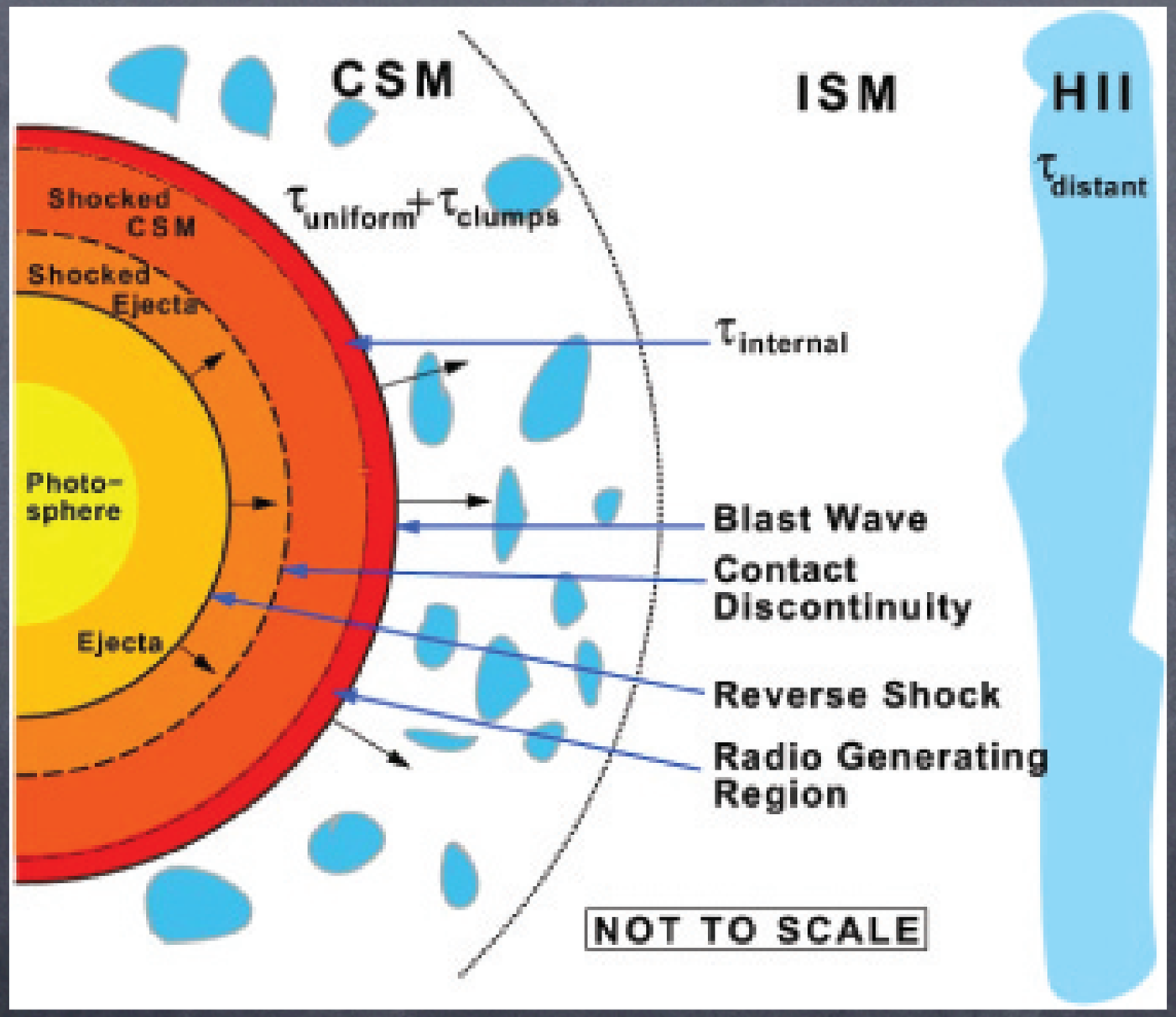
Early Radio Observations of Supernovae

Assaf Horesh
(Caltech)
Collaborators:
S. R. Kulkarni, Dale Frail, C. Stockdale, Derek B. Fox, John Carpenter and the PTF team

Radio Emission Physics



Stockdale et al. 2007

What can we learn from the radio?

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The Palomar Transient Factory (PTF; PI Kulkarni)

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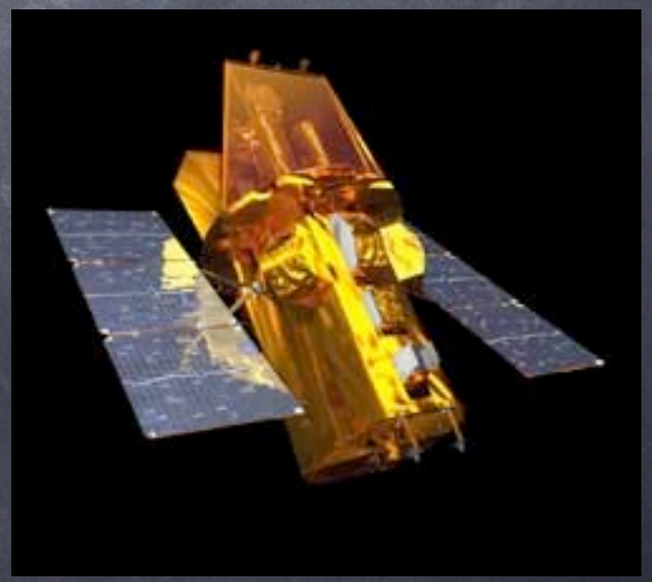

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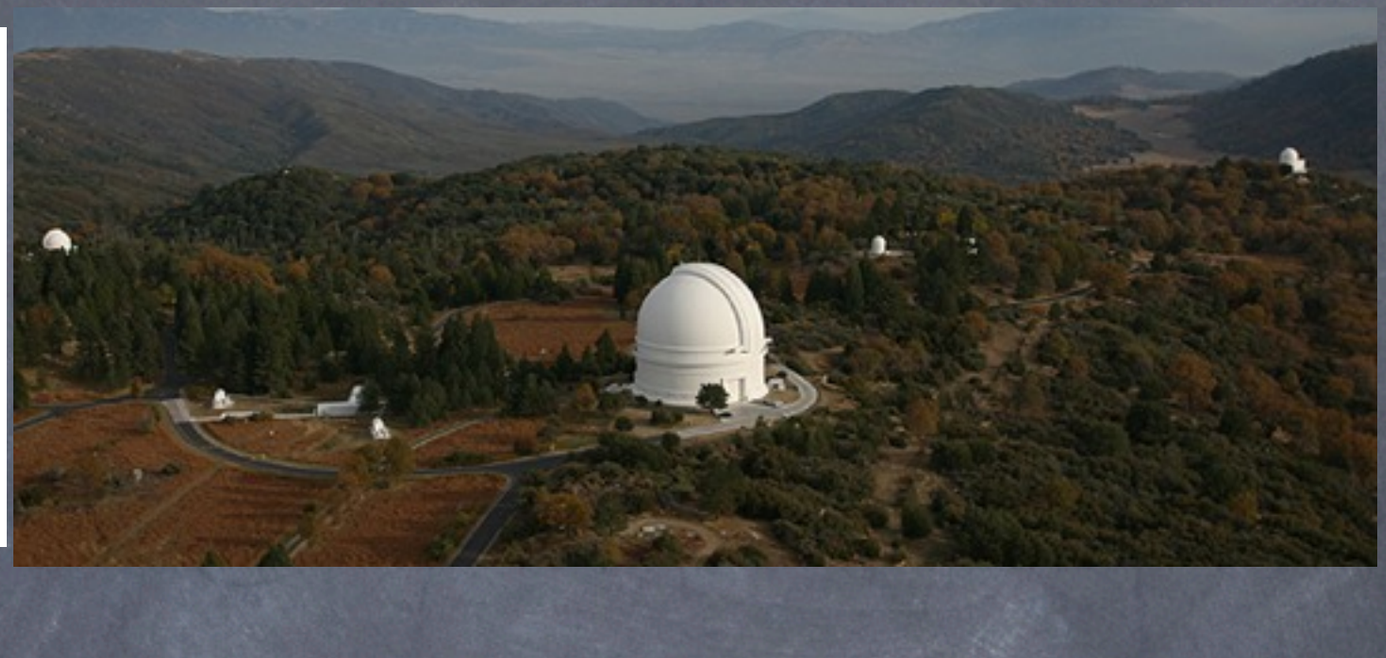
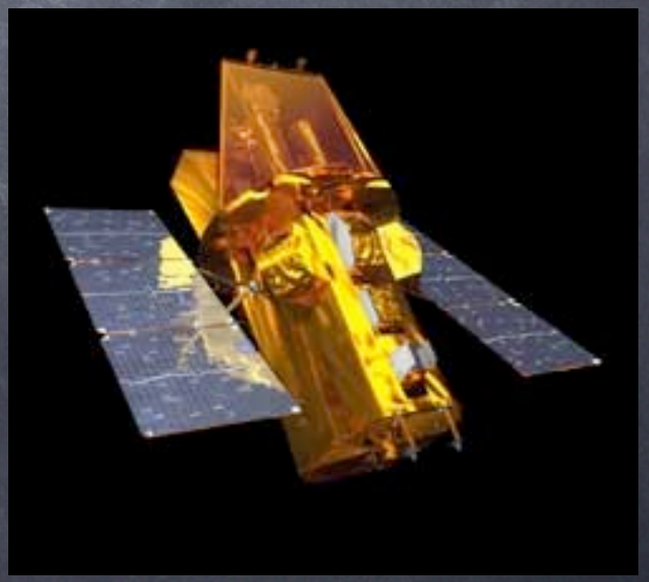
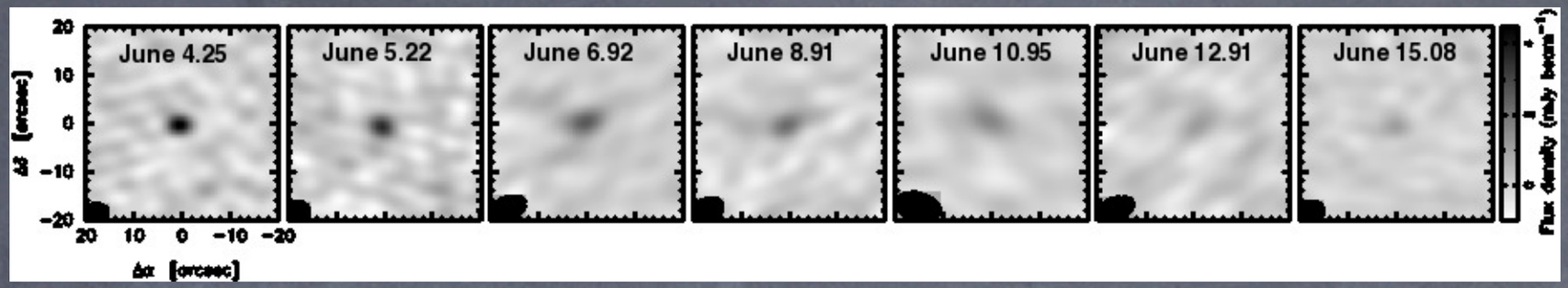




