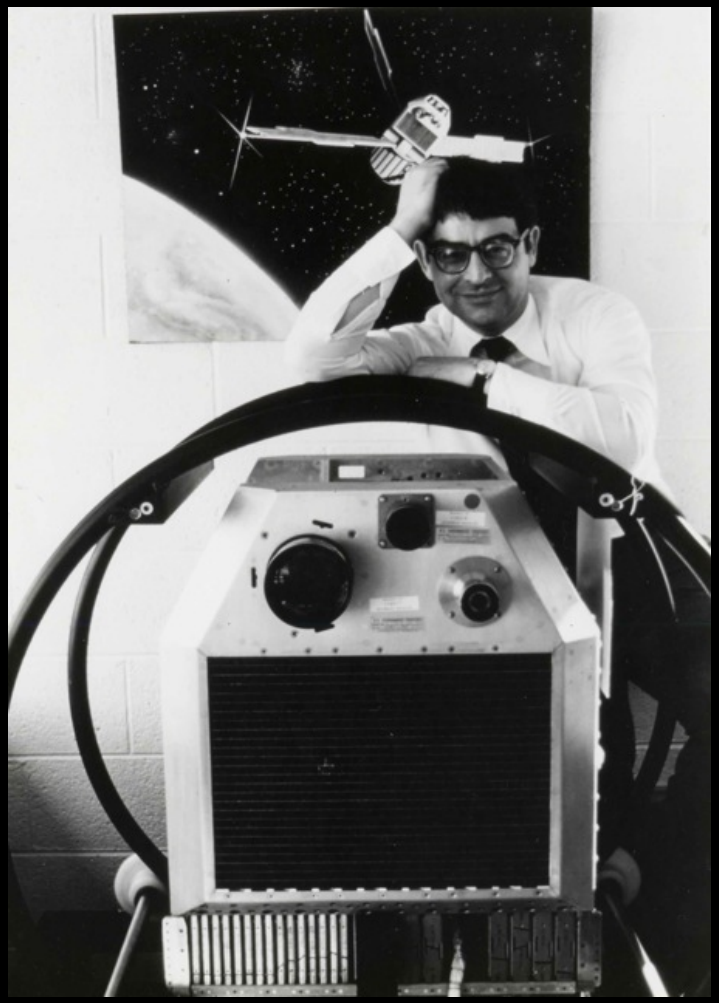
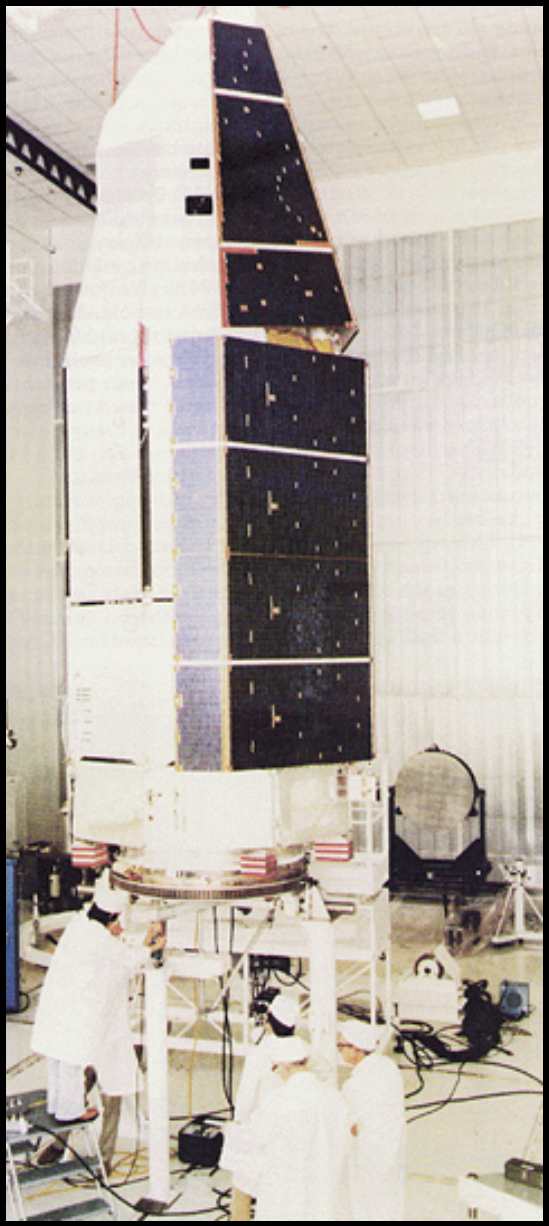
Riccardo Giacconi

Uhuru & Einstein: The Blossoming of X-ray astronomy





Ambitious plans were made for future missions, following the detection of Sco X-1 and an isotropic X-ray background on June 18, 1962

(Giacconi, Gursky, Paolini, Rossi 1962, Phys Rev Letters 9, 439)

A Proposal for

AN EXPERIMENTAL PROGRAM
OF EXTRA-SOLAR X-RAY
ASTRONOMY

Prepared for

National Aeronautics and Space Administration
Washington 25, D. C.

Prepared by

American Science and Engineering, Inc.
11 Carleton Street
Cambridge 42, Massachusetts

25 September 1963

Approved:

