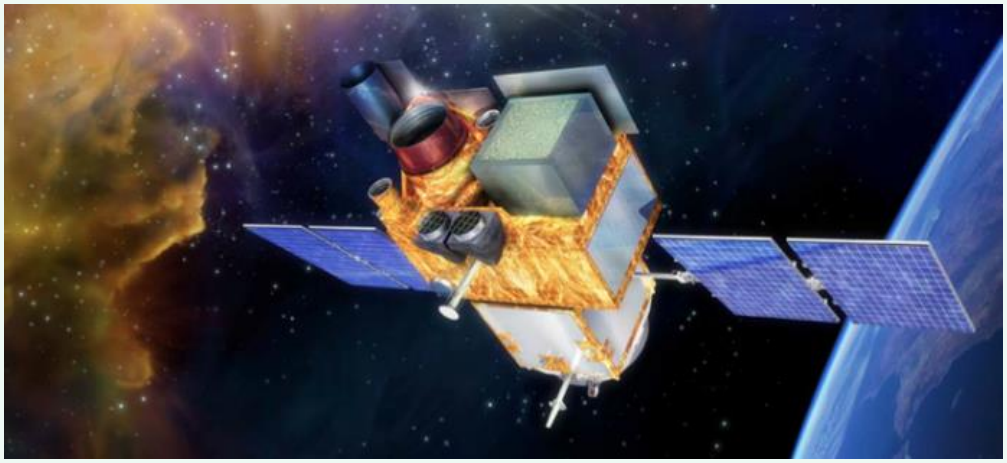
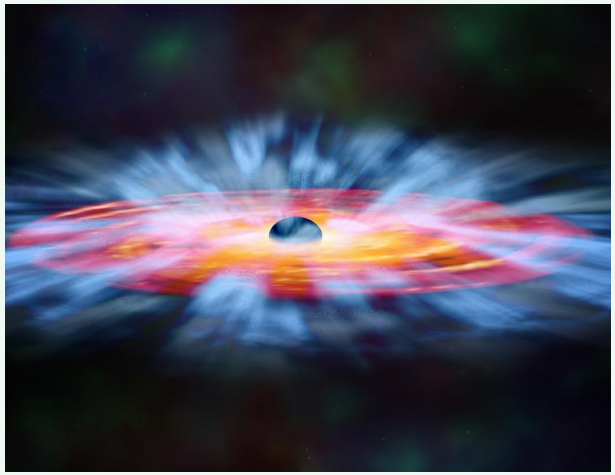
SVOM SCIENCE Workshop





SVOM Observatory Science Miscellanea: CXB and GDE

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SVOM Observatory Science

Extragalactic Compact Objects:

- AGN including Blazars
- Tidal Disruption Events
- Ultra Luminous X-ray Sources

Galactic (or LMC/SMC) Compact Objects:

- BH / NS X-ray Binaries and transients
- Magnetars, SGRs, isolated NS and bright plerions
- CVs (White Dwarf binaries) and Active Stars

Some diffuse components:

- Cosmic X-Ray Background
- Galactic Ridge X-ray Emission (& some bright SNR)

Peculiar objects and exceptional events:

- Terrestrial Gamma-Ray Flashes (TGF)
- Solar Emission, Earth albedo, Aurorae, …
- (Near-)Galactic SN, Sgr A* outburst, Magnetars S-Burst

