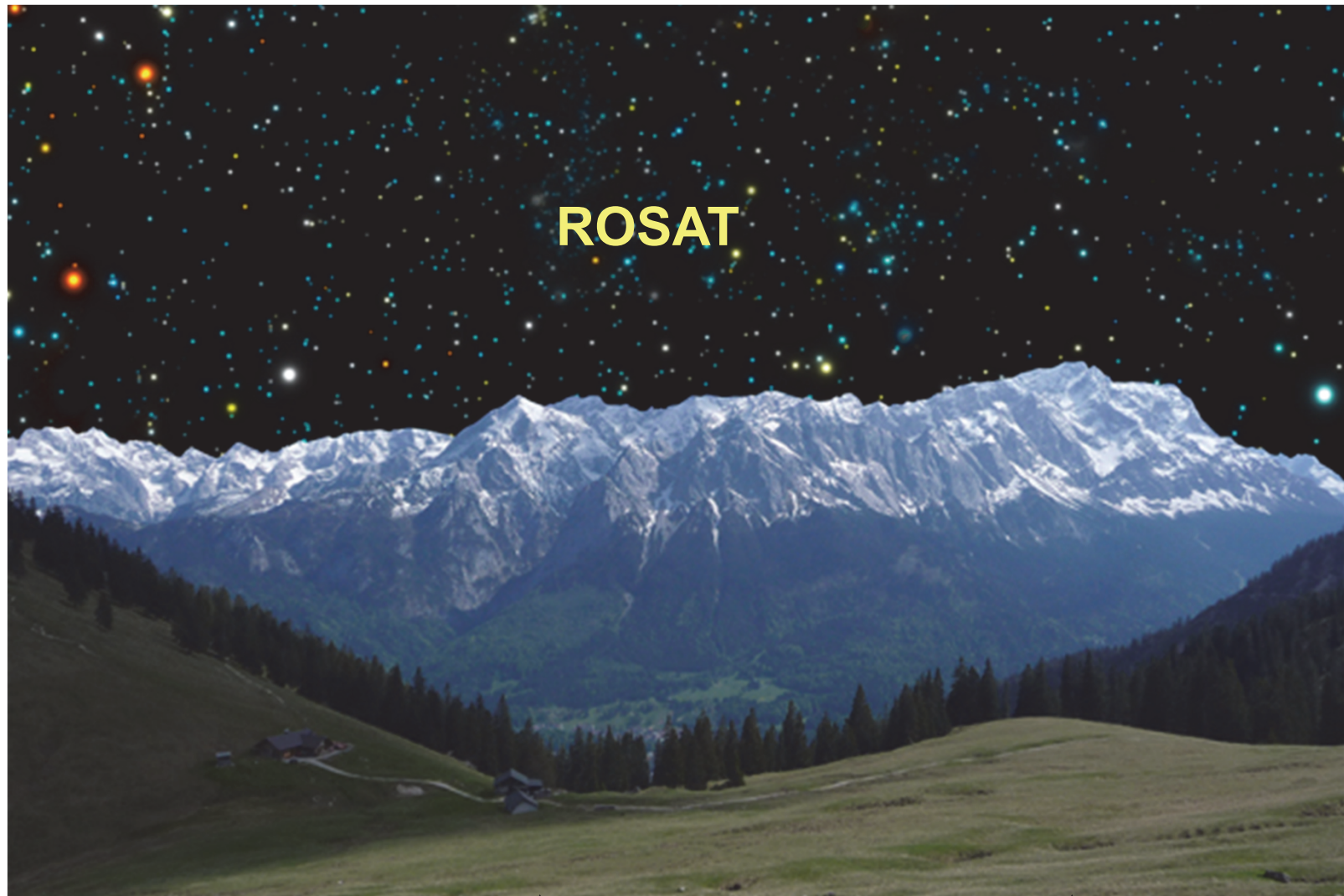


A composite image featuring a mountain range with snow-capped peaks and green slopes in the foreground. The sky is a dark, starry night sky with numerous stars of various colors (blue, yellow, orange, white). The word "ROSAT" is written in large, bold, yellow capital letters across the center of the image.

ROSAT

Joachim E. Trümper, eROSITA-Meeting, Garmisch 2011



ROSAT

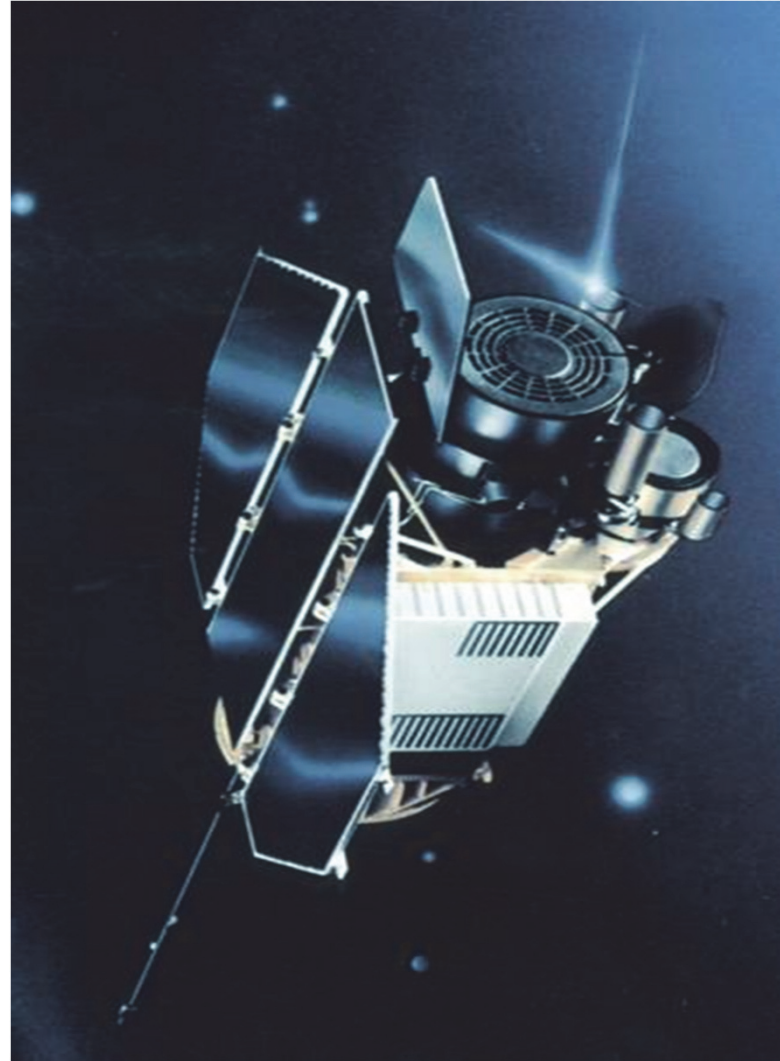
↑
16 August 1950
Ascent of the
Alpspitze

↑
1961/1962
Cosmic Ray Spectra on the
Zugspitze

Brief ROSAT Project History

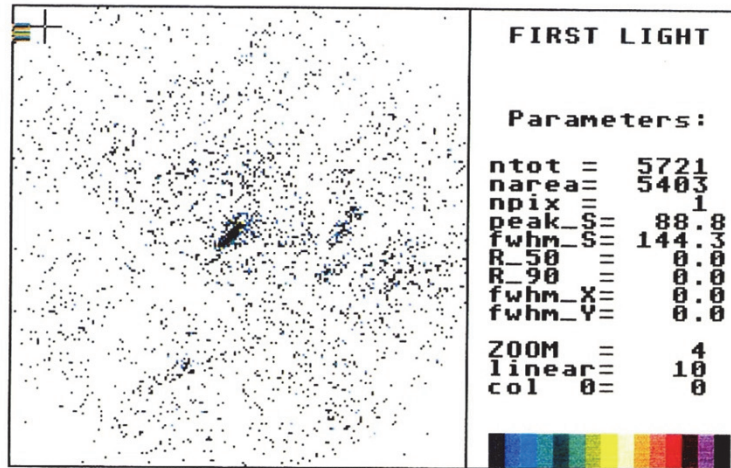
- 1974/5 AO on „Big national Projects“ by the Ministry of Research & Technology (BMFT)
J. T. proposes a satellite carrying a large X-Ray telescope which is selected along with Petra (DESY) and a 30m Millimeter telescope
Industry studies, development of the X-ray mirrors and the PSPC
- 1980 BMFT: Big projects must show a “substantial international contribution”
- 1982/83 MOUs with NASA and SERC:
NASA: Shuttle launch, HRI (Steve Holt, Riccardo Giacconi, Harvey Tananbaum)
SERC: XUV Telescope (Ken Pounds et al.)
- 1986 Challenger explosion: Shuttle launch delayed from 1987 to 1994/5
Shuttle launch → rocket launch
- 1990 June 1st - Launch from Cape Caneveral
- PSPC First light on June 16, WFC a few days later
- Verification observations 2 weeks
- All Sky Survey 6 months
- Pointed Observations ~ 8 years
- Final contact with ROSAT on February 12, 1999
- Re-entry and crash next week

June 1st, 1990



Two weeks later at the German space control center:

ROSAT FIRST LIGHT
16 June '90



The first light observation began shortly before midnight. The target was the region around SN 1987A in the LMC

Handwritten signatures and names:
 Vic Wood, de. Skiboff, Ulrich Bödel, Hans Schindler, John Wright, Frank, Siegfried Ulmer, Günter Hei, Peter Pöschel, D. Roth, Klaus Stephaan, K. Brauer, Michael Fritzsche, Eberhard Pfefferkorn, Hans-Joachim Wende, Wolfram Zinner, K. Bräunig, and others.

ROSAT – Large Steps

First All Sky Survey with an Imaging X-ray Telescope

- very large increase in sensitivity compared with previous surveys
- Unlimited field of view
- large flux limited samples
- discovery of rare classes of objects

First All Sky Survey in the XUV

Eight years of pointed observations:

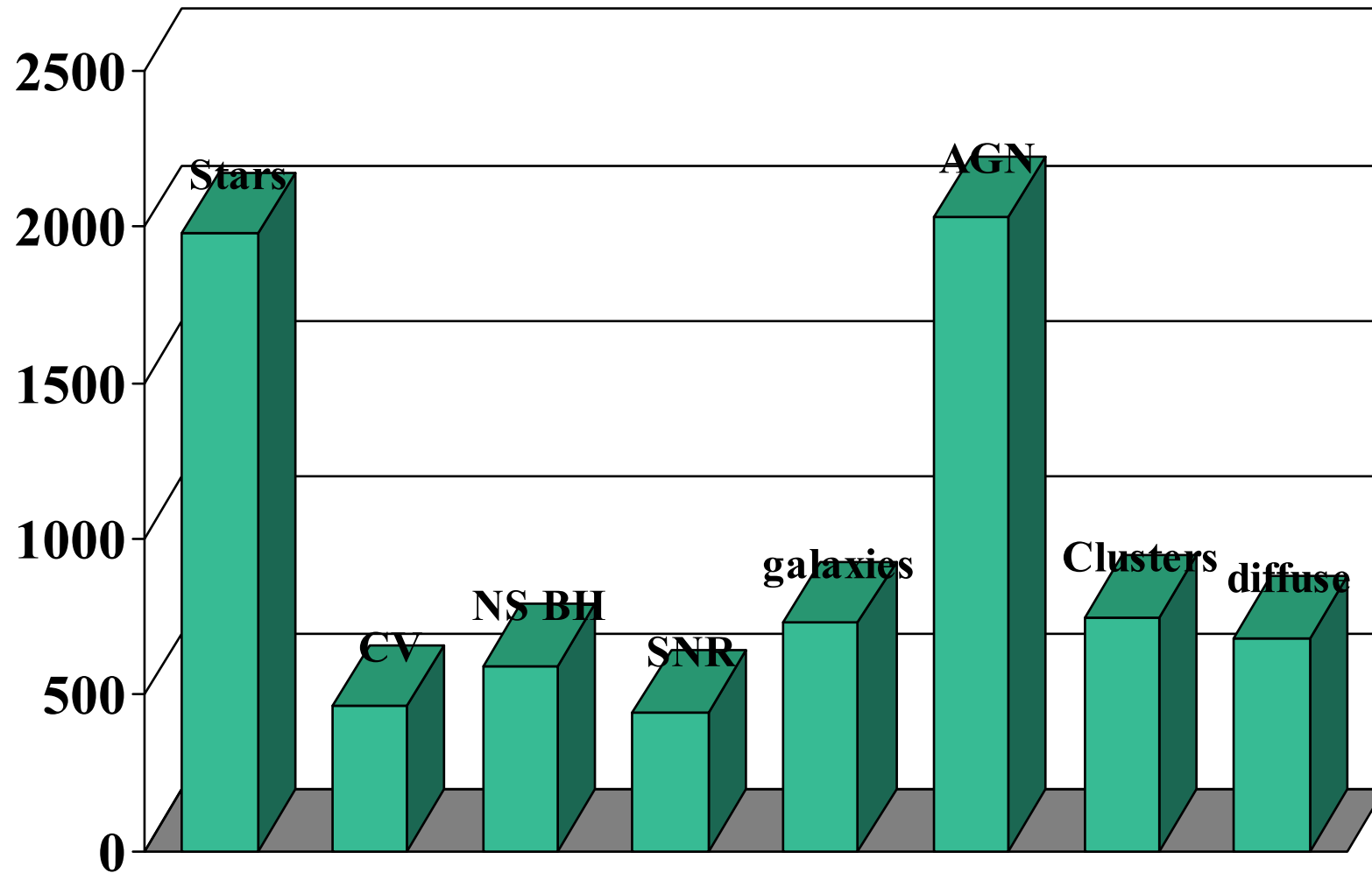
ROSAT PSPC versus Einstein IPC:

- grasp ~ **5**
 - spectral resolution ~ **4**
 - angular resolution ~ **3**
 - non-X-ray background per arcmin² ~ **0.06**
per resolution element ~ **0.01**
- (~ 1 non-X-ray background count per arcmin² in three days)
- ROSAT was the first mission to image the sky background!**

ROSAT HRI versus Einstein HRI:

- angular resolution ~ **2**

Number of ROSAT observations per object category



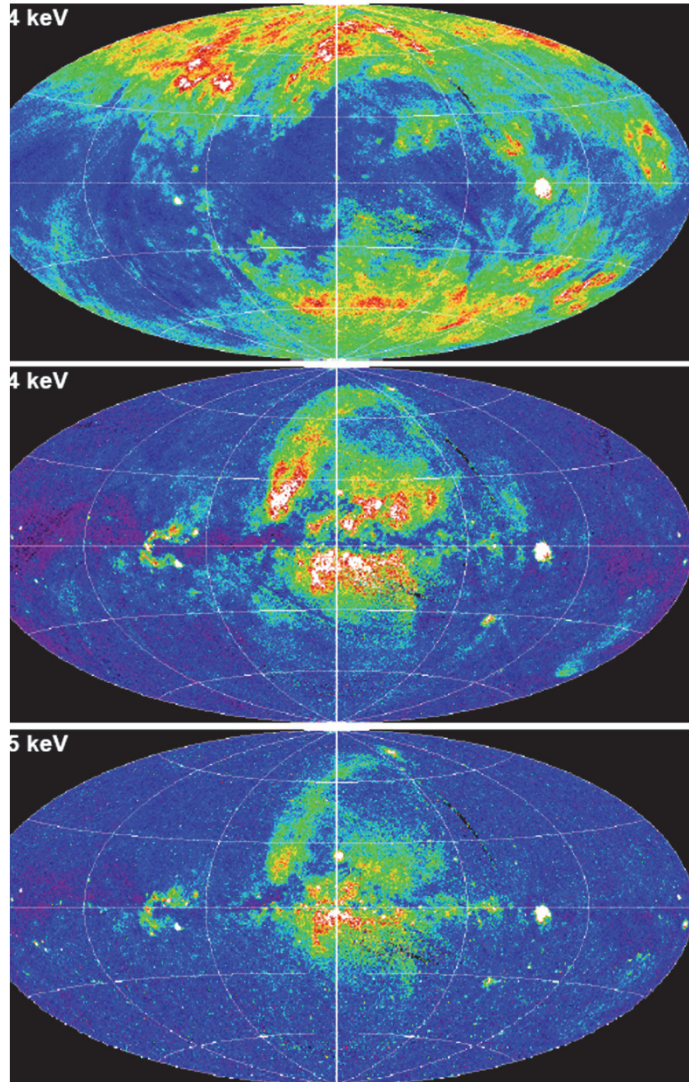
total number of refereed ROSAT publications ~ 4250, ~ 140 000 citations

