Observations of Soft Gamma-ray Repeaters with Konus experiments

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Outline

- Konus Gamma-Ray Burst experiments and SGR observations: historical review
- Second Konus SGR Catalog (1994-2009)
Konus GRB Experiments (1978-2011)

- Konus (Venera 11, 12)
- Konus (Venera 13, 14)
- Konus-WIND
- Konus-A (Cosmos 2326)
- Konus-A2 (Cosmos 2367)
- Helicon (CORONAS-F)
- Konus-A3 (Cosmos 2421)
- Konus-RF (CORONAS-Photon)
Venera Missions (1978-1983)

- **Konus (Venera 11,12, Venera 13-14)**
  6 NaI detectors onboard a pair of distant s/c (separation up to $60 \times 10^6$ km)

- **Giant Periodic Flare** on March 5, 1979 (Mazets et al. 1979) followed by 16 short burst from the same source in the next few years (Golenetskii, Il'inskii & Mazets 1984)
  
  **FXP 0526-66**
  (N49, LMC, 55 kpc; Cline et al., 1982)

- **B1900+14** (3 bursts in March 1979)

- First two sources of short recurrent bursts with soft spectra were discovered and localized, a distinct class of sources different from other GRBs suggested (Golenetskii, Il'inskii & Mazets 1984)

- **SGR 1806-20** (Prognoz 9, ICE, SMM) Atteia et al. 1987, Laros et al. 1987, Kouveliotou et al. 1987
  
  Jan 7, 1979
Konus-WIND GRB experiment

- NASA GGS-WIND s/c (November 1994 - now)
- Two NaI(Tl) 130 x 75 mm (5 x 3 in.) scintillation detectors
- Al housing, Be entrance window
  Lead glass shielding
- S ~ 100-160 cm² (100 keV), 80-100 cm² (10 MeV)
- Detection range:
  10 keV - 10 MeV (1994)
  20 keV - 17 MeV (2011)
- Detection threshold:
  $10^7 - 10^6$ erg cm⁻²
GGS-WIND orbit

- Far outside the Earth’s magnetosphere:
  1-1.5 \times 10^6 \text{ km},
  up to 6 lt. seconds away

- No Earth occultation,
  no SAA passes,
  stable background

- >6000 days of uninterrupted observations since November, 1994

- > 2000 GRB triggers

- > 250 SGR triggers

- > 769 Solar triggers
Konus-WIND – SGR 1900+14

- **1998-1999 reactivation**
  40 typical short bursts + GF

- **980530 burst “series”**
  (cluster): multiple closely packed and partially overlapped bursts
  \[ T > 250 \text{ s} \]
  \[ S > 5 \times 10^5 \text{ erg cm}^2 \]
  \( (20-200 \text{ keV}) \)

- Three months before GF
**Konus-WIND – SGR 1900+14 GF**

- **Giant Flare**
  - Aug 27, 1998
  - \(\sim 20\) yrs after March 5 event
- \(L_{\text{max}} > 2\times10^{46}\) erg s\(^{-1}\)
- \(Q_{\text{tail}} \sim 1.2\times10^{44}\) erg

(Mazets et al. 1999)
Konus-WIND – SGR 1627-41

- Discovered by CGRO and precisely localized by IPN in **1998**
  
  \( CGRO, \) Ulysses, Wind; 
  

- **Konus-Wind**: 13 short bursts 
  
  (Mazets et al., 1999)

- Spectral evolution

- **June 18, 1998 event**
  
  \( F_{\text{max}} = 3 \times 10^{-2} \text{ erg cm}^{-2} \text{ s}^{-1} \)
  
  \( S = 8 \times 10^{4} \text{ erg cm}^{-2} \)
  
  \( kT_{\text{OTTB}} \sim 100 \text{ keV} \)

  \( Q \sim 1 \times 10^{43} \text{ erg} \) (10 kpc)

  close to GF
Konus-WIND – SGR 1806-20

- **1996 – 2008** (126 short bursts)
- 2004 reactivation (>70 bursts)
- Several burst clusters, observed before Dec 27, 2004 (Frederiks et al. 2007)

A Giant Flare was predicted in October 2004 (Golenetskii et al., GCN #2769)
Dec 27, 2004 Giant Flare (3\textsuperscript{rd} in history and most powerful GF yet)
KW triggered on bright short burst (precursor) at $T_0-143$ s ($Q = 3.4\times10^{42}$ erg)
Initial GF pulse: full detector saturation for $\sim500$ ms
Helicon (CORONAS-F) detection of SGR 1806-20
Giant Flare short hard initial pulse, reflected from
the Moon
(Frederiks et al., 2007)
Reconstruction of the SGR 1806-20 Giant Flare initial pulse from Konus-Wind and Helicon data