Accretion / Ejection Physics

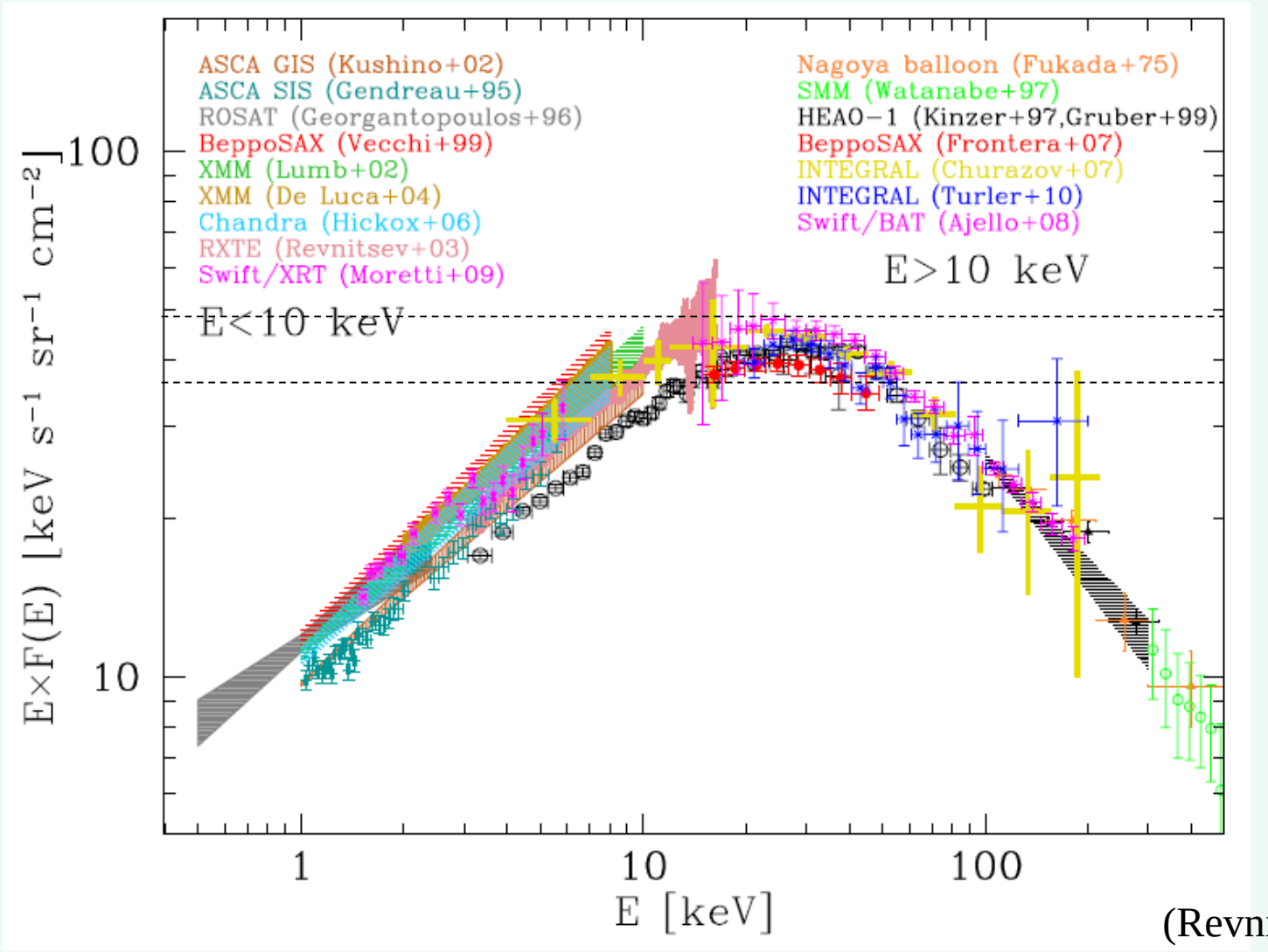
Matter in extreme conditions of Gravitation, Magnetic Fields and Densities

Particle Acceleration

Motivation of CXB measurement

- Accurate measurements of the CXB coupled to
- Detailed studies of population of point sources in deep fields
- Allow one to determine the characteristic of the unresolved AGN population and trace the history of SM Black Hole formation, growth and evolution in Universe.
- In the 1-2 keV range 80-90 % of CXB is resolved in P-S (~ 10^4/deg^2) thanks to the sensitive and high resolution X-ray telescopes (Chandra, XMM)
- In the > 7 keV range most of the CXB is unresolved (2.5% in 20-60 keV) and will remain such in the near future (Hitomi ?)
- This range trace the highly absorbed Compton thick AGN population (not visible at low E): accurate CXB measurement here is crucial for these studies
- Present measurements show disagreements of ~ 20 %: large impact on the computation of the Compton thick AGN demography

