

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 → 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

Science Goals	E/PO Goals
When and where are the chemical elements created?	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
How does nature heat gas to X-ray emitting temperatures?	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
What are the X-ray signatures of accreting black holes?	Use the engagement of black holes to develop science literacy for grades 4-12 and the general public



E/PO Program Overview

Management 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
 - Trained in 2004, 2006, 2008, 2010 and 2012 at SSU
- 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)



XMM Educator Ambassadors

• 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





Supernova Educator Unit – with Fermi

- 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

- 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





CLEA Laboratory





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

🕝 CLEA Exercise - Dying Stars and the Birth of the Elements \times File Slew Tools Help Local Time October 10, 2019 Cassiopeia A 16:19:55 Universal Time XMM-Newton Satellite Control Center Hrs Mins Secs -View **Grwch Sidereal Time** Control Field 1 🛉 Chart Field Hrs Mins Secs J.D. 2458767.180501 Chart Instruments Spectrometer 6 Ι E I S Slew Rate **Right Ascension** Declination 8 16 2 4 ۰. 6 Degs Mins Secs Hrs Mins Secs



Zoom in to see the knots





Take a Spectrum



Fit the Spectrum





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. Xray





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



- 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 highenergy 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



XMM-Newton Eposode

This special episode of Epo's Chronicles is not part of the main storyline.





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









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





- 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



XMM-Newton E/PO website



- 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

Night Sky Network

Astronomy Clubs bringing the wonders of the universe to the public



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!



- 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