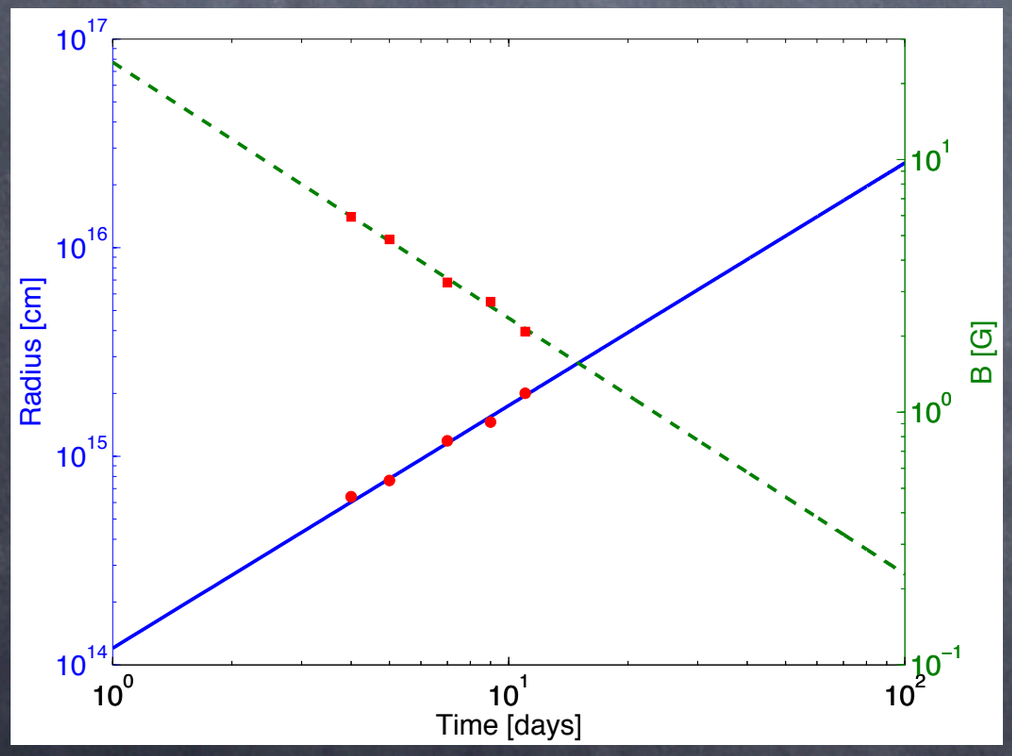
SN 2011dh

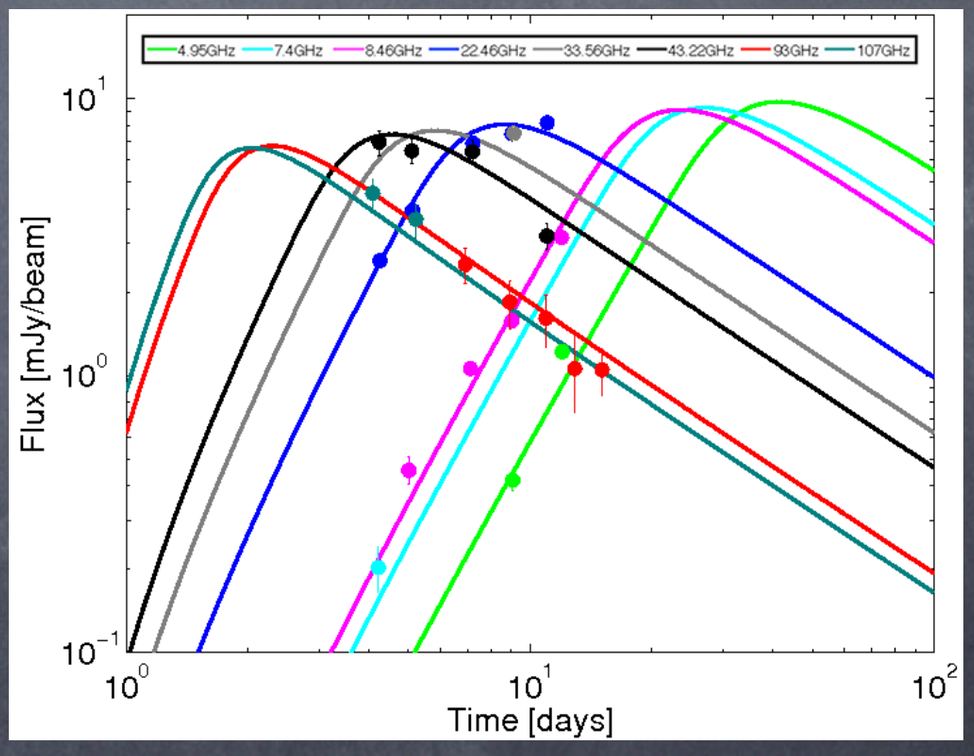
- SN 2011dh (Arcavi et al. 2011; Maund et al. 2011; Van Dyk et al. 2011).
- Type IIb SN
- 8 Mpc away

SN 2011dh Radio Analysis



Early millimeter observations (Horesh et al. 2012b)





Horesh et al. 2012b

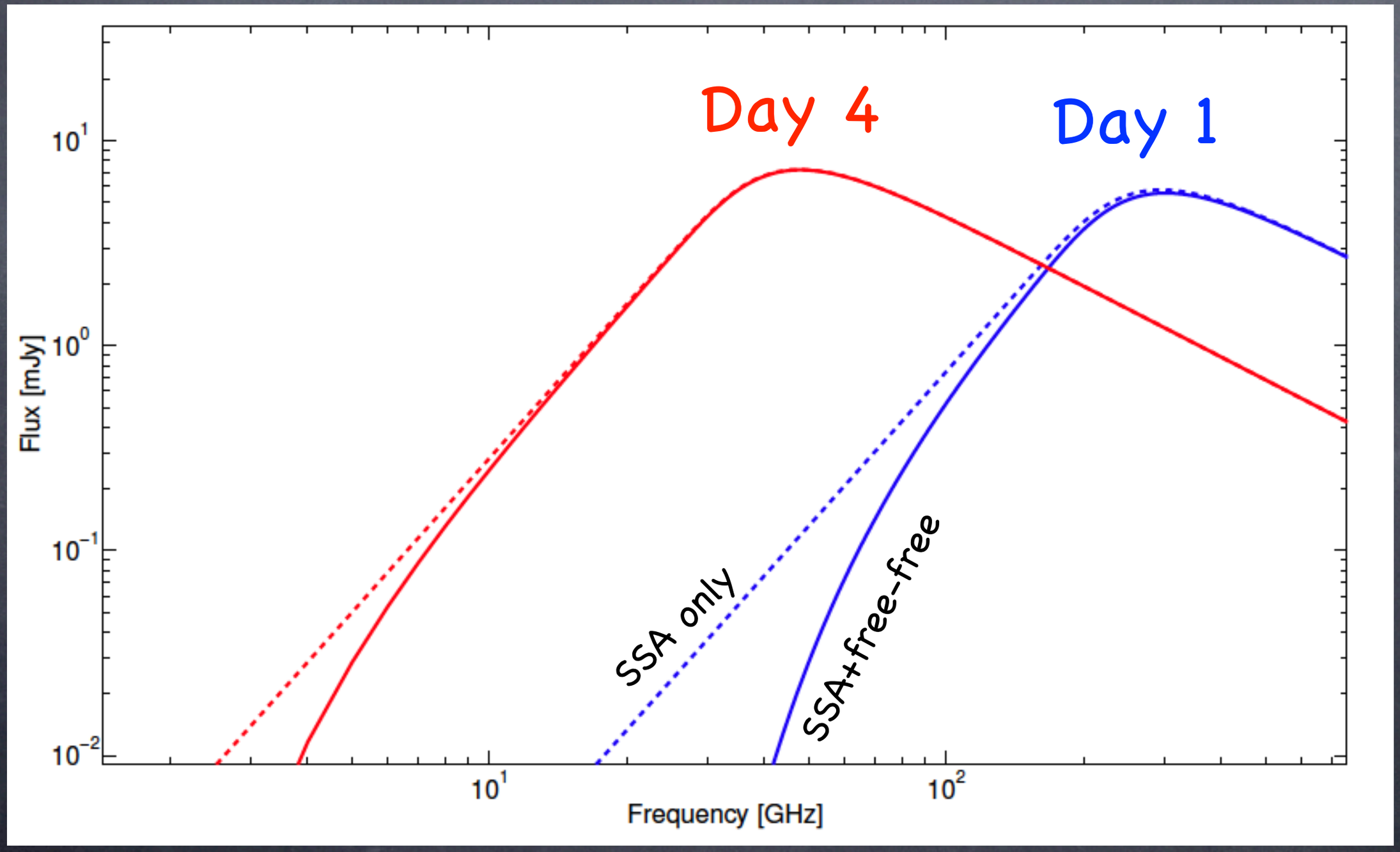
(See also Soderberg et al. 2012, Krauss et al. 2012)

SN2011dh - Main Results

1. Intermediate progenitor (between red super giant and wolf-rayet star) - suggests a continuos progenitor population

2. Combined X-ray+Radio analysis show: Large Deviation from equipartition (Horesh et al. 2012b; see also Soderberg et al. 2012)

Why Early Observation?