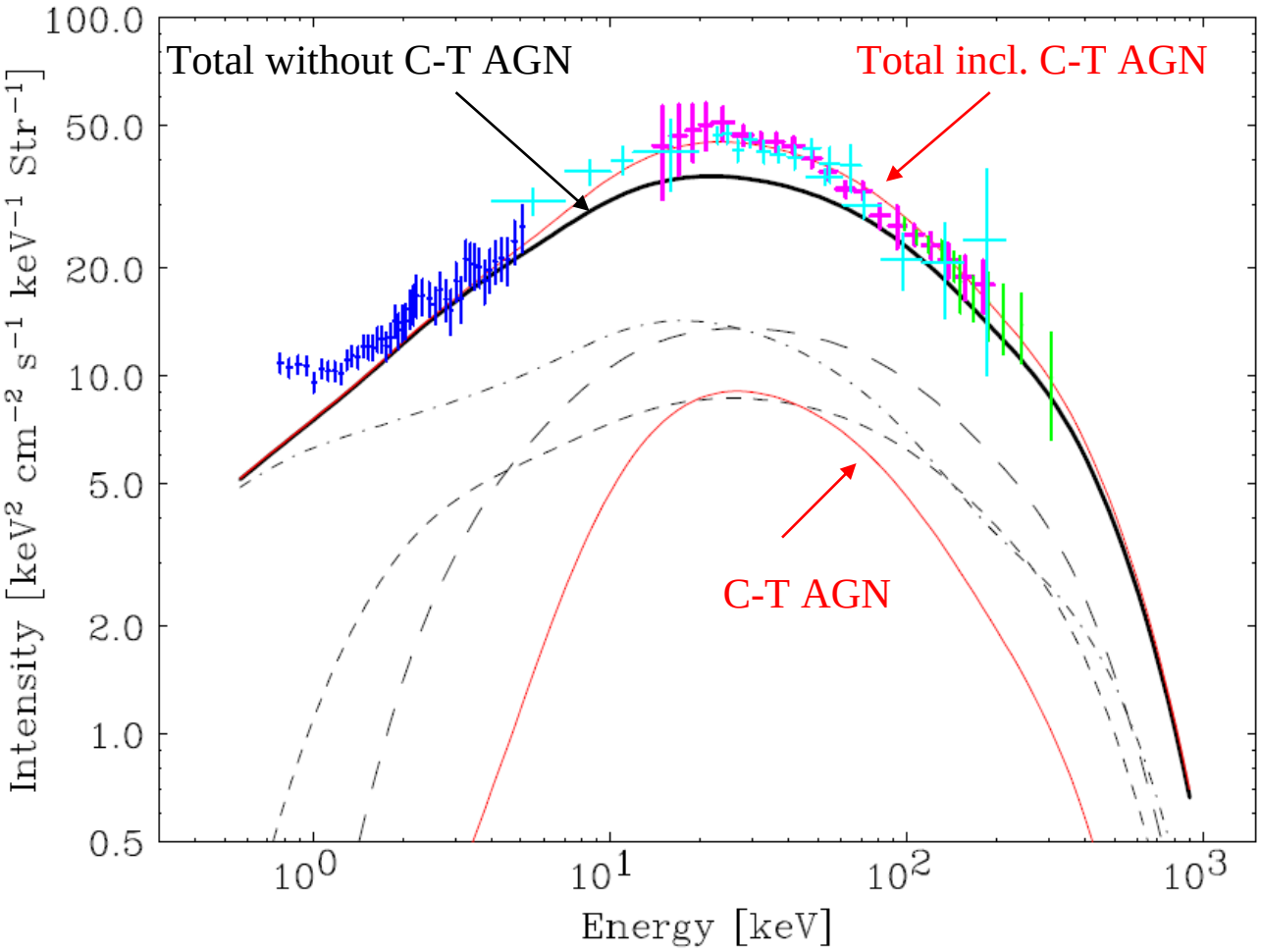
CXB spectrum: Compilation



} ~ 30 %

(Revnivtsev 2014)

CXB measurement: SMBH census



AGN population synthesis model compared to CXB data

CXB measurements and AGN demography:

- Total AGN with column densities log N_H ~ 21-26 cm^{-2}
- Compton-Thick AGN with column densities log N_H ~ 24 - 26 cm^{-2}
- AGN with column densities log N_H < 24 cm^{-2} (curves for < 22, 22-23, 23-24)

(Ueda et al. 2014)

CXB measurement issues

Reasons for systematic errors :

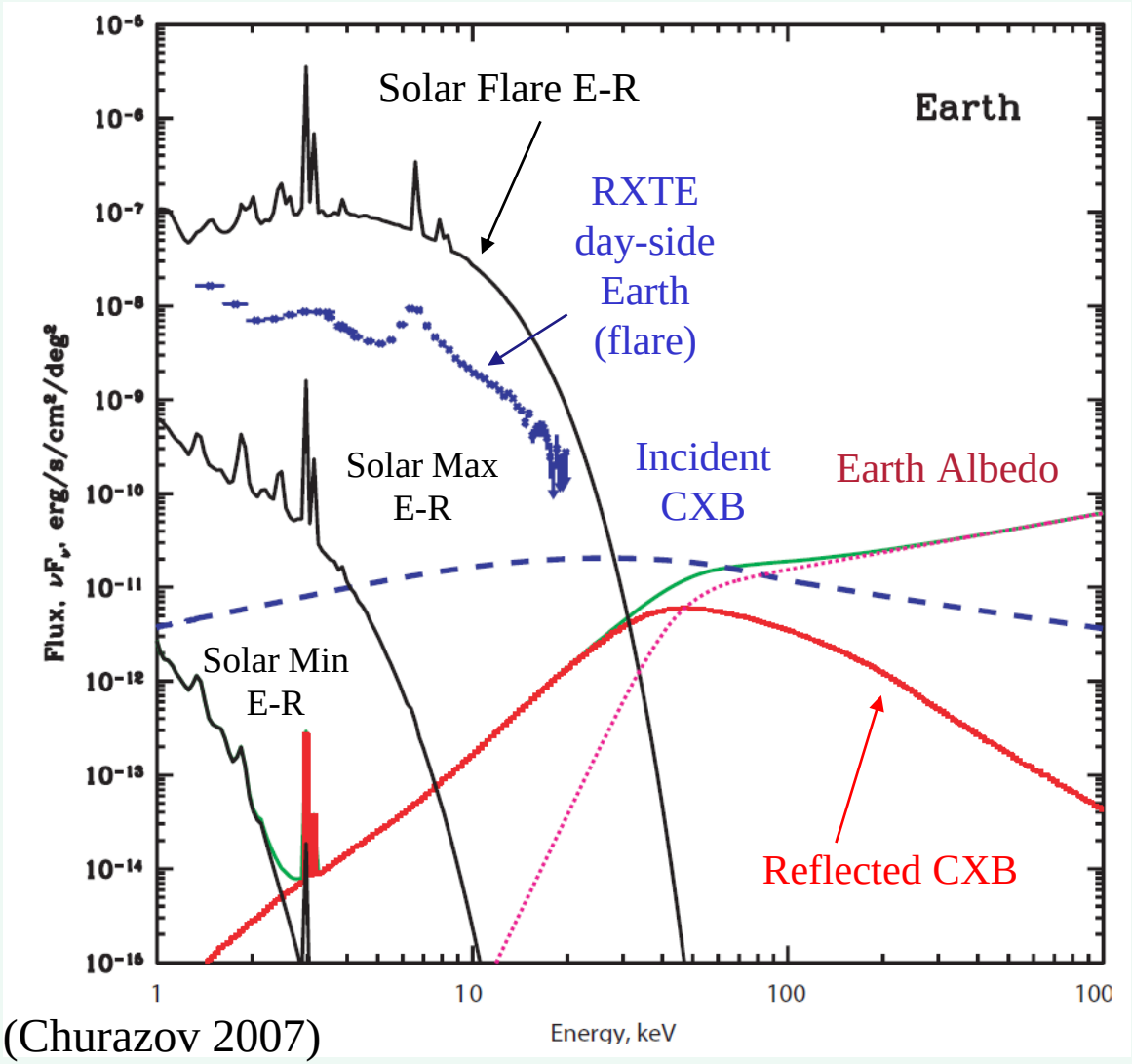
- Accuracy of instrument calibrations in energy and efficiency
- Rejection of intrinsic particle induced background
- Rejection of sky background (sources, sun)
- Factors impacting CXB absolute measure (solid angle): vignetting and stray-light