Riccardo Giacconi
Vice President
Space Research and Systems Division

This document consists of 75 pages.
Copy No. 4 of 7 Series A

ASE Log No. 63-164-b

With compliments
Riccardo Giacconi

Smithsonian Institution Archives

-18-

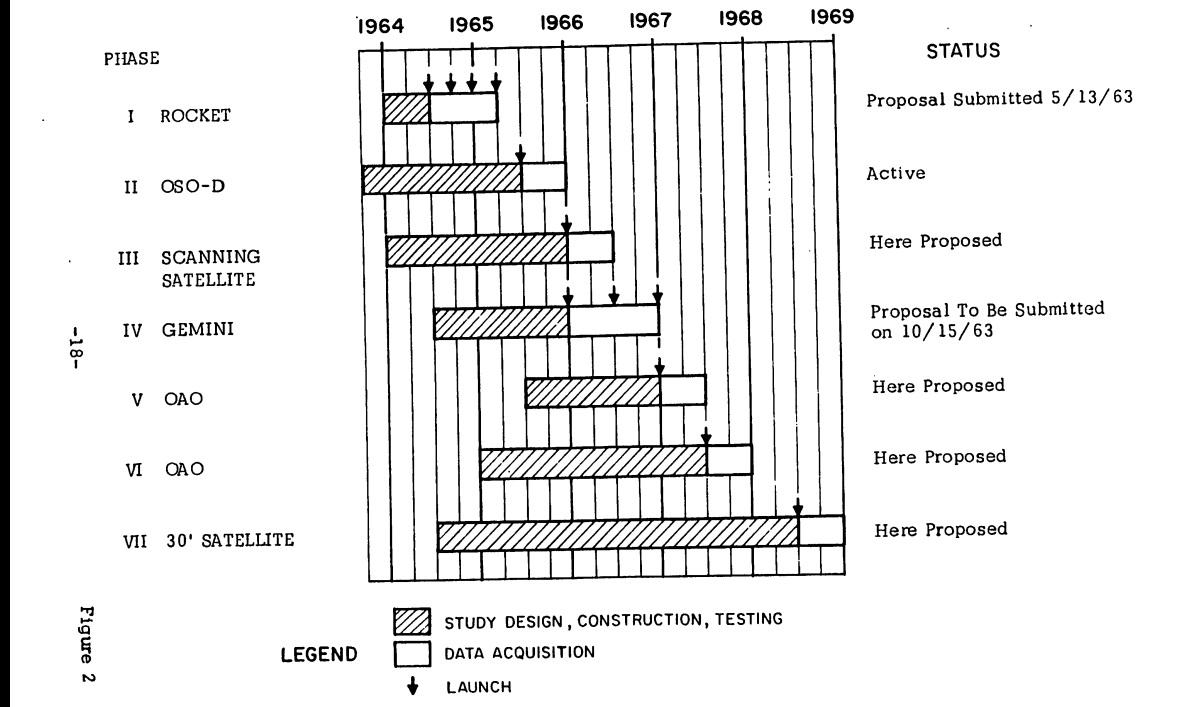
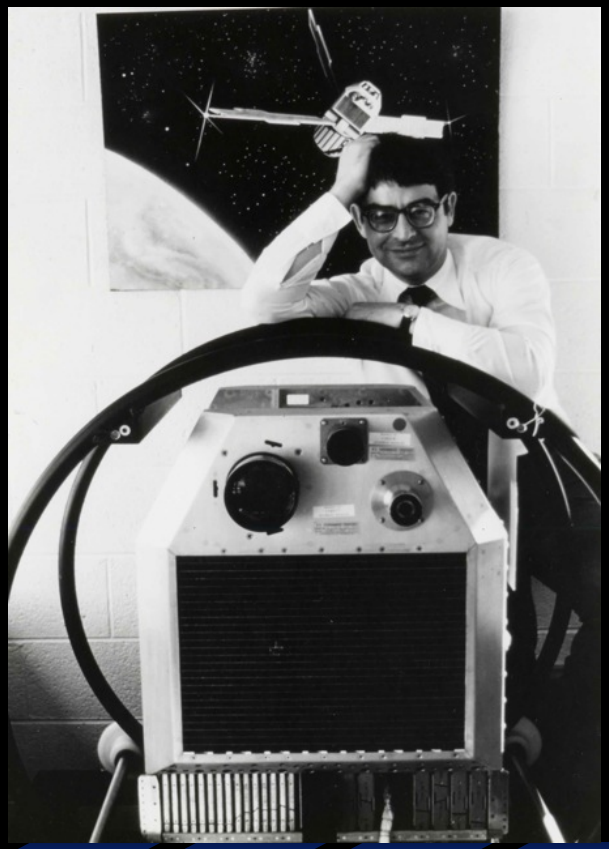
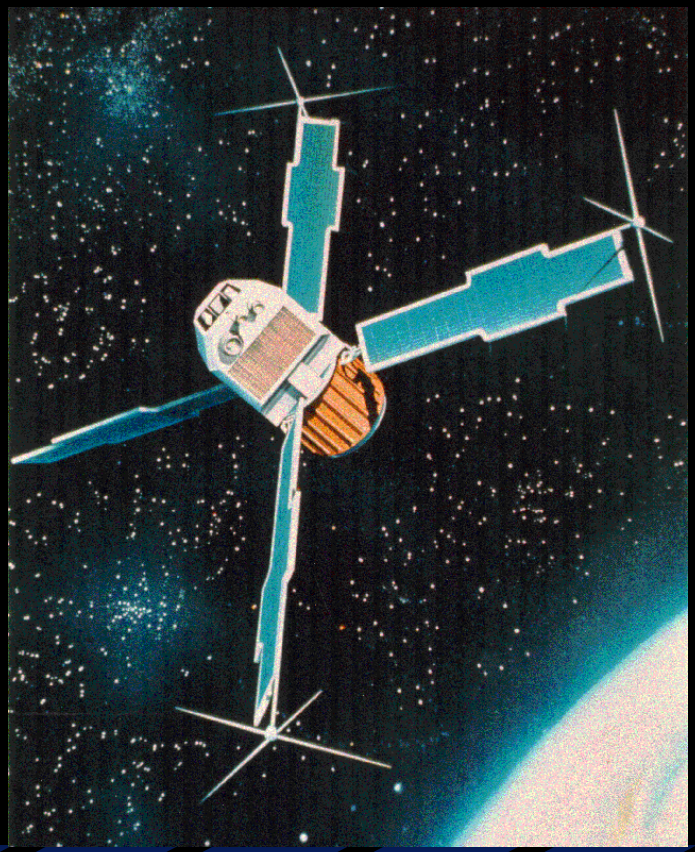


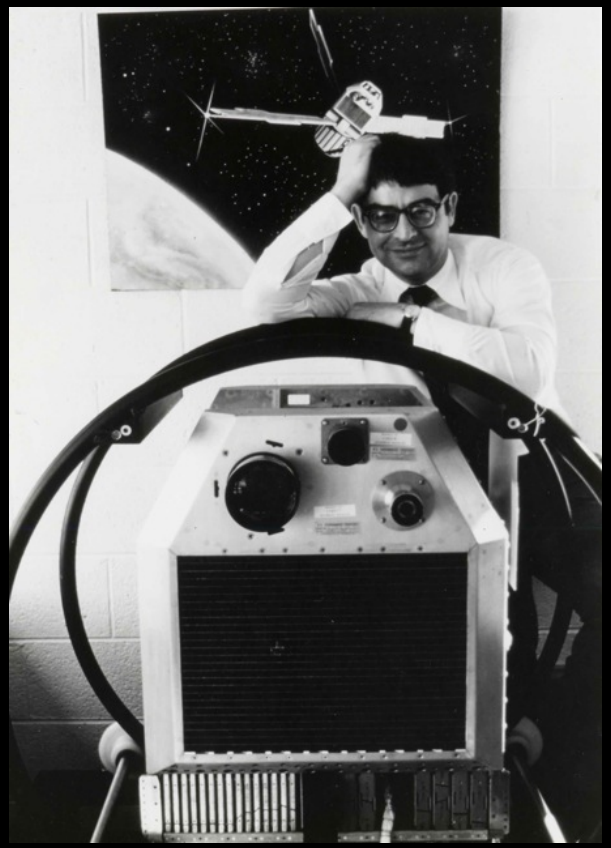
Figure 2

PROPOSED TIME SCHEDULE

Uhuru - launched December 12, 1970 (Kenyan Independence day)
from an Italian launch platform off the coast of Kenya.
Uhuru was built and operated by scientists at AS&E
Giacconi, Kellogg,Gorenstein, Gursky, Tananbaum: 1971 ApJ 165, L27
Schreier, Murray, Matilsky, Tucker

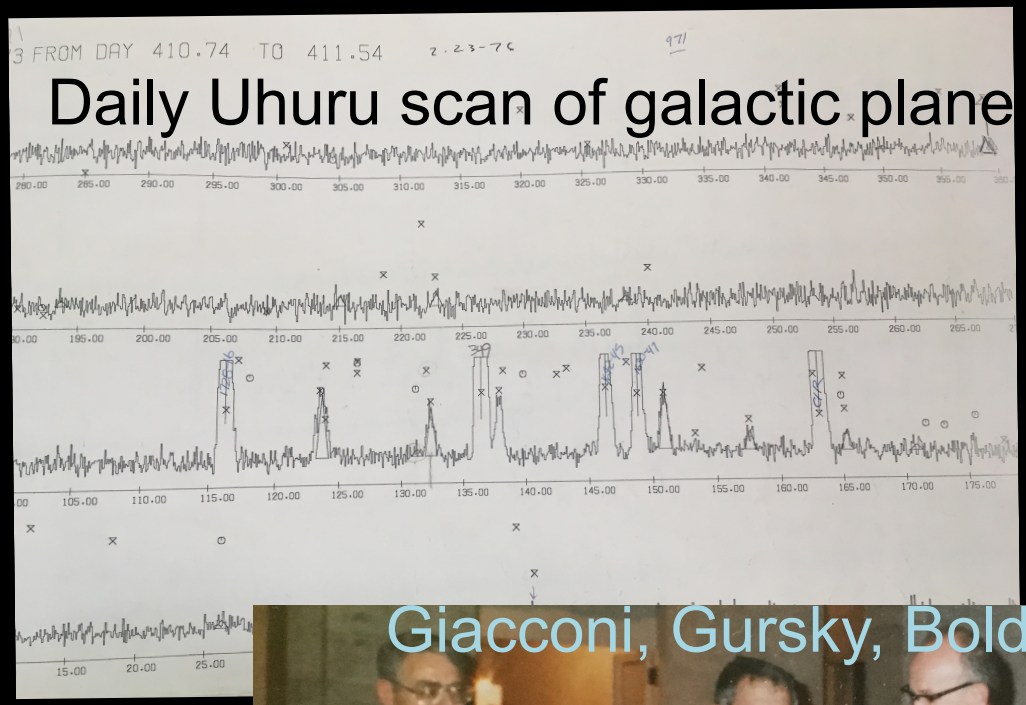






"The launch of Uhuru was a triumph for our group, for me personally, and I daresay for all astronomy. …
Nature, always kind, rewarded us with dazzling sights…..Had I but known it, those were the happiest years of my life."