ROSAT Discoveries

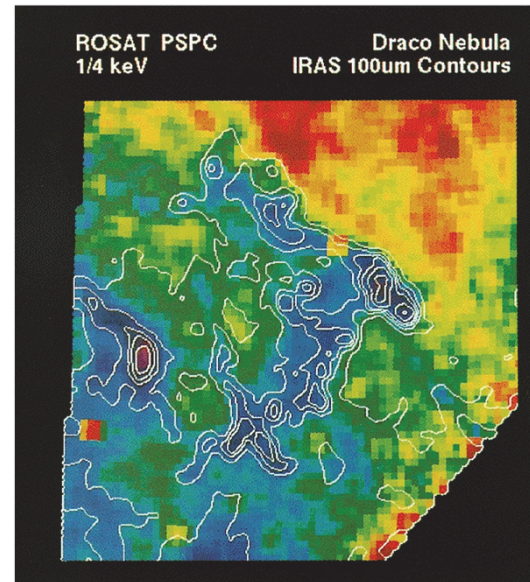
and Highlights

RASS – Diffuse Emission

The final product
> 99.9 % complete

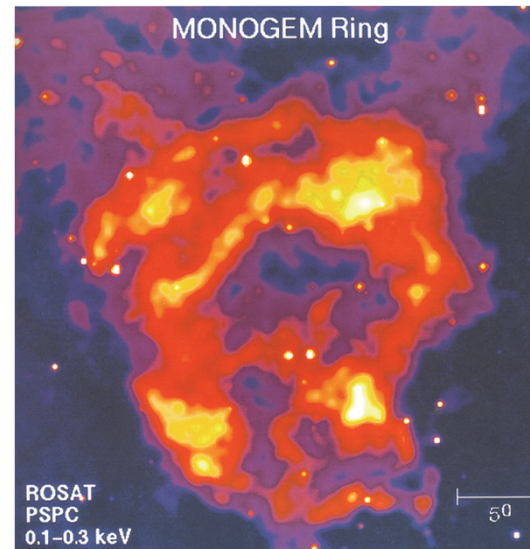


First Discovery of X-Ray Shadows



Snowden et al.
1991

The unlimited Field of View



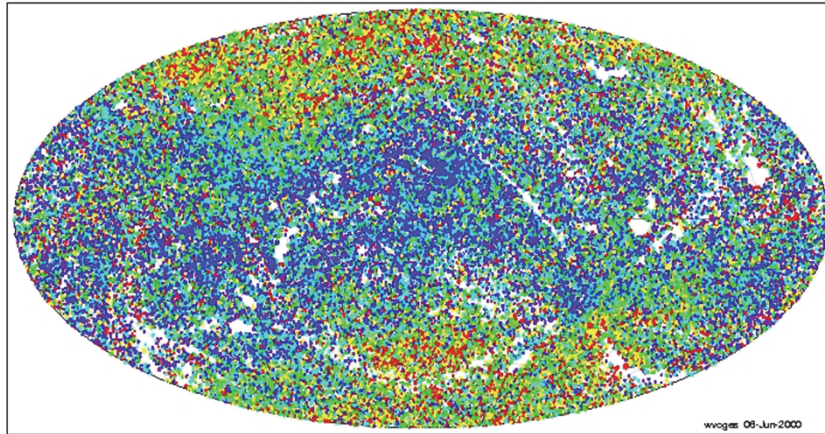
J. Trümper, Garmisch, 2011

ROSAT X-ray Surveys – the final versions

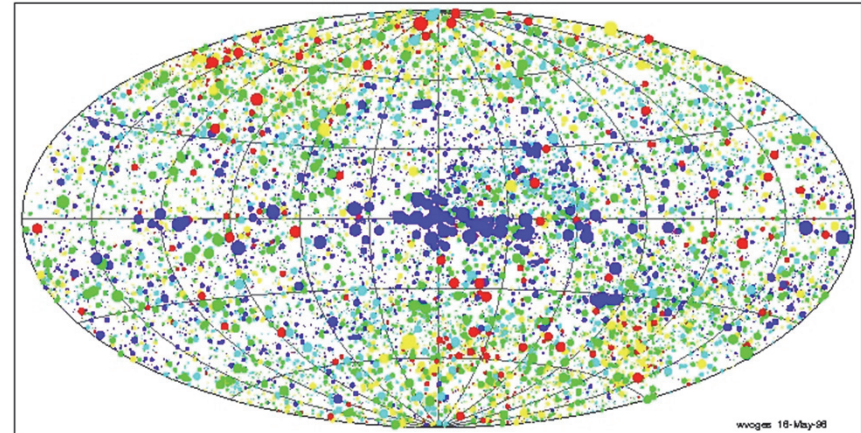
All-Sky Survey Faint Source Catalogue

All-Sky Survey Bright Source Catalogue

Voges et al. 1999, 1010 citations



Energy range: 0.1 - 2.4 keV
Number of RASS-II sources: 105924
Hardness ratio: -1.0 | -0.6 | -0.2 | 0.2 | 0.6 | 1.0 (soft -> hard : red - yellow - green - blue - violet)

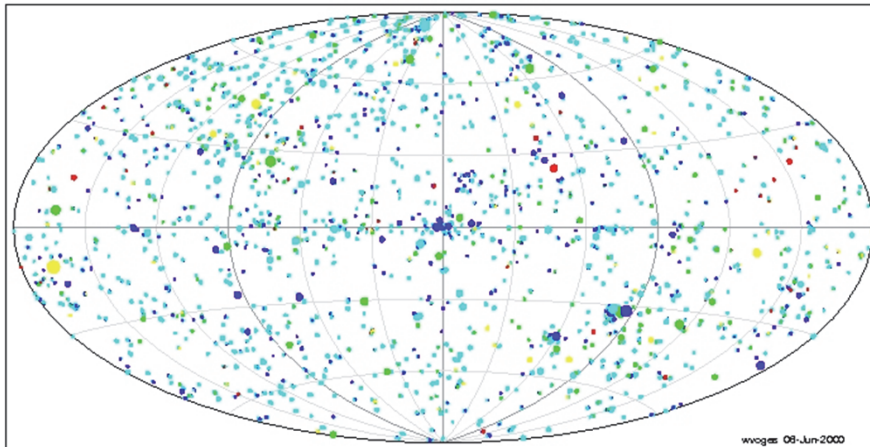


Energy range: 0.1 - 2.4 keV
Number of RASS-II sources: 19130
Hardness ratio: -1.0 | -0.6 | -0.2 | 0.2 | 0.6 | 1.0 (soft -> hard : red - yellow - green - blue - violet)

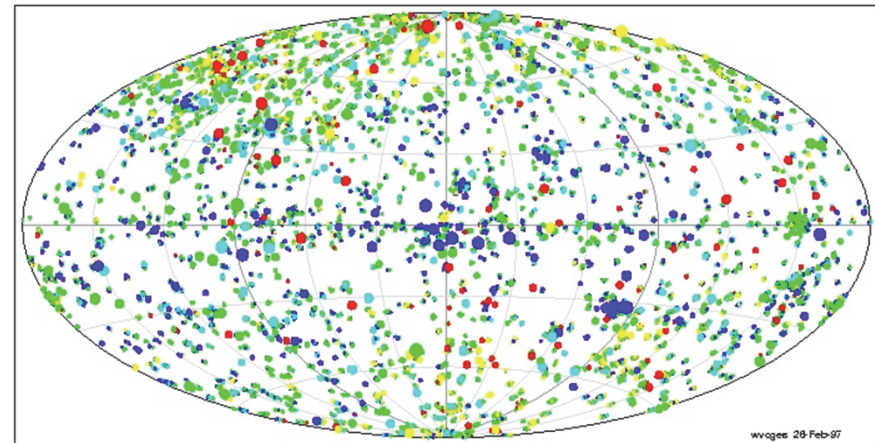
HRI Catalogue

pointing

PSPC Catalogue



Energy range: 0.1 - 2.4 keV
Number of HRI sources: 27464
Hardness ratio: -1.0 | -0.6 | -0.2 | 0.2 | 0.6 | 1.0 (soft -> hard : red - yellow - green - blue - violet)



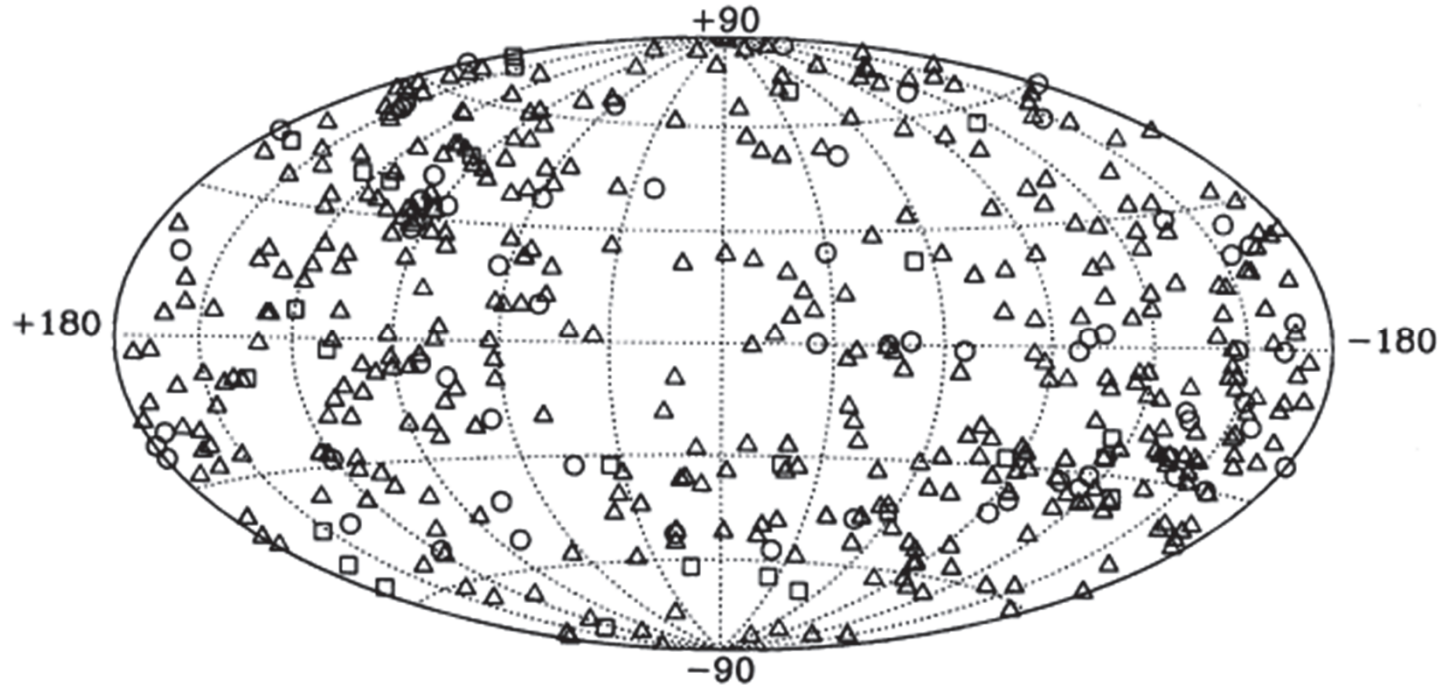
Energy range: 0.1 - 2.4 keV
Number of ROSAT sources: 82221
Hardness ratio: -1.0 | -0.6 | -0.2 | 0.2 | 0.6 | 1.0 (soft -> hard : red - yellow - green - blue - violet)

