XMM-Newton Education and Public Outreach Program

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SSU took over responsibility for NASA’s portion of the XMM EPO program in 2003

In 2013 NASA announced a change to their long-standing framework for E/PO

New program is handled by Agency-selected teams proposed to 2015 CAN-AO \( \rightarrow \) NASA’s Universe of Learning covers all Astrophysics

Communications and Outreach – still the responsibility of individual missions

SSU’s funding for XMM ran out in 2015
# XMM-Newton goals

<table>
<thead>
<tr>
<th>Science Goals</th>
<th>E/PO Goals</th>
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<tr>
<td>When and where are the chemical elements created?</td>
<td>Use X-ray observations of supernova remnants as an engagement to teach students about the relationship between the death of stars and the birth of the chemical elements</td>
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<td>How does nature heat gas to X-ray emitting temperatures?</td>
<td>Use the map of the X-ray sky to illustrate the diversity of objects in the high-energy Universe, compare them to the visible sky and teach about the properties of different energies of light</td>
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<td>What are the X-ray signatures of accreting black holes?</td>
<td>Use the engagement of black holes to develop science literacy for grades 4-12 and the general public</td>
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E/PO Program Overview

1) Management
2) Formal Education
   – Educator Ambassador Program
   – Supernova Educator Unit
   – CLEA X-ray Spectroscopy Lab
3) Informal Education
   – Space Place Partnership
   – eXtreme Universe planetarium show
   – Global Telescope Network
4) Public Outreach
   – Epo’s Chronicles webcomic
   – E/PO Web Site
   – Amateur Astronomers & Night Sky Network
5) Assessment and Evaluation (WestEd)
Educator Ambassadors

- XMM-Newton supported 2 Educator Ambassadors
  - Master teachers selected in national competition
- XMM-Newton workshops and talks directly reached over 6700 students, teachers, and members of the general public through 71 talks and workshops in 2003-2015
- Over 65,000 educators trained through 2015 for entire EA program (which included Fermi, Swift, NuSTAR and other missions)
Christine Royce, Ed. D.
- Professor at Shippensburg Univ (PA)
- co-director of the Master of Arts in Teaching STEM Education program
- NSTA President 2018 - 2019
- Chandra Teacher Resource Agent
- Presidential Excellence in Science Teaching award winner
- Author of Teaching Science through Trade Books
Chris Royce at work
XMM Educator Ambassadors

• Tom Estill: CA
  – Went on to work at NASA GSFC as aerospace education specialist
  – Now teaching in Vermont
Tom Estill at work

- Narrating the Extreme Universe planetarium show in NASA GSFC dome
XMM Educator Ambassadors

• Neta Apple: OK then MO
  – Still teaching HS in Butler, Missouri
  – Avid amateur astronomer
  – Participated in many Astro4Girls events
Neta Apple at work
• Fishing for Supernovae
  • What do supernova remnants look like in different wavelengths of light?
  • How do different supernovae remnants compare to each other?
Magnetic Poles and Pulsars

Seeing magnetic fields:
extends typical 2D iron filings model to 3D using supermagnet

Make your own pulsar

Very popular activity teaches about pulsars and electronics
Crawl of the Crab - 1956

- Pulsar is in same location in each image
- Measure distance from pulsar to 11 knots in each image
- Images are same scale
- Calculate expansion rate
- Predict date of supernova
Crawl of the Crab - 1999

- Pulsar is in same location in each image
- Measure distance from pulsar to 11 knots in each image
- Images are same scale
- Calculate expansion rate
- Infer date of supernova
Neutron Stars in the News

• Compare and contrast two stories:
  – XMM-Newton makes the first measurement of a dead star’s magnetism (1E1207.4-5209, Bignami et al. 2003)
  – Starquake’ reveals star’s powerful magnetic field (XTE J1810-197, Guver et al 2007)

• Who are the scientists that did the work discussed in each article? What instruments did they use?

• What is the difference in the strength of the magnetic field? How do they compare to the Earth?
Other printed materials

• Magnetic Globe

• Two articles by our Space Place partners (Dr. Tony Phillips, author)
  – “Not a Moment Wasted” – about XMM Slew Survey – distributed to over 200 astronomy clubs for their monthly newsletters
  – “Brush your teeth and avoid black holes” – children’s article about x-rays distributed to 14 major newspapers nation-wide – in English and Spanish - promotes Black Hole Rescue spelling game

• Space Exploration and Humanity: A Historical Encyclopedia – article by LRC
DYING STARS AND THE BIRTH OF THE ELEMENTS
A LABORATORY EXERCISE IN ASTRONOMY
CLEA Laboratory

- Released in early 2006, debuted at AAS in Washington DC
- Uses simulated x-ray spectra to teach about the abundances of chemical elements in supernovae
- Uses XSPEC to fit simulated spectra
- **CLEA labs only run on PCs**
Slew to the Target
Zoom in to see the knots
Take a Spectrum
Fit the Spectrum

Then repeat for different knots in Cas A and compare abundances
Black Hole Rescue!