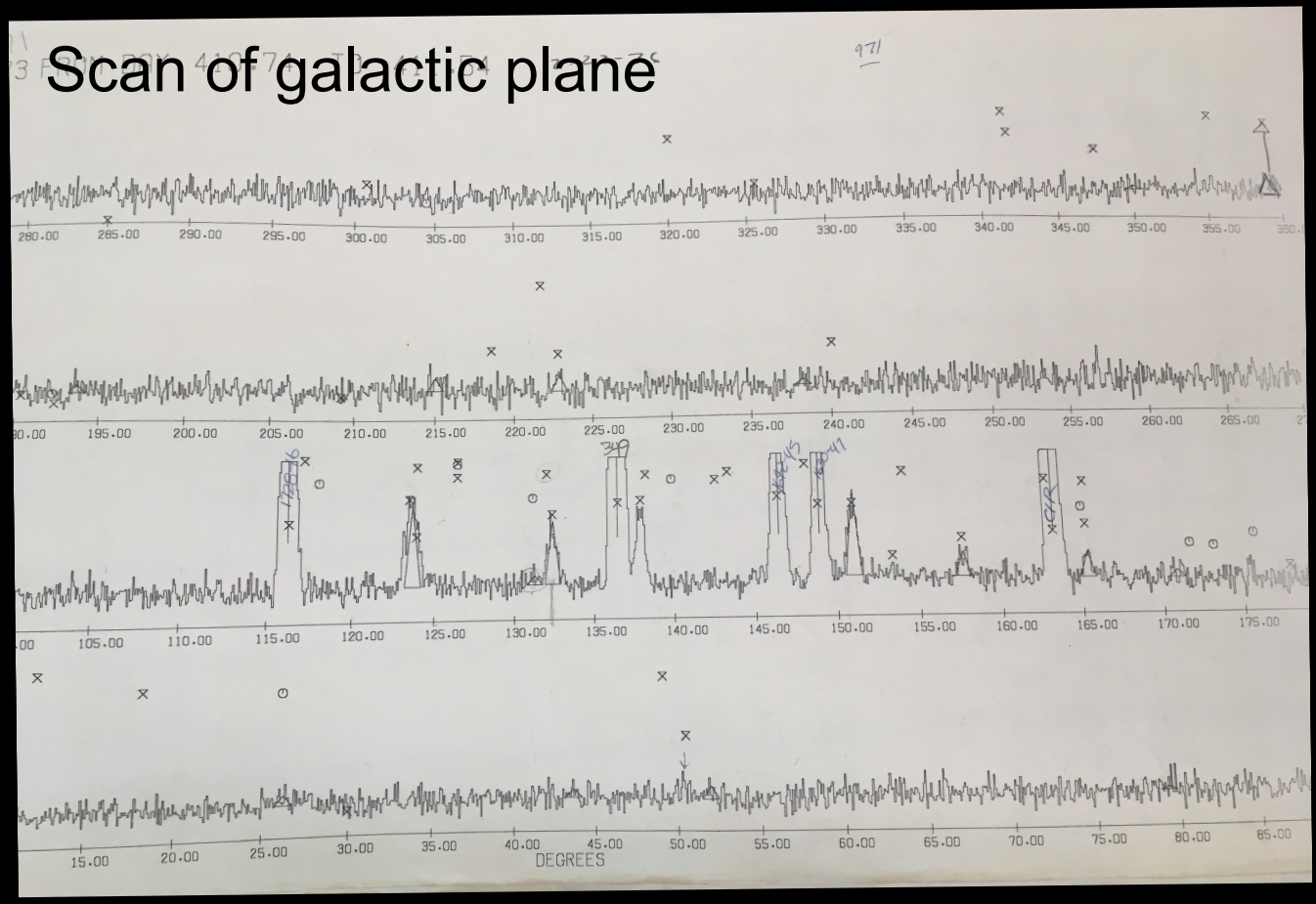
R. Giacconi
"Secrets of the Hoary Deep"



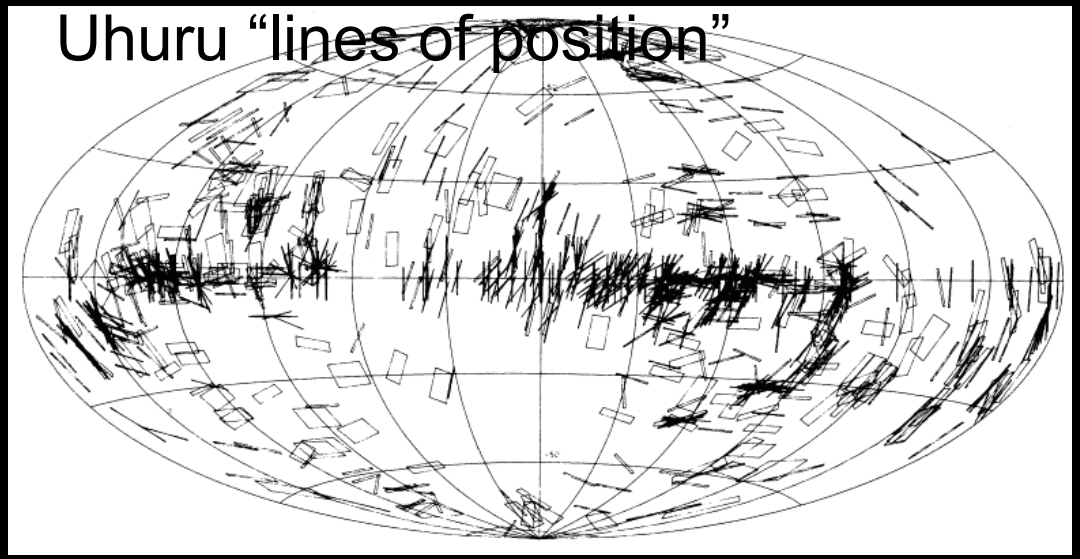
Uhuru scan of the sky

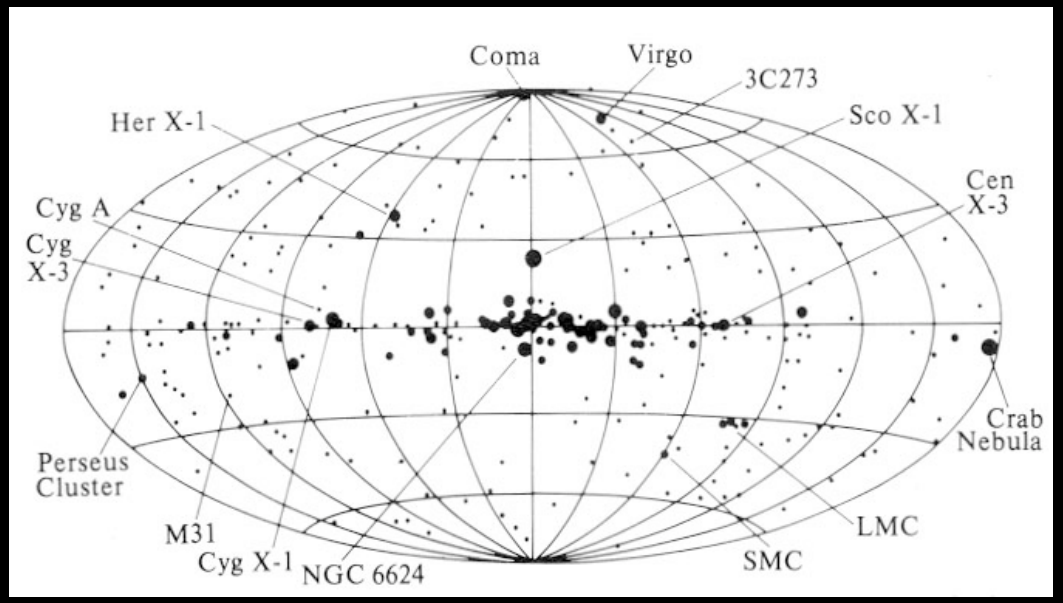
Individual scans (not summed daily scans) were used to measure and look for changes over time in intensities of X-ray sources e.g. pulsations (Cen X-3) or binary periods (Her X-1, 4U1700-17)

