Stars in the eROSITA all-sky survey

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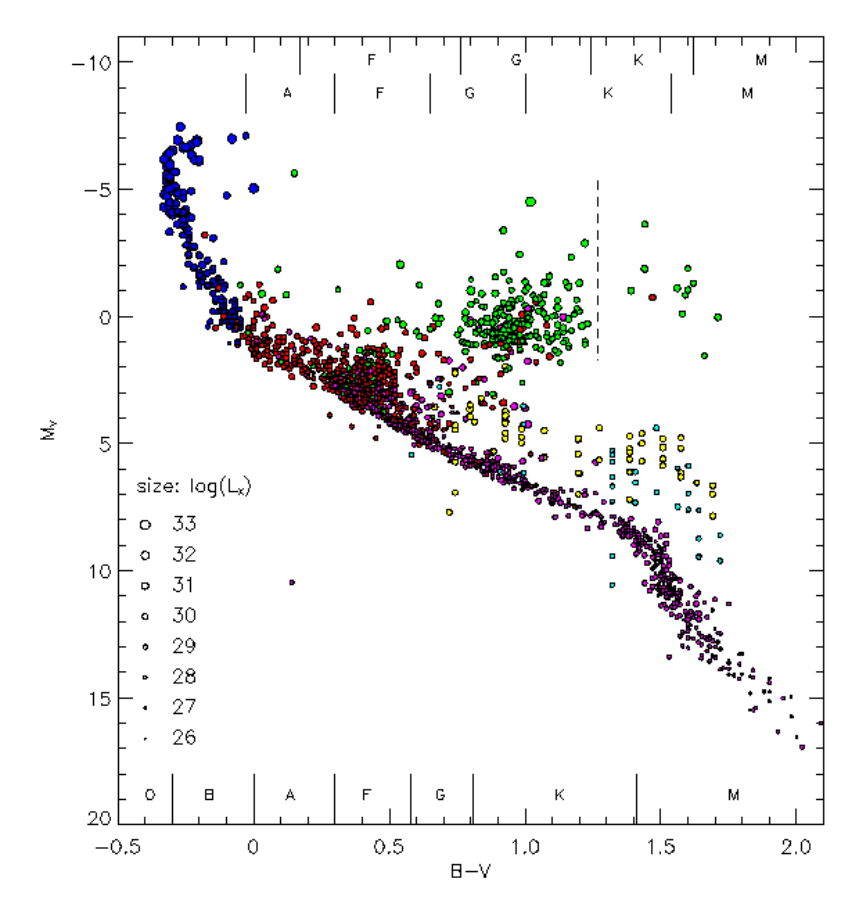
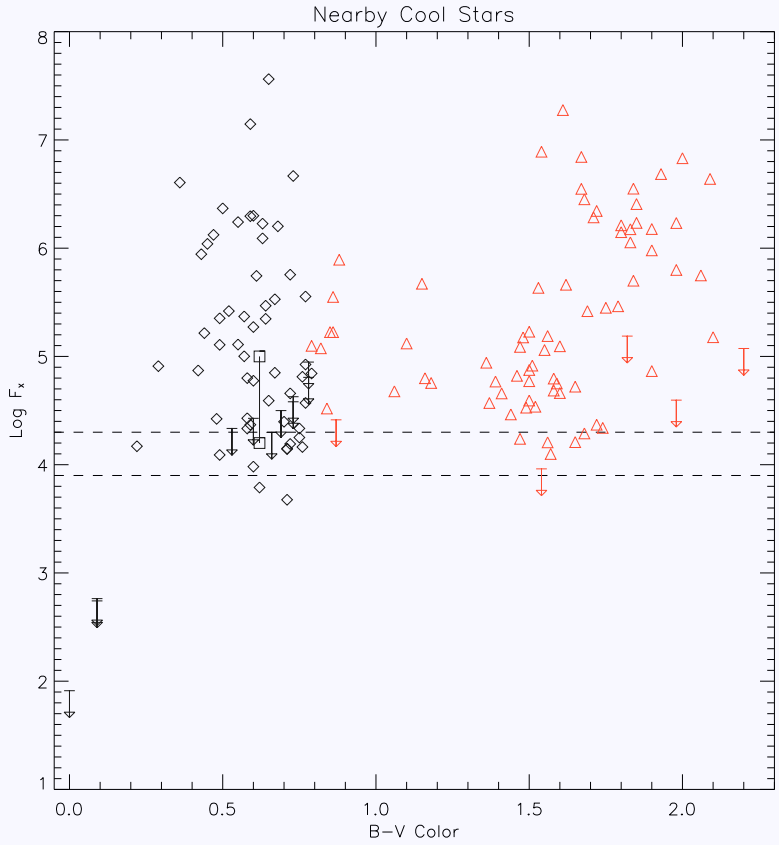
X-rays from stars