The youngest Type Ia SN

Earliest mm and cm wave observations a day after explosion (Horesh et al. 2012a)

Early Swift observation (Kasliwal et al. 2011)

No radio or X-ray detected

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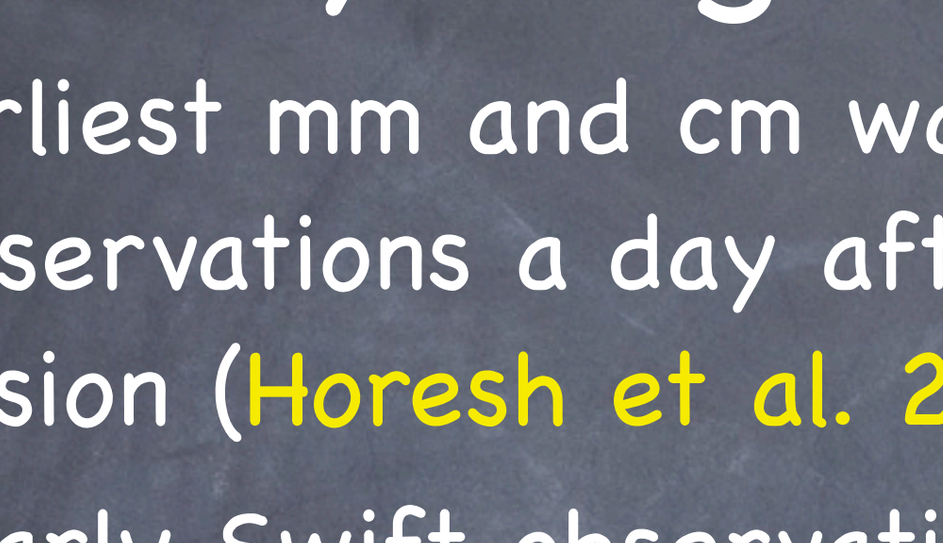

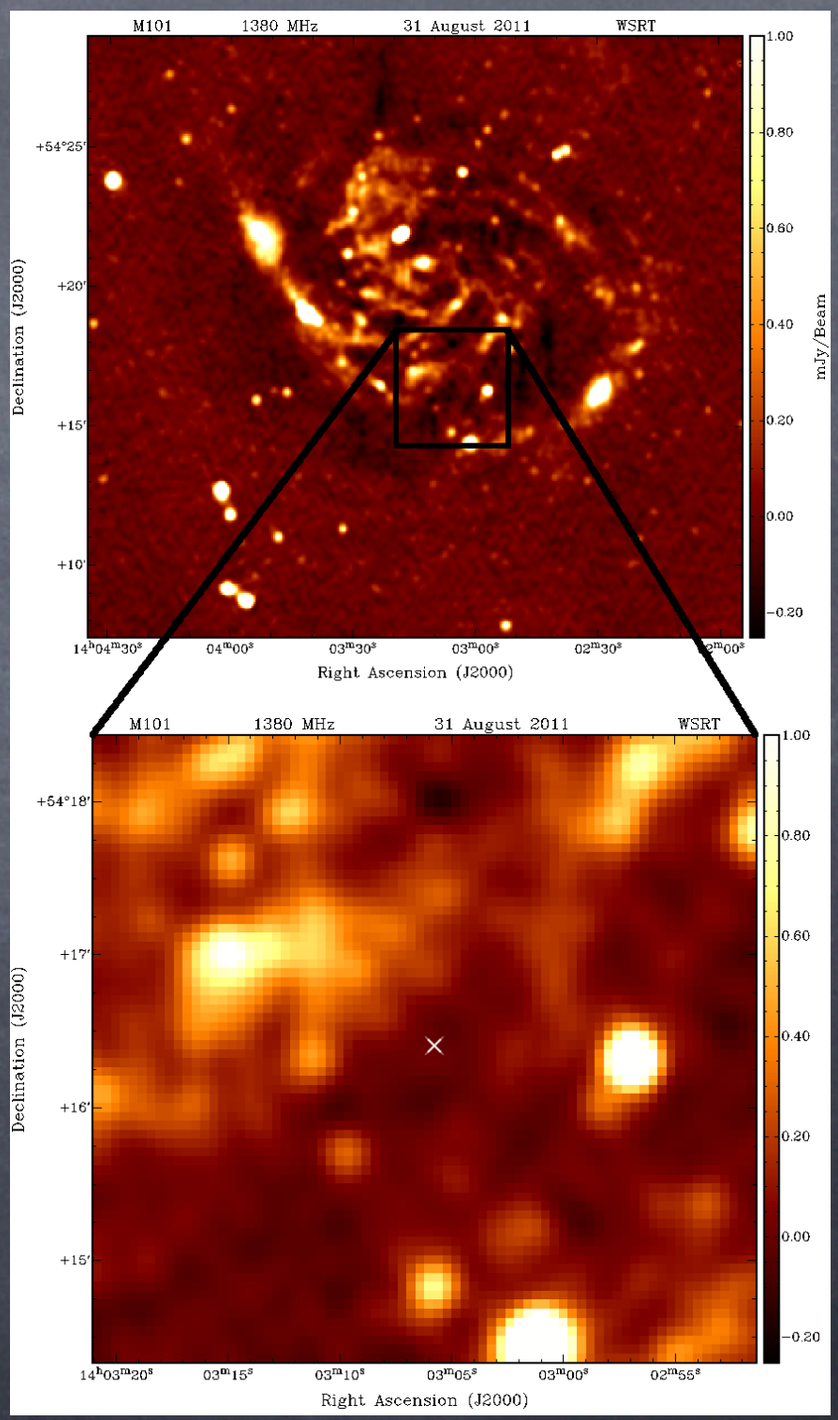

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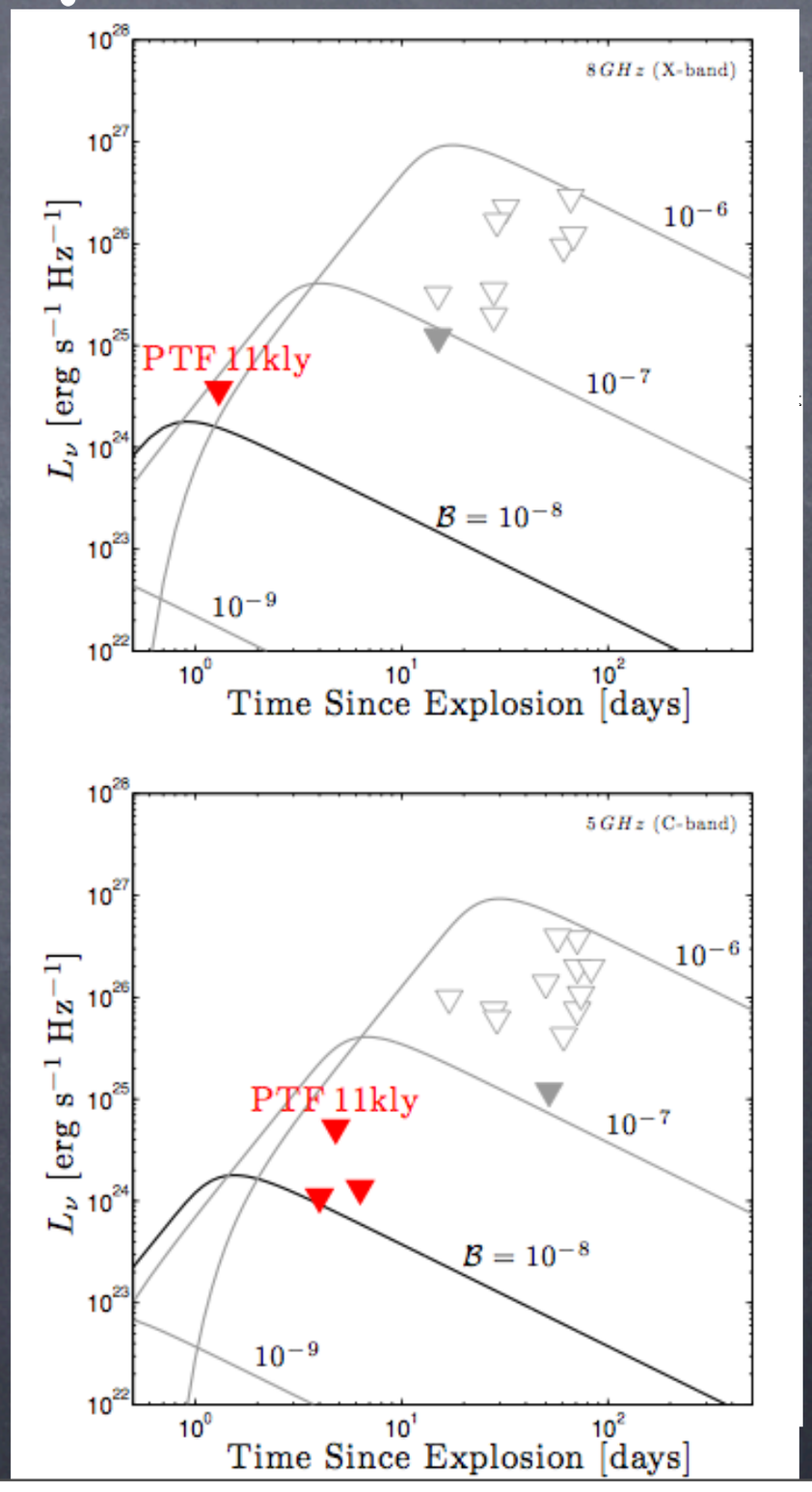
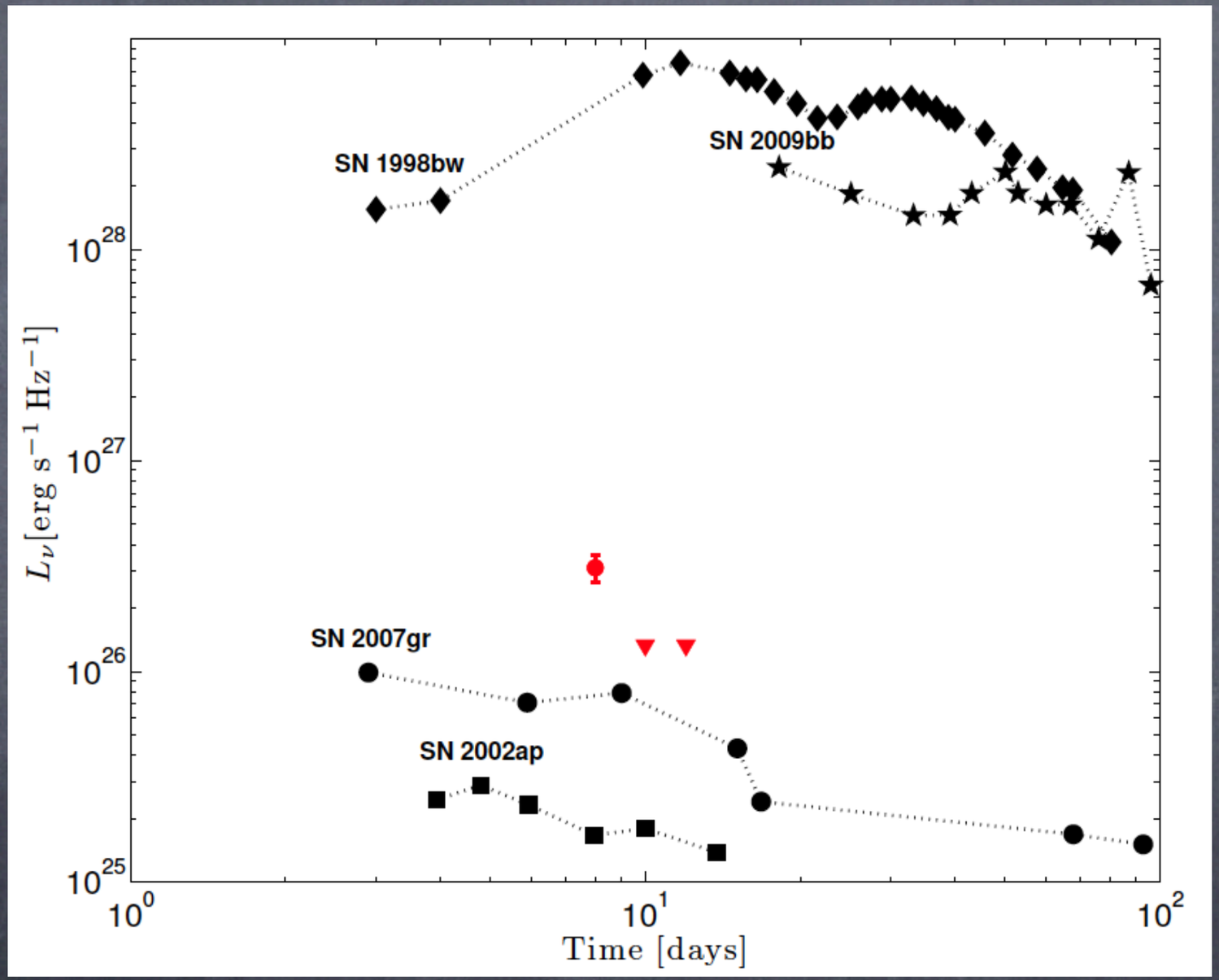