Scan of galactic plane



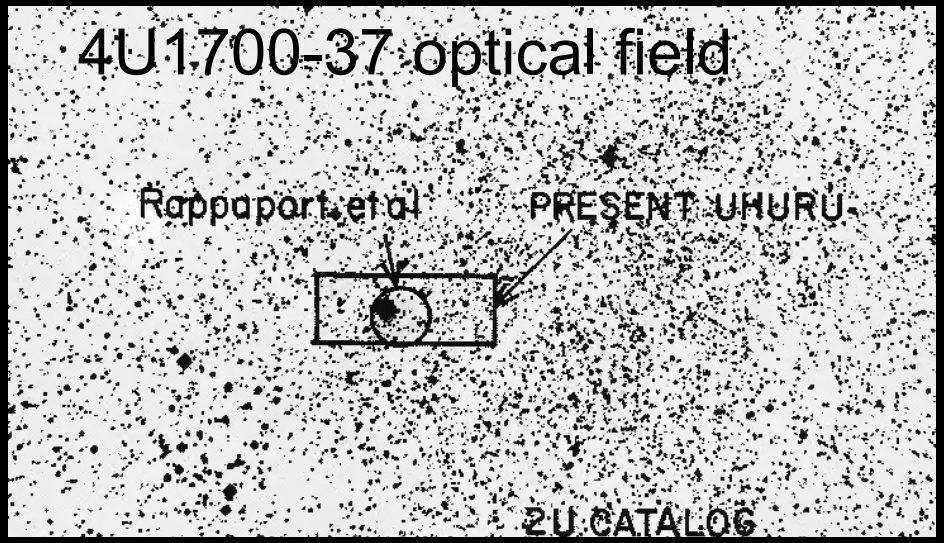
20% of daily Uhuru data received as “quick-look” allowed rapid changes in observing schedule.



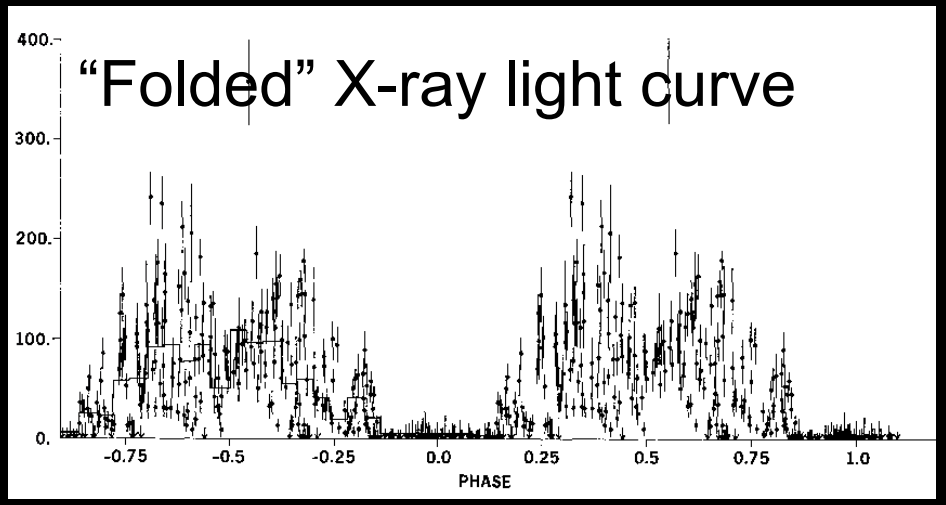


Uhuru scans of the sky provided source “lines of position”

These were then used to determine source postions “Uhuru catalogs”



Accurate positions from Uhuru allowed optical identifications.

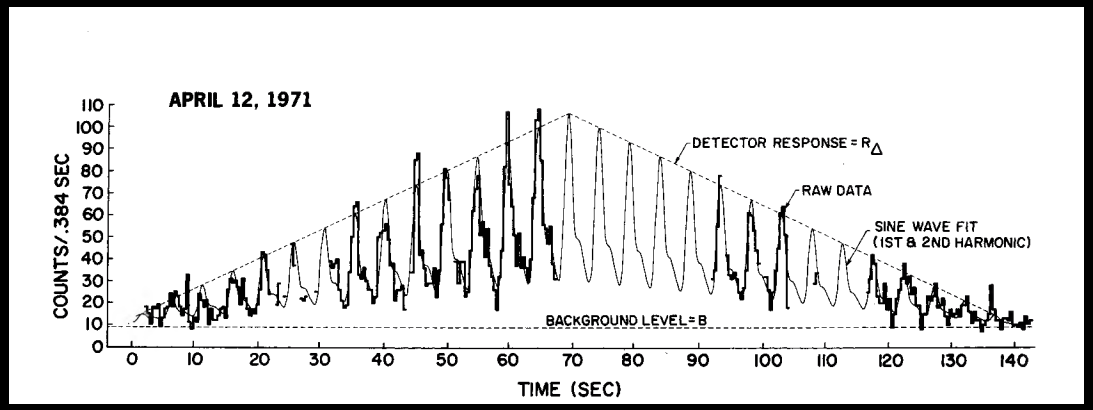


Jones+1973, ApJL, 181, 43

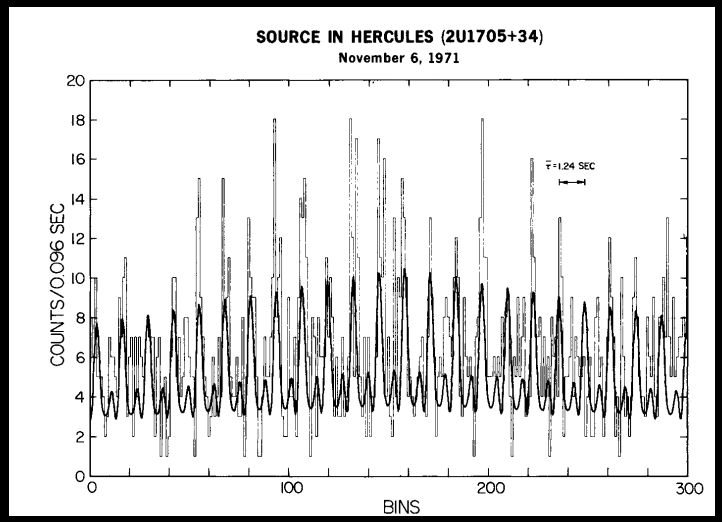
X-ray binaries with luminous optical counterparts -OB supergiants (not like Sco X-1)

Discoveries from Uhuru - X-ray pulsars in binary systems

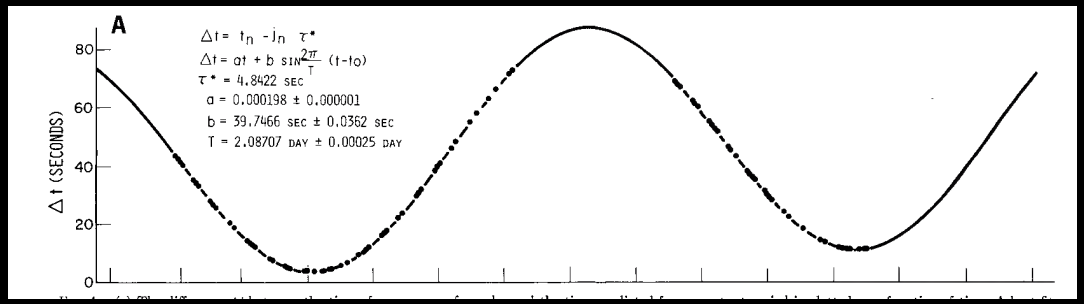
Centaurus X-3 (Giacconi+ 1971)