- Flash-based game developed with NASA JPL SpacePlace
- Learners read article about black holes and XMM-Newton then try to spell words in English or Spanish as the letters swirl around a black hole

https://spaceplace.nasa.gov/black-hole-rescue/en/ or /sp/
Screenshot of Black Hole Rescue
eXtreme Universe Planetarium Show

- For portable (inflatable) Planetaria
- Planetarium show student manual and teacher’s guide completed
- Poster at AAS in Seattle in 2011
- Used Stellarium 0.8.1
- Used ROSAT all-sky survey catalog, plus about a dozen embedded object images that you can zoom in on.
eXtreme Universe Screenshots

- CAS A
- Direct comparison of images in visible vs. X-ray
Global Telescope Network

- **PROMPT telescopes at CTIO**
  - 5 optical and 1 IR 0.4 m
  - Operated by SkyNet software
- **Pi of the Sky** – at Las Campanas – Polish collaboration

6 PROMPT telescopes at CTIO

2 Pi of the Sky 4 Mpixel CCD cameras at Las Campanas
XMM-Newton GTN – Polar project

- Observations were begun in 2003 with GTN (but AAVSO were already monitoring many of the target objects.) Standard sequences are given for each.
- Validated data (usable for publication) are available upon request to AAVSO.
- Polar list: AN UMa, AR UMa, MR Ser, AM Her, QQ Vul, BL Hyi, EF Eri, VV Pup, GQ Mus, V834 Cen, V2214 Oph, V347 Pav
- GTN projects on variable stars being revived within NASA’s Universe of Learning.
Epo’s Chronicles webcomic

- Weekly from 2008-2013
- Translated into French, Spanish and Italian
- Calendars for 2010 featured IYA “Go Observe” objects
- Calendars for 2011 featured high-energy astrophysics missions including XMM-Newton
- About 1500 calendars distributed in 2010 and 2011
- Read by about 7,000 per month, 80,000 unique IPs per year in 2013
This special episode of Epo's Chronicles is not part of the main storyline.

Epo, what other satellites from Earth do you have information about?

I have been able to recover some data about an Earth satellite called XMM-Newton...

It was launched in the Earth year 1999 and was named after the X-ray Multi-Mirror technology it used, hence XMM, and Isaac Newton, another famous Earth scientist.

XMM-Newton, when launched, was the largest satellite built by the scientists of the continent of Europe.

Cool, what was its greatest discovery?

That question is subjective.

However, it did discover the most massive cluster of galaxies seen from Earth while it was operational.

The discovery of this rare cluster was striking evidence for the existence of dark energy.

That is great! I would love to hear more about it in the future.
IYA 2009

- Epo’s Chronicles Lithos for each month’s “Go Observe” object
- Over 18,000 distributed through NSN
- Traveling exhibit reached over 100K in SF Bay Area

Joint with Swift, Fermi
No longer operational

Approved education products available through NASA wavelength
SUPERNOVA! Toolkit

• Developed by ASP for NSN of over 200 amateur astro clubs
• Over 246,000 attendees through 2000 events (through 10/15)
• Over 39,000 minorities and over 59,000 women/girls

Joint with Swift, Fermi and Suzaku
SUPERNOVA! Activities

• Supernovae in the Lives of Stars
  – Life Cycles of Stars poster
  – Let’s Make a Supernova
  – Star Maps: Stars Likely to Go Supernova
SUPERNOVA! Activities

• Protecting the Earth from Cosmic Radiation
  – Nuclear Fusion, Cosmic Radiation and Supernovae
  – Protecting the Earth Activity
  – Air as a Shield
  – Gamma-ray Bursts
SUPERNOVA! Activities

- Universe without Supernovae
  - Cosmic Connection to the Elements (GSFC)
  - Activity, Guide and Poster

- Supernova Education Unit CD
- DVD training video
- Ppts and other resources
Supernova Toolkit messages

• Supernovae and gamma-ray bursts are normal processes in the lives (or rather the deaths) of massive stars.
  – Massive stars are short-lived and rare
  – These explosions are very powerful.
• Supernovae shape the universe and sow the seeds for new worlds & life
  – By creating and circulating the heavier elements from which planets and life are made
  – By compressing clouds of gas and dust to initiate the process of forming new stars
• X-rays and gamma rays are released in the death of massive stars and from black holes and neutron stars that remain after the supernovae.
  – This kind of radiation can be dangerous to life.
  – This radiation is light energy, just much more energetic than visible light
  – Although the radiation from these events can be destructive to life, in a universe without these powerful explosions, there would be no life
• Earth’s atmosphere protects us from most of this radiation and as a consequence, prevents us from detecting this radiation from Earth’s surface.
  – We must put detectors above the atmosphere – out in space – to study this radiation.
  – NASA has missions to study X-rays and gamma rays emitted by powerful events in the universe.
XMM-Newton ruler

In both inches and cm

Very popular!
E/PO Summary

• For a decade, XMM-Newton E/PO excited the public and students of all ages
• All XMM Products were approved by NASA Product Review
• Over 6700 teachers, students and others participated in workshops given by XMM-Newton Educator Ambassadors and SSU staff
• Night Sky Network kit used heavily by amateur astronomers after 2008