The Rossi X-Ray Timing Explorer
“taking the pulse of the Universe”

Jérôme Rodriguez (CEA/Sap, France)
The 'R' in RXTE

- In 1996, after its launch XTE has been renamed Rossi-XTE in honour of Bruno B. Rossi
- Prof. Bruno B. Rossi († 1993) is a pioneer of X-ray astronomy.
- Discovery of Sco X-1 in 1962, by a team composed of Riccardo Giacconi, Herb Gursky, Frank Paolini & Bruno B. Rossi
Mission Characteristics

- **Lifetime**: 30 December 1995 to the present
- **Energy Range**: 2 - 250 keV
- **Special Features**: Very large collecting area and all-sky monitoring of bright sources
- **Payload**:
  - All-Sky Monitor (ASM)
  - Proportional Counter Array (PCA)
  - High Energy X-ray Timing Experiment (HEXTE)
- **Low Earth Orbit, ~ 90 minutes period**

**VERY HIGH FLEXIBILITY** of its scheduling => unprecedented instrument to study all type of X-ray emitting objects
Technical view

PCA: 5 PCUs

HEXTE: 2 Clusters

ASM: 3 cameras
The All Sky Monitor

Built by the Center for Space Research at MIT
The principal investigator is Dr. Alan M. Levine

- 3 Scanning Shadow Camera (SSC), 6° x 90° FOV/SSC
- Collecting area: 90 cm², Effective area/SSC: 10 cm², 30 cm², 23 cm² @2, 5, 10 keV
- Xenon proportional counter, position-sensitive
- Sensitivity: 20 mCrab
- Spatial resolution: 3' x 15'
- 1 Crab <-> 75 cts/s (1.5-12 keV)
- 3 spectral channels 1.5-3, 3-5, 5-12 keV
- Time resolution: histograms accumulated every 90s
- 80% of the sky every 90 minutes (1 RXTE orbit)
Uses/Advantages of the ASM

Long term evolution

GRS 1915+105

Spectral Evolution

Transients: New/outbursts

XTE J1550-564

Periods in X-ray lightcurves

IGR J19140+0951

ASM Count Rate (cts/s)

HR: 5-12/3-5 keV

Time (MJD)

Observing the X- and Gamma-ray sky Spring School / Cargèse April 3-14, 2006
The Proportional Counter Array

- 5 proportional counters (PCU)
- Total collecting area: 6500 cm²
- Energy range: 2 - 60 keV
- Energy resolution: < 18% at 6 keV
- Time resolution: 1 μs
- Spatial resolution: collimator with 1° FWHM
- Sensitivity: 0.1 mCrab
- Background: 2 mCrab

Built by the EUD (formerly 'LHEA') @ GSFC
The principal investigator is Dr. Jean H. Swank
PCA: Dedicated to timing analysis (1)

Study of QPOs & Spectro-temporal analysis

Spectral and temporal fitting short time scales => spectro-temporal connections

Large collecting area => « spectra » of QPOs

Swank et al. '98, Markwardt et al. '99
Rodriguez et al. '04

Observing the X- and Gamma-ray sky Spring School / Cargèse April 3-14, 2006
PCA: Dedicated to timing analysis (2)

Discovery of high Freq. QPOs

Twin kHz QPOs in NS

Sco X-1

hHz QPOs: in NS

4U 0614+09

« kHz » QPOs in BH

GRO J1655-40

Review by van der Klis, astro-ph '04; to be published in '06
PCA: Dedicated to timing analysis (3)

Discovery of Accreting ms pulsars

=> Coherent pulsations => Spin
=> Msp = missing link between slow isolated pulsars and radio ms pulsars

Review by Wijnands, astro-ph '05
The High Energy Timing Experiment

Built by the CASS at UCSD.
The principal investigator is Dr. Rick E. Rotschild

- Detectors: 2 clusters of 4 NaI/CsI scintillation counters
- Cluster "rock" (beamswitch) along mutually orthogonal directions 1.5 or 3.0° off source
- Energy range: 15 - 250 keV
- Energy resolution: 15% at 60 keV
- Time sampling: 8 microsecond
- Field of view: 1 degree FWHM
- Collecting area: 2 times 800 cm²
- 1 Crab = 360 count/s per HEXTE cluster
- Background: 50 count/s per HEXTE cluster
3-200 keV spectral analysis (1)

Spectral transitions in X-ray sources, evolution of spectral components

XTE J1550-564

Low Hard State

Interm. State

Rossi et al. ’05

XTE J1650-500

Total flux

PL flux

Fe Line Flux

Rodriguez et al. ’03

Observing the X- and Gamma-ray sky Spring School / Cargèse April 3-14, 2006
3-200 keV spectral analysis (2)

Reflection component

XTE J1650-500

Rossi et al. ‘05

(multiple) Cyclotron lines

V0332+53

Kreykenbohm et al. ‘05
Data reduction

Data reduction straightforward
Entirely based on ftools/HEASOFT

=>RXTE Getting started guide:
http://rxte.gsfc.nasa.gov/docs/xte/start_guide.html

=>RXTE Cook Book:

=>The ABC of RXTE:
http://rxte.gsfc.nasa.gov/docs/xte/abc/contents.html
Some of the (numerous) discoveries

- "kilohertz" QPO's in NS & BH systems

- ms coherent pulsations in LMXBs (=> ms X-ray pulsars)

- Spin periods in LMXRB

- Extensive observations of spectral transitions in transient systems

- Black hole reflection component

- Temporal properties tightly linked to spectral properties

- Connection of TeV-keV flaring in blazars

- More pulsars with cyclotron resonance lines
References


• PCA:
  – Jahoda et al. '96, proc. SPIE, 2808
  – Jahoda et al. '06, astro-ph 0511531, APJS, April '06

• HEXTE: Rothschild et al. '98, ApJ 496, 538