Englhauser 2001: Catalogue of the (70)! ROSAT catalogues

J. Trümper, Garmisch, 2011

The ROSAT Wide Field Camera XUV Survey

479 Sources



Pounds et al. MNRAS 1993

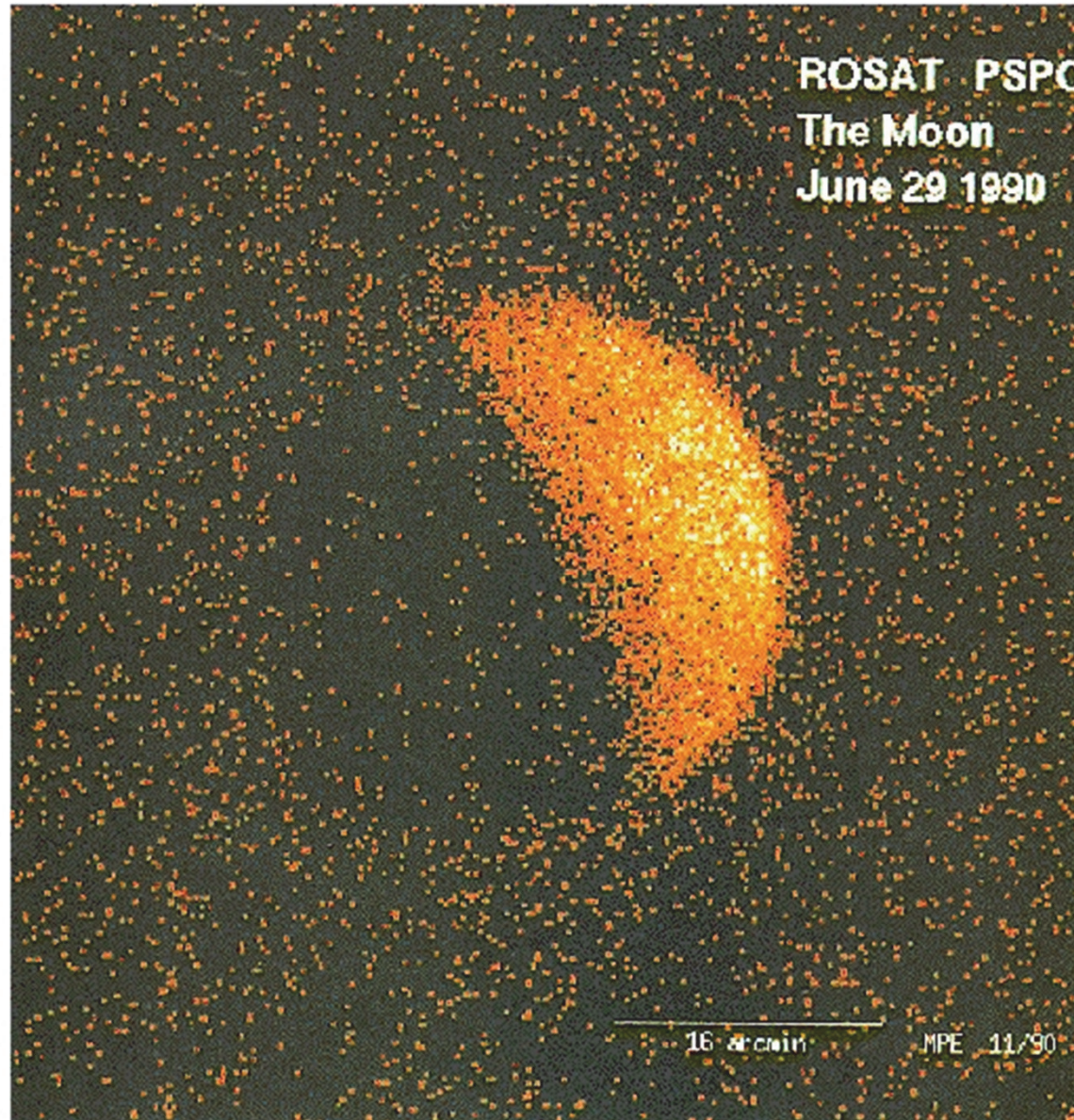
Pye et al. MNRAS 1995

**Discovery: PSPC & WFC surveys detect only 175 White Dwarfs,
while 5500 were predicted!**

➤ **Mixing of heavy elements into the photospheres (Fleming et al. 1996)**

Martin Barstow talk

Discovery of X-ray emission from the Moon



Reflected X-ray emission
from the Sun

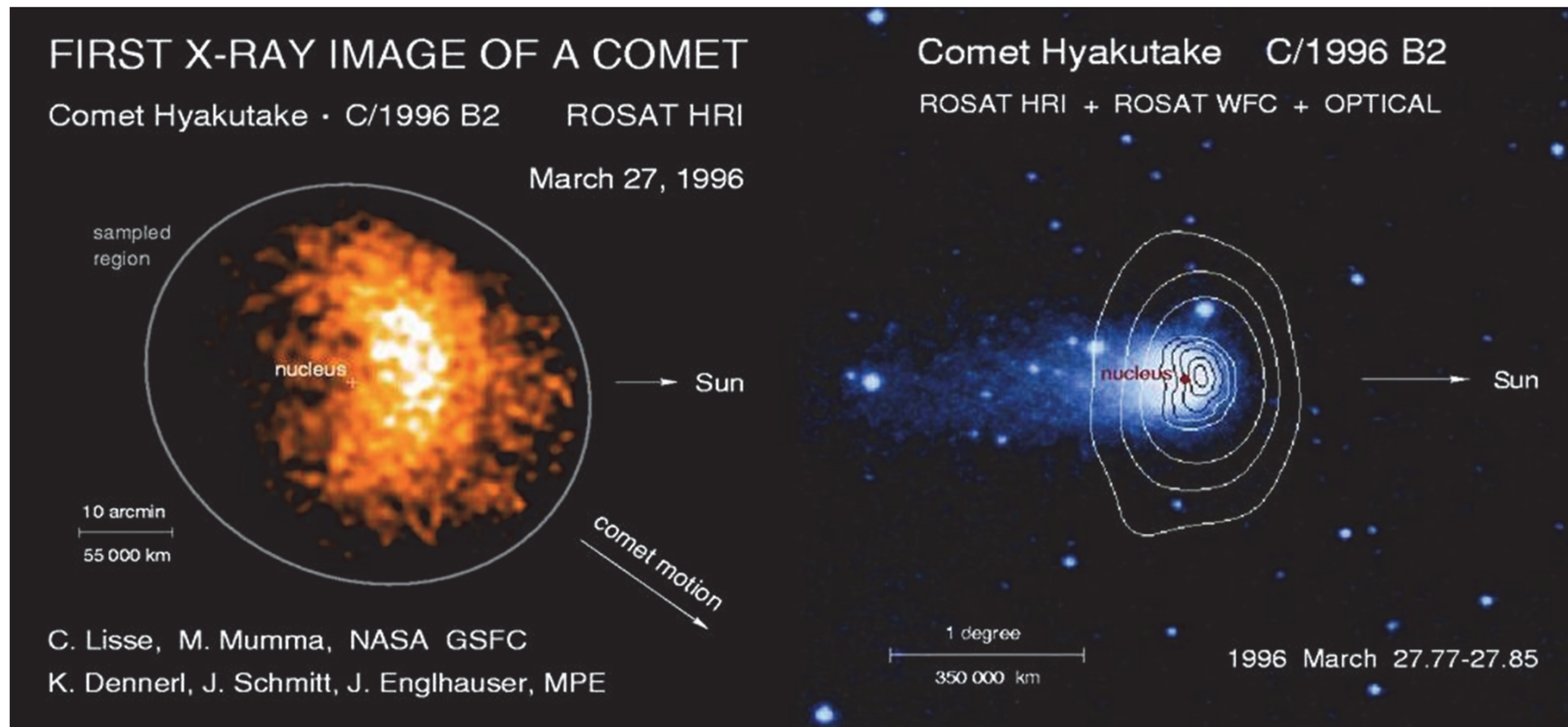
X-ray background emission
occulted by the moon

(Schmitt et al. Nature 1991)

Nature of the counts from
the dark side of the moon?

Later ROSAT observations
(long term enhancements,
X-rays from comets) showed:
This is X-ray foreground
produced by charge
exchange of solar wind ions
in the exosphere

Surprise: X-ray emission from dirty snowballs!

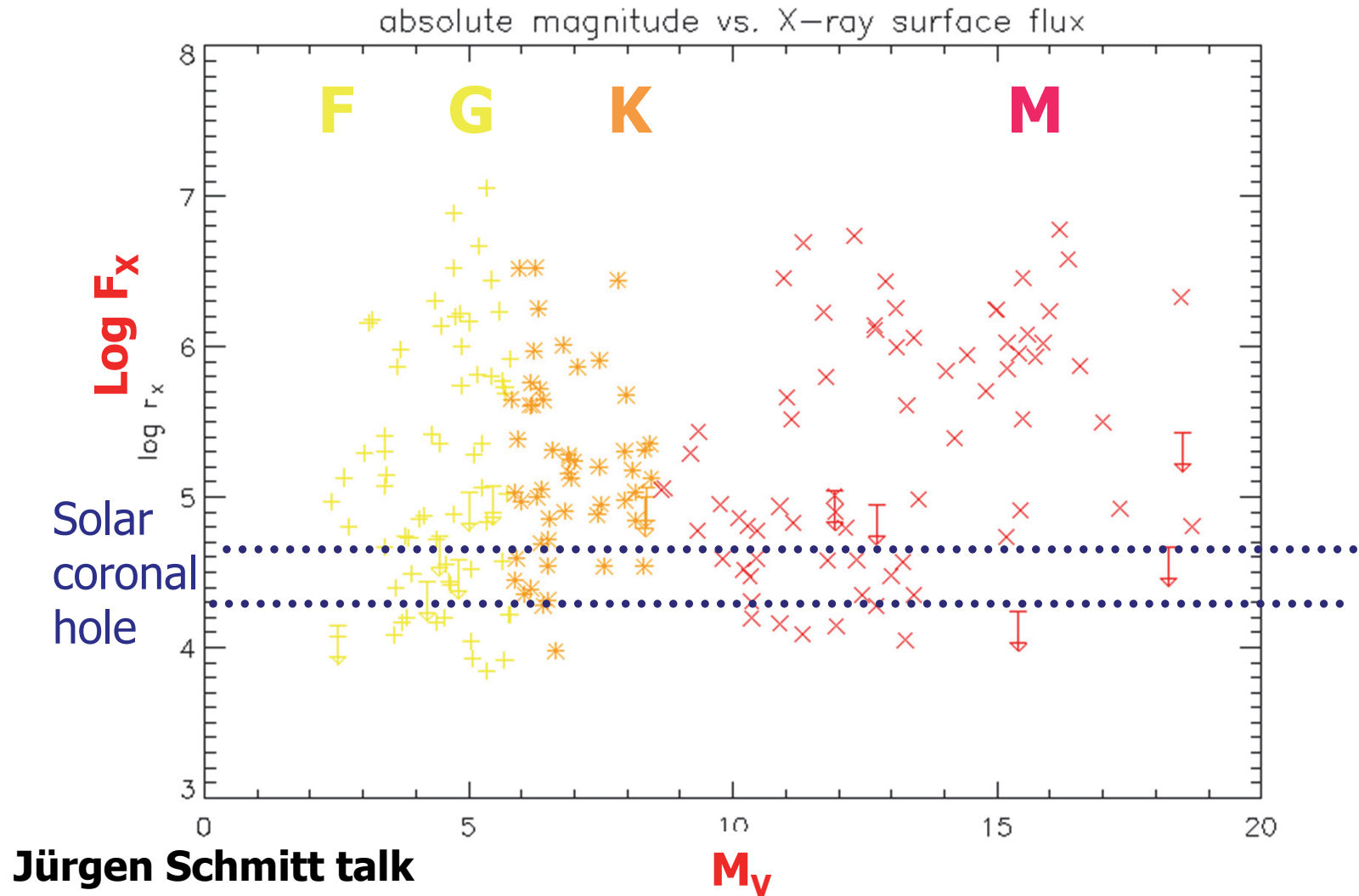


charge exchange between solar wind ions and water molecules in the cometary coma

up to now 23 comets have been X-ray detected,
11 by ROSAT
and 12 by EUVE, Chandra & XMM-Newton et al. (Dennerl 2010)

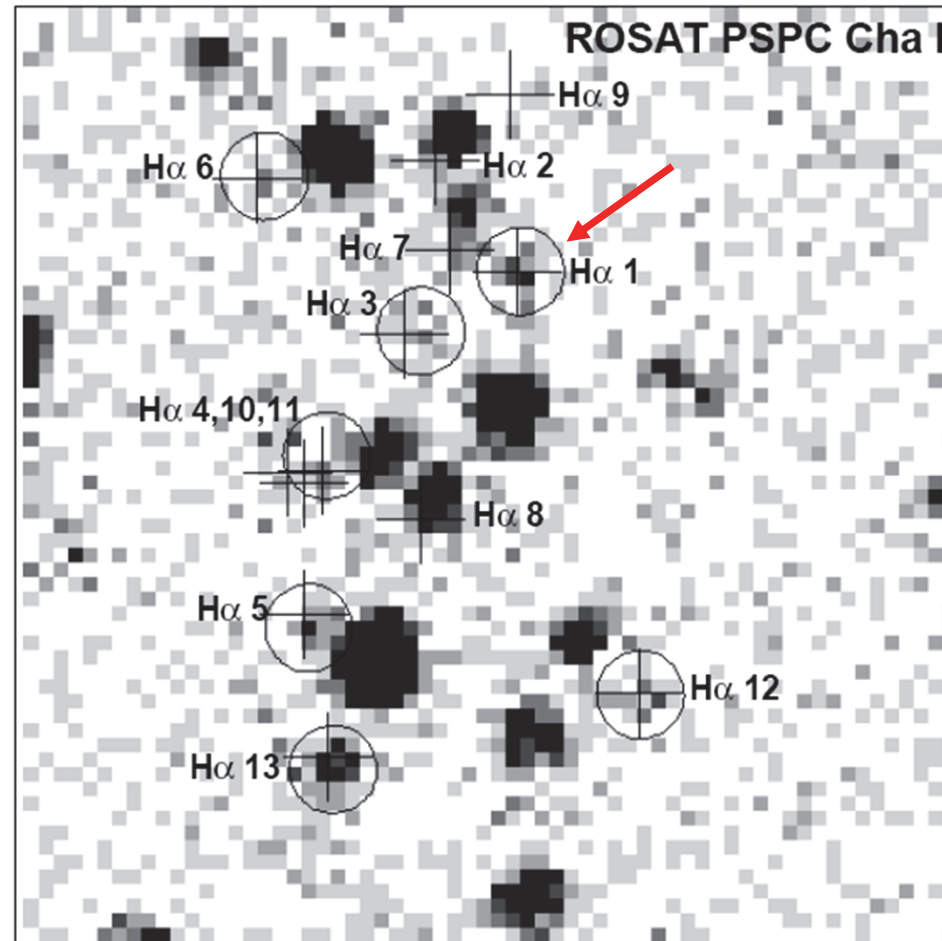
X-Ray Surface Flux for a Volume-limited sample of F,G,K,M dwarfs having Hipparcos distances

Schmitt & Liefke A & A 2004



Discovery of the first Brown Dwarf candidate in X-rays

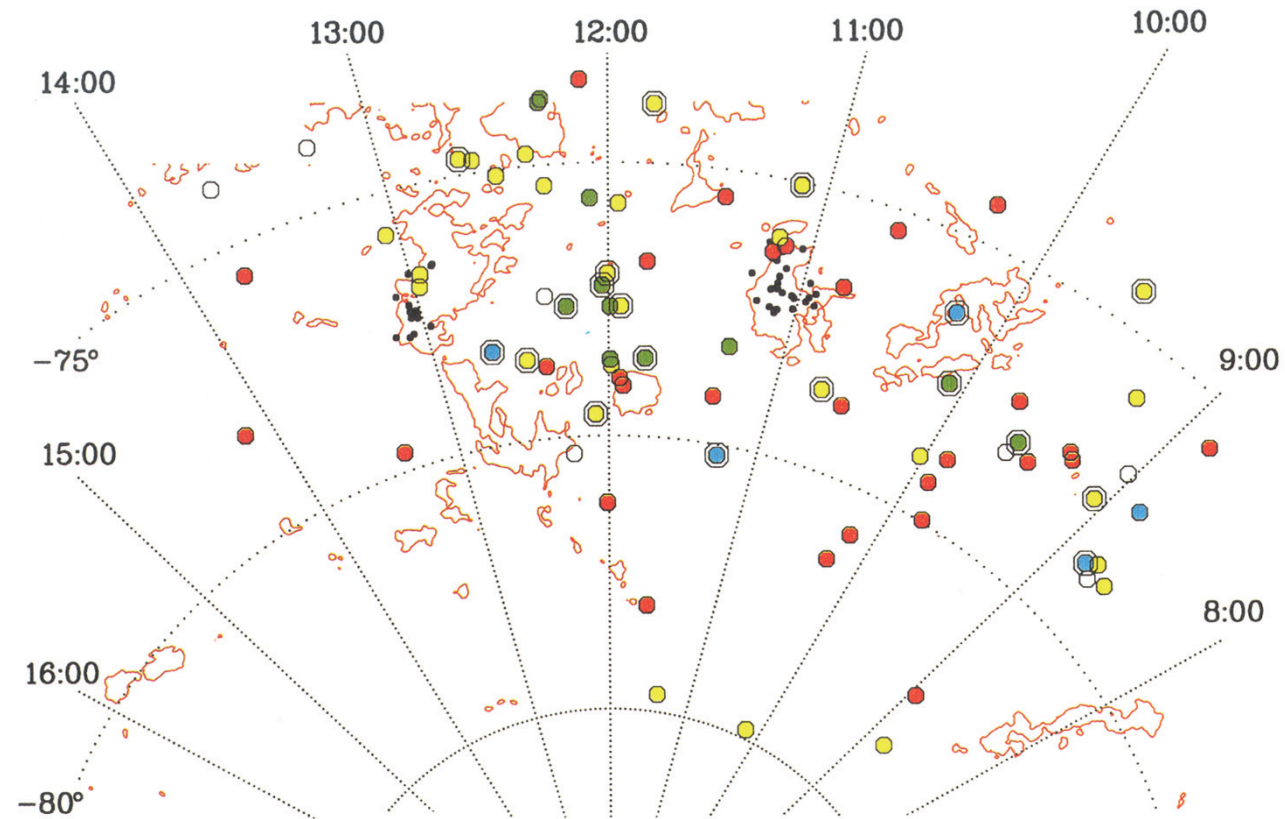
Neuhäuser & Comeron Science 1998



Discovery of young T Tauri stars far off star forming regions

Neuhäuser, Science 1997

Spatial distribution of new T Tauri stars in Chamaeleon

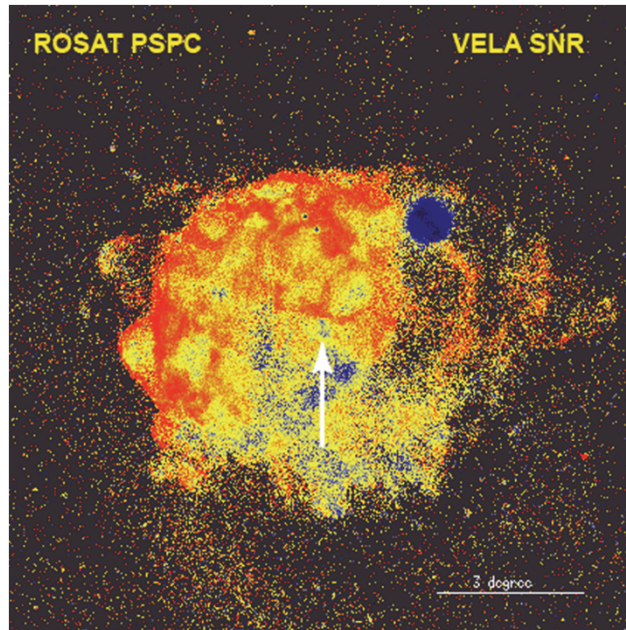


T Tauri stars discovered with follow-up observations of ROSAT All-Sky Survey sources:

● $3 \cdot 10^5$ yrs old ● 10^6 yrs old ● $3 \cdot 10^6$ yrs old ● 10^7 yrs old ○ age unknown

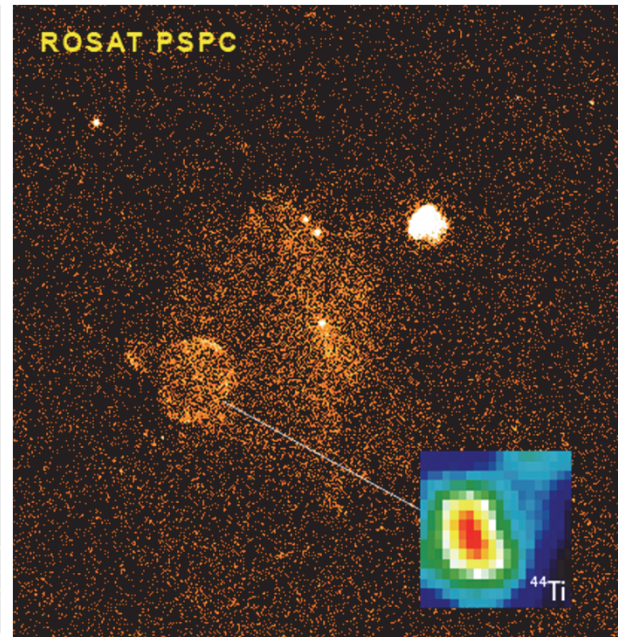
Red lines are 100 μm infrared contours (IRAS), i.e. the star forming clouds.
Small black dots are previously known classical T Tauri stars, all on-cloud.