'The X-ray HRD' (Güdel 2004)



'The solar neighborhood' (Schmitt 1997)

$\Longrightarrow$ **Nearly all stars are X-ray emitter**

Stellar sources in X-rays

Classical regimes of stellar X-ray emission:

- cool stars (late A to late M-type)
  - X-rays from magnetic activity (coronae)
  - $L_{\rm X} \propto 1/R_{\rm o}^2$ (dynamo efficiency), $\log L_{\rm X}/L_{\rm bol} \approx -3 \ldots -7$
  - includes active binaries (RS CVn, Algol...)
- hot stars (O to early B-type)
  - X-rays from wind shocks
  - $L_{\rm X} \propto L_{\rm bol}$, $\log L_{\rm X}/L_{\rm bol} \approx -7$
  - includes WR stars, colliding wind binaries
- evolved stars (giants); peculiar stars (ApBp); substellar objects (BDs)...
- the young ones (Class 0/I, T Tauri stars, HAeBe stars)
  - X-rays from magnetic activity, accretion-shocks, shocks in winds/jets

eRASS – Stellar sensitivities

eRASS stellar limits: $L_{\mathrm{Xmin}} \approx 1.0 \times 10^{24} \times d^2(\mathrm{pc})$ erg/s

- Stars are bright at soft X-ray energies -

lim. $F_{\mathrm{X}} = 1 \times 10^{-14}$ erg cm^{-2} s^{-1} in the 0.3−2.0 keV band

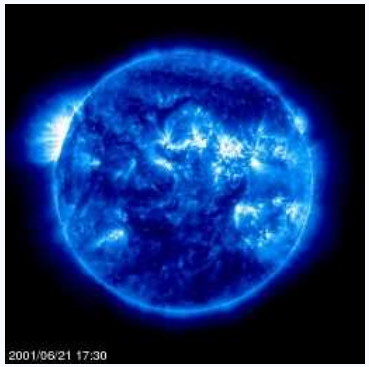
eRASS is $\gtrsim$ 20 times more sensitive than RASS (0.1−2.4 keV)

eRASS : 8 all-sky scans, soft to medium energy X-rays (0.3−8.0 keV)

\+ more accurate positions and higher spectral resolution

eROSITA is less sensitive to very soft sources

optical brightness might be an issue



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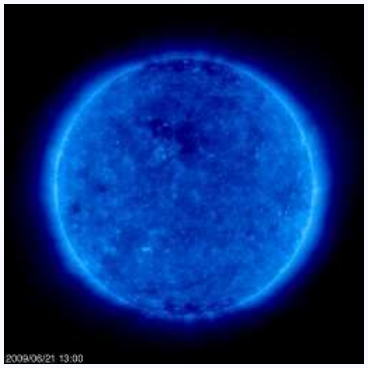

