

To the dichotomy of short gamma-ray bursts



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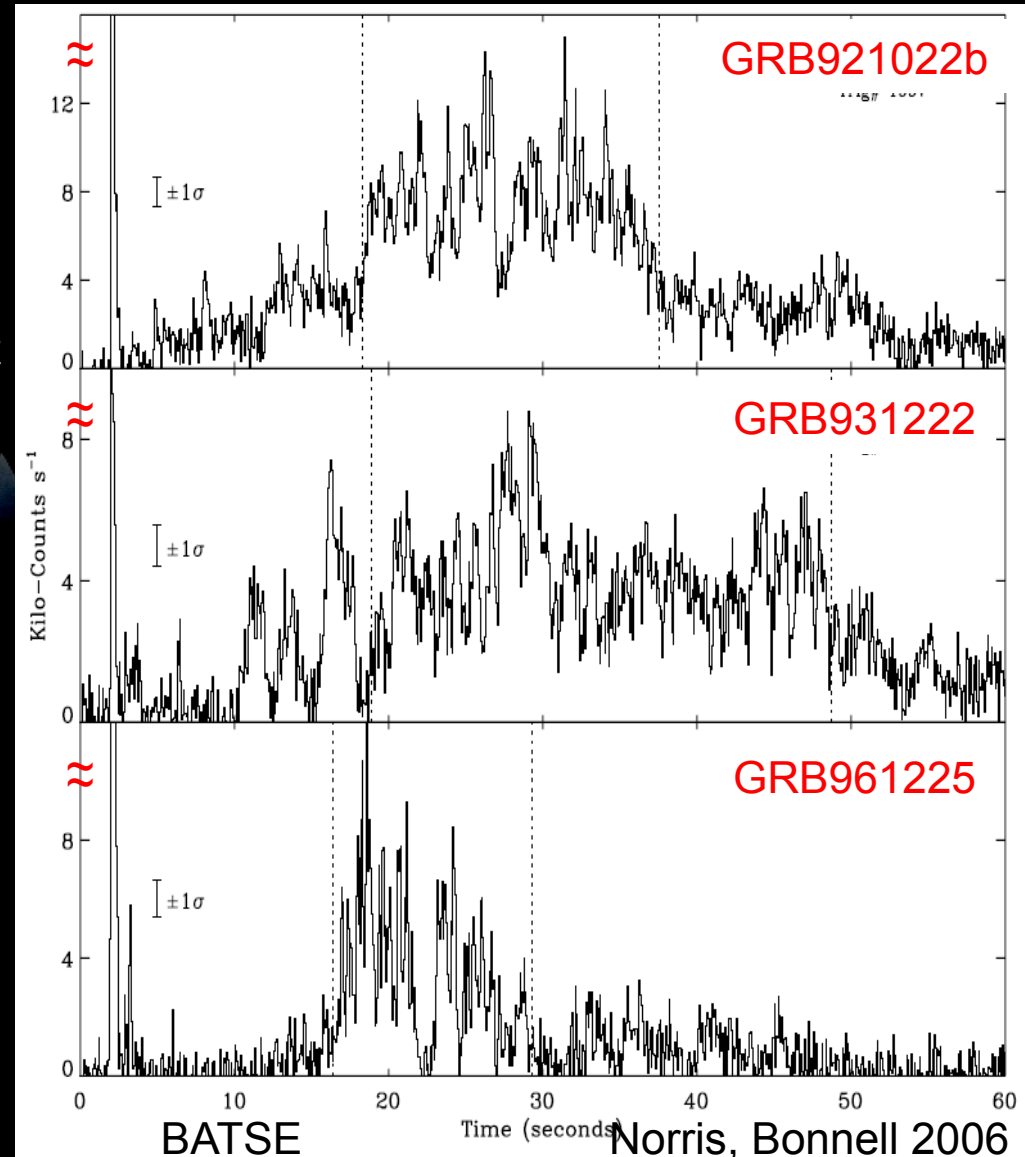
Extended emission of single events

Discovered in light curves of single events:

- - Konus – 10% (Mazets et al, 2002)
- - BATSE, Swift, HETE-2 - (Norris, Bonnell, 2006)
- - SPI-ACS/INTEGRAL – 4% (Minaev et al., 2010)
- - BATSE – 7% (Bostanci et al., 2012)
- - Swift – 25% (Norris et al., 2010)

