GECAM 磁星观测展望

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- 磁星及其观测特点
- GECAM 磁星观测展望
- GECAM 地球掩食成像特点



Magnetar,磁星(超磁星): 极强磁场的脉冲星

Soft-Gamma Repeaters (SGRs)& **Anomalous X-ray Pulsars (AXPs)**

•
$$L_X \sim 10^{33} - 10^{35} \text{erg/s} > L_{rot}$$

•
$$P = 2 \sim 12 \text{ s}, \dot{P} = 10^{-10} \sim 10^{-13} \text{ s} \cdot \text{s}^{-1}$$

• $B_{surf} \sim 10^{14} - 10^{15} \text{ G}$



~30 已知磁星 • 主要分布在银盘上,大小 麦哲伦云各一个



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Peak Luminosity



Giant Flare:

 邻近星系磁星的GF → SGRB
GRB 200415A @
The Sculptor Galaxy
(3.5 Mpc)

 若GECAM爆发探测灵 敏度 2×10⁻⁸cgs,则 GF(peak)理论可见距 离~300 Mpc





Yang et al. 2020

4



Peak Luminosity



Intermediate Flares

Burst forest from SGR 1900+14 on 2006-3-29 observed with Swift/BAT in 15-100 keV





Peak Luminosity



Short Burst

- The most common events but unpredictable
- From both SGRs and AXPs





不同磁星在活跃期的爆发数量和持续辐射的变 化不尽相同

- **Prolific bursters** Magnetars with GFs
- Prolific transients SGR J1550-5418, SGR J1935+2154 ...
- AXPs with SGR-like bursts
- Transients SGRs with low burst rates (Gogus et al. 2014)



Coti Zelati et al. 2018

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- SGR J1550-5418
 - 3 active episodes in 2008-2009
 - Burst forest on Jan. 22, 2009
- SGR J1935+2154
 - 6 active episodes in 2014-2020
 - Burst forest on Apr. 27, 2020"
- ✓ hundreds of bursts in <u>several</u> <u>minutes</u> [can be missed by GBM but won't by GECAM]
- ✓ Enhanced hard X-ray persistent emission in GBM



✓爆发性质有演化

Burst forest 爆发宽能段能谱一般为BB+BB

- SGR J1550-5418
 - 2008年活跃期爆发能谱仅需单一BB成分 (von Kienlin et al. 2012)
 - 2009年爆发则需要双BB成分 (Israel et al. 2008, van der Horst et al. 2009, Lin et al. 2012)
- SGR J1935+2154
 - •2014-2016的爆发能谱比2019-2020的爆发能谱硬



✓基于STEMS模型,表面磁场可能 发生变化

(Ng et al. 2010, Gogus et al. 2020 submitted)

✓X-ray脉冲轮廓发生变化

- 可能出现新的辐射较强的相位
- 脉冲辐射比例降低

 $B_{surf} > B_{dip}$

(Ng et al. 2010, Younes et al. 2020 submitted, Gogus et al. 2020 submitted)



- ✓ Burst forest 之后有(FRB-like) 明亮的射电脉冲辐射
- ? A radio pulse from SGR J1550-5418 is possible associate with an X-ray burst

20

15

0.8135

Time (d-1486510)

0.81375

- 2019-02-03, ~5 days after the peak of the burst forest
- The radio pulse highly saturated the Parkes. $\frac{1}{2}$
- The X-ray burst detected with XMM-Newton $\frac{3}{0}$ 10 is also piled-up.
- The 6 GHz radio flux >1Jy, pulse width ~200 ms 5

(Burgay et al. 2018)

✓ Burst forest 之后有(FRB-like) 明亮的射电脉冲辐射
• SGR J1935+2154 爆发 – FRB 200428
Fermi/GBM : NO
KW , INTEGRAL , HXMT : YES





Li et al. 2020

Younes et al. 2020a

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12

Time (UTC)	Events	Telescope
April 10 & 22	2 bright bursts	Konus-Wind, Fermi/GBM, CALET/GRBM
April 27 18:26:20 [T0]	Many bursts + burst forests (~300 s)	Swift/BAT, Fermi/GBM,
April 27 23:55:00 [~T0+5 hr]	FAST started a series monitoring observation	
April 28 07:14:50 [~T0+13 hr]	Insight/HXMT started 60 ks pointing observation	
April 28 14:34:24	FRB 200428	CHIME/FRB and STARE2
	Hard X-ray burst	Insight/HXMT, Konus-Wind, INTEGRAL
April 30 06:58:25 – May 31	the long ToO observation of Insight/HXMT [GBM and HXMT together cover ~80% of time]	
April 30	A weak radio pulse	FAST

GECAM will provide 100% coverage all the time!

Transients SGRs with low burst rates

- •一两个较弱的爆发+明亮的持续较长的outburst
- •基本都是由Swift/BAT发现的,GBM定位精度不够
- 低磁场磁星、银河系中心磁星等

√GECAM

- 全天覆盖捕捉爆发
- 定位精度较GBM明显提升
- 与交宽视场X射线望远镜可以 发现认证更多磁星



GECAM磁星观测的展望

▶ 全天全时,可定位

✓捕捉磁星爆发,了解完整的活跃期爆发性质✓发现更多新磁星

✓探测磁星活跃期高能持续辐射增亮现象✓捕捉快速射电暴的高能对应体