An X-ray Transient Goes Bump in the Night

CDF-S
2000-2009
4Ms

Obs16454
Oct 1, 2014
47ks

Obs16176
Oct 3, 2014
24ks

Franz Bauer
(Pontificia Universidad Católica, MAS)

Ezequiel Treister (UdeC), Kevin Schawinski (ETH), Steve Schulze (PUC/MAS), Bin Luo (PSU), Niel Brandt (PSU), Francisco Forster (CMM), Kei'ichi Maeda (Kyoto), Ken'ichi Nomoto (IPMU), Alex Tolstov (IPMU), Nozomu Tominaga (Konan), Alex Kann (Tutenburg)
High Energy Properties

- Detected 2014 October 01 07:04:37 UT
- 110 counts in 0.5-8 keV band in ~1ks
- Event fell outside of both Swift/BAT and Fermi FOVs (not sampled above >10 keV).
- Not detected by GRB Network/MAXI.

\[ \Gamma = 1.40 \pm 0.3 \text{ (90\% conf.) power law} \]

\[ kT = 12 \text{ thermal (unconstrained)} \]

\[ N_H \Rightarrow \text{Galactic (3e20 cm}^{-2}) \]
Faint/off-axis GRB? Shock Breakout from CCSNe?!?!?!
Potential Host?

X-ray position should be good to ~0.5"

(10^{45} \text{ erg/s})

<table>
<thead>
<tr>
<th>Redshift</th>
<th>L_{2-10\text{keV}}</th>
<th>M_{R,\text{Host}}</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.30</td>
<td>0.3</td>
<td>-12.5</td>
</tr>
<tr>
<td>0.50</td>
<td>1.1</td>
<td>-14.5</td>
</tr>
<tr>
<td>1.00</td>
<td>6.0</td>
<td>-16.5</td>
</tr>
<tr>
<td>2.00</td>
<td>32.9</td>
<td>-17.5</td>
</tr>
<tr>
<td>5.00</td>
<td>297.0</td>
<td>-20.5</td>
</tr>
<tr>
<td>8.00</td>
<td>884.0</td>
<td>-21.5</td>
</tr>
</tbody>
</table>

<= 4.5 kpc / 1"

<= 8.0 kpc / 1"

<= 6.3 kpc / 1"

R~27.4 (0.5"
0.8” offset
zph (90% conf) = 1.4-3.3

R~27.5 (0.6"
0.4” offset
zph (90% conf) = 0.2-3.1
### Optical Imaging

<table>
<thead>
<tr>
<th>Date</th>
<th>Reference</th>
<th>Camera</th>
<th>Image Type</th>
<th>Exposure Time</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct 01, 2014</td>
<td>reference</td>
<td>CANDELS</td>
<td>F814W</td>
<td>R&lt;~25.5</td>
<td>(80 min)</td>
</tr>
<tr>
<td>Oct 19, 2014</td>
<td></td>
<td>VIMOS</td>
<td>R</td>
<td>R&lt;~26.5</td>
<td>(18 day)</td>
</tr>
<tr>
<td>Oct 29, 2014</td>
<td></td>
<td>FORS2</td>
<td>Rspecial</td>
<td>R&lt;~26.0</td>
<td>(28 day)</td>
</tr>
<tr>
<td>Jan 22, 2015</td>
<td></td>
<td>GMOS</td>
<td>Rspecial</td>
<td>J&lt;~27.5</td>
<td>(113 day)</td>
</tr>
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</table>

**X-ray position should be good to ~0.5”**

Nothing obvious, still need to finalize difference imaging for better constraints.
Optical Imaging

Nothing obvious, still need to finalize difference imaging for better constraints.
Optical Transient Constraints

Corrected $R$-band magnitude vs. $\log t_{\text{observed}}$ [days]

CDF-S
SN 1987A
SN 1999br
SN 1999em
Ni-poor SN

$E (10^{48} \text{ erg})$

<table>
<thead>
<tr>
<th>Redshift</th>
<th>$M_{R, E1}$</th>
<th>$M_{R, E2}$</th>
<th>$M_{R, E3}$</th>
<th>$M_{R, E4}$</th>
</tr>
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<tr>
<td>0.30</td>
<td>-14.5</td>
<td>-13.5</td>
<td>-14.0</td>
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<tr>
<td>0.50</td>
<td>-16.5</td>
<td>-15.5</td>
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<td>-14.5</td>
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<td>-18.5</td>
<td>-17.5</td>
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<tr>
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<td>-22.5</td>
<td>-21.5</td>
<td>-22.0</td>
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Radio observations point to a faint afterglow but some GRBs had even deeper limits.

- consistent with optical and X-rays, but radio limits nowhere near as deep.
Some Conclusions....

★ Tidal Disruption? X-rays “hard”, no optical or radio?

★ 100x fainter than Swift GRBs => Off-axis / faint long duration GRB?

=> Early optical constraint probably rules out normal afterglow (at z>5-6?). HST F110W constraint may rule out hi-z afterglows too?

★ Short duration GRB?

★ SBO from CCSNE?

=> Optical constraints seem to rule out all known SNe LCs to z ~ 0.5, and most even to z ~ 1-2 (+ energetics get difficult here as well?). Full fallback?

★ M dwarf flare? typically have $M_R \sim 8-14$

=> beyond 5-79 kpc (halo?) but $L_X \sim (3.4-850) \times 10^{35} \text{ erg/s} (>10^{35-5} \times \text{typical?})$

★ XRB flare? But what companion? would push outside MW?

★ Something else?
Prospects for More…Prospects for Gemini…

- Crude estimates of space densities suggest these transients could be ~10-1000x more common than currently detectable GRBs.
- Future wide-field X-ray surveys could potentially find MANY.
- Extremely fortunate “luck” for VIMOS constraint 80min after.
- Unfortunate “luck” to wait 14-20 days to get next non-detection confirmations.
- Multi-band opt/NIR constraints would have been quite helpful.
  - Gemini Fast ToO well suited to constrain these.
  - Sensitive Multiband Imager or IFU (e.g., OCTOCAM) would provide much stronger constraints.