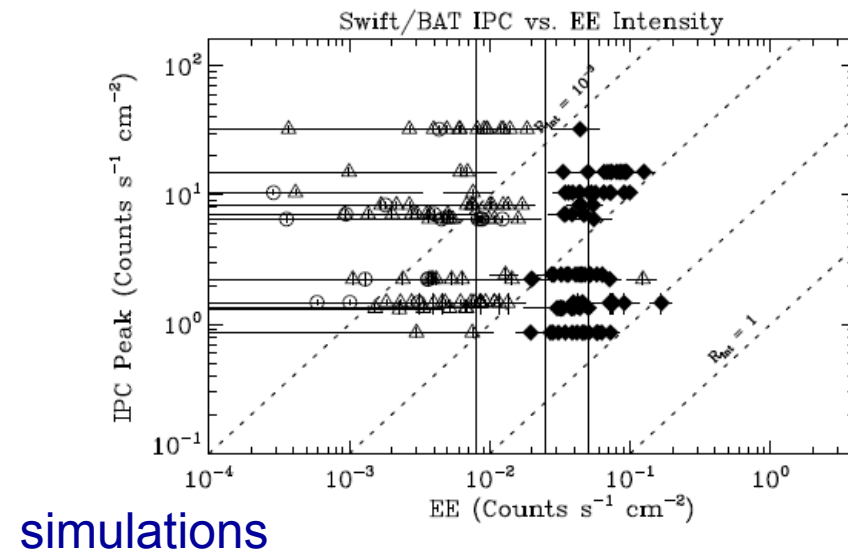
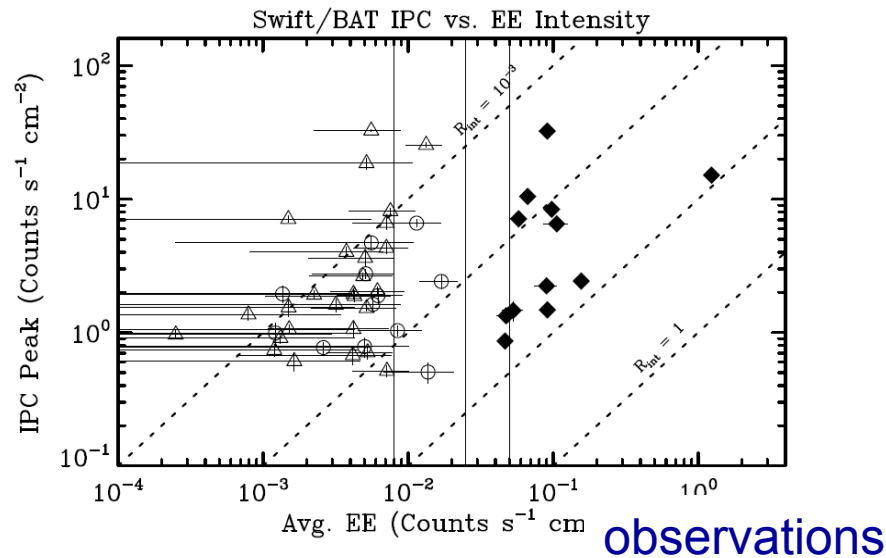
Features of short GRBs with EE:

- - total duration ~ 100 sec
- - high variability
- - zero spectral lag of IPC and EE
- - spectrum of EE is softer
- - no association with SN