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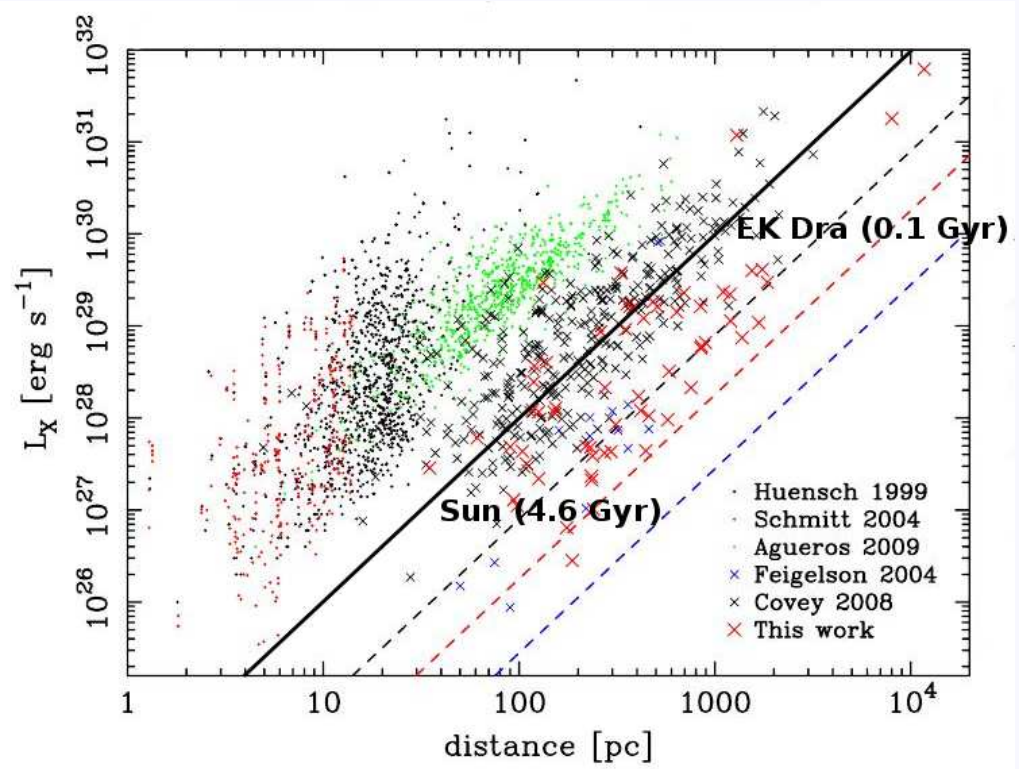
Stellar detection limits - source numbers

Which stars can be seen with eROSITA ... and how many?

- **0.3 – 0.5 million stars in eRASS** (Besancon X count model)
- av. stellar densities: 30 per deg^2 (gal. plane) to 5 per deg^2 (pole)



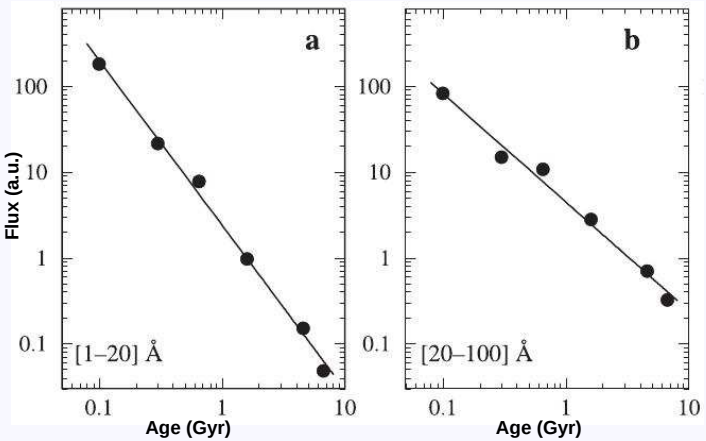
(adapted from Wright et al. 2010)

Very low-mass star (M9)	10 pc
Sun, Altair (A7), Prox Cen (M5)	30 pc
Procyon (F5), Eps Eri (K2)	100 pc
T Tauri star, active M dwarf	300 pc
active young Sun, bright TTS	1 kpc
active binary, B star	3kpc
massive O star	$\gtrsim$ 10 kpc

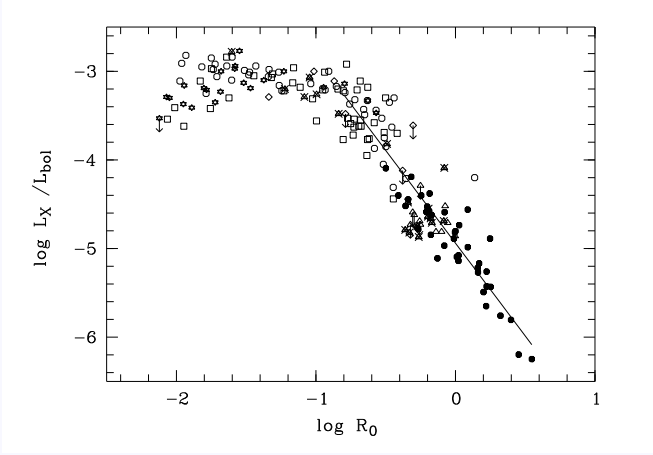
X-ray surveys are most sensitive to young stars!