Methods employed to reduce them

- Accurate calibrations, accurate estimations from MC detector simulation
- Rejection techniques and estimations of the internal bkg
- Closing doors for detector apertures: bkg variation from diff. configuration
- **Earth – Moon Occultation**: problem of estimation of Earth emission

SVOM/ECLAIRs (and GRM) nominal mission (B1 law GP with large Earth Occultations) will provide unprecedented statistics for accurate CXB measurements in the crucial range 4-150 keV

X-ray emission from Earth

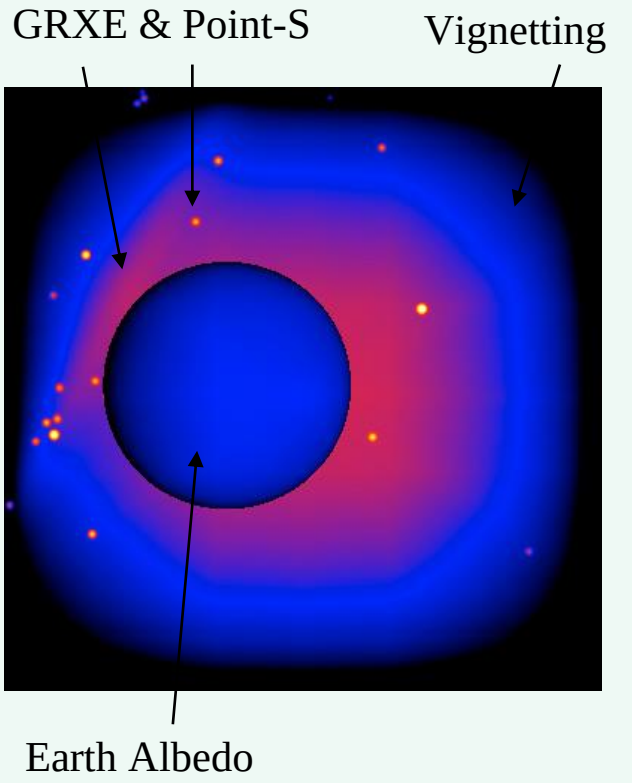


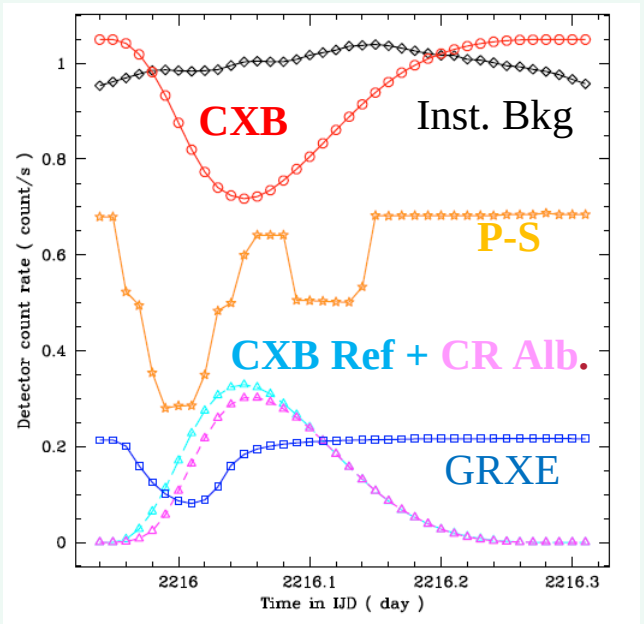
(Churazov 2007)