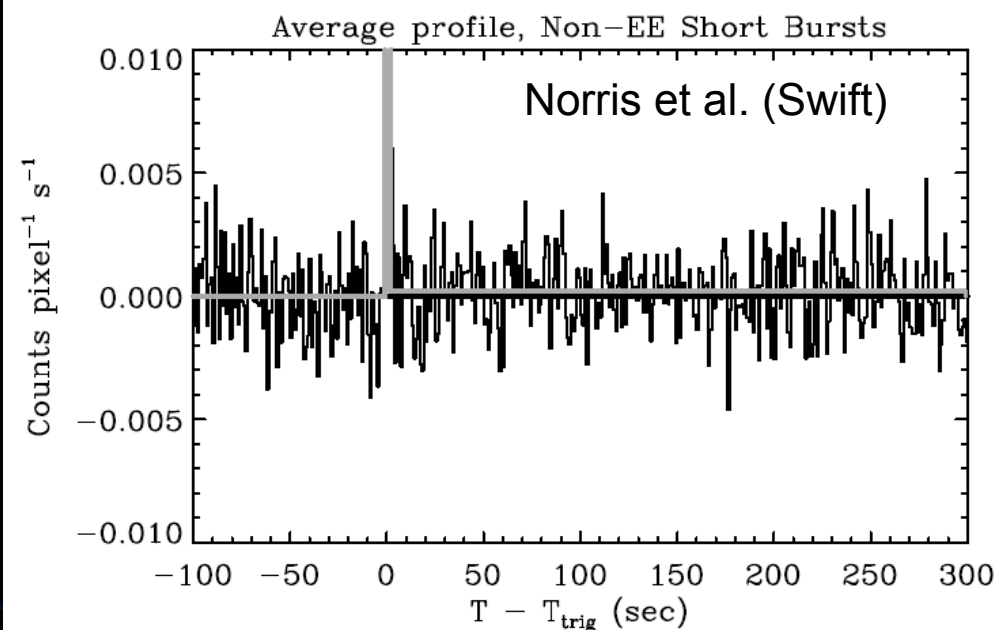
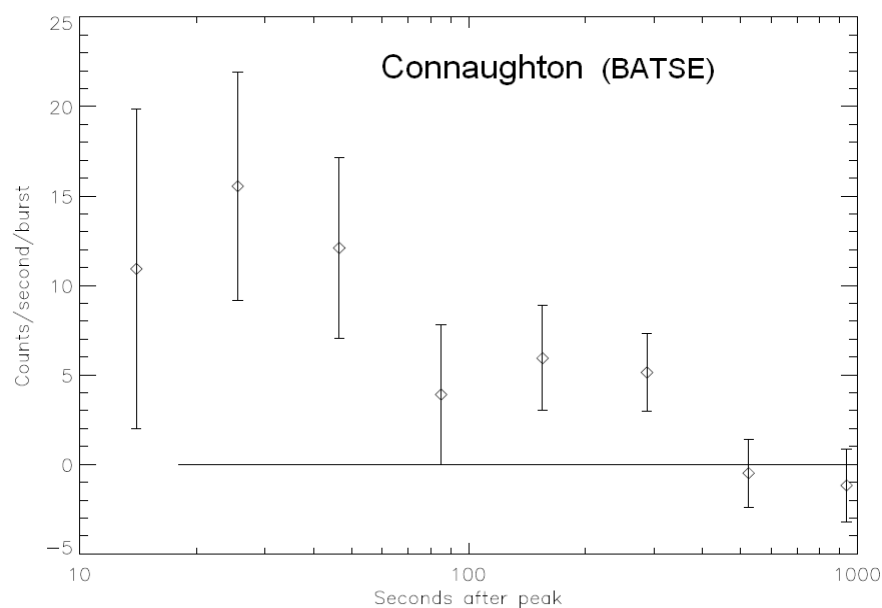
Dichotomy problem

- Paper Norris, et al. 2010.
- 53 short Swift GRBs were investigated
- EE was found in light curves of 25% events
- Light curve simulations showed that Swift could detect EE in a half of cases