Fast Radio Supernovae



Horesh et al. 2013, in prep

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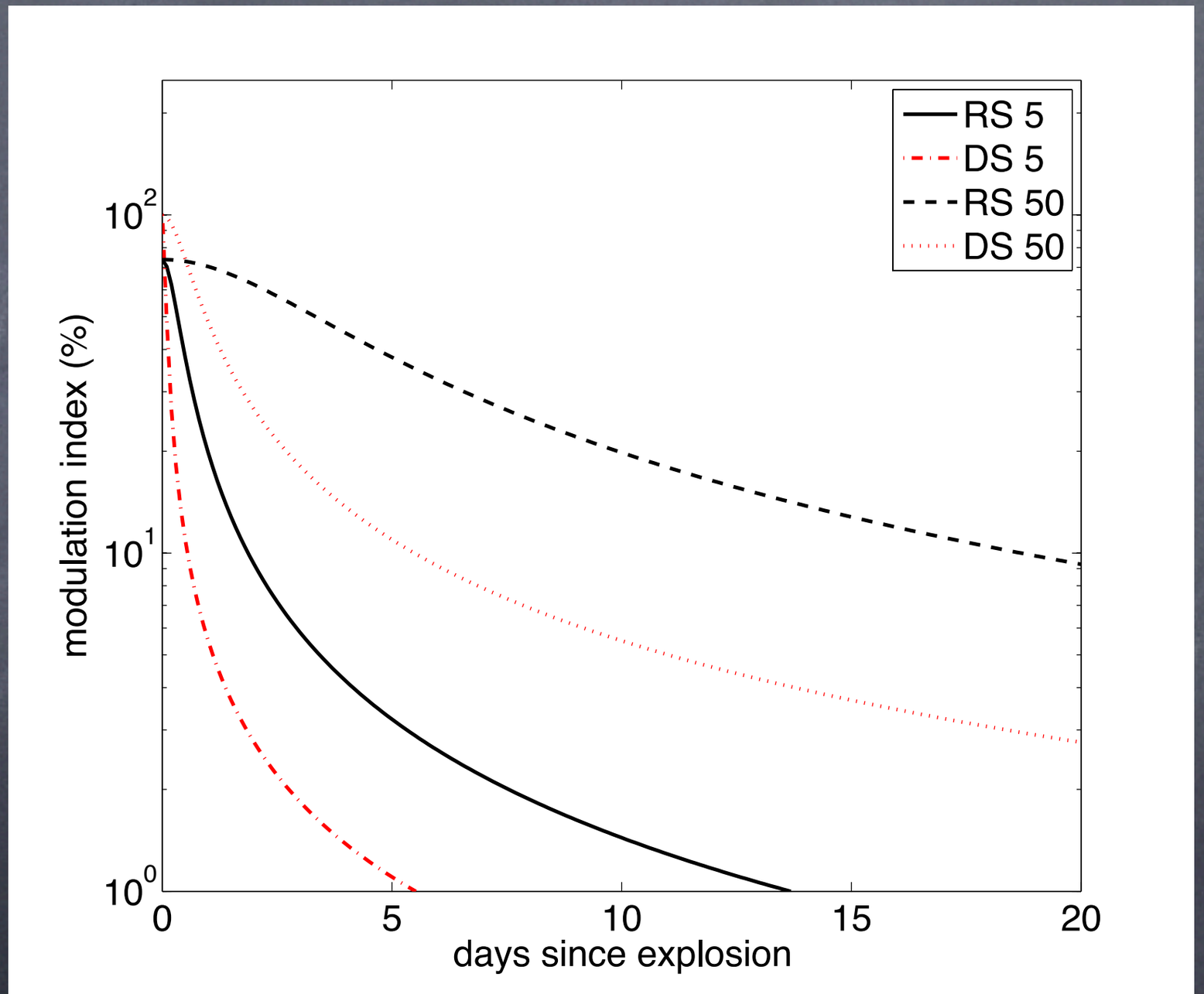

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Lessons

1. Panchromatic observations are important - requires coordination

2. Fast response -
   a. Track fastest ejecta and track shock before deceleration
   b. Detect fast radio SN.
   c. At early times, emission usually peaks at high frequency which is less sensitive to scintillation.

3. Frequent hourly multi-band observations - requires simultaneous multi-band capabilities

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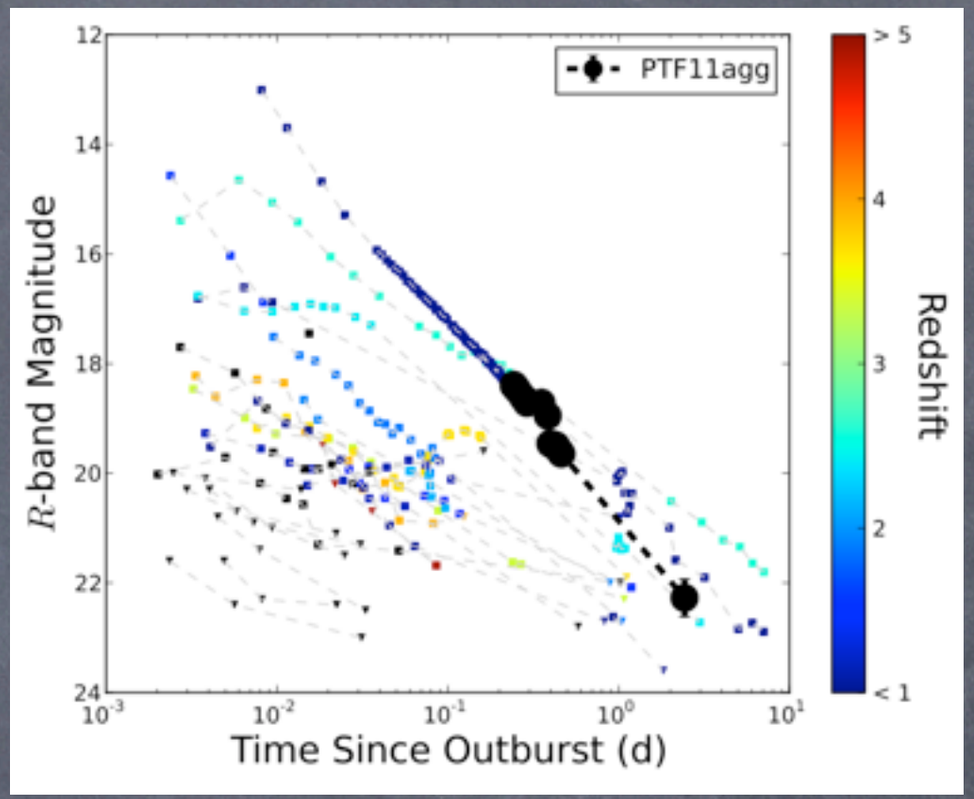

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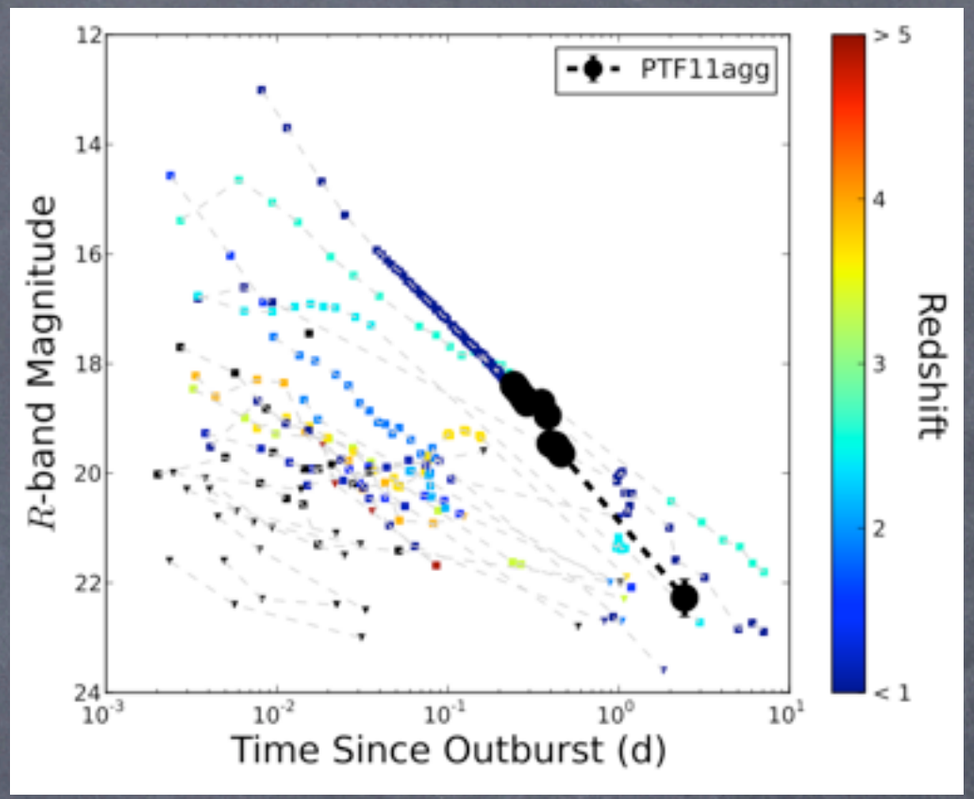