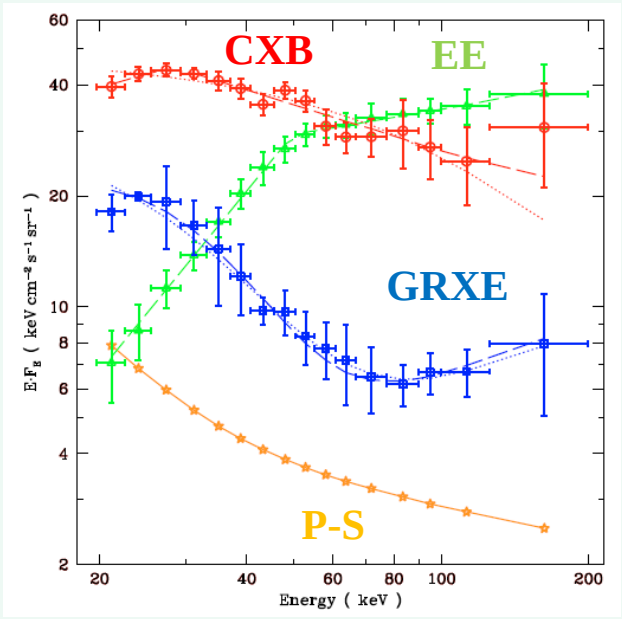
Earth emission from reflection and particle generated Albedo

- Reflection of Sun emission from Max and Min activity and from a powerful flare
- Reflection of incident CXB
- Earth Albedo from CR
- RXTE spectrum of Earth day-side emission (active ☉), day-side non-flare corona em. refl. very soft
- Up to 10 keV the Earth em. is quite weak, albedo start to dominate CXB at > 40-50

INTEGRAL Obs of CXB







Model of different components in Images – Light Curves – Spectra that contribute to the detected signal in INTEGRAL instruments during Earth Observations

(Turler et al 2010, see also Churazov et al. 2007)

SVOM CXB measurement Conclusions

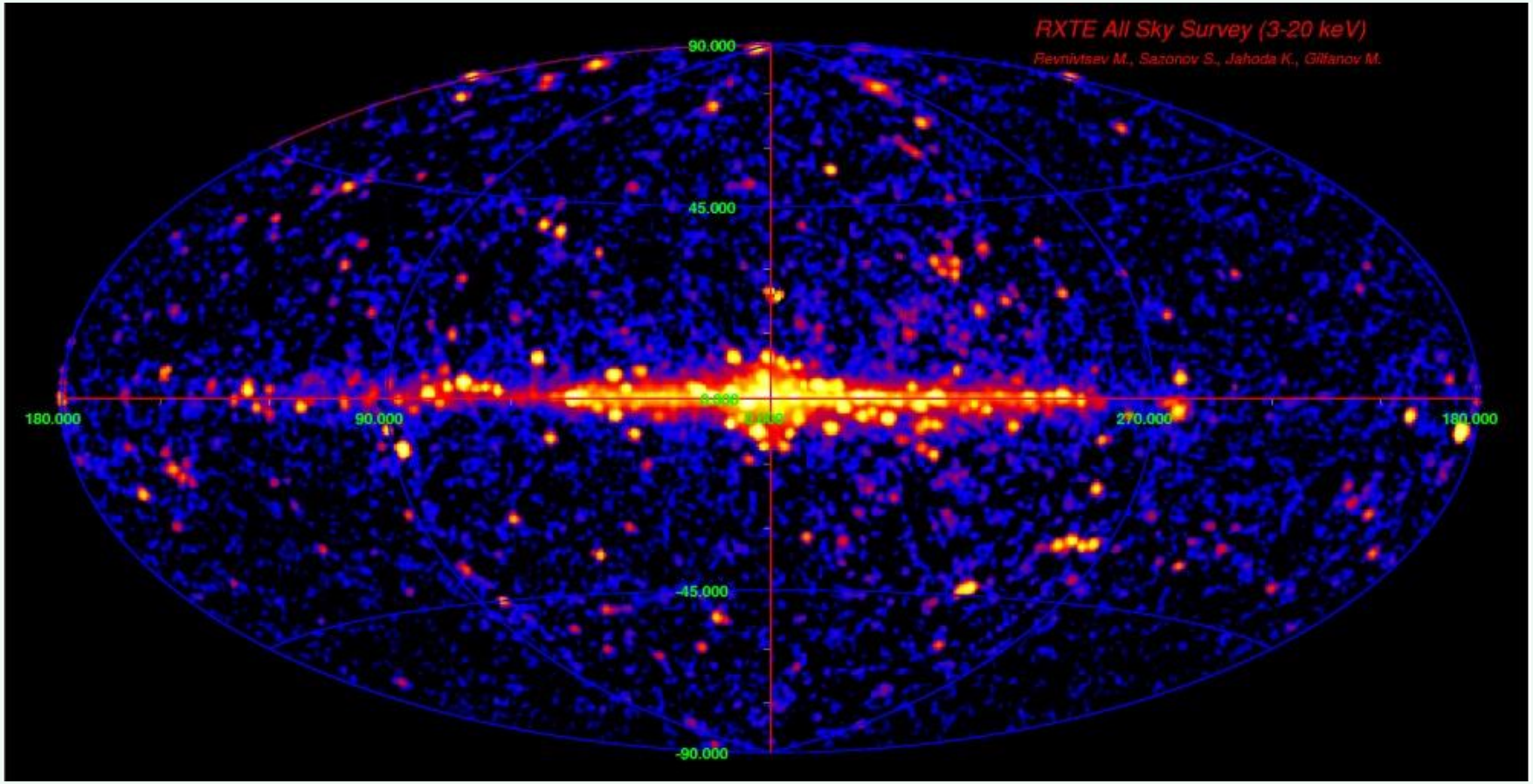
- SVOM/Eclairs with 60% of the time on B1 GP with large full/partial Earth Occultation periods will provide unprecedented statistics for accurate CXB measurements in the range 4-150 keV and in particular in the > 10 keV crucial range
- Given high galactic latitude GP, source/GRXE contamination during non occulted obs. will be also low, possible to select ~empty sky region and still gather large statistics
- Observation mostly the day side: luckily reflection of solar emission is soft, a part from s. flares