Stellar X-ray census I

The Solar neighborhood - a volume complete sample



'Sun in Time' (Ribas et al. 2005)



'Activity-Dynamo relation' (Randich et al. 2000)

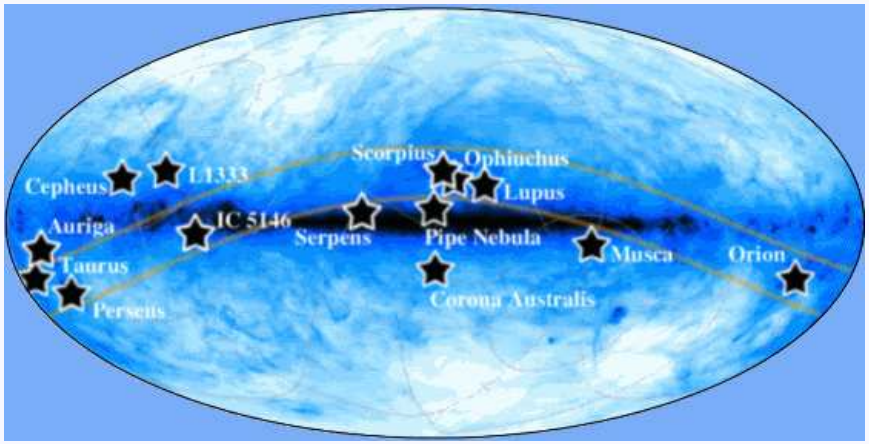
Nearby Stars:

- virtually complete coverage of stellar population ($\sim$ 4000 GJ stars within 25 pc)
- field stars at all activity levels + nearby very low-mass stars

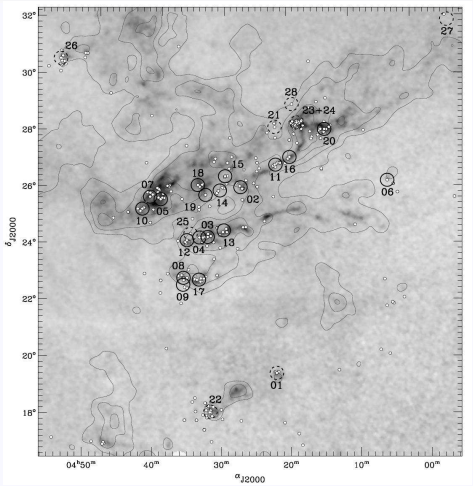
Magnetics structures and their evolution, astrophysical dynamos

- basic coronal properties for large unbiased samples
- magnetic activity vs. age, rotation, mass, eff. temperature
- coronal (super-) saturation and transition effects

Stellar X-ray census II



Gouldbelt - IRAS (100 μm)



Taurus/XEST (Güdel 2006)

Star formation: large regions - ideal for all-sky survey

- star forming regions (age $\lesssim$ 10 Myr)
- associations, moving groups, young open cluster (10 Myr . . . 100 Myr)
- older open cluster, dispersed (100 Myr . . . 1 Gyr)

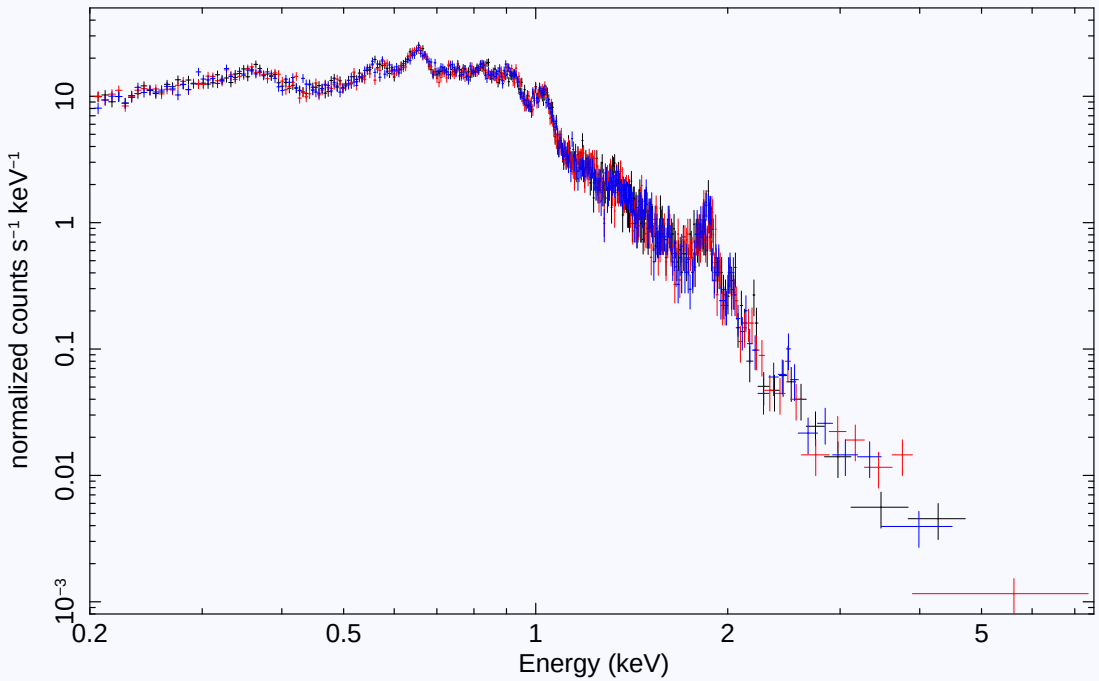
Stellar birth, local star formation history & galactic structure