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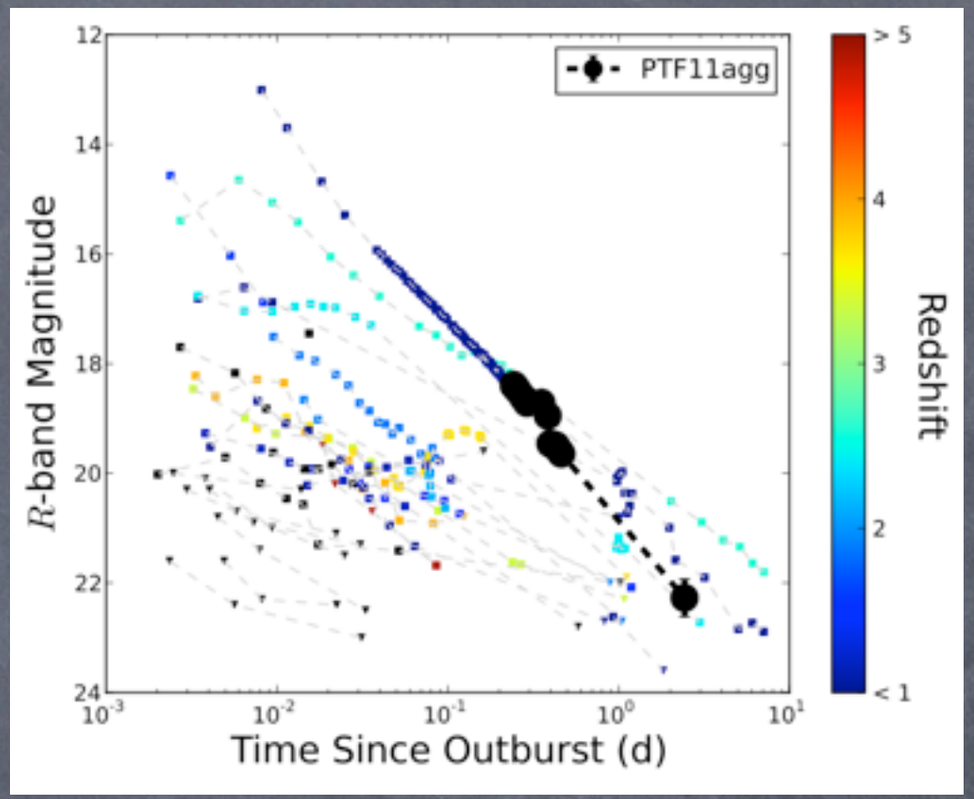

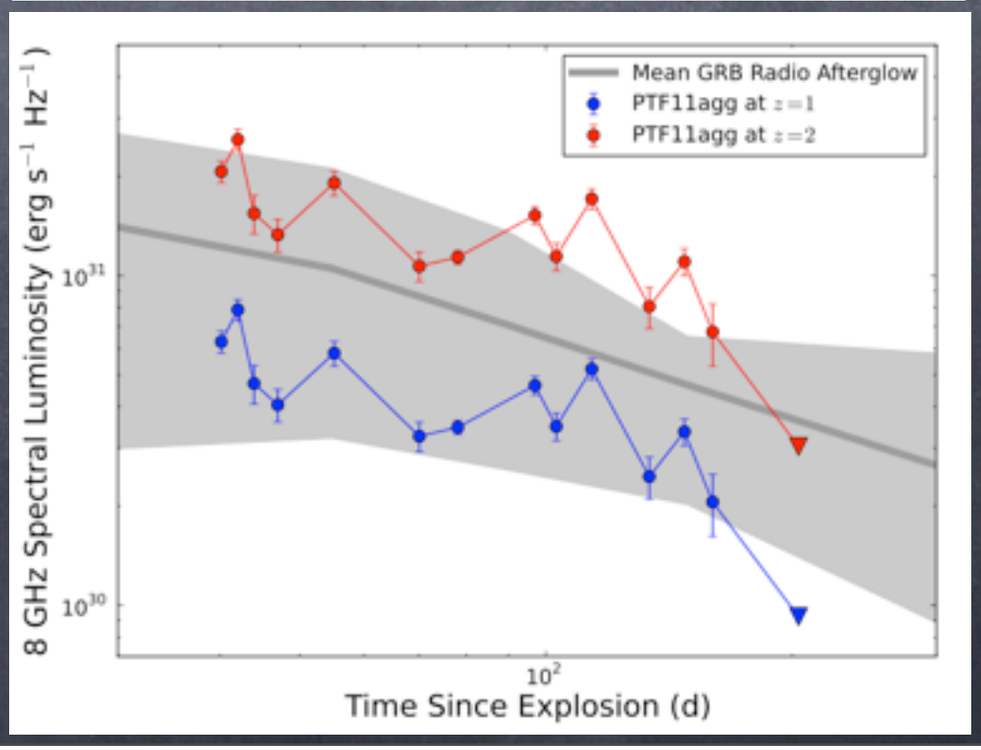

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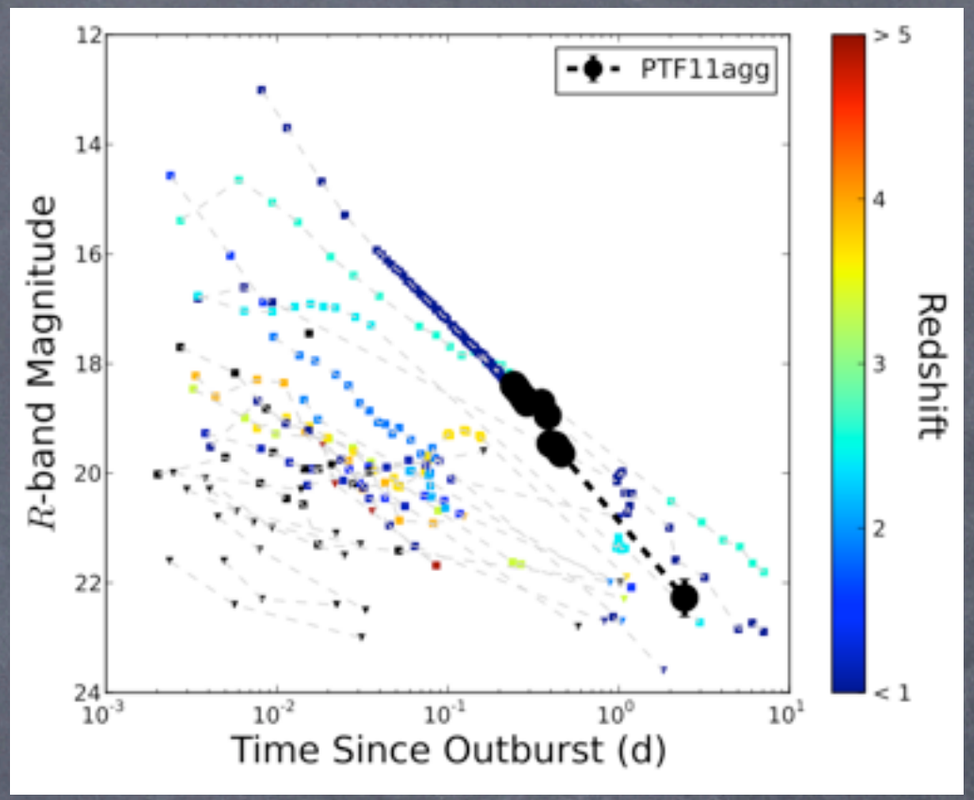