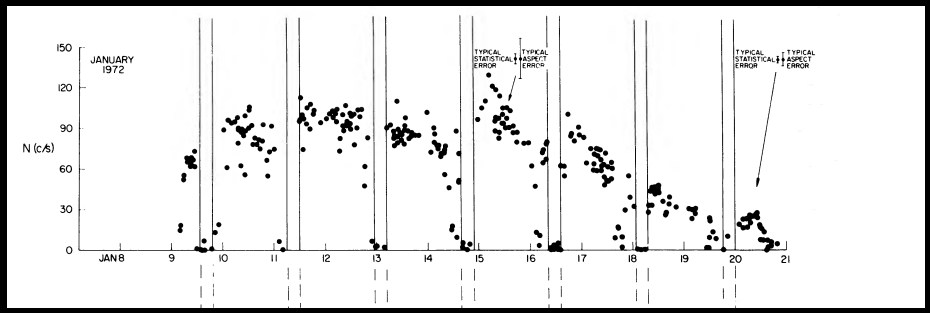
Hercules X-1 (Tananbaum+ 1972)



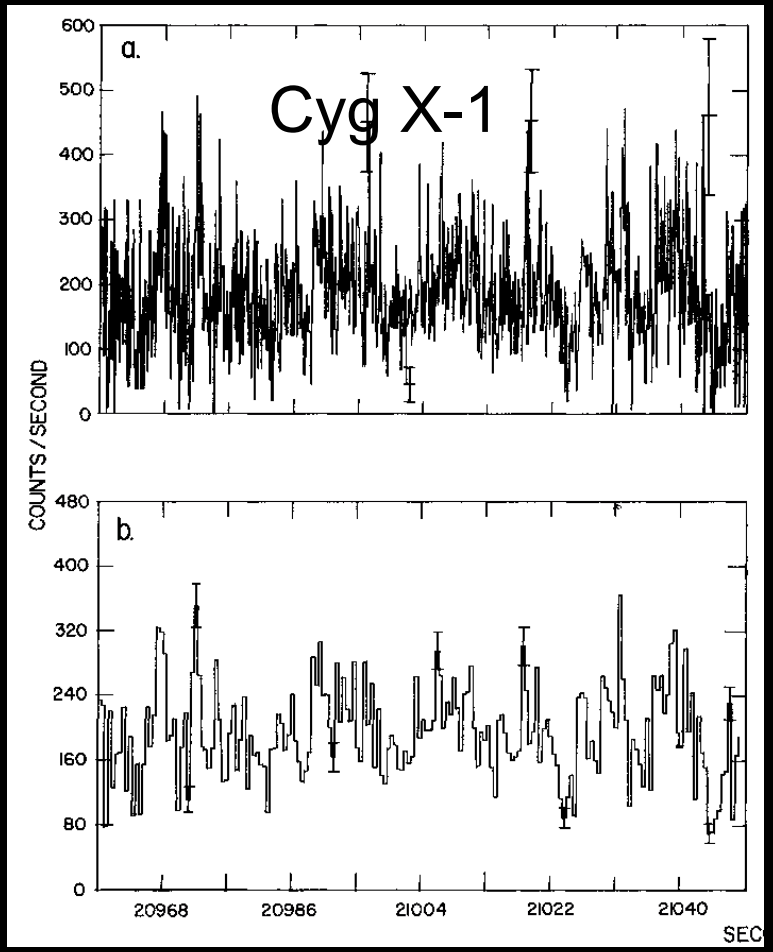
Centaurus X-3 (Schreier+ 1972)

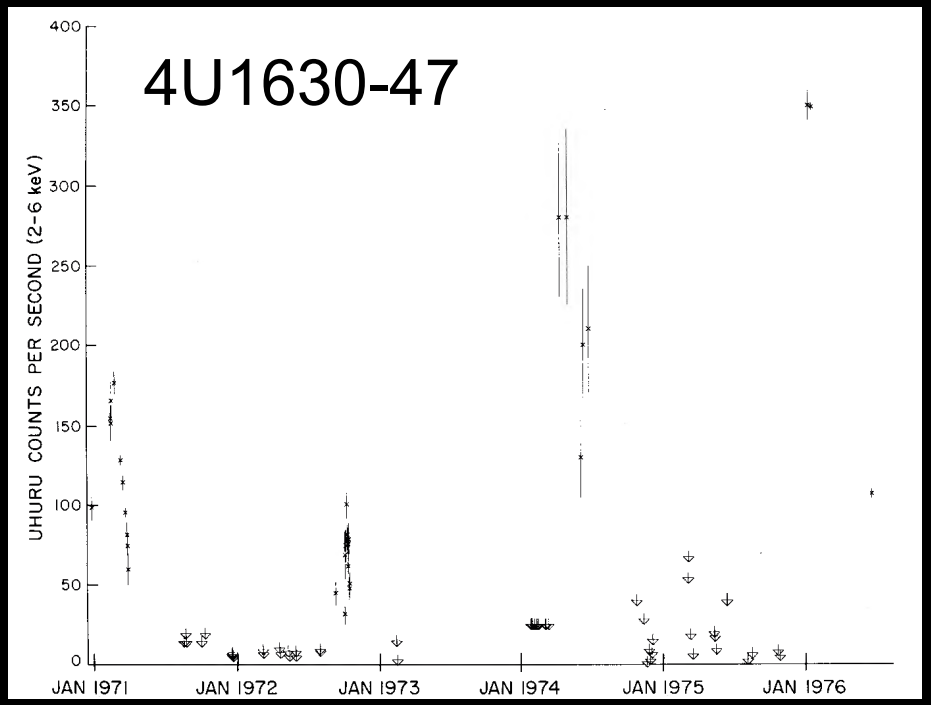


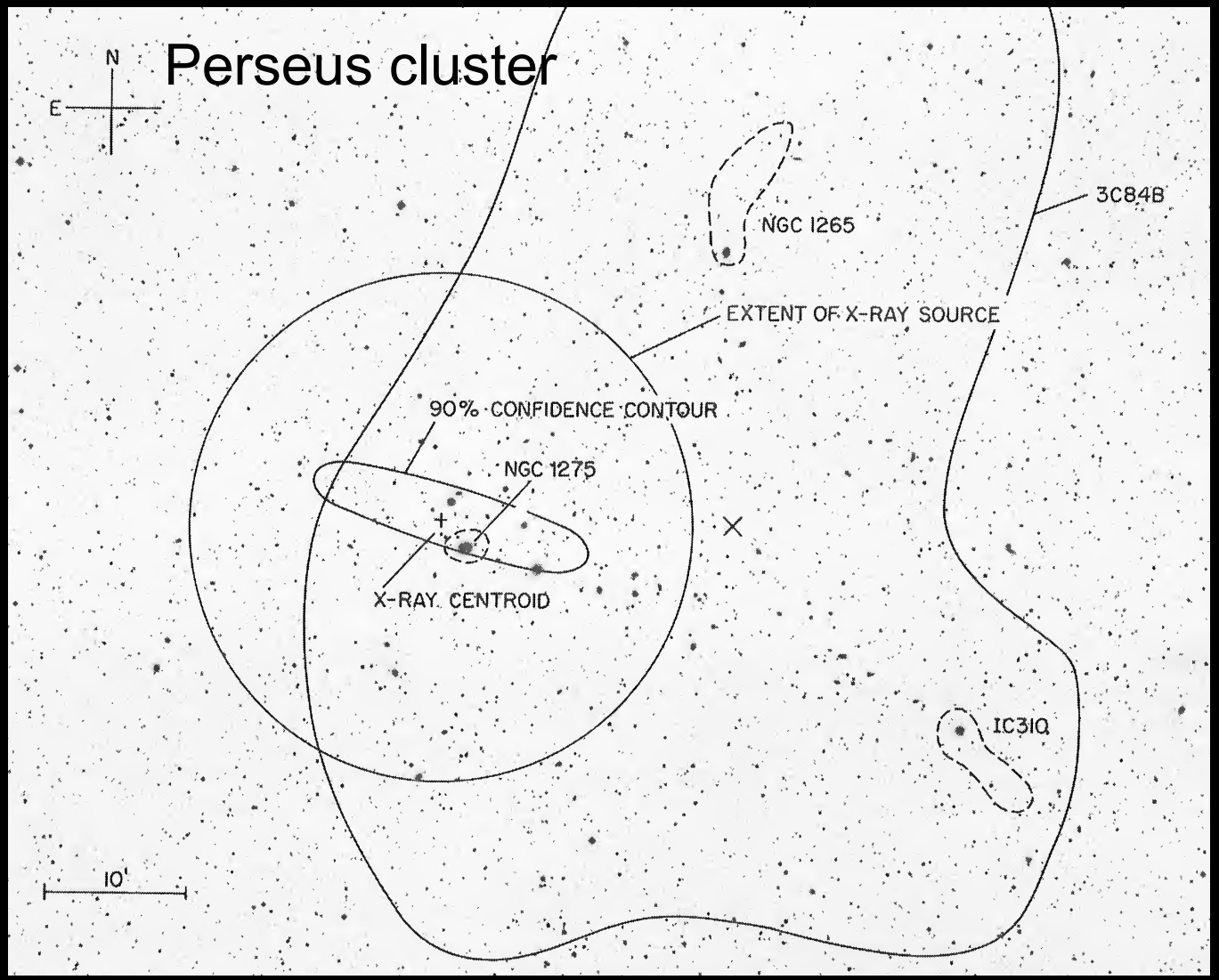
Hercules X-1 (Giacconi+ 1973)