- extensive coverage of ZAMS, T Tauri and HAeBe stars
- massive SFRs/OB associations, hot O/B stars
- properties of SFRs, star formation modes, influence on intergalactic medium

Spectral studies

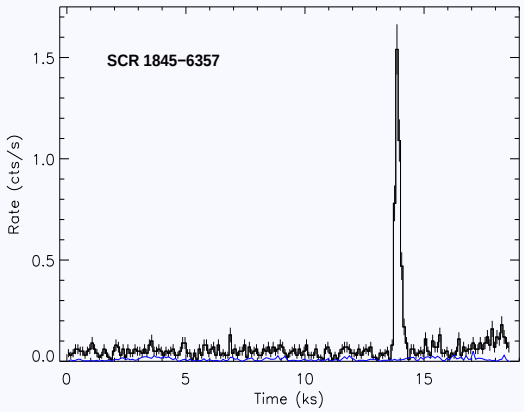
Medium resolution spectra for thousands of stars

- spectral analysis of stellar coronal structures
- time resolved spectroscopy, multiple spectral components
- study of YSOs, massive stars, peculiar objects

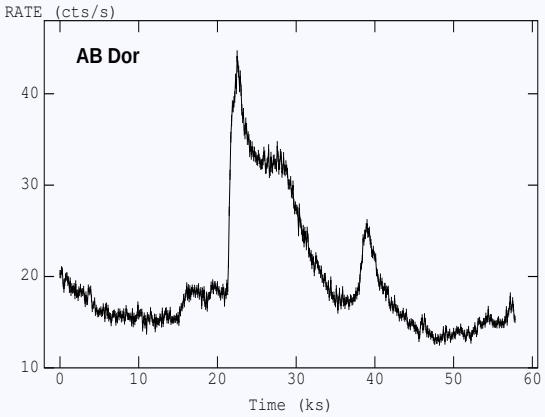


eROSITA spectrum of a nearby active M dwarf (AD Leo, 2.5 ks simulation).

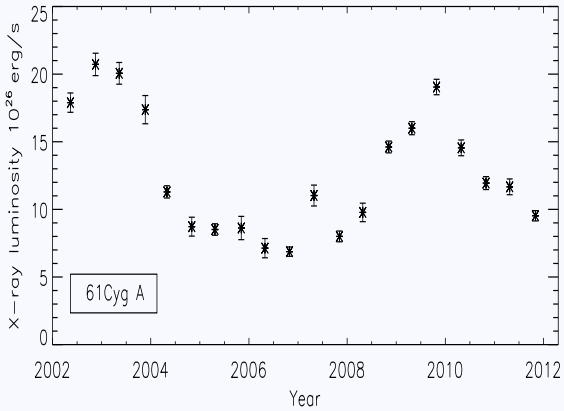
Variability studies



seconds...minutes



hours...days



months...years

(XMM data: Robrade et al., div.)

Stars are X-ray variable on all timescales

- bursts/short flares $\Rightarrow$ PMS + low mass stars, $\log L_{\rm X}/L_{\rm bol} \simeq -1$
- long duration flares, rotational modulation
- activity cycles, long duration trends, accretion outbursts

Summary

eROSITA all-sky survey very promising for stellar science

- several hundred thousand stars with X-ray detection
- spectra and light curves for many thousand sources
- large variety of astrophysical topics to be addressed
- wealth of synergetics with existing/forthcoming surveys