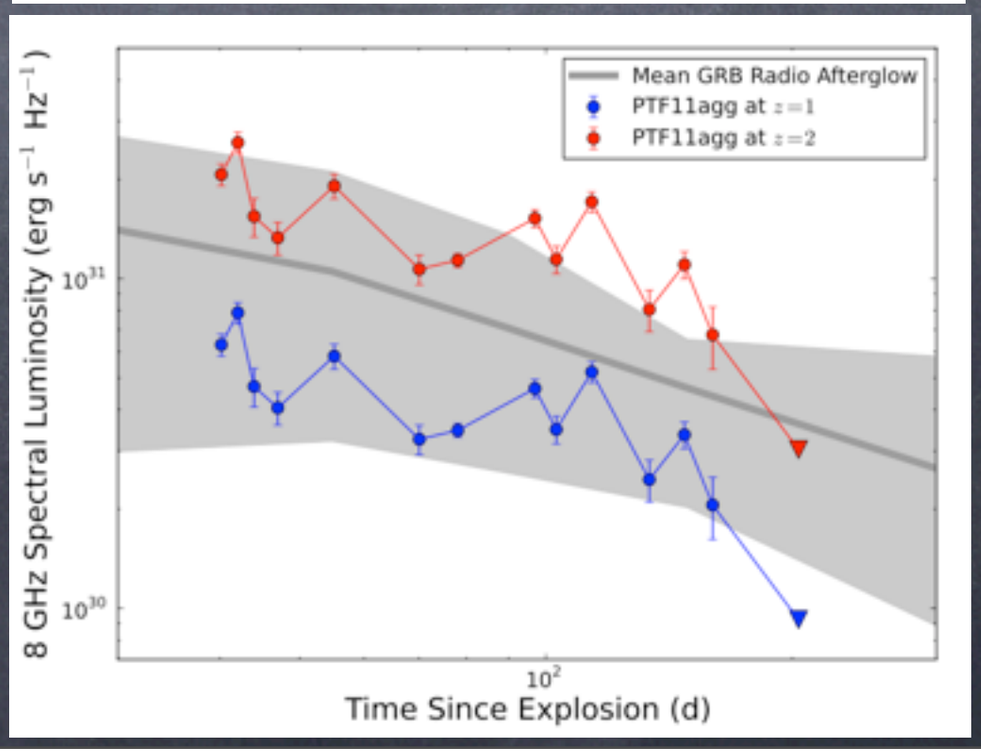

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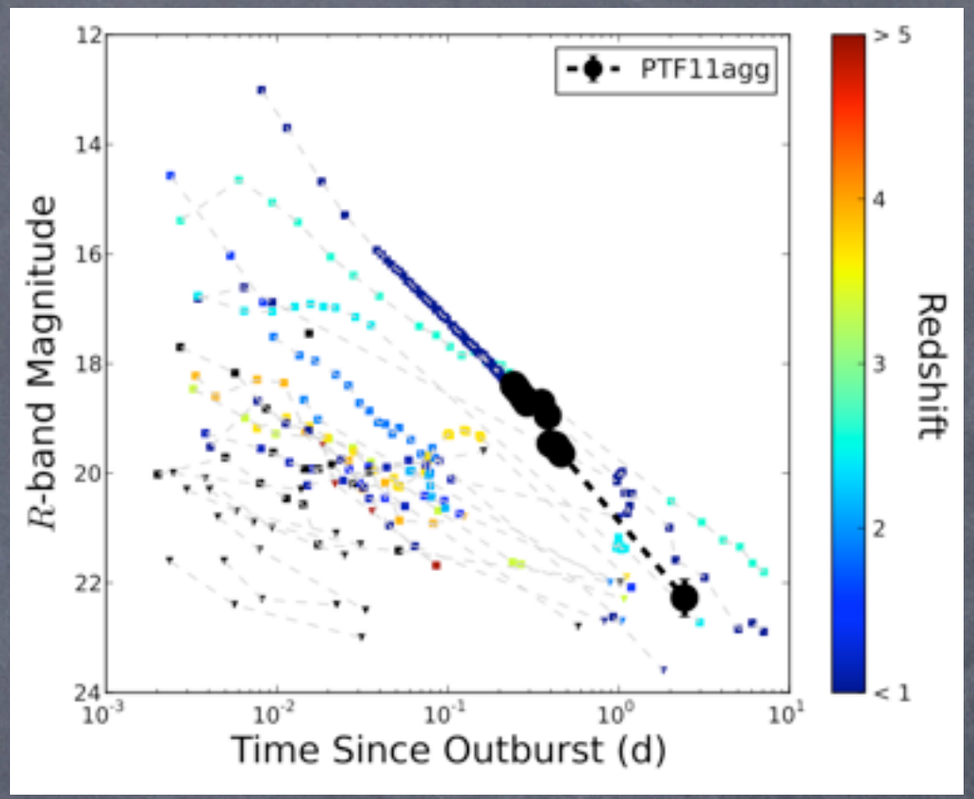

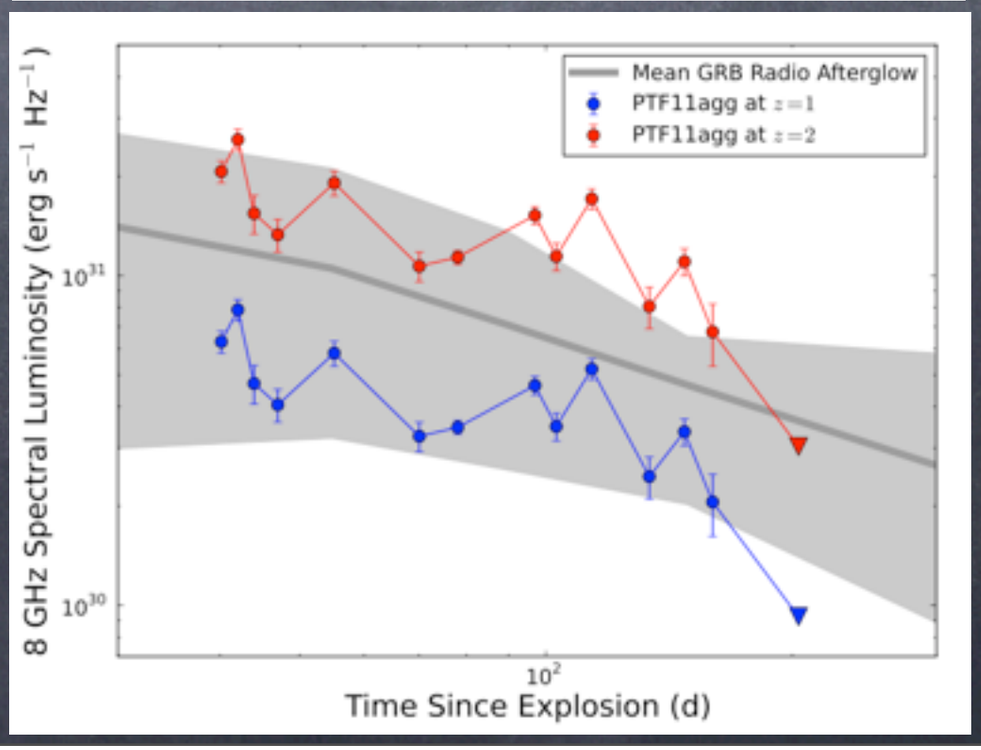

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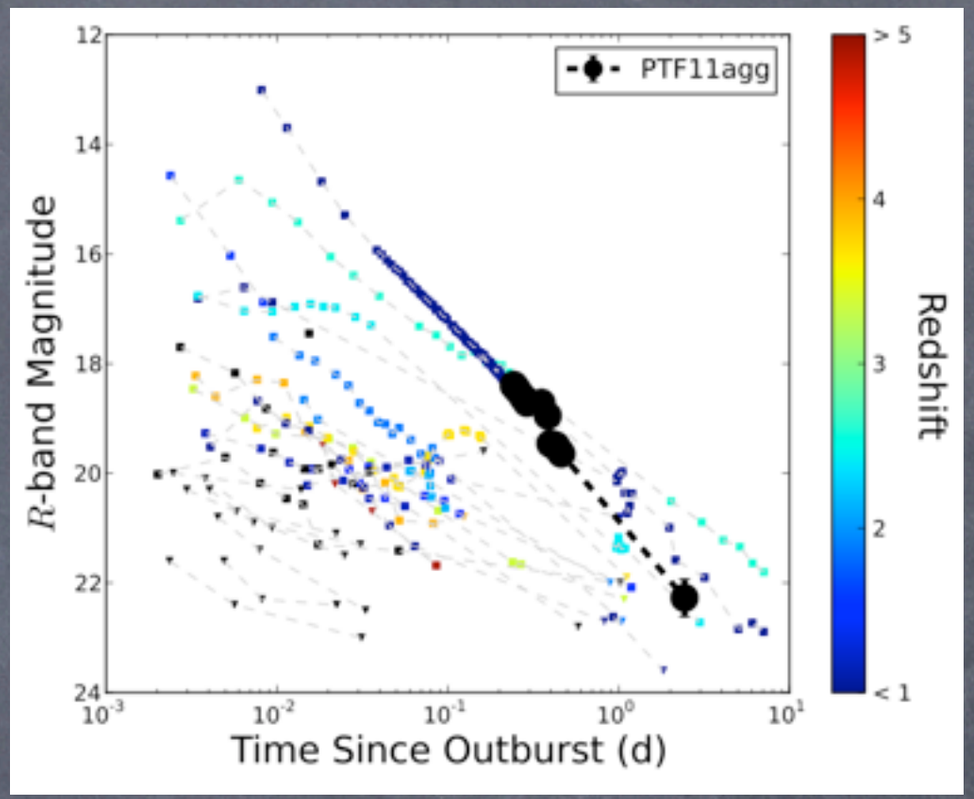

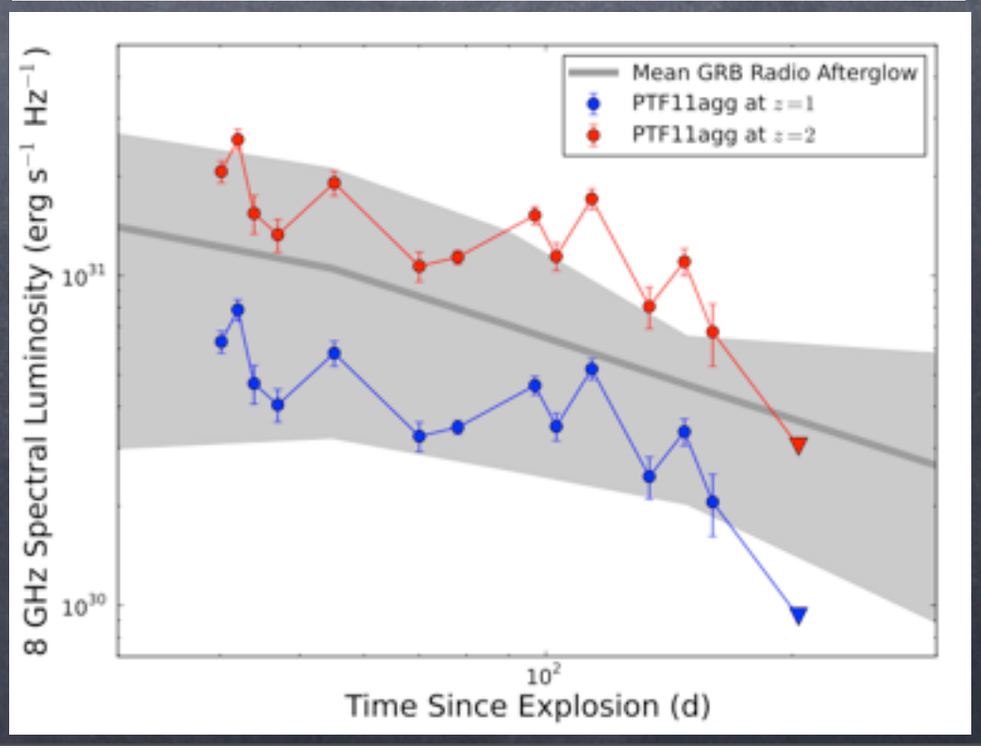

The VLA Stripe 82 Survey

EVLA time-domain survey (PI Shri Kulkarni)

- Area - 50 square degrees
- Frequency - 3GHz
- Sensitivity - 75 micro Jy
- Cadence - 3 epochs separated 1 month and 1 week
- PTF optical monitoring