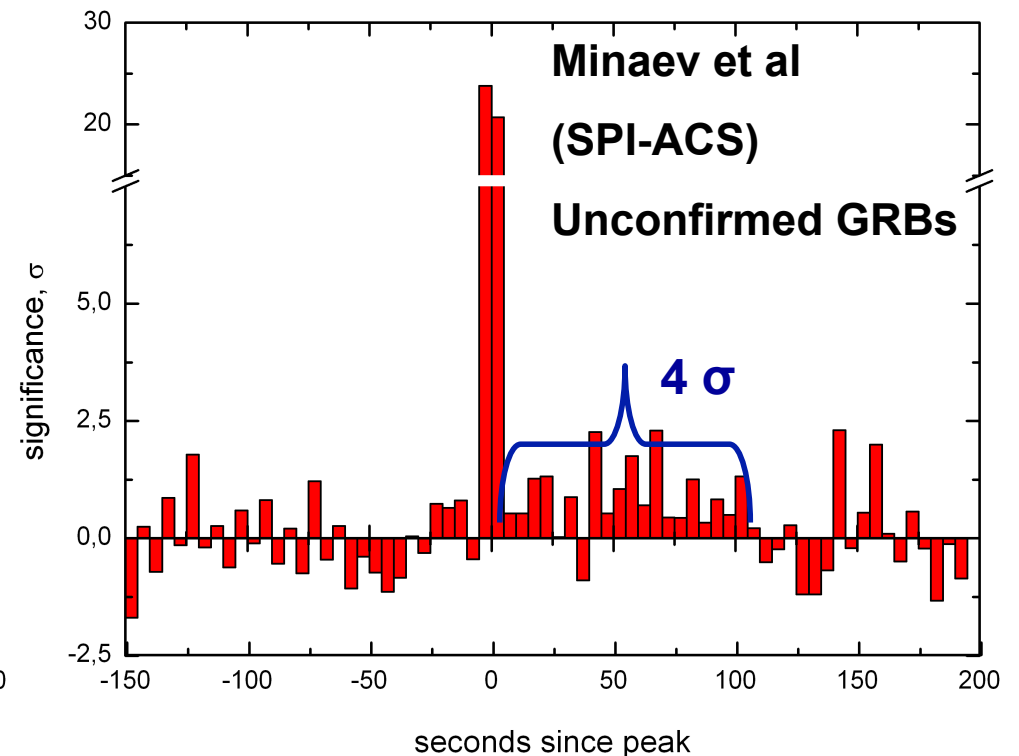
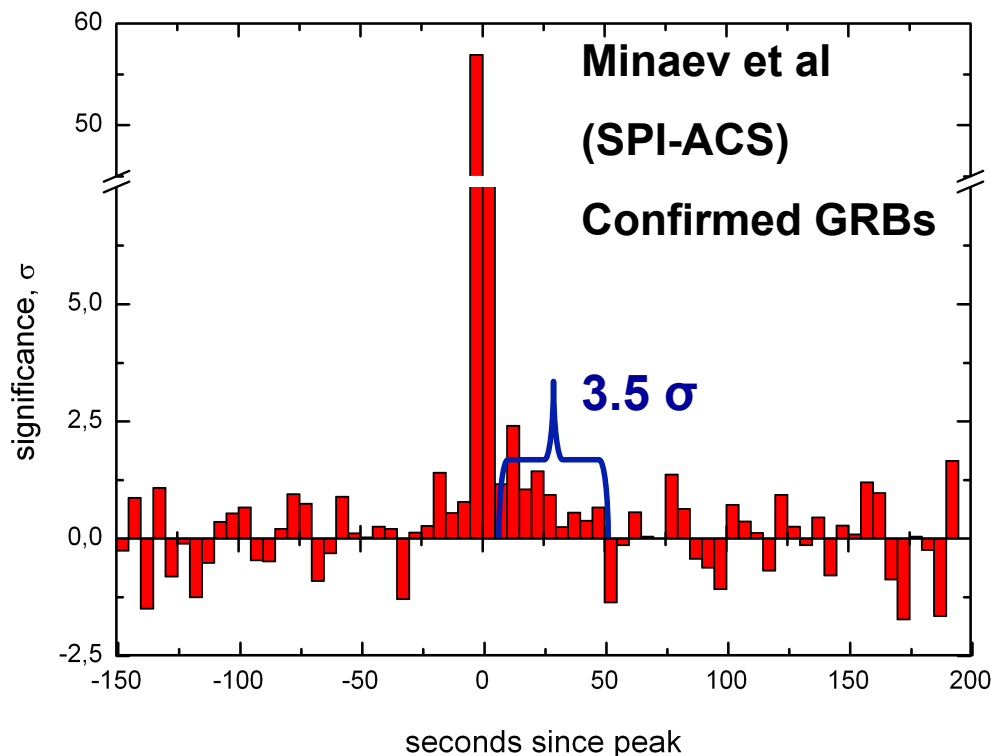
Extended emission of averaged light curves

Experiment	Energy range (keV)	N	Duration of emission
BATSE (Connaughton, 2001)	50-300	100	Up to 100 sec
BATSE (Lazzati et al., 2001)	25-110	76	Up to 30 sec
BeppoSAX (Montanari et al., 2005)	40-700	93	Up to 100 sec
Konus (Frederiks et al., 2004)	10-750	76	Up to 100 sec
SPI-ACS (Minaev et al., 2013)	> 80	204	Up to 35 sec



Extended emission of averaged light curves

- EE was found in SPI-ACS experiment in energy range > 80 keV.
- 204 confirmed short GRBs from paper [Savchenko et al., 2012](#) were analyzed.
- 106 unconfirmed short GRBs were also analyzed.

