Bulge Latitude Survey - status report

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Wang et al. 2002

**goal**: study faint Galactic X-ray point source population ($L_x < 10^{34}$ ergs/s); mainly interested in accreting binaries (CVs, quiescent NS&BH XRBs), also coronal sources

**method**: analyze archival and targeted Chandra/ACIS observations in the plane ($|b| < 12$ deg), follow-up optical and infrared imaging and spectroscopy for source classification

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**ChaMPlane**  
= **Chandra Multiwavelength Plane Survey**

Grindlay et al. 2005

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**distribution of ChaMPlane fields**

- 144 fields  
- Chandra cycles 1-8  
- 15,000 sources  
- 7 deg$^2$

- ACIS-I  
- ACIS-S  

* size $\propto$ exposure time

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**other ChaMPlane presentations:**  
- next talk by Ping Zhao on foreground sources towards Galactic Center  
- Allen Rogel’s Poster #470.01 on CVs in anti-Center fields (Wednesday)
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= *Chandra Multiwavelength Plane Survey*

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focus on Galactic-bulge and Galactic-center region:
• >9000 point sources (e.g. Muno et al. 2008, Hong et al. 2009)
• properties consistent with CVs & quiescent XRBs
• most are heavily absorbed (i.e. in bulge) => difficult to find optical/IR counterparts
Bulge Latitude Survey (BLS)

X-ray:
• 36 Chandra/ACIS-I overlapping pointings, 15ks each, Chandra cycles 7-10
• sensitivity: $L_x \approx 9 \times 10^{31}$ ergs/s for $d=8$ kpc

near-infrared (nIR):
• JHK imaging with NOAO CTIO-4m/ISPI
• search for candidate counterparts and extinction map

2 regions of $0.8 \times 1.4$ deg$^2$, centered on SgrA*, lines up with our deep Chandra/HST survey of low-extinction Windows in the south

started '06, to be completed in summer '09

main goals:
study nature/origin of inner bulge & Galactic-Center region X-ray population by tracing the radial distribution
observe larger area needed to study the distribution of relatively bright sources in the bulge
use IR imaging to find candidate counterparts and make extinction map
BLS X-ray mosaic (33 pointings)

- 2347 unique sources
  - only 13 sources with net counts > 250
  - have to rely on X-ray colors for classification

- based on X-ray colors: 2/3 of bright sources (SNR>3) lie in bulge

- median 95% positional error r95=1.7"
  - based on K-band source density (with SNR>3):
    - expect 0.2-1.2 chance alignments in a typical X-ray error circle

Looking for near-IR counterparts is challenging!
Identification cannot be based on astrometry alone
BLS infrared mosaic

- sensitivity (3-band detection, SNR>3): K≈16.3 limited by crowding
- in BLS region: $4 \leq A_V \leq 20-30$ or $0.4 \leq A_K \leq 2-3$
- sensitive to foreground CVs ($M_K\approx 6$) and HMXBs ($M_K\approx -4$) up to Galactic-Center distances
- goals: source identification & extinction map

crowding & small-scale extinction variations

1 arcmin x 1 arcmin
**X-ray/infrared matching**

- for X-ray sources included in infrared survey
  - 74% with candidate counterparts
  - 51% with multiple candidate counterparts

- soft sources mainly match with foreground sources
- hard sources mainly match with reddened sources

- soft sources: $N_{\text{match}} \approx 2 N_{\text{random}}$ (excess $\approx 16$ sigma)
- hard sources: $N_{\text{match}} \approx N_{\text{random}}$ (excess $\approx 2.3$ sigma)

- red sources SNR(soft) > 3 & SNR(hard) < 3, r95 < 2"
- blue sources SNR(hard) > 3 & SNR(soft) < 3, r95 < 2"

![X-ray/infrared matching diagram](image-url)
Future IR work:

- follow-up IR spectroscopy (can only be done for brightest ones)
- consider variability, e.g. compare with UKIDSS Galactic-Plane Survey
- construct extinction map

Example of likely identification

absorbed X-ray point source aligned with absorbed and bright IR source, embedded in compact HII region (age < few million years)

=> probably young star, e.g. massive OB star or colliding-wind binary