X-ray source intensity variations on timescales of seconds - (e.g. Cyg X-1, Oda+ 1971, Schreier+1971) to years (e.g. recurrent transient 4U1630-47, Jones+ 1976)





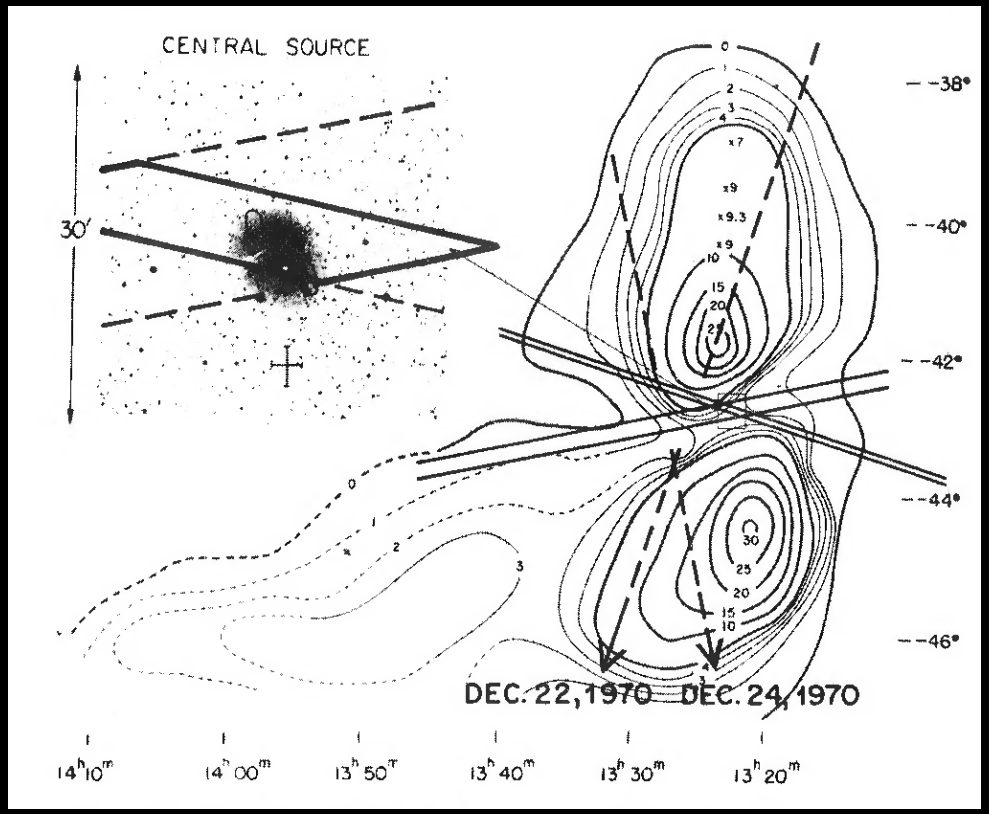


Discoveries based on Uhuru observations -

Extended X-ray emission from clusters of galaxies

Forman et al, 1972
ApJ 178, 309

Uhuru detections of active galactic nuclei



Centaurus A with Uhuru lines of position

X-ray emission from AGN
Centaurus A & 3C273
Kellogg+71, ApJL, 165, L49

NGC4151 (Gursky1971
ApJL, 165,L43

“During my university years in Milan, not one of my senior colleagues had ever invited me over to his home (except for Beppo Occhialini).”

“Secrets of the Hoary Deep”
Riccardo Giacconi

Riccardo and Mirella invited students and colleagues to their home for wonderful dinners or larger social gatherings.

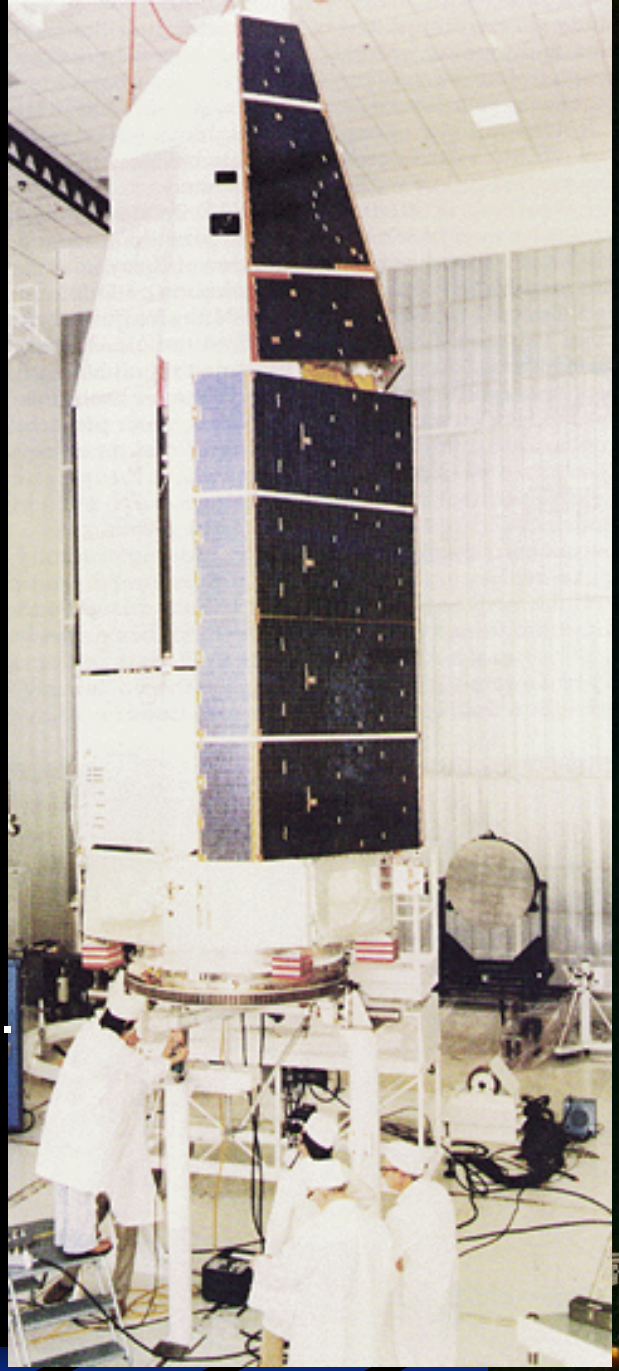
They lived just a short walk from the observatory.

Einstein launched on July 23, 1999.