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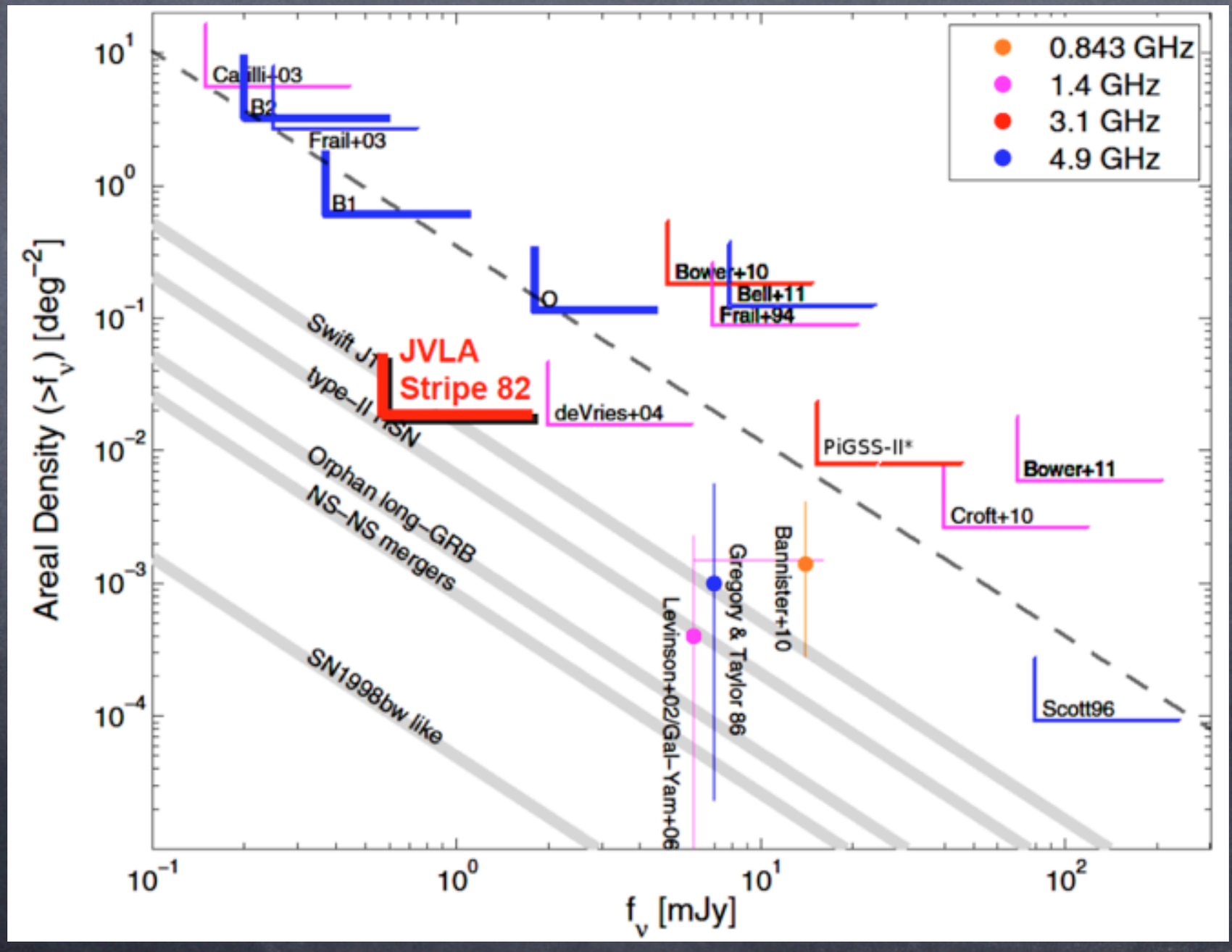
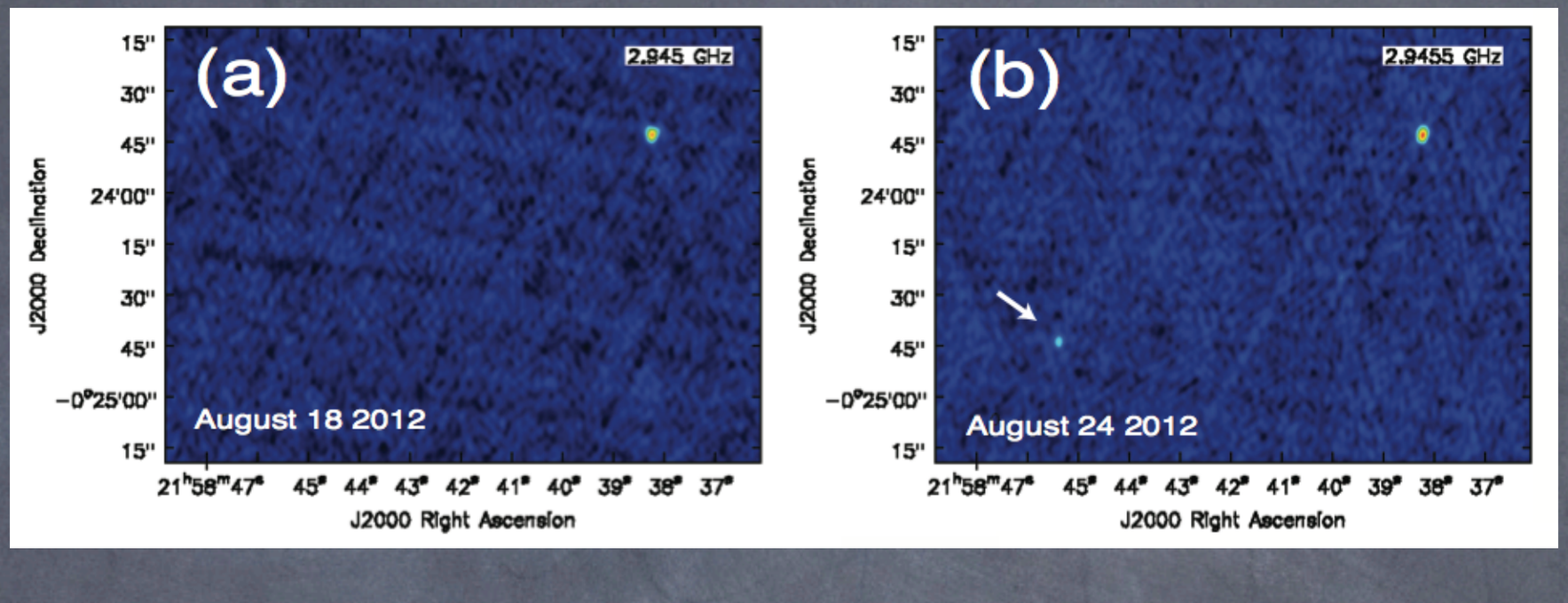


Frail et al. 2012

A promising candidate



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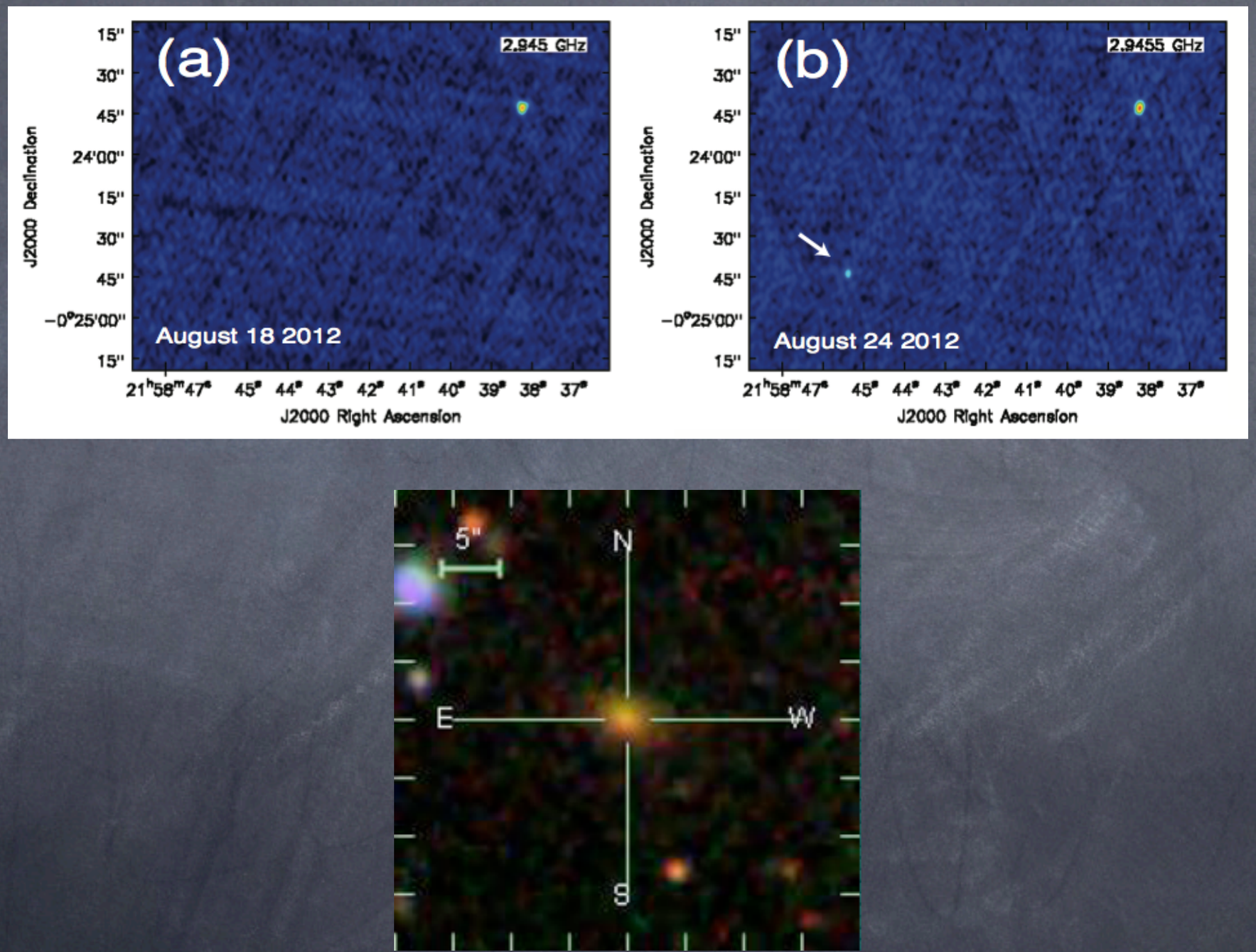

