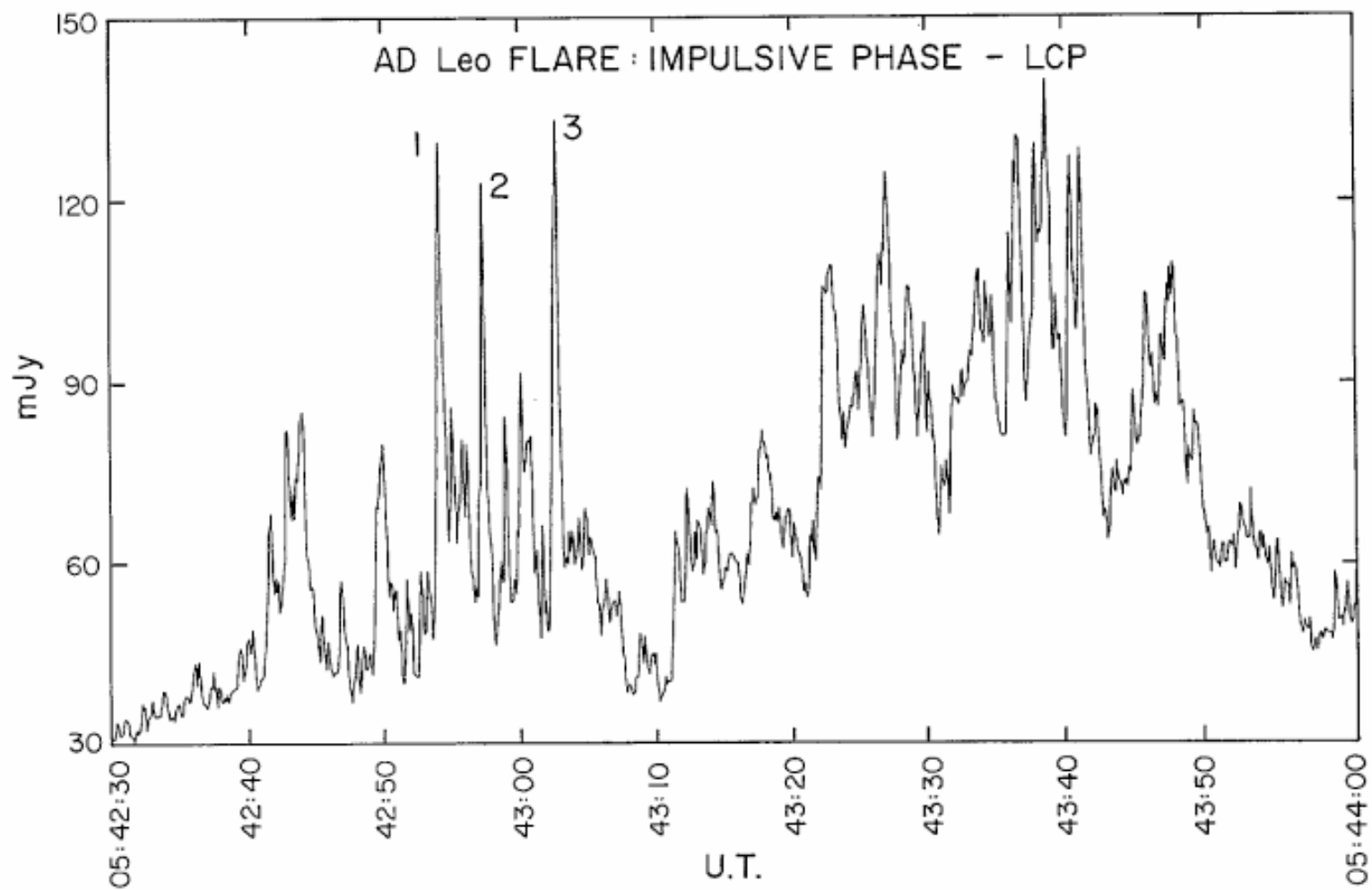
Fast DLS Transients (Becker et al.)

Some unknown unknowns



(e) VLA can be in driver's seat

- Many interesting transients are flares
 - Flares from stars
 - Flares from magnetars
 - Flares from microquasars
 - Flares from pre-main sequence stars
- “Strike the source when it is hot”
 - Rapid response by VLA and VLBA (and millimeter telescopes)
 - Radio offers superb astrometry
 - Radio offers unique diagnostics (cf GRB and SGR experience)





**It's somewhere between a nova and a supernova
... probably a pretty good nova."**

VLA GRB Program

- Calorimetry
- Geometry (jet opening angles)
- Dark bursts (arcsecond localization)
- High z (negative K correction!)
- Short hard burst localization

http://www.nrao.edu/~dfrail/grb_public.shtml