- In order to exploit the available data we will need (mission req.)
  - Stability of operations (subset of them)
  - Accurate ground and in-flight calibrations
  - Data and information to accurately model detector response, background, Earth albedo
  - Specific analysis techniques, not a “pipeline processing”
- No need for specific observations or modes (B1 law: plenty of Earth occulted data).

Motivation for GDE studies

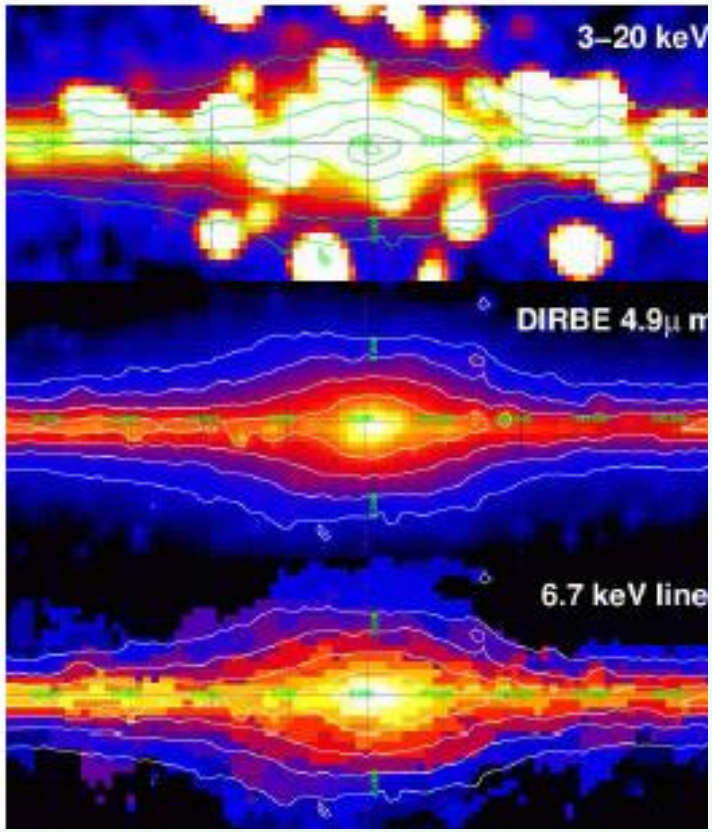
- A large High-Energy Galactic Diffuse Emission
- In Gamma-ray domain (100 MeV-300 GeV) truly diffuse and explained by CR interaction with ISM
- Above 300 keV dominated by diffuse 511 keV emission
- In X-rays and hard X-rays the so called Galactic Ridge X-ray Emission origin (diffuse vs point source) still debated
- RXTE (Krivonos 2007) and INTEGRAL (Lebrun 2007) have shown that this emission follows the stellar distribution and were able to resolve some fraction in point-sources
- In X-rays Revnivtsev+ (2009) have resolved 80% with a Chandra deep survey of a region of the GD
- Such measurements shall provide information on the unresolved hard point-source population that produce such component (mainly CV and active stars)