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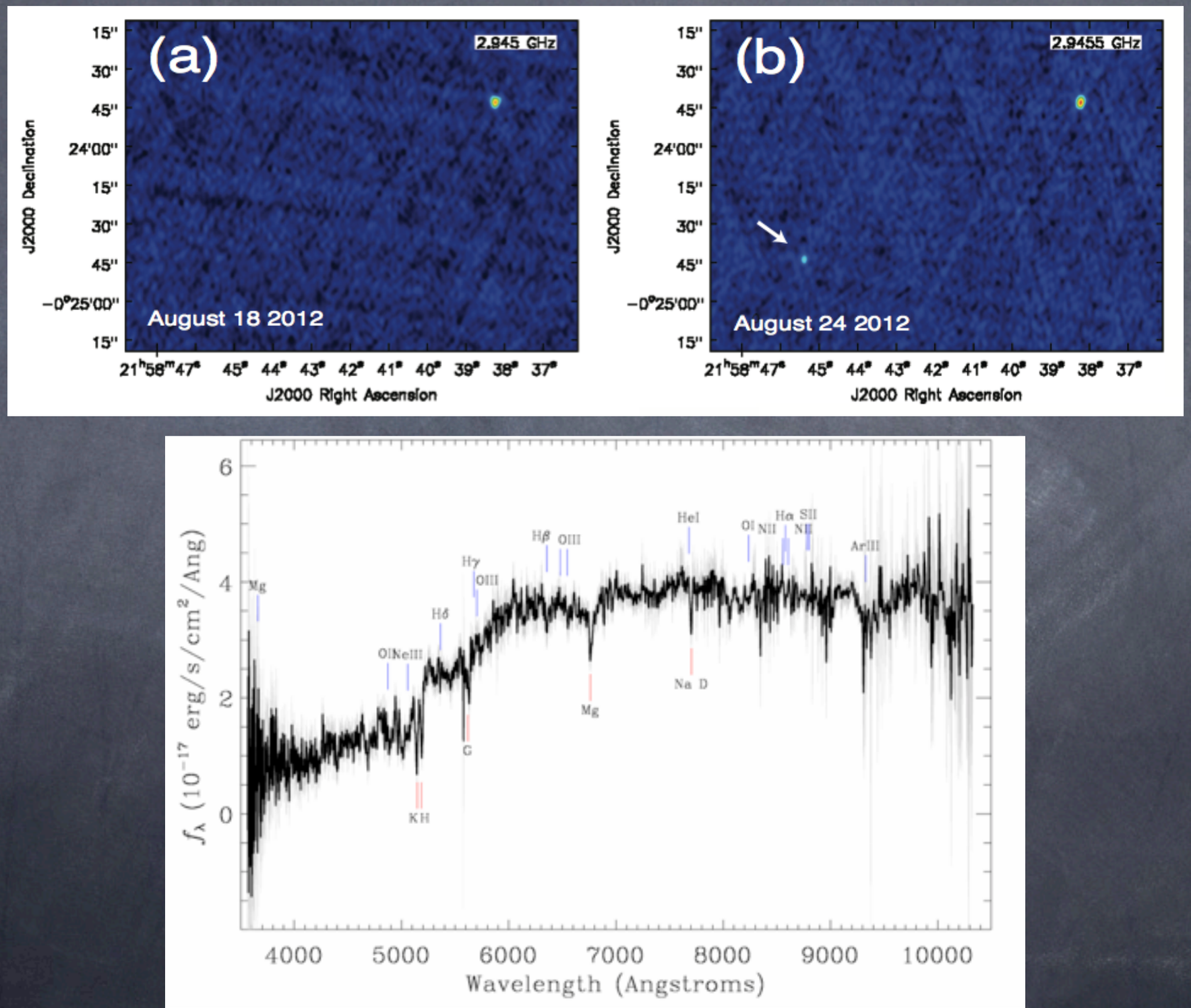

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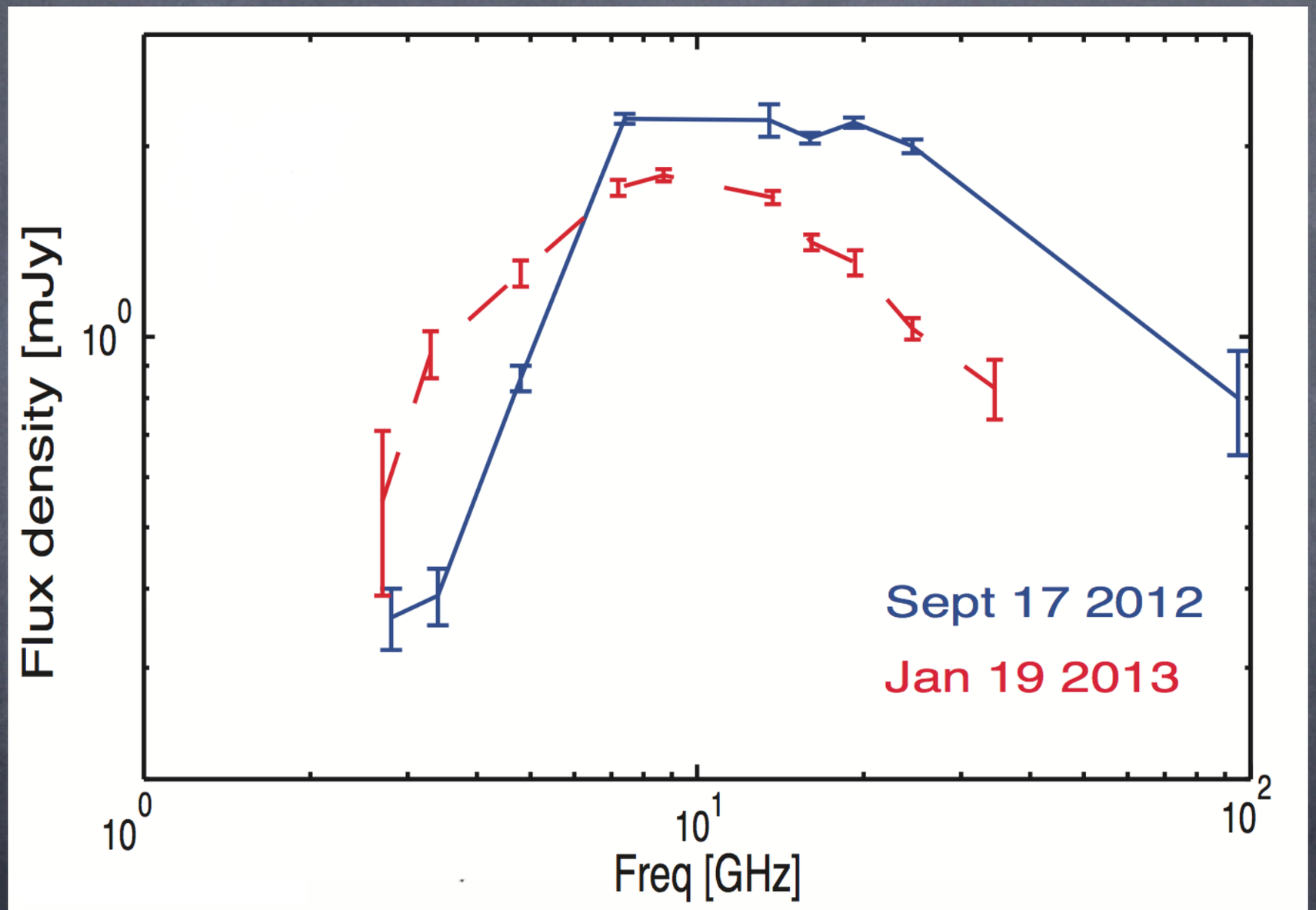
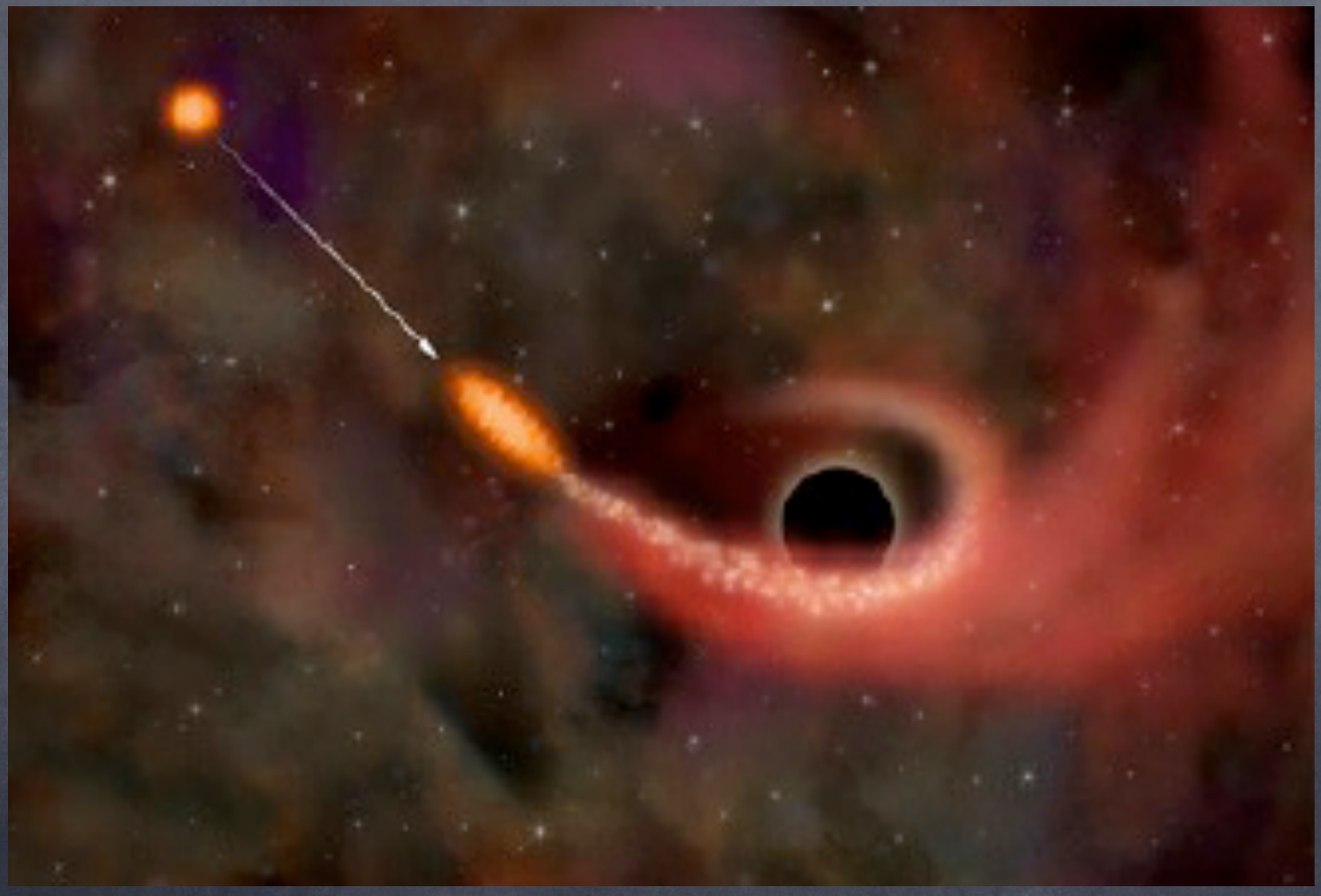


A Tidal Disruption Event?



Thank You