ROSAT discoveries in the Vela-Puppis-A complex



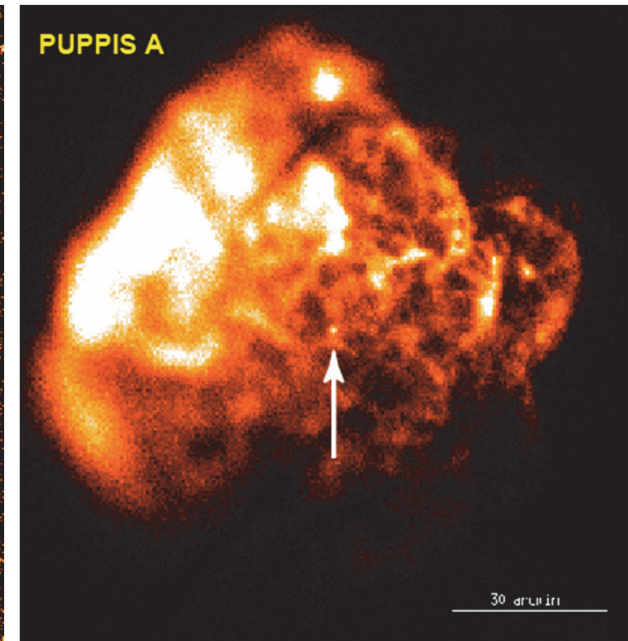
Mach cones in the hot
ISM caused by
explosion fragments

Aschenbach et al.
Nature 1995



„Vela Junior“
In the hard PSPC band
young and closeby

Aschenbach
Nature 1998

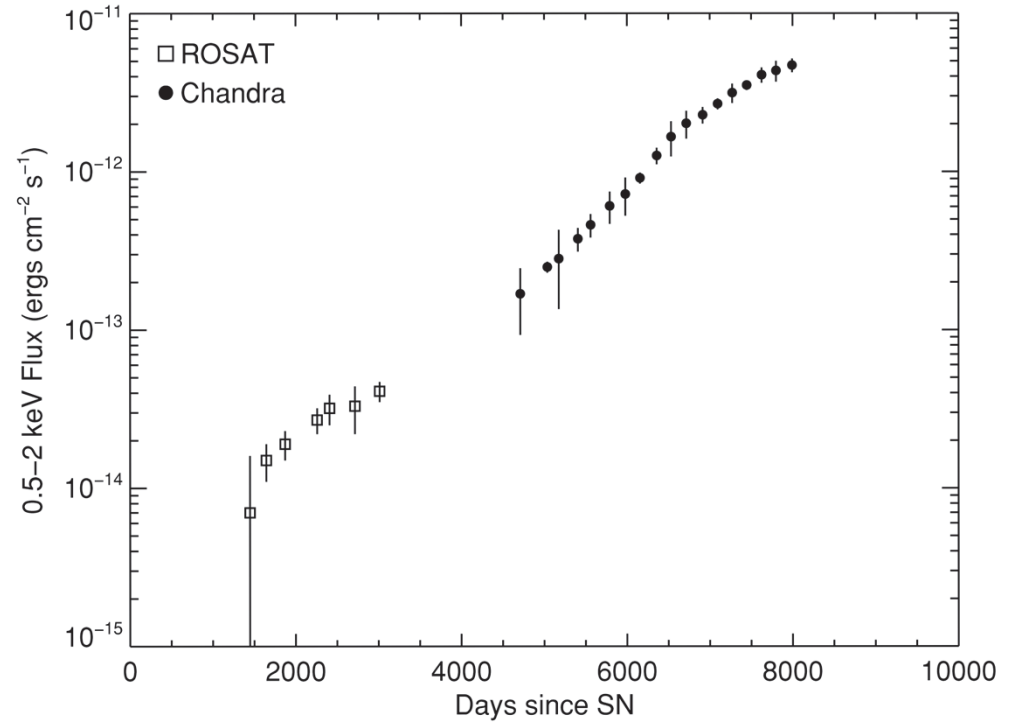
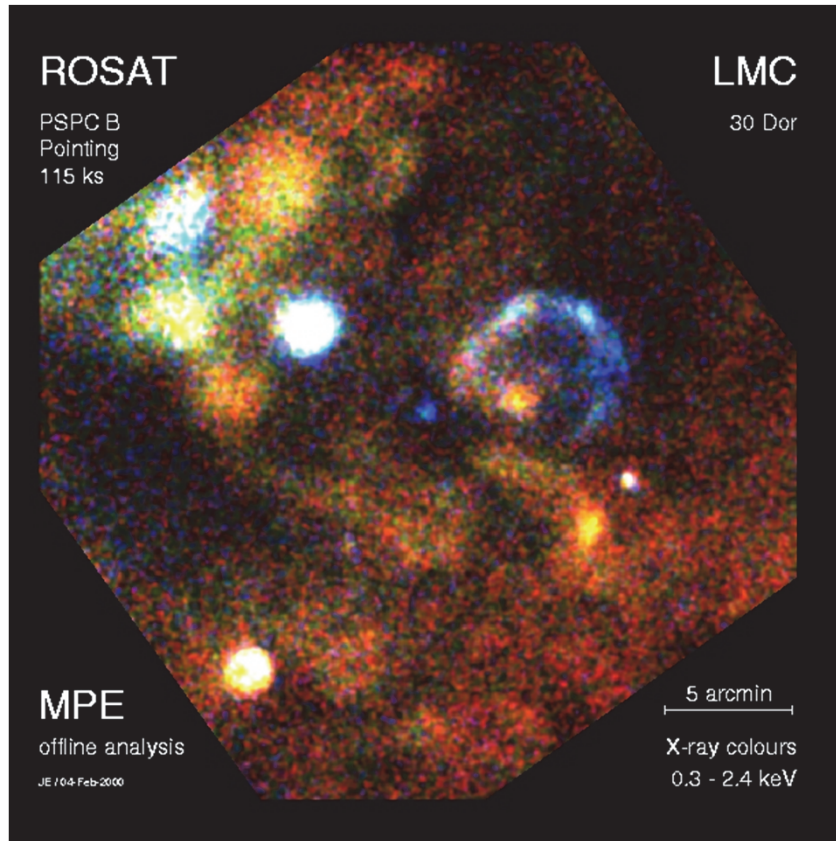


Thermal Emission
from the neutron star
in Puppis A

Petre et al.
A&A 1996

Discovery of soft X-rays from the SN 1987A remnant

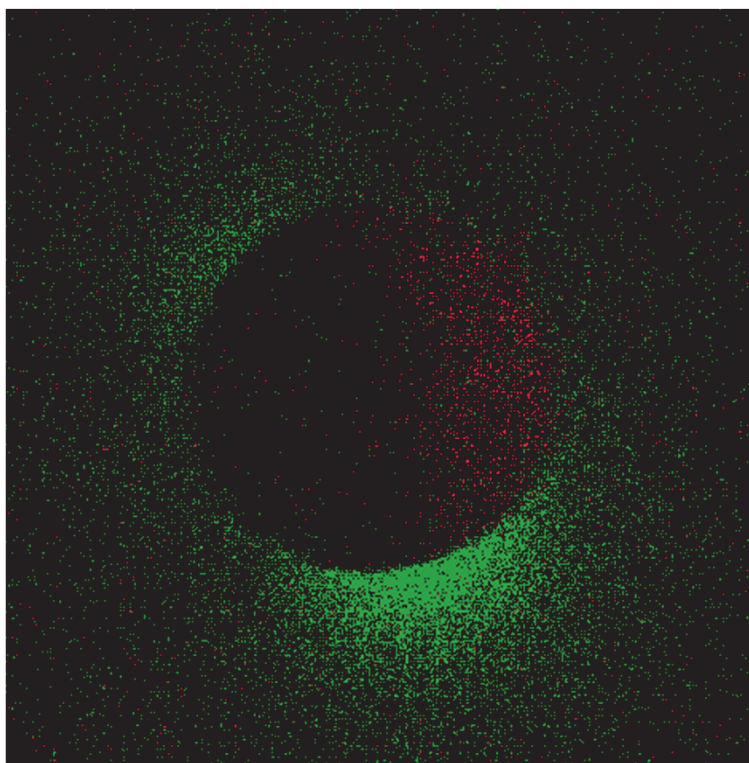
Beuermann et al. A & A 1994



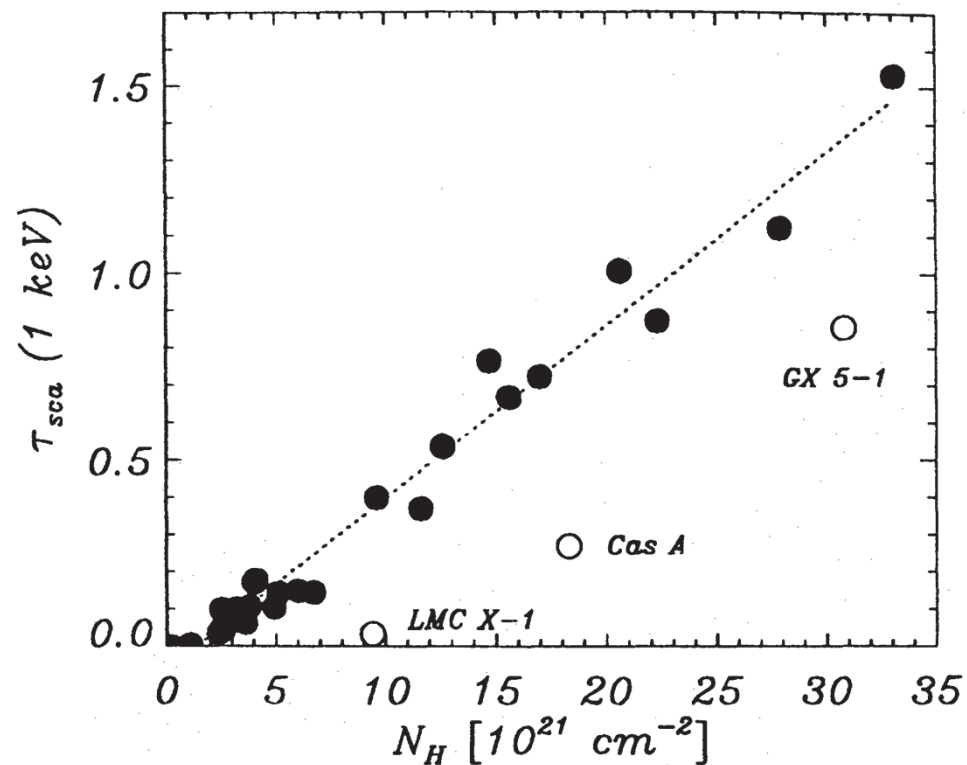
ROSAT

Chandra

Highlight: Correlation of interstellar absorption and dust scattering



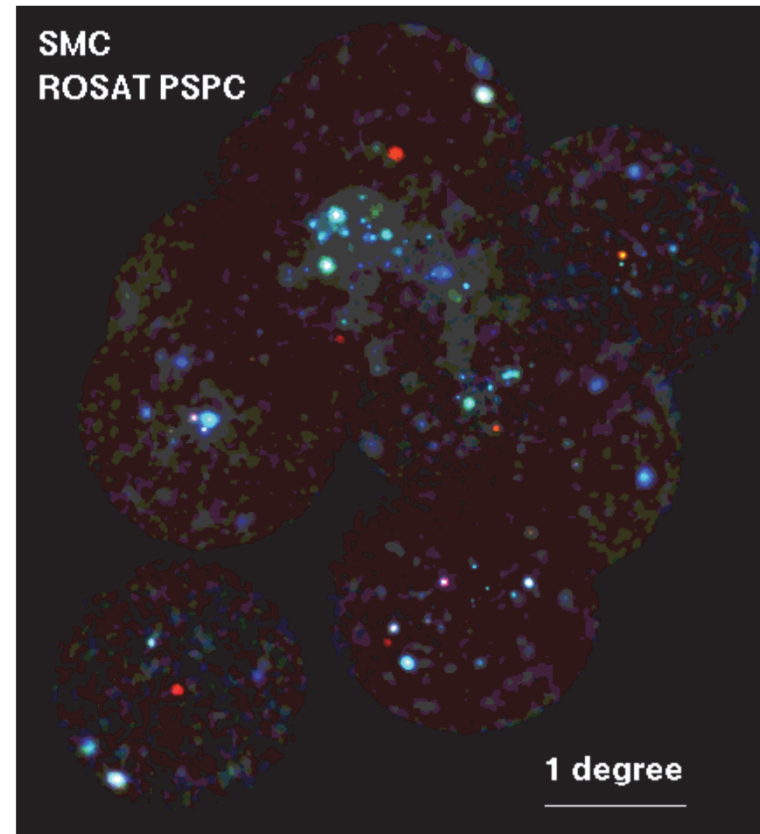
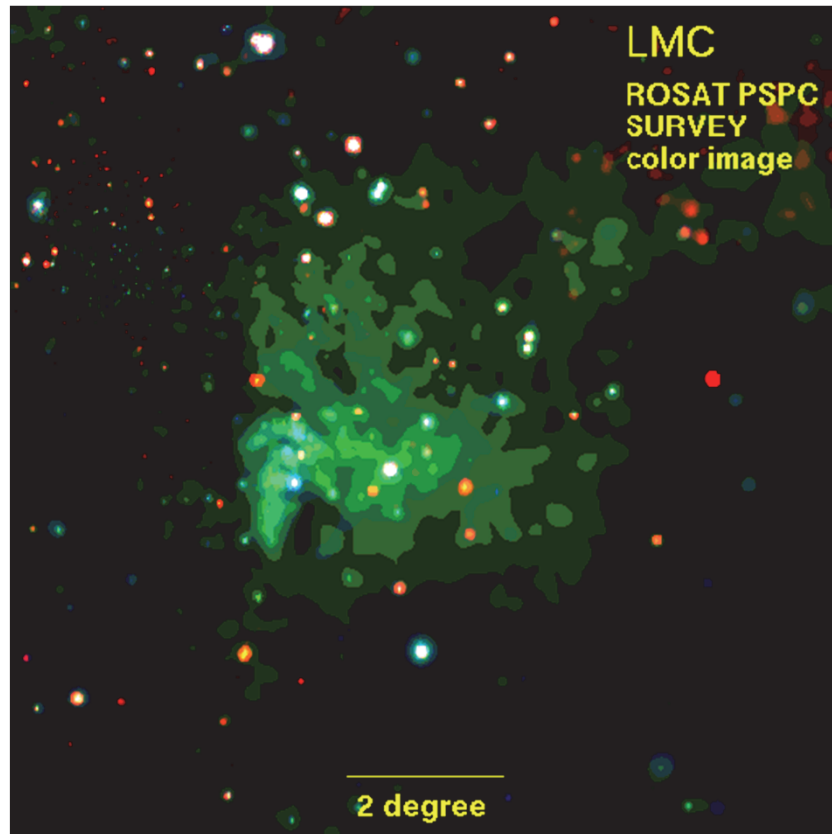
Dust scattering halo of Sco X-1
(Predehl, *The Sky in X-Rays 2008*,
Trümper & Hasinger editors)