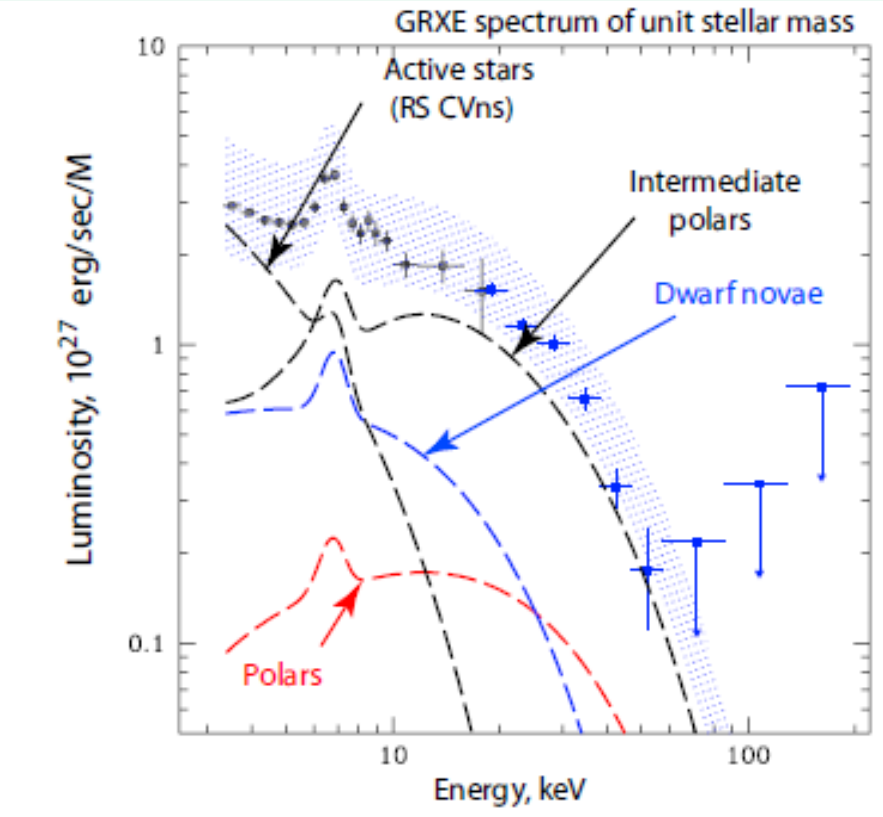
GRXE



- Galactic Ridge X-Ray Diffuse Emission discovered with EXOSAT (Warwick et al 1985), studied with several other instruments (RXTE, Integral, Suzaku)
- Hot Thermal spectrum, strong Iron 6.7 keV line, tempetature 6-10 keV : Origin ?

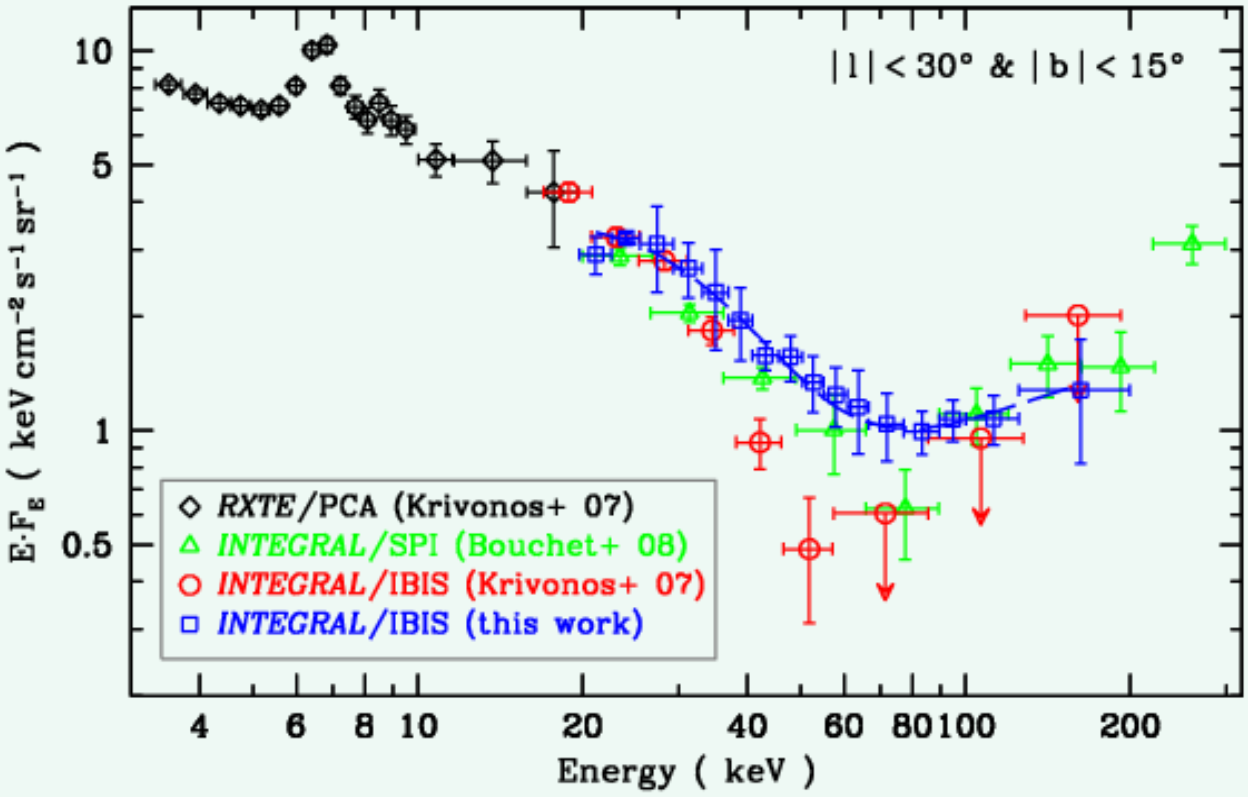
GRXE Science





- Galactic Ridge X-ray Emission measurements with RXTE and INTEGRAL
- Compared to expected contribution wt uncertainties (shaded area) from unresolved populations of hard point sources (CVs) (Revnivtsev et al 2007)