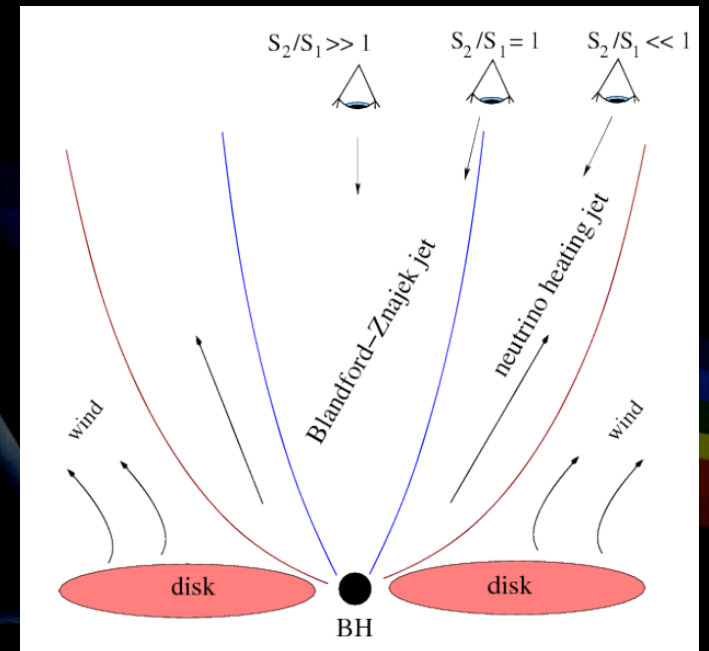


Theoretical models of Extended Emission

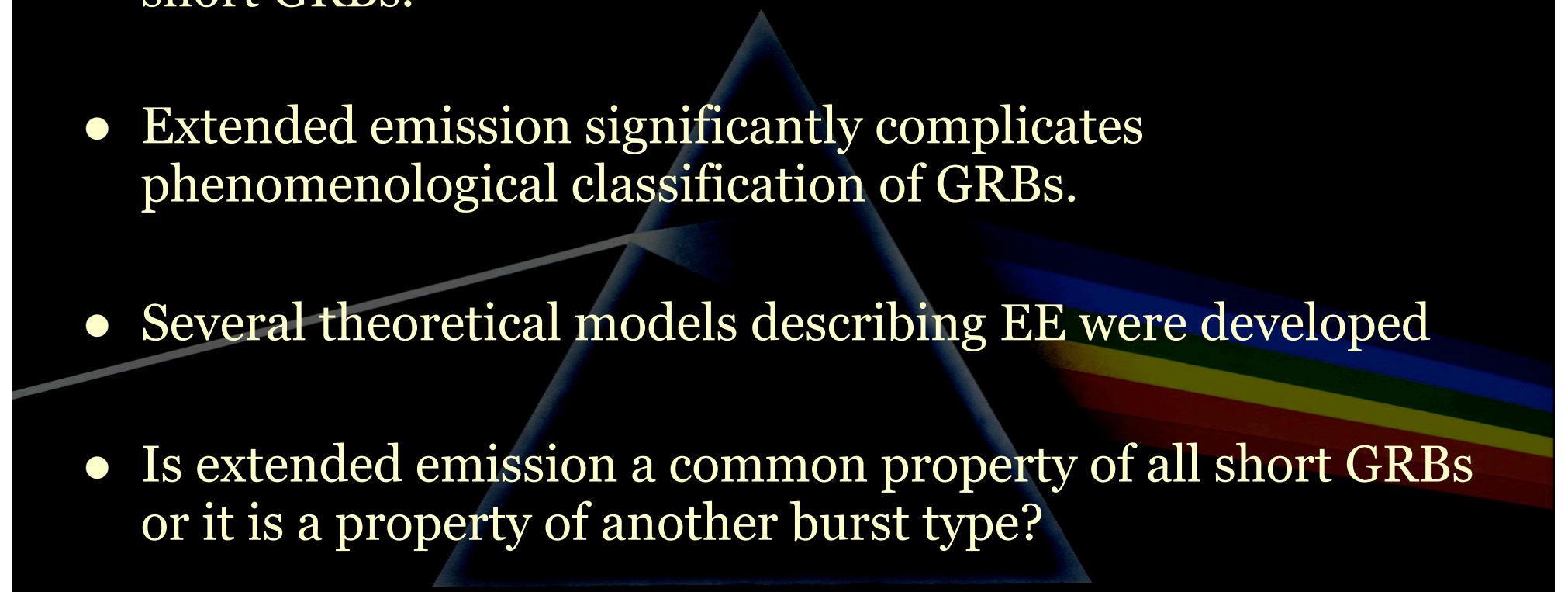
- Metzger et al., 2008:
- Magnetar is formed after NS-NS or NS-WD merging. It's relativistic outflow generates Extended Emission.
- Confirms dichotomy.

- Lazzati et al., 2010:
- Short GRBs with EE are the long GRBs observing at large angles to jet axis.
- Confirms dichotomy.

- Barkov and Pozanenko, 2011 (the next talk):
- Two-jet model.
- IPC – wide-angle neutrino heating jet.
- EE - Blandford-Znajek jet.
- Does not confirm dichotomy.



Conclusions

- Extended emission was found in light curves of single short GRBs
 - Extended emission was found in averaged light curve of all short GRBs.
 - Extended emission significantly complicates phenomenological classification of GRBs.
 - Several theoretical models describing EE were developed
 - Is extended emission a common property of all short GRBs or it is a property of another burst type?
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**Thank you
for your attention!**