Predehl & Schmitt, *A&A* 1995
745 citations (16 Oct. 2011)

Discovery of the new class of supersoft sources

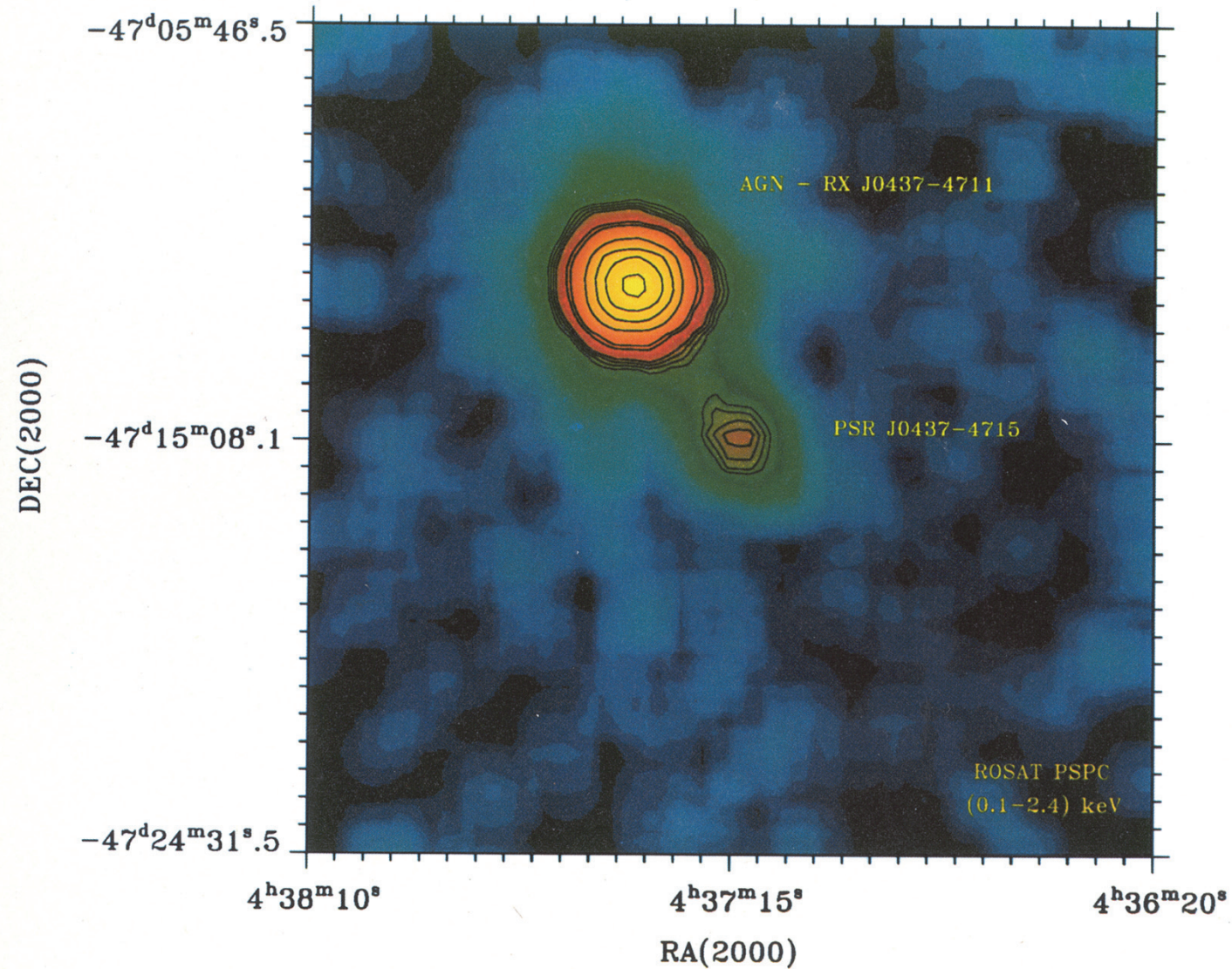
Trümper et al. 1990



CV's, nuclear burning of accreted matter on the White Dwarf surface

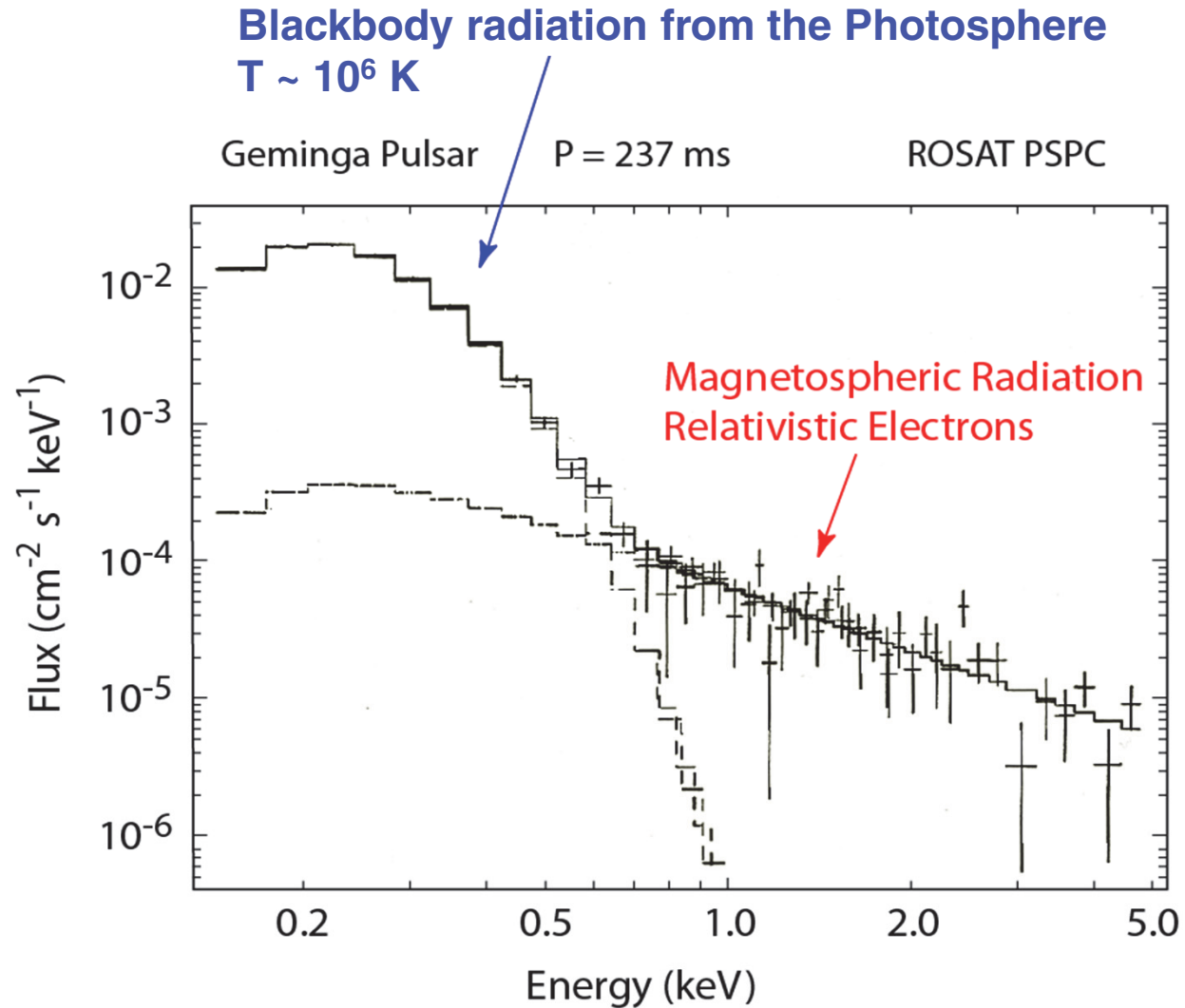
Discovery of the first Millisecond Pulsar in X-rays

Becker & Trümper, Nature 1993



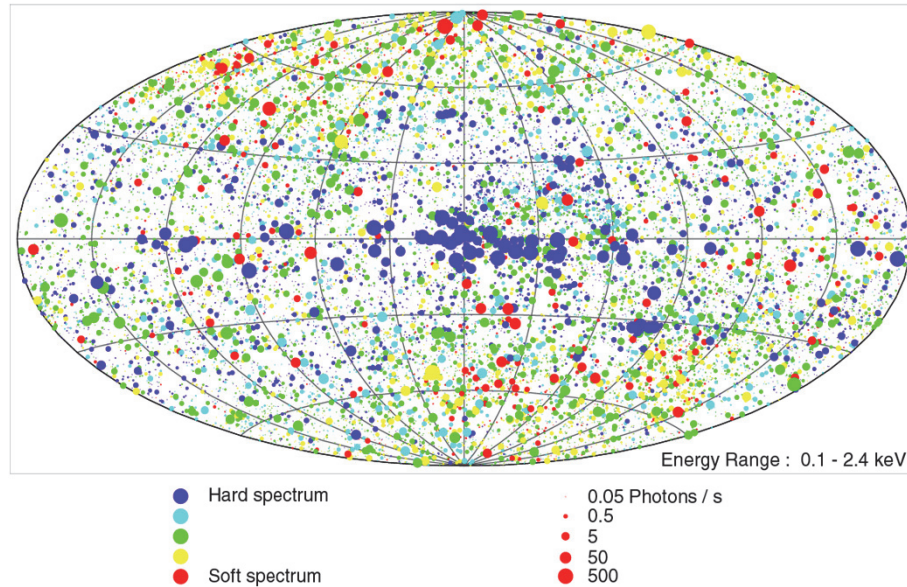
Discovery of the first radio-quiet pulsar: Geminga

Halpern & Holt 1992

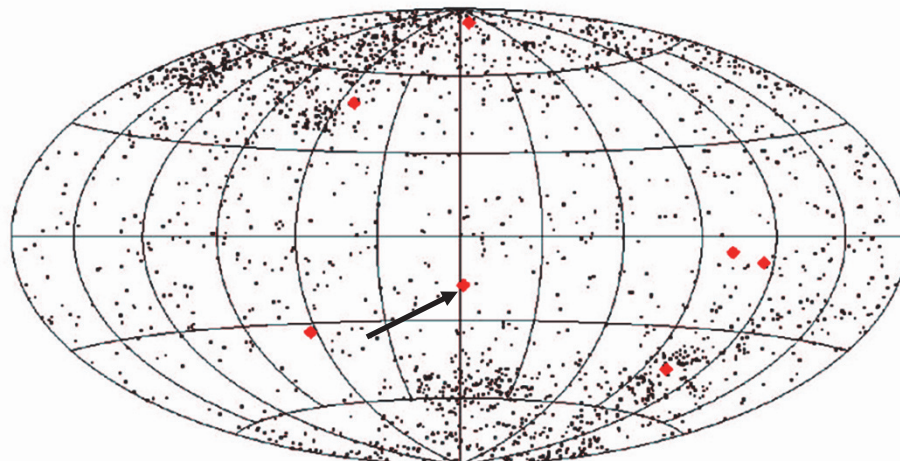


Discovery: 7 neutron stars showing purely thermal emission

ROSAT Bright Survey (~ 20 000 Sources)

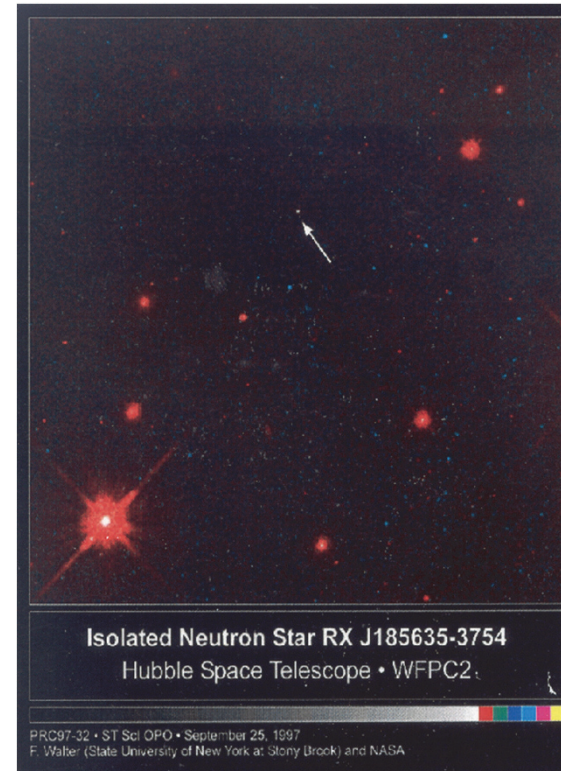


Soft X-ray spectrum + faint in optical



Walter et al., Nature 1996 : RX J1856-3754

RX J1856-3754 :
perfect blackbody in X-rays
and in the optical range
(Rayleigh-Jeans-Law)
 $d = 120 \pm 8$ kpc (HST)
(Walter et al. 2010)
Large NS radius! (> 14 km)