Imaging X-ray telescope
58 cm aperature

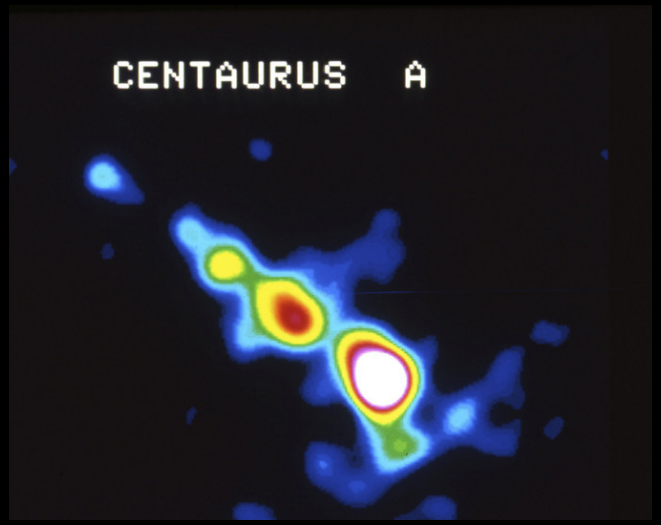
Einstein was as great an advance in sensitivity over early detectors on rockets, as the 200 inch Telescope was to Galileo's 1610 telescope.

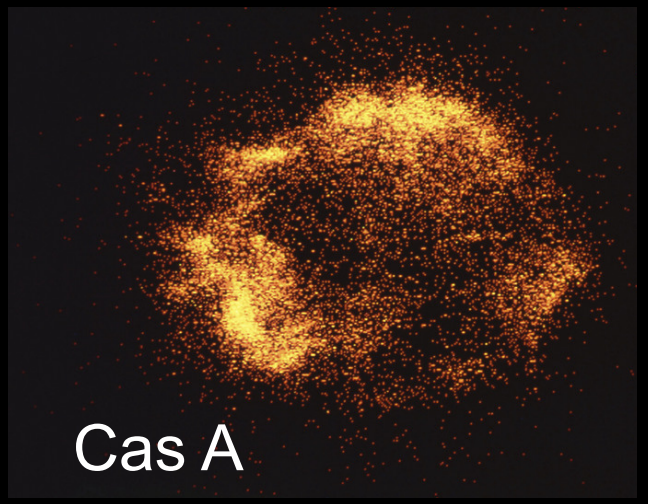
Increase in sensitivity ~1,000,000.

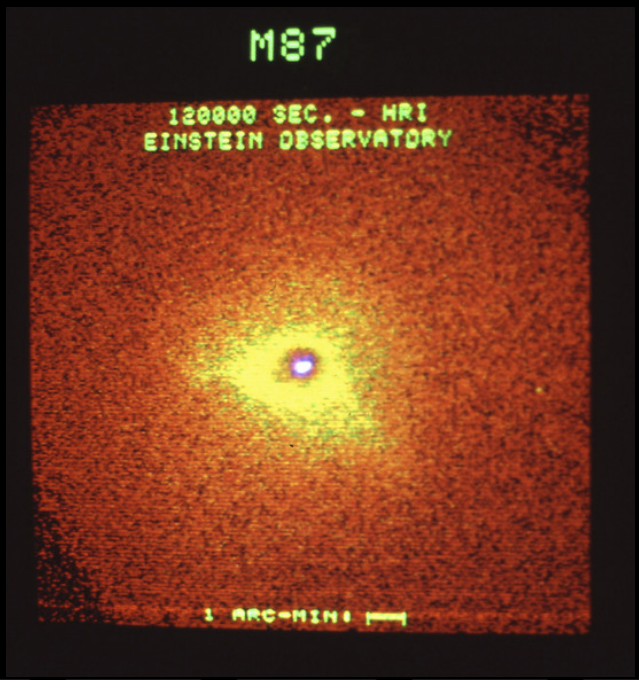


Scientific direction from the HEAO 2 Consortium Institutions

Harvard-Smithsonian Center for Astrophysics
Center for Space Research, MIT
Columbia Astrophysics Laboratory
Laboratory for High Energy Astrophysics/GSFC

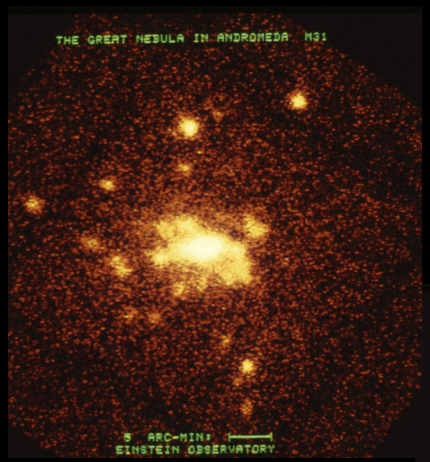


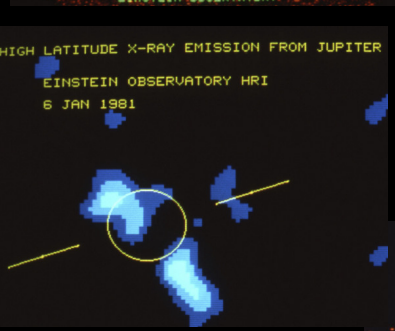


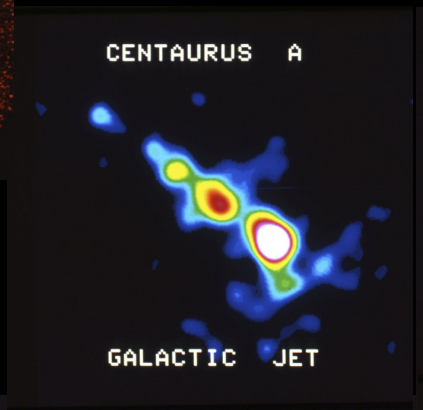


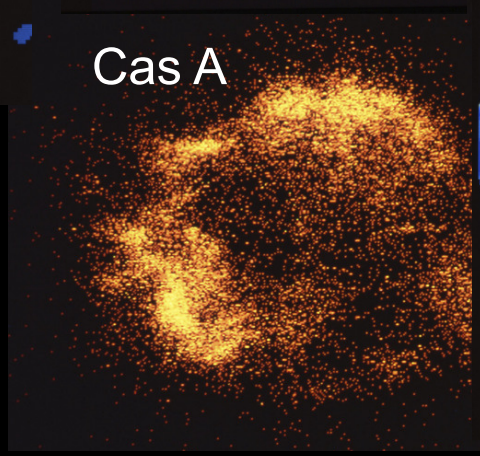
First Einstein images!

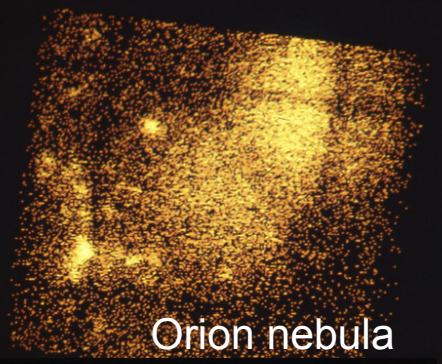
Einstein contributed to understanding planets, stars, supernova remnants, galaxies, clusters, AGN/jets and resolving the X-ray backround !