(Frederiks et al., 2007)

\[ Q = 2.3 \times 10^{46} \text{ erg} ; \quad L_{\text{max}} = 4 \times 10^{47} \text{ erg s}^{-1} (15 \text{ kpc}) \]
Konus-WIND – SGR 1806-20 GF tail

- $P = 7.56\ s$
- OTTB ($kT \approx 30\ kev$) + PL ($1.8 \pm 0.2$)
- $Q_{tail} = 2.1 \times 10^{44}$ (15 kpc)
"New" SGRs in Konus Experiments (2008-2009)

**SGR 0501+4516**
- 5 short KW bursts in Aug 2008
  (Aptekar et al., 2009)

**AXP 1E1547-5408**
- 21 bright short KW bursts in
  Jan-Mar 2009
  $S \sim 2.6 \times 10^{-4}$, $kT_{\text{OTTB}} \sim 70$ keV,
  resembles SGR 1627-41

**SGR 0418+5729** (2009, *Femi-GBM, Konus-RF, Swift-BAT*)
Konus Catalog of SGR activity (1978-2000)


- Konus (Venera 11, 12, 13, 14), Konus-Wind, Konus-A
- 165 short bursts (~ 120 in the triggered mode) + 2 GFs
- Sources: SGR 0526-66, SGR 1806-20, SGR 1900+14, SGR 1627-41, and SGR 1801-23 (unconfirmed SGR)

http://www.ioffe.ru/LEA/SGR/Catalog/sgr_cat.htm
Konus-Wind happily continues its operation
(~175 SGR triggers since 2000)

Three new Ioffe Institute GRB experiments since 2000:

SGR 1806-20 reactivation (>100 triggers + Giant Flare since 2000),
SGR 1900+14 (~35 short bursts since 2000)
Newly discovered SGR were observed:
SGR 0501+4516, AXP 1E1547-5408, SGR 0418+5729

Re-process data obtained since 1994 with a focus on the triggered events
and standard automated analysis procedures;
Extend a set of presented parameters
Provide online access to the burst data (light curves)
Second Konus SGR Catalog (outline)

- **Instruments and Observations**: timeline, spacecraft & observing conditions, detectors, measurements, SGR-specific constrains

- **Data reduction procedures**: parameter definitions, temporal analysis and spectral fits, special cases

- **Data tables**:
  - general burst parameters (instrument ID, trigger time, Earth-crossing time)
  - peak and integral count rates
  - durations (T100, T90), peak count rate time
  - time-integrated and time-resolved spectral fits (OTTB & CPL models)
  - peak (2 and 16-ms) energy fluxes and total energy fluence

- **Overview** of the results and special cases (hard bursts, “long” bursts, bursts clusters (“storms”))

- **Online Supplements** (tables, plots, light curves)
Second Konus SGR Catalog (example)

Date: 20040622
Time: 70209
T100: 0.716
T90: 0.422 ± 0.058

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<th>Spectra</th>
<th>NG1G2</th>
<th>Fluence</th>
<th>Peak flux 16ms</th>
<th>Peak flux 2ms</th>
<th>OTTB</th>
<th>CPL</th>
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<td>E0</td>
<td>α</td>
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<td>3ch</td>
<td>4305.893</td>
<td>(6.24 ± 0.17)×10^{-6}</td>
<td>(3.78 ± 0.26)×10^{-5}</td>
<td>(4.39 ± 0.82)×10^{-5}</td>
<td>18.8 ± 0.986</td>
<td>18 ± 0.896</td>
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<td>1–4 (0.256)</td>
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<td>(6.3 ± 0.27)×10^{-6}</td>
<td>(3.83 ± 0.43)×10^{-5}</td>
<td></td>
<td>15.1</td>
<td>14.3 ± 3.78</td>
</tr>
</tbody>
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Konus SGRs Summary (1994-2009)

- SGR 1900+14 - 75 bursts (KW+Hel)
- SGR 1806-20 - 150 bursts (KW+Hel+KA3)
- SGR 1627-41 - 14 bursts (KW)
- SGR 0501+4516 - 5 bursts (KW)
- AXP 1E1547-5408 - 21 burst (KW+KRF)
- SGR 1801-23 - 1 burst (KW)
- SGR 0418+5729 - 1 burst (KRF)

267 short SGR bursts
Concluding Remarks

- Second Konus SGR Catalog is expected in 2011
- Konus-Wind operation is confirmed until 2013
- New Konus experiments in preparation
- SGRs are welcome!