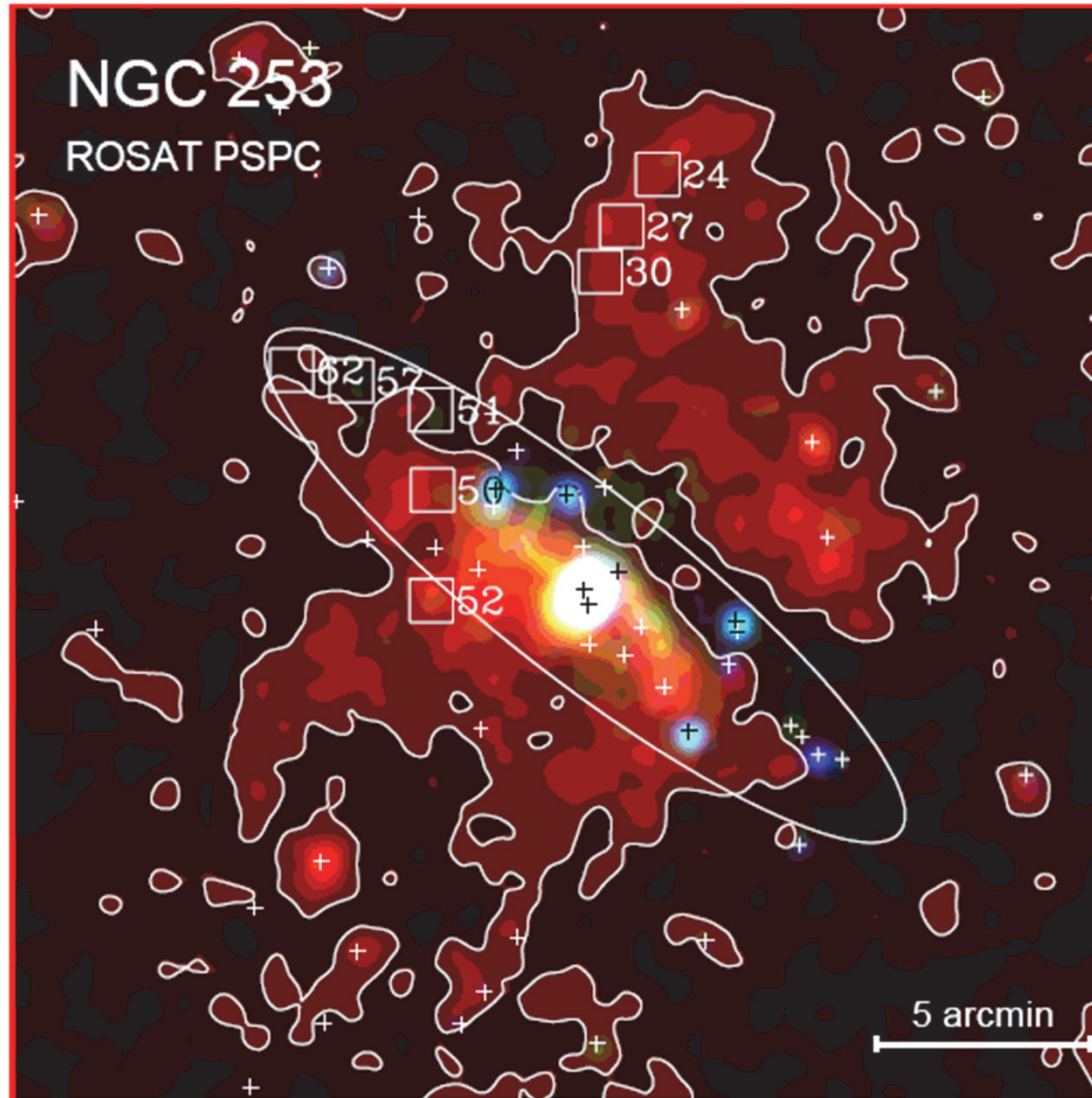


HST: $m = 25,7$

J. Trümper, Garmisch, 2011

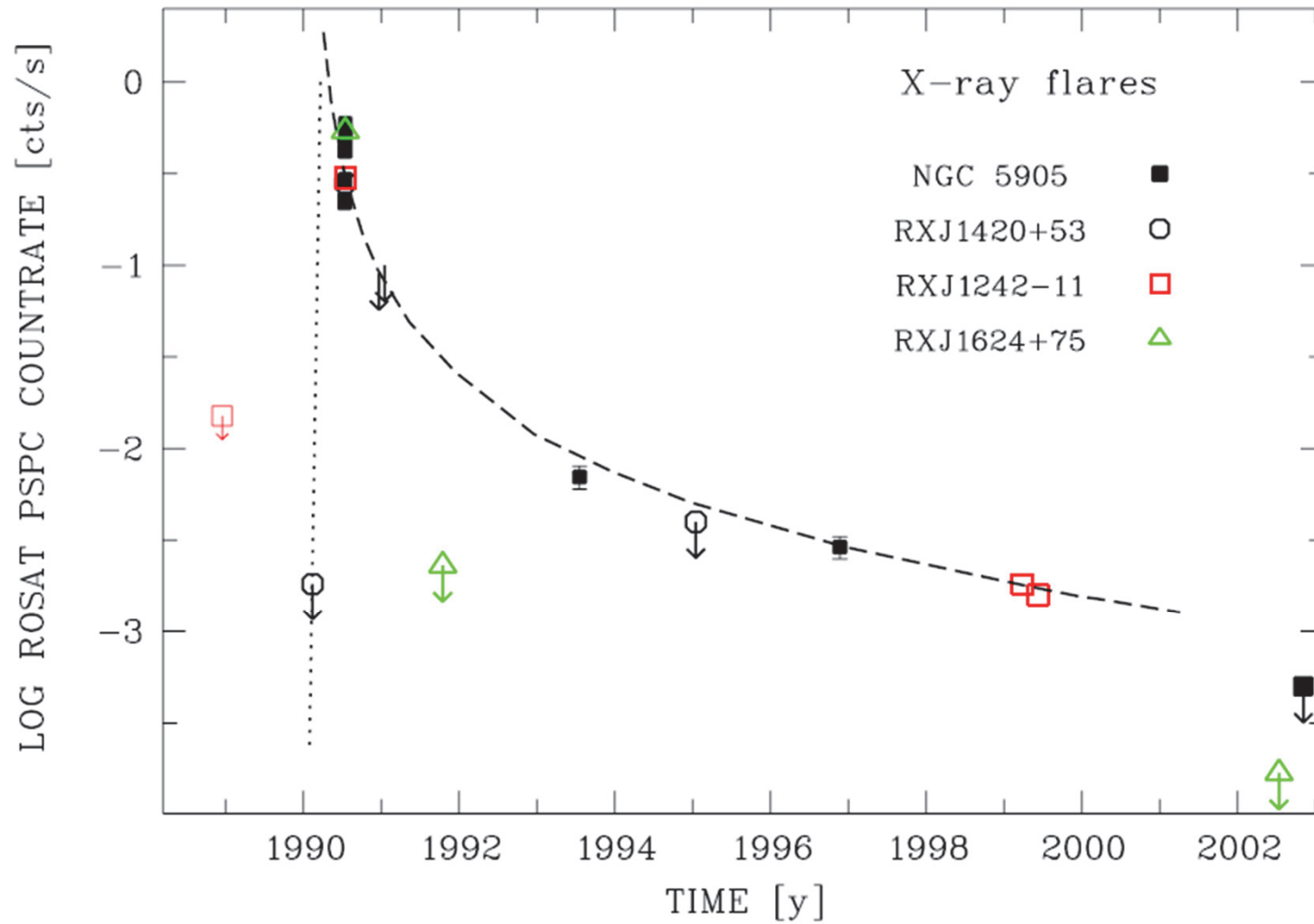
Galactic Halo of a Starburst Galaxy

Pietsch et al. A & A 2000



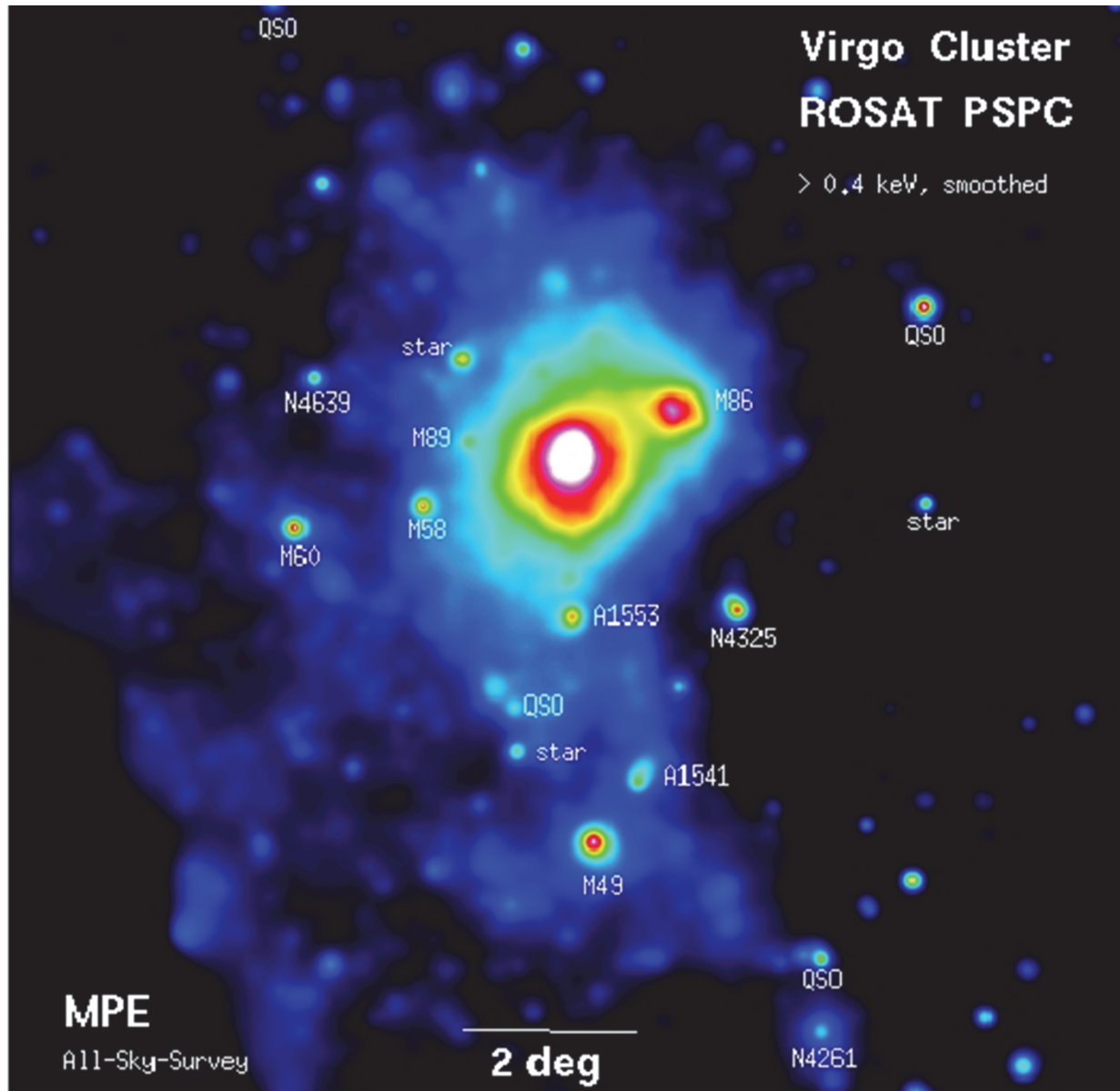
Discovery of X-Ray flares in cores of normal galaxies

Komossa & Bade A & A 1999



Disruption of stars by the central black hole

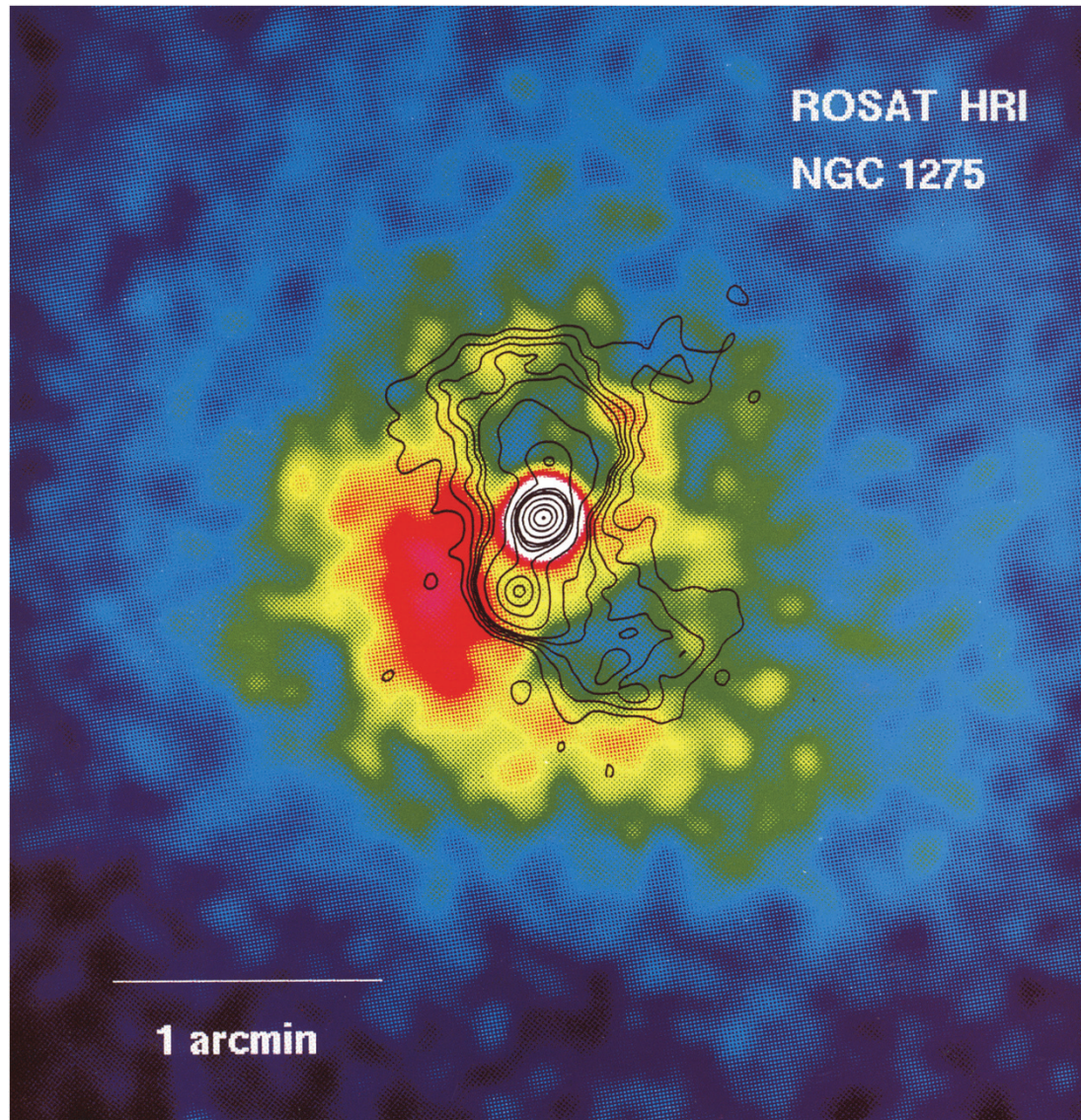
The Virgo Cluster seen with an unlimited field of view



**Böhringer et al.
Nature 1994**

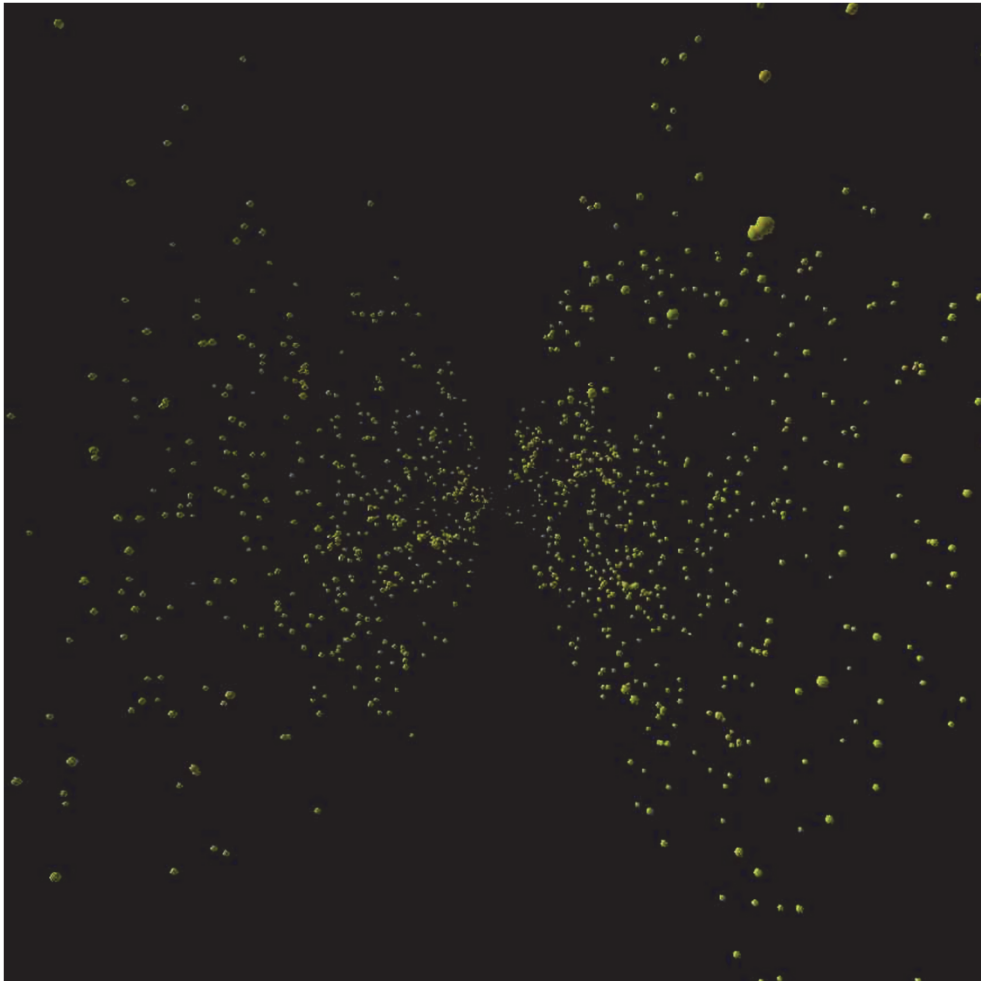
Discovery of bubbles blown by the AGN jets into the hot cluster medium