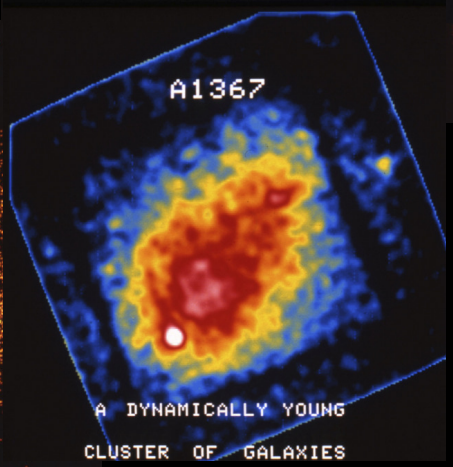


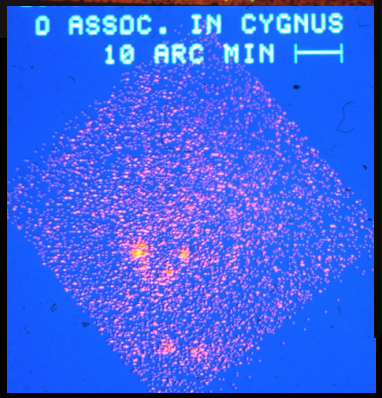


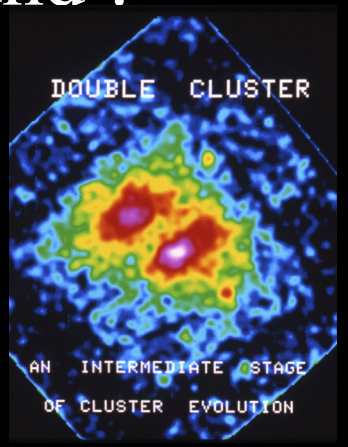


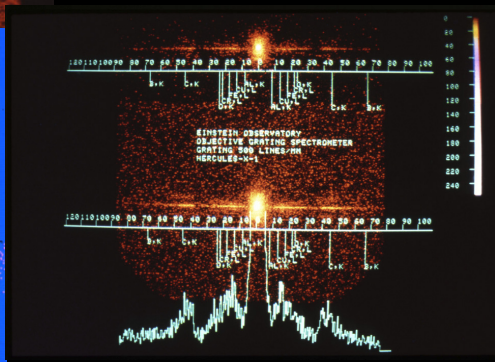






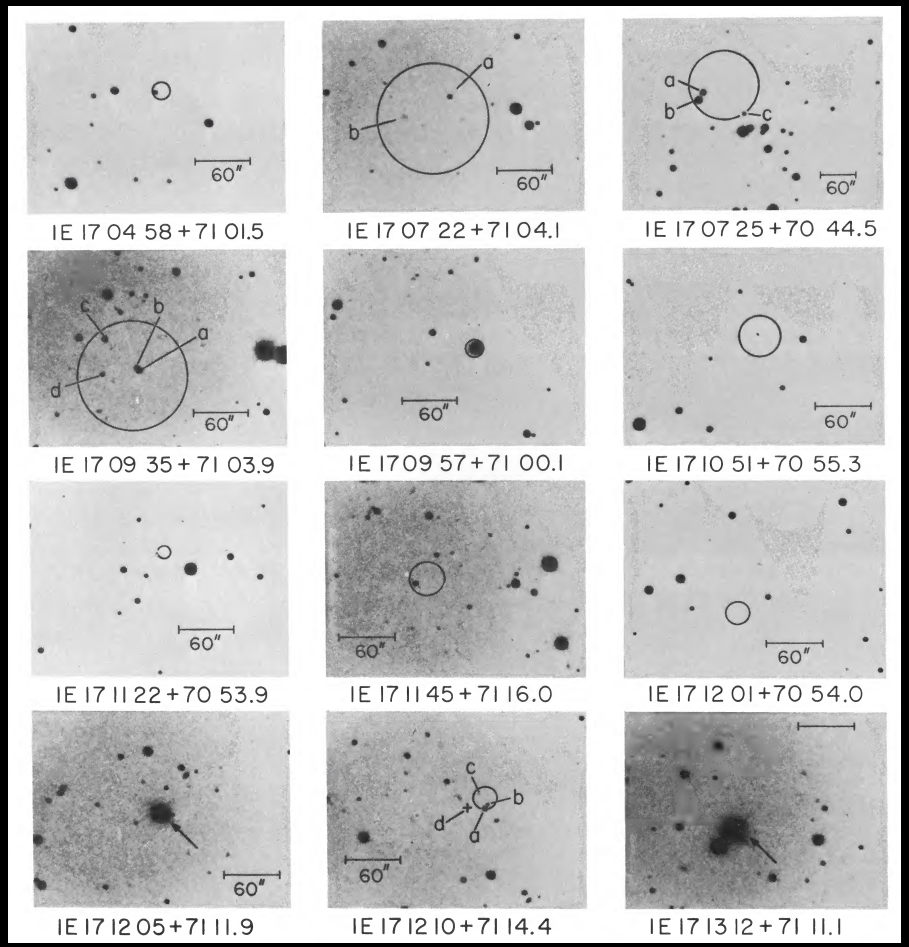






Selected Discoveries from Einstein - I

Draco & Eridanus Einstein HRI observations - the first Deep Survey Giacconi+1979 ApJL, 234, 1

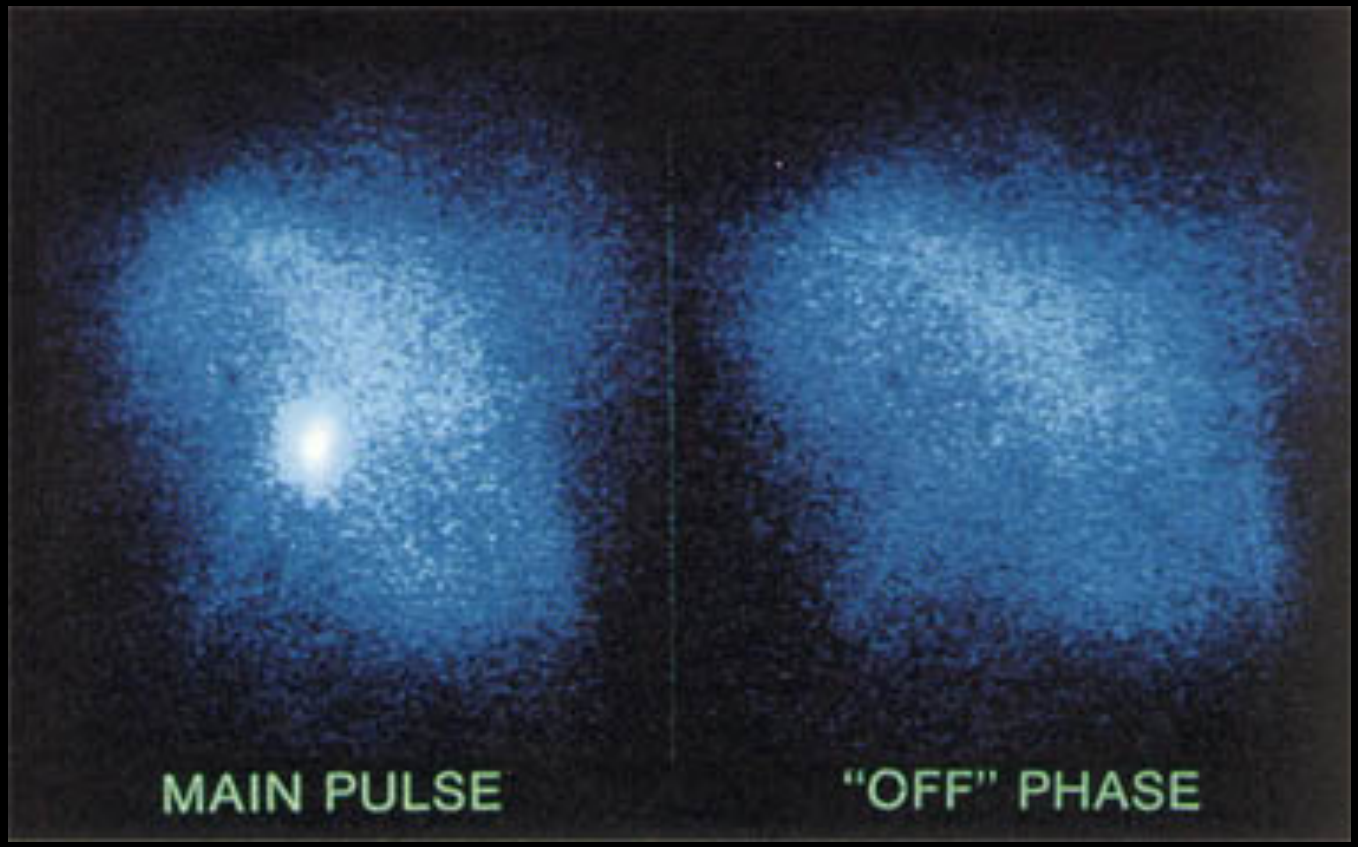


Limiting flux 1.3 x 10^{-14} ergs/cm^2/s in 1-3 keV energy band

Resolved 26 (+/- 11) % of 1-3 keV background

