5th Gaia Science Alerts workshop 2014

Hunting for GRB afterglows with Gaia

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Outline

1. Introduction: GRBs
2. Gaia and GRBs
3. Orphans
4. Conclusions
**Cosmic explosions**

- Bright, unpredictable and extremely energetic explosions: $\sim 10^{45}$ J in 0.01 to 1000 s
- Occurring at a rate of $\sim 1$ per day
- Of cosmological origin: $z \lesssim 10$
- Followed by an *afterglow* emission (from X-rays to radio)
- We (still!) live in the *Swift* era

NASA
Light curve - path to enlightenment

Light curve diversity

Kann et al. 2011
What does late-time afterglow offers?

- Spectral features
- Jet breaks
- GRB supernovae
- Host galaxies

GRB 110219A at $z = 4.9$ (Thöne et al. 2013)

Xu et al. 2013

Gorosabel et al. 2006
Why Gaia?

- All-sky surveys becoming more and more important for transient detections
- Recent detection of the first afterglow not preceded by a GRB detection (iPTF; Cenko et al. 2014)
- Long-term mission is appealing
- Can provide important contribution to the field
Detectability

- Simulation predicts \( \sim \) few afterglows per year (Japelj & Gomboc 2011).
Identification: step I

- Automatic classification: GS-TEC (Blagorodnova et al. 2014)
- Light curve: typical values, change over $\sim 2, 4$ (etc.) hours, colours
- RP/BP: non-thermal spectrum, high redshift $\rightarrow$ Ly$\alpha$ dropout

GRB 090926A ($z = 2.107$): Japelj J.
Identification: step II

- Classification $\neq$ identification
- Follow-up observations necessary!

Photometric $\rightarrow$ to establish decay

Spectroscopic $\rightarrow$ to confirm non-thermal and cosmological nature

However...
Regular (on-axis) vs. orphan afterglows

Granot et al. 2005

Japelj & Gomboc 2011

Orphan afterglows have not been conclusively detected yet!
Orphans

- Simulation - assuming simple adiabatic jet without sideways expansion (Zou et al. 2007) - predicts \( \sim 10 \) detections per year
- More challenging for classification - photometry?
- Less challenging for follow-up observations

Japelj & Gomboc 2011
Conclusions

- We expect $\approx 10$ detections per year, including both regular and orphan afterglows.
- The most important step is the rapid classification - work in progress.
- *Gaia* offers nice scientific opportunities in the GRB field.