Böhringer et al., MNRAS 1993

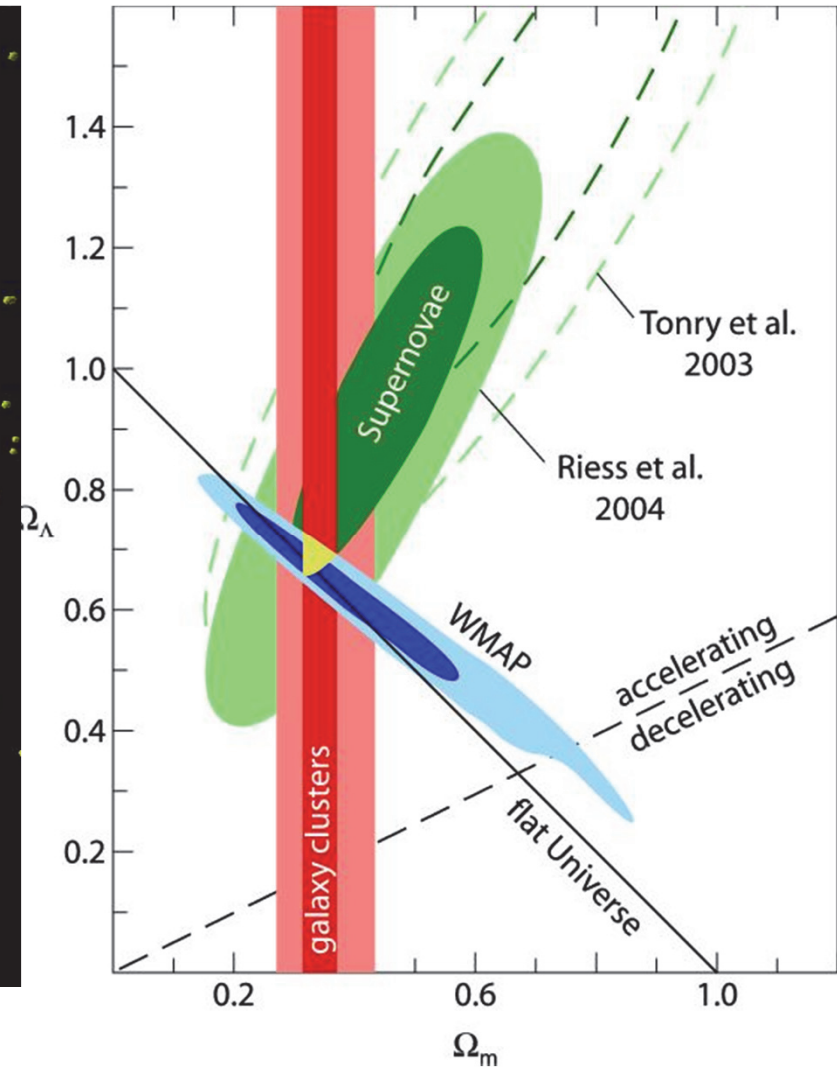


REFLEX Survey - Constraints on Dark Matter

Böhringer et al. A & A 2004



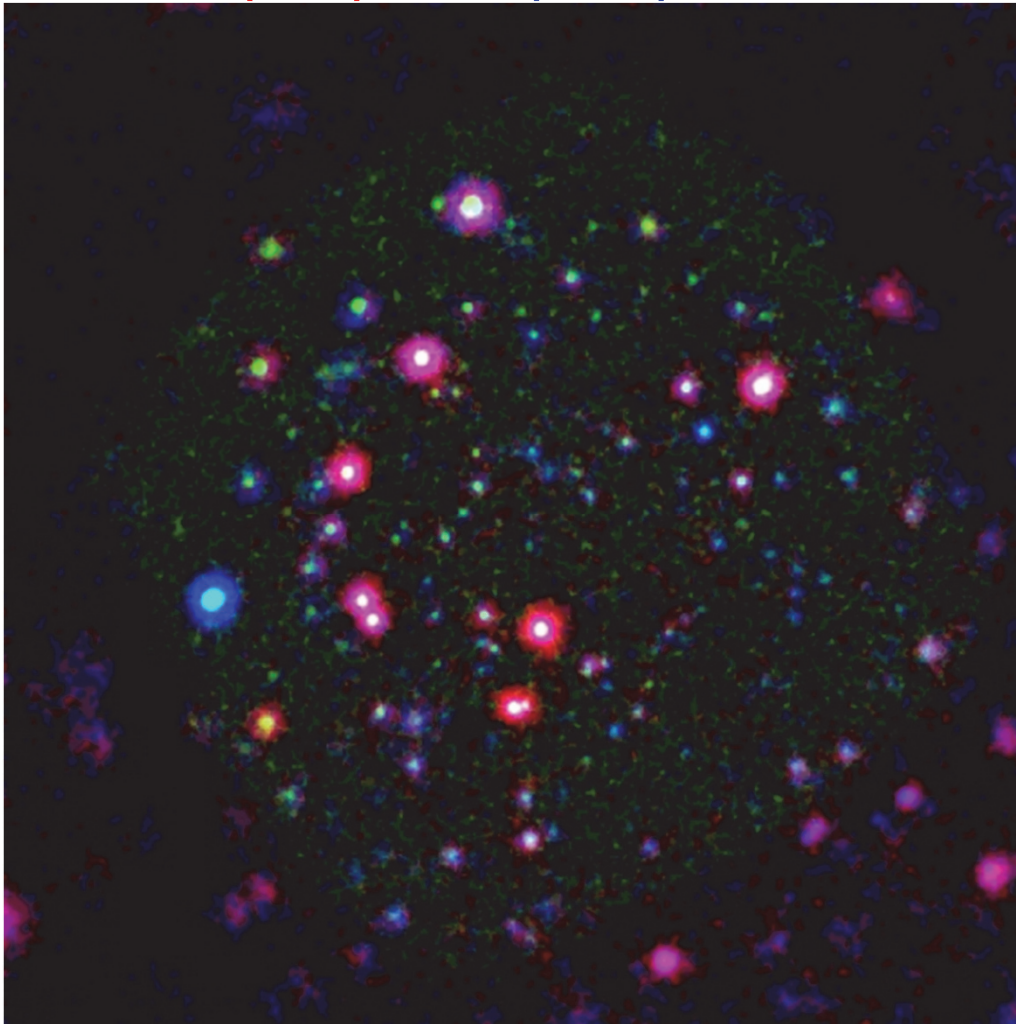
Schücker et al. A & A 2003



Ultradeep X-ray survey of the Lockman Hole

Hasinger et al., A & A 1998

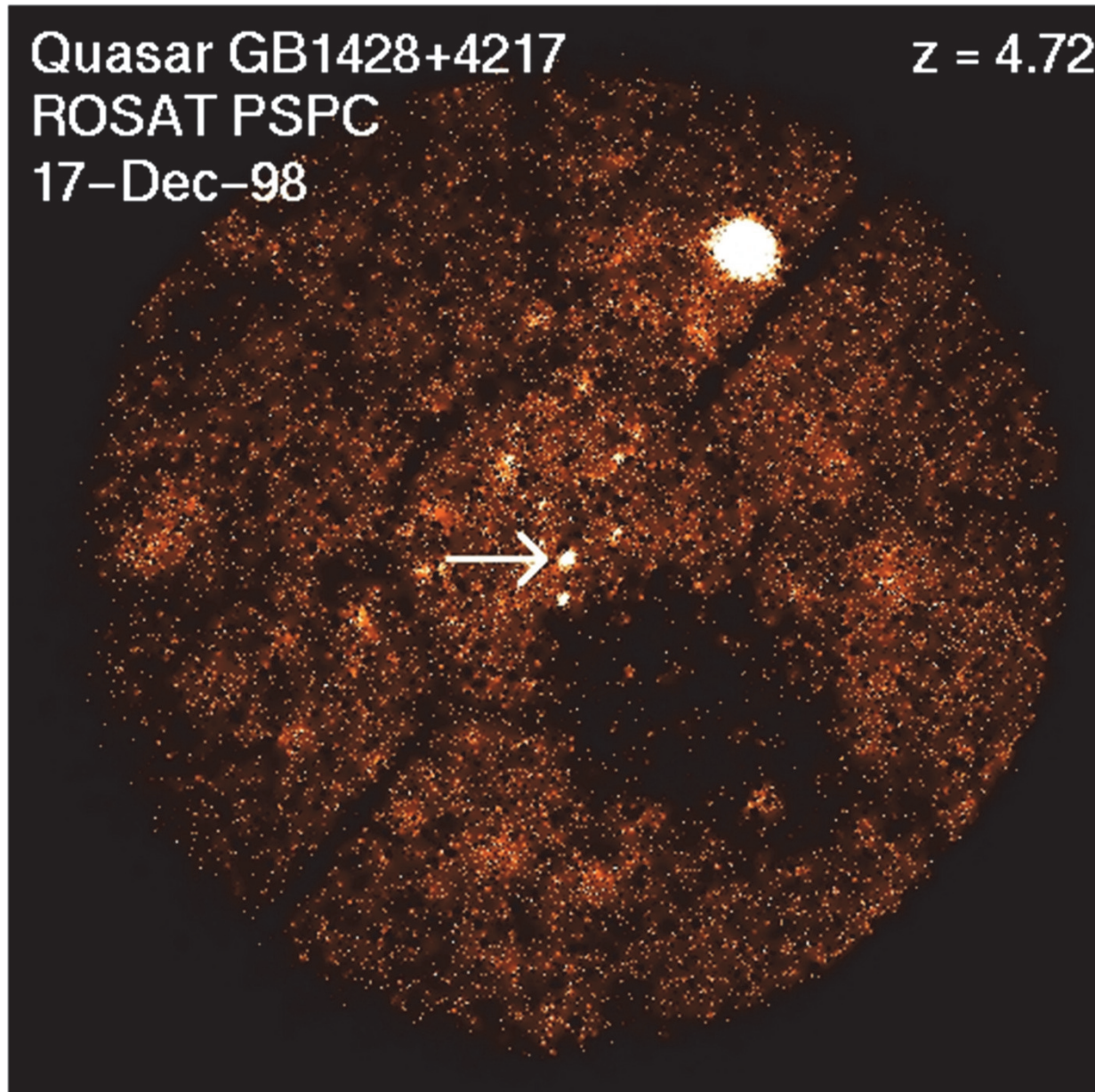
- 1.2 Ms (two weeks!) ROSAT PSPC + HRI image
- red (soft), blue (hard)



~ 80% of the sky background
resolved into sources, mostly AGN;
(Einstein observatory: ~ 20%)

AGN evolution.....

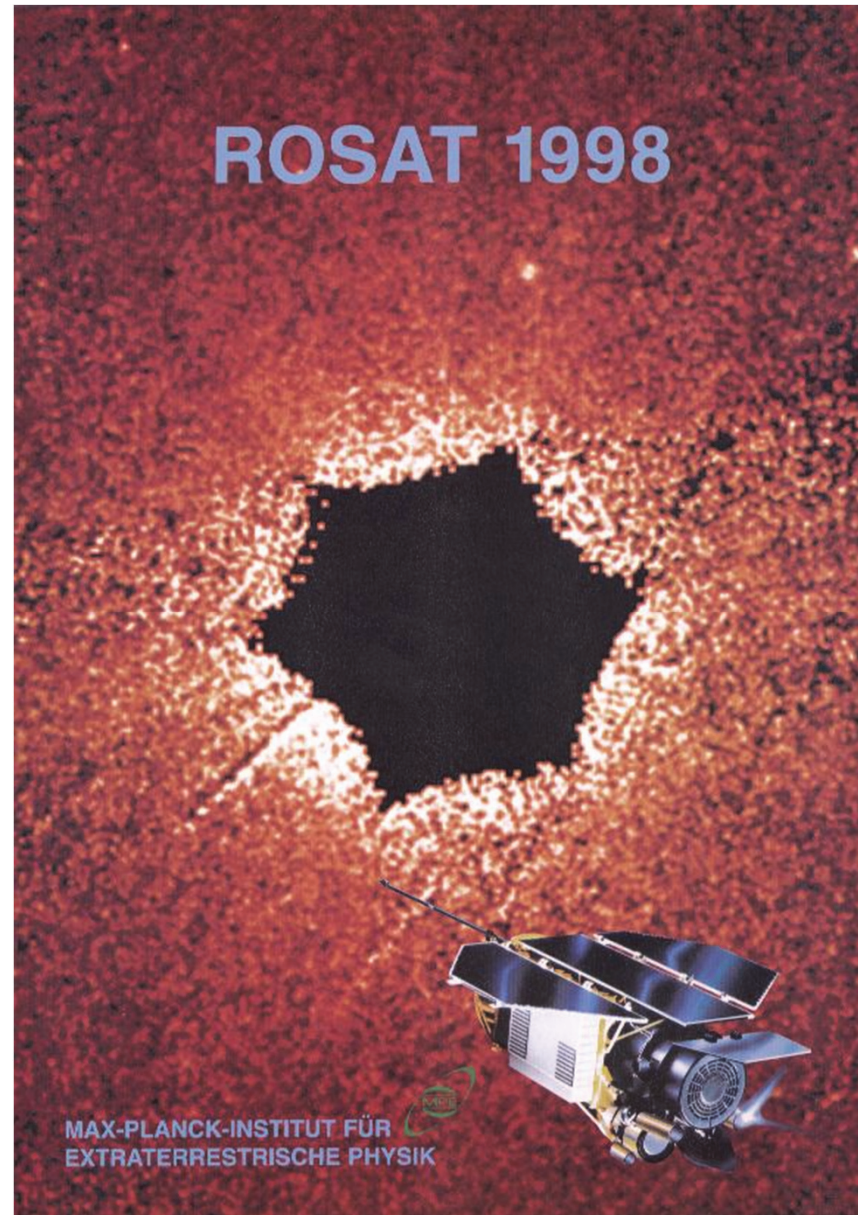
The final days of ROSAT



significant extragalactic
X-ray absorption

“the most distant
matter yet probed with
X-ray spectroscopy”

