ASTROSAT

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(with thanks to P. C. Agrawal, G. Stewart & M. Srivastava)
ASTROSAT : A Broad Spectral Band Indian Astronomy Satellite

An Indian National Space Observatory

A collaborative project of the

Tata Institute of Fundamental Research (TIFR), Mumbai
ISRO Satellite Centre (ISAC), Bangalore
Indian Institute of Astrophysics (IIA), Bangalore
Inter-University Centre for Astronomy & Astrophysics, Pune.
Raman Research Institute, Bangalore
Physical Research Laboratory, Ahmedabad

Canadian Space Agency, Canada

Leicester University, U.K.

with the participation of
many Indian Universities and research centers

Neutron stars and GRBs 2009, Egypt, March 2009
ASTROSAT Science Goals

• **Multi-wavelength observations:**
  - ASTROSAT will be a powerful mission for multi-wavelength astronomy for a wide variety of both Galactic and extra-galactic source types (AGN, binaries, flaring stars, SNRs, clusters...)
  - Five co-aligned telescopes simultaneously cover the hard X-ray to visible bands

• **Broad band X-ray spectral measurements:**
  - Emission and absorption features with medium energy resolution capability in the 0.3 – 100 keV spectral band with 3 co-aligned X-ray instruments
  - Study both non-thermal and thermal components, reflection etc.

• **High time-resolution studies:**
  - Periodic, aperiodic and chaotic X-ray variability in X-ray binaries
  - Detect new accreting milli-sec binaries and AXPs
  - Study evolution of pulse and orbital periods
ASTROSAT payload

- Large Area X-ray Proportional Counter
- Scanning Sky Monitor (SSM)
- UV Imaging Telescope
- Soft X-ray telescope (SXT)
- Cadmium Zinc Telluride Imager
- Charged Particle Monitor

*Neutron stars and GRBs 2009, Egypt, March 2009*
## ASTROSAT instrument details

<table>
<thead>
<tr>
<th></th>
<th>UVIT</th>
<th>SXT</th>
<th>LAXPC</th>
<th>CZTI</th>
<th>SSM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
<td>Twin, RC, 38cm telescopes</td>
<td>Focussing X-ray conical foil mirrors</td>
<td>Proportional counters</td>
<td>CZT array</td>
<td>3 PSPCs with 1-D coded mask</td>
</tr>
<tr>
<td><strong>Energy range</strong></td>
<td>125-550 nm (NUV, FUV, VIS)</td>
<td>0.3-8 keV</td>
<td>2-80 keV</td>
<td>10-150 keV</td>
<td>2-10 keV</td>
</tr>
<tr>
<td><strong>Energy Resolution (FWHM)</strong></td>
<td>&lt; 100 nm (depends on choice of filters + R~100 grisms)</td>
<td>3% @ 6 keV</td>
<td>10% @ 22 keV</td>
<td>5% @ 60 keV</td>
<td>19% @ 6 keV</td>
</tr>
<tr>
<td><strong>Angular Resolution</strong></td>
<td>1 arcsec</td>
<td>3-4 arcmin (HPD)</td>
<td>~ 1 to 5 arcmin (scan mode)</td>
<td>8 arcmin</td>
<td>5 – 10 arcmin</td>
</tr>
<tr>
<td><strong>Time Resolution</strong></td>
<td>few ms</td>
<td>2.6 s, 0.3 s, 1 ms</td>
<td>10 microsec</td>
<td>1 ms</td>
<td>1 ms</td>
</tr>
<tr>
<td><strong>Sensitivity (Obs.Time in ks)</strong></td>
<td>20 magnitude (4 σ) in 50 nm band (1Ks)</td>
<td>0.1 milliCrab (3 σ) (1 Ks)</td>
<td>0.1 milliCrab (3 σ) (1 Ks)</td>
<td>0.5 milliCrab (5 σ) (10 Ks)</td>
<td>~30 milliCrab (3 σ) (0.3 Ks)</td>
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**Neutron stars and GRBs 2009, Egypt, March 2009**
ASTROSAT hard X-ray effective area

Effective area (cm²)

Energy (keV)

Neutron stars and GRBs 2009, Egypt, March 2009
ASTROSAT sensitivity and targets

- Galactic Objects
  - Crab
  - LMC, SMC

- Extra Galactic Objects
  - Galaxies / QSOs
  - Clusters of Galaxies

- Intensity (mCrab)
- Luminosity Distance (light year)

- 300 s (SSM)
- 1 ks (CZT)
- 1 ks (SXT)
- 1 ks (LAXPD)

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Galaxy cluster (20ks)

Simulated wide band X-ray spectrum of the Coma cluster showing the thermal and non-thermal components.

Spectral model from Rephaeli et al. (1999)
Be/X-ray transient pulsar 4U 0115+63 (10ks)
UVIT simulation (6ks)

INPUT  (Simulation) OUTPUT

(Original image: HST B-band)

Polar Satellite Launch Vehicle (PSLV)

ASTROSAT will be launched on a PSLV from the Satish Dhawan Launch Center at Shriharikota (India).

Well-proven rocket (e.g. AGILE)

Date: 2010

Orbit: ~600 km with inclination of 8 degrees (stable radiation environment)

Mission life: at least 5yrs

Spacecraft: 3-axis stabilised + star trackers, slew rate up to 4 degrees min\(^{-1}\)

Chandrayaan-1 launch 12/11/08

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### ASTROSAT observing time

<table>
<thead>
<tr>
<th>T0 +</th>
<th>1st yr</th>
<th>2nd yr</th>
<th>3rd yr</th>
<th>4th yr</th>
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<tbody>
<tr>
<td>Instrument teams</td>
<td>6m - PV</td>
<td>50%</td>
<td>30%</td>
<td>-</td>
</tr>
<tr>
<td>Instrument teams</td>
<td>6m - GT</td>
<td></td>
<td></td>
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<tr>
<td>CSA</td>
<td>5%</td>
<td>5%</td>
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<tr>
<td>Leicester</td>
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<td>Open IND</td>
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<td>35%</td>
<td>45%</td>
<td>65%</td>
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<td>Open Intl</td>
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<td>-</td>
<td>10%</td>
<td>20%</td>
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<tr>
<td>TOO</td>
<td>-</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
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<td>Calib</td>
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<td>2%</td>
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All Science Data archived to a National Space Science Data Archival Centre (ISRO) accessible to the world.

*Neutron stars and GRBs 2009, Egypt, March 2009*
Summary

- ASTROSAT will provide multi-wavelength data covering Visible, UV, Soft X-ray and Hard X-ray regions for a wide variety of sources.
- Timing observations with 10 µs accuracy over 3-80 keV band using the LAXPC.
- Medium energy resolution capability of CZT for accurate spectra and detection of cyclotron features over 10-150 keV band.
- SXT for imaging and spectral studies over 0.3-8 keV band.
- UV studies and UV survey of selected sources and regions with UVIT to a limit of $m \sim 21$.
- Detection and monitoring of transient and persistent X-ray sources with the SSM over 2-10 keV.
- ASTROSAT due for launch in 2010.

http://meghnad.iucaa.ernet.in/~astrosat/