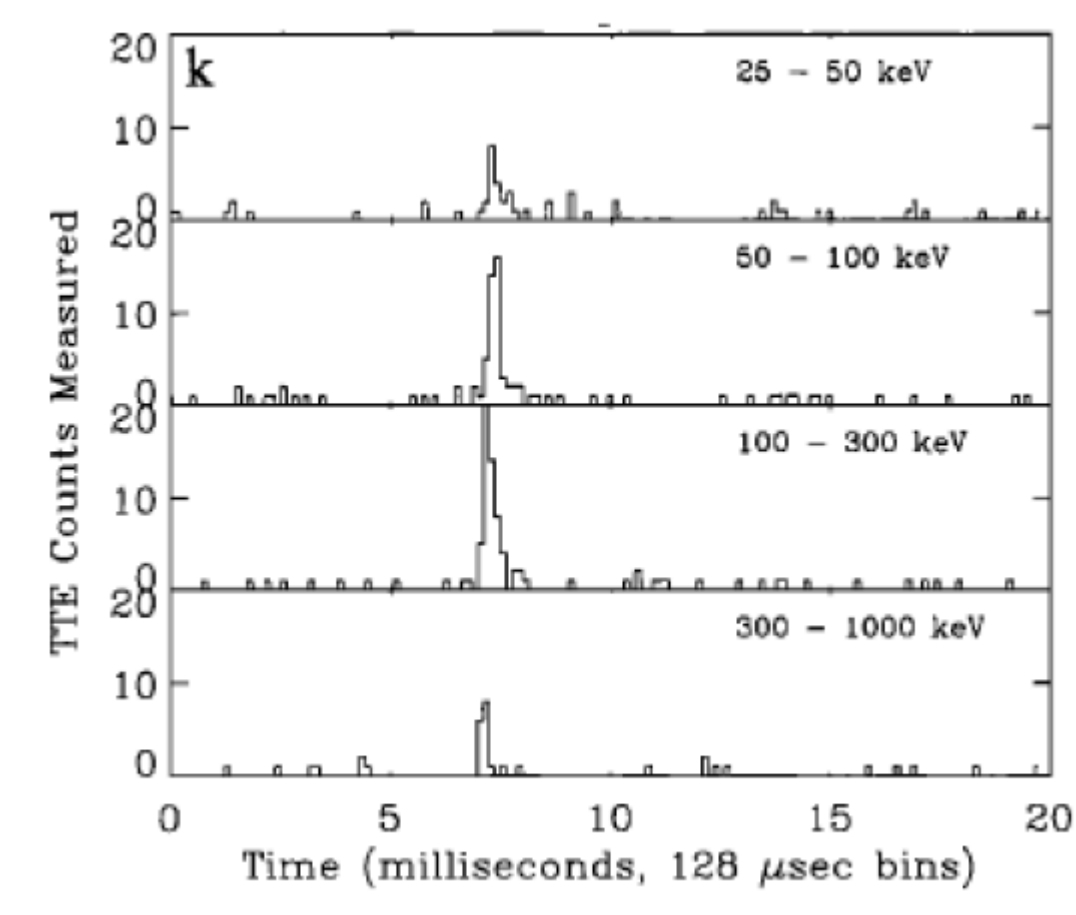
GRXE with SVOM



INTEGRAL/IBIS Earth Occultation Measurement of GRXE (blue squares Turler et al 2010)

- 120 ks Earth Observ. wt INTEGRAL: accurate GRXE measurements ~ those obtained with many years of data and other bkg estimation techniques
- SVOM will naturally provide large set of useful data on GDE even if B1 will generally avoid the galactic plane

SVOM Obs Scie Miscellanea: Terrestrial Gama-Ray Flashes



BATSE TGF light Curve (Nemiroff+ 97): very fast events

TGF spectra: range ~ 20 keV–20 MeV, sp. peak ~ 100 keV

- G-ray flashes associated to tropical thunderstorms (atmospheric electrodynamics, partic. Acceleration, thunders.)
- BATSE discov. in ’94 studied by RHESSI, Agile, Fermi
- Future dedicated Taranis and ESA ASIM missions
- TGF models: large-scale relat. runaway e^- avalanches in thunderstorms vs. direct production from lightning discharges
- Localization (altitude) with ECLAIRs & GRM spectra will set constraints on TGF models

SVOM Observatory Science: Miscellanea

- Even for **non-GRB, non-Time Domain Astronomy and non-multi-wavelength Science** interesting contribution by SVOM is expected

- CXB and GDE can be studied in particular with ECLAIRs (GRM ?)

- Other Phenomena will benefit from Earth observations: Terrestrial Gamma-ray Flashes (in particular with GRM and ECLAIRs)

- Launch of Taranis (2018 ?) will probably change our view of TGF but will also build up a community that will be highly interested in the SVOM complementary data: let's not forget TGFs !