Boller et al. MNRAS

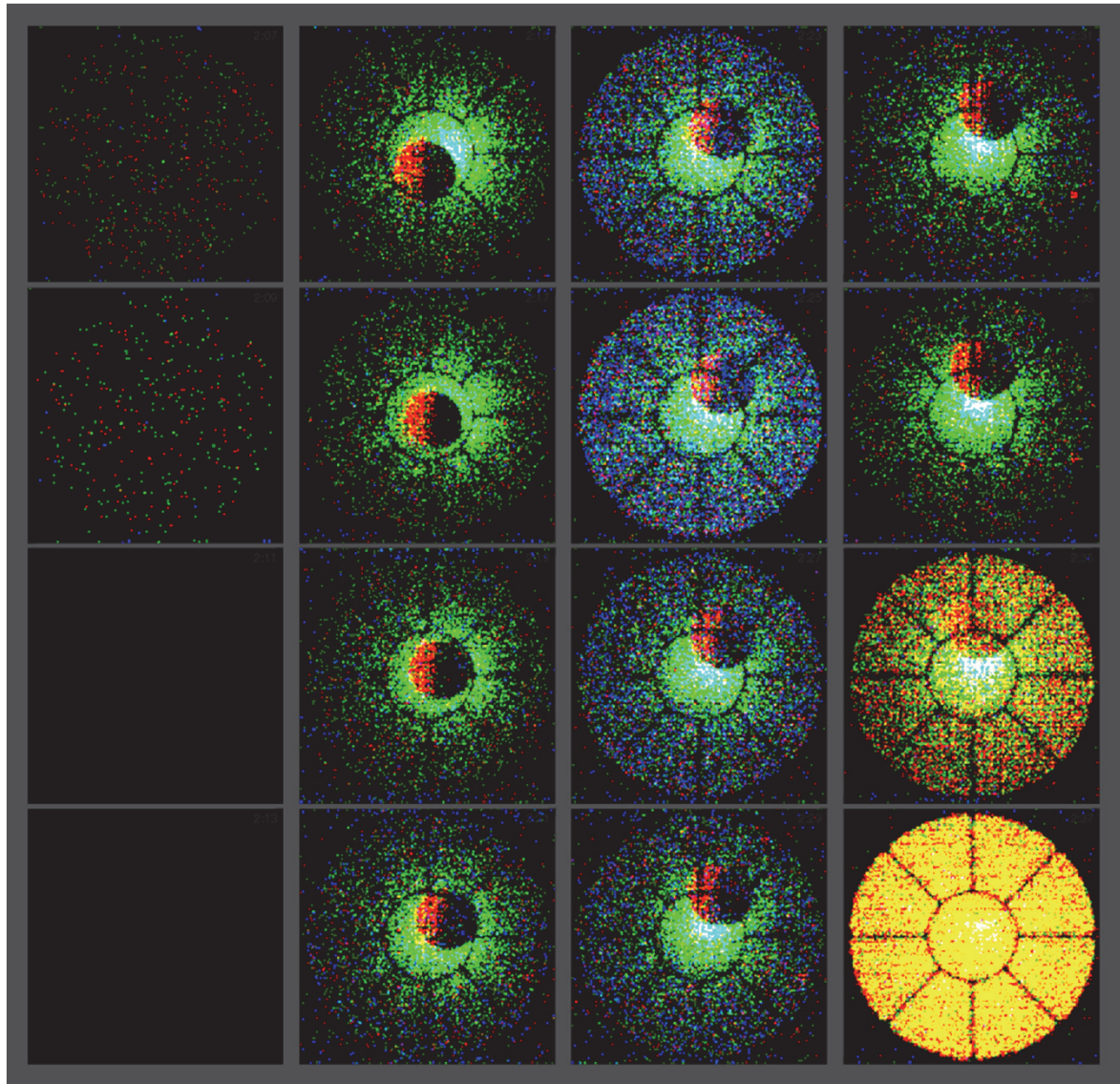


**Scorpius X-1 was
the only source
ROSAT could not
look at**

dust halo of Sco X-1

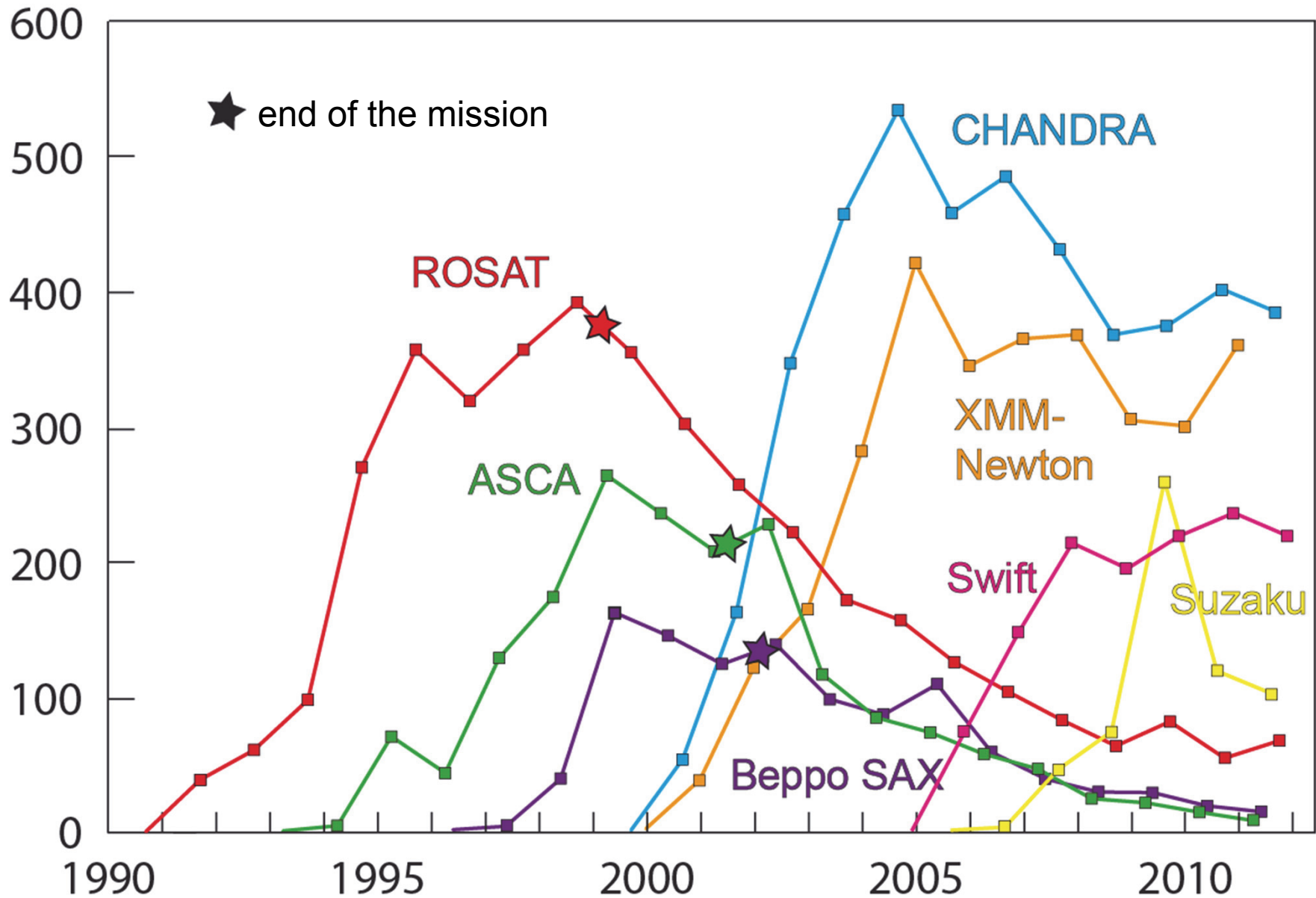
The lunar occultation of Sco X-1 on April 28, 1998

Predehl & Englhauser, unpublished

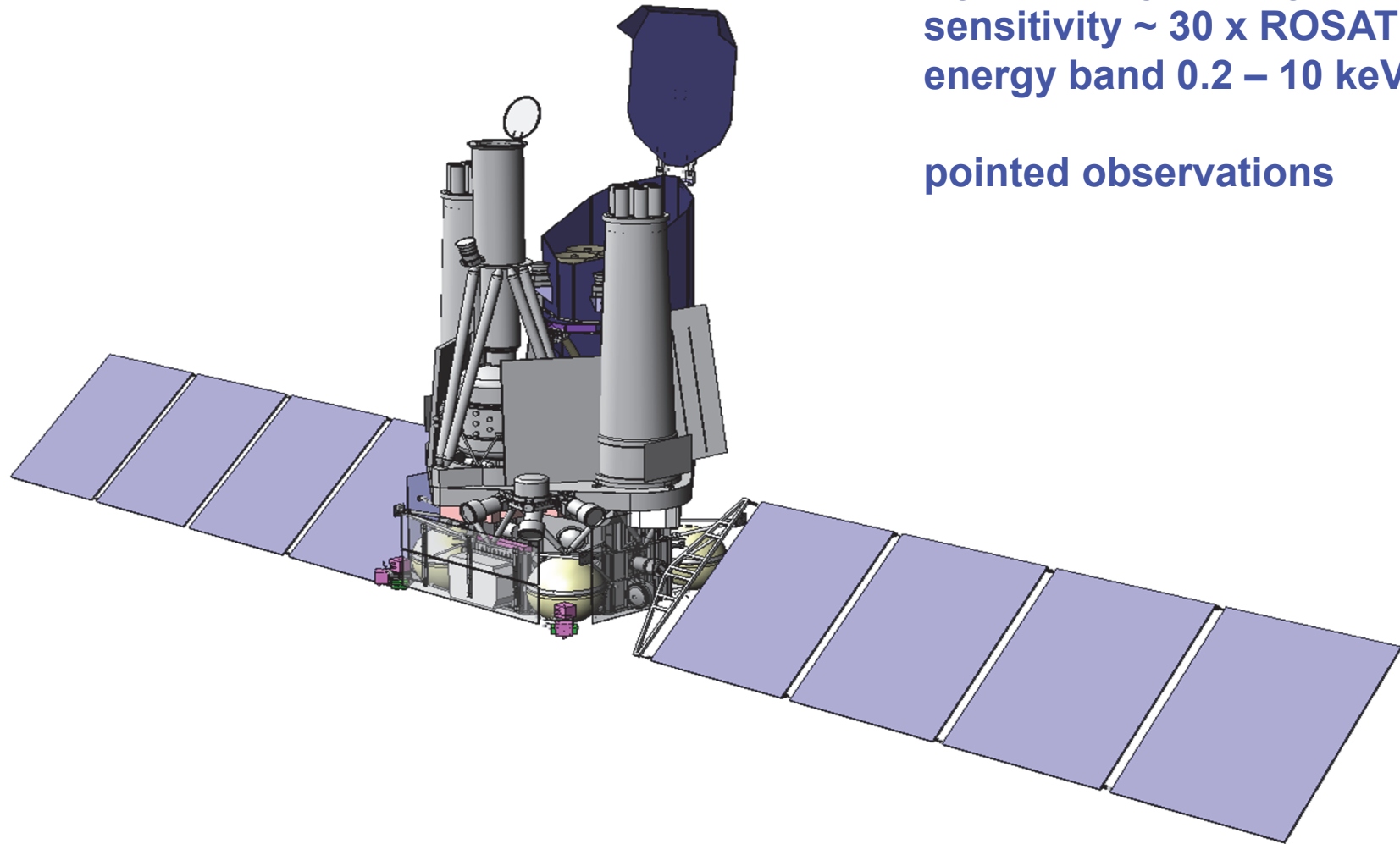


the next occasion will be in 2016!

Number of Publications in refereed Journals (ADS)



SRG

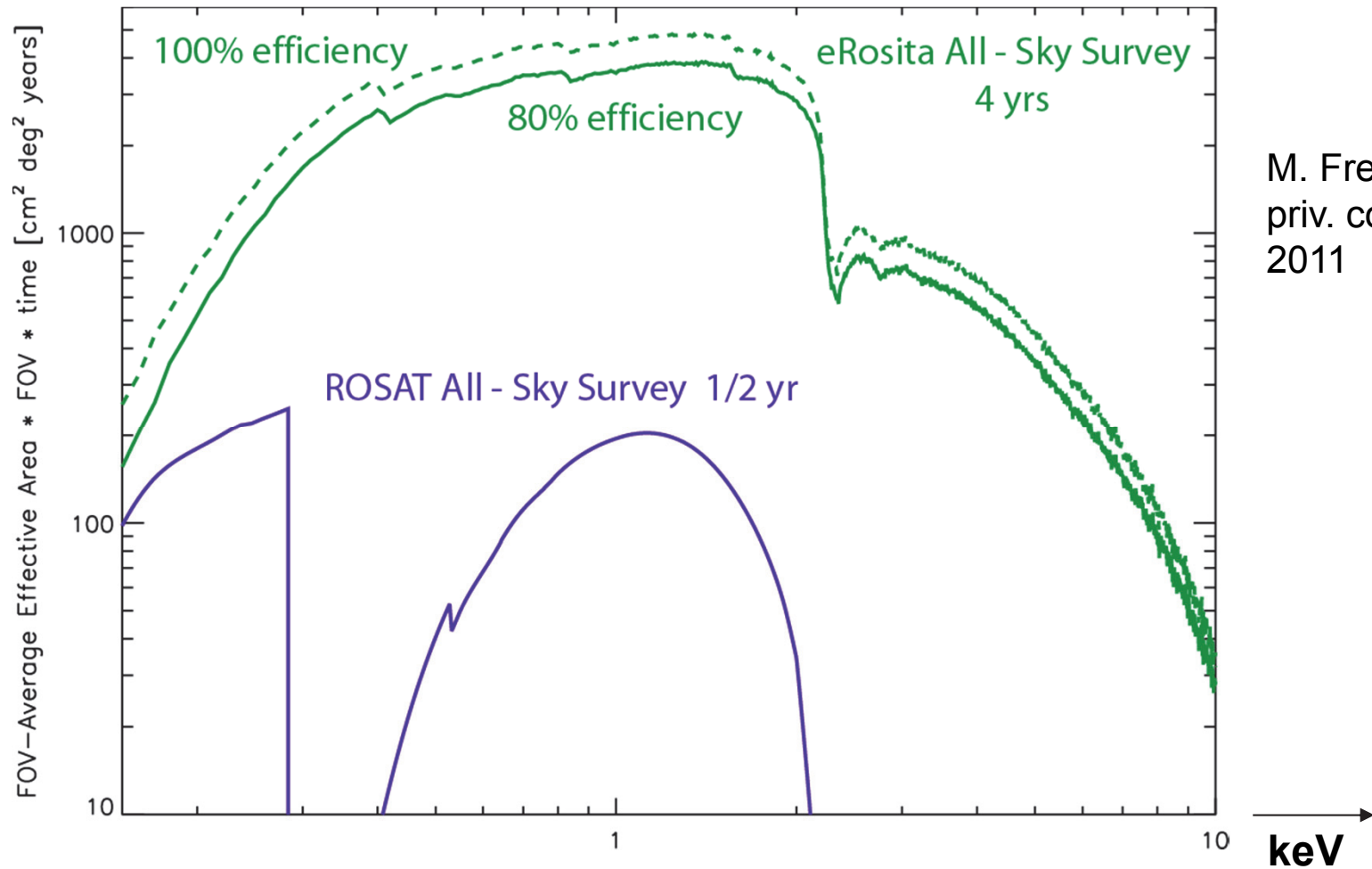


eROSITA

4 yrs All Sky Survey, 25"
sensitivity ~ 30 x ROSAT!
energy band 0.2 – 10 keV

pointed observations

Grasp of the eROSITA and ROSAT All Sky Surveys

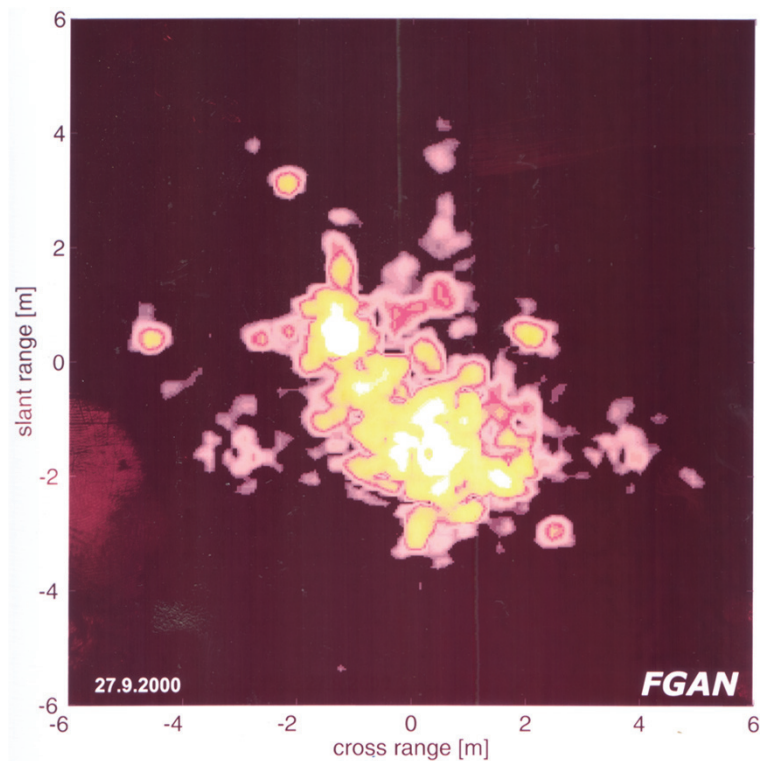


M. Freyberg
priv. com.
2011

energy resolution ~ 4' ROSAT PSPC

eROSITA will be an extremely powerful instrument!

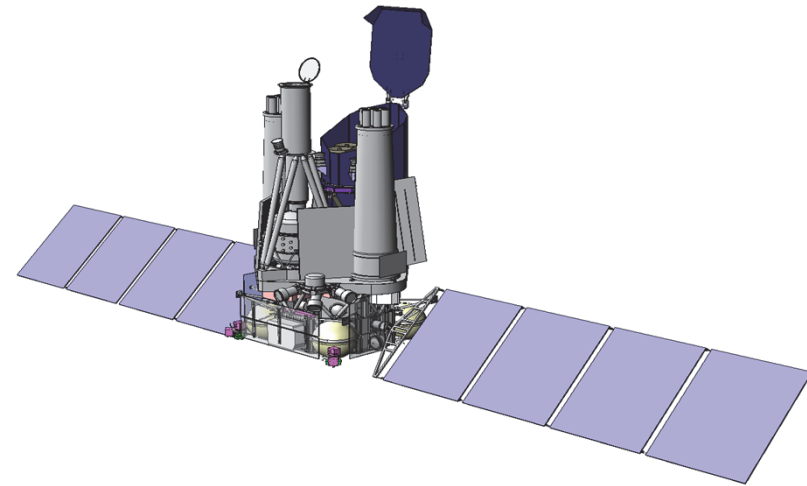
My last ROSAT Image



Radar image taken on
27 Sep 2000

Re-entry: ~ next week!

Best wishes for
eROSITA and SRG!



Lets hope that everything
goes well!

It will be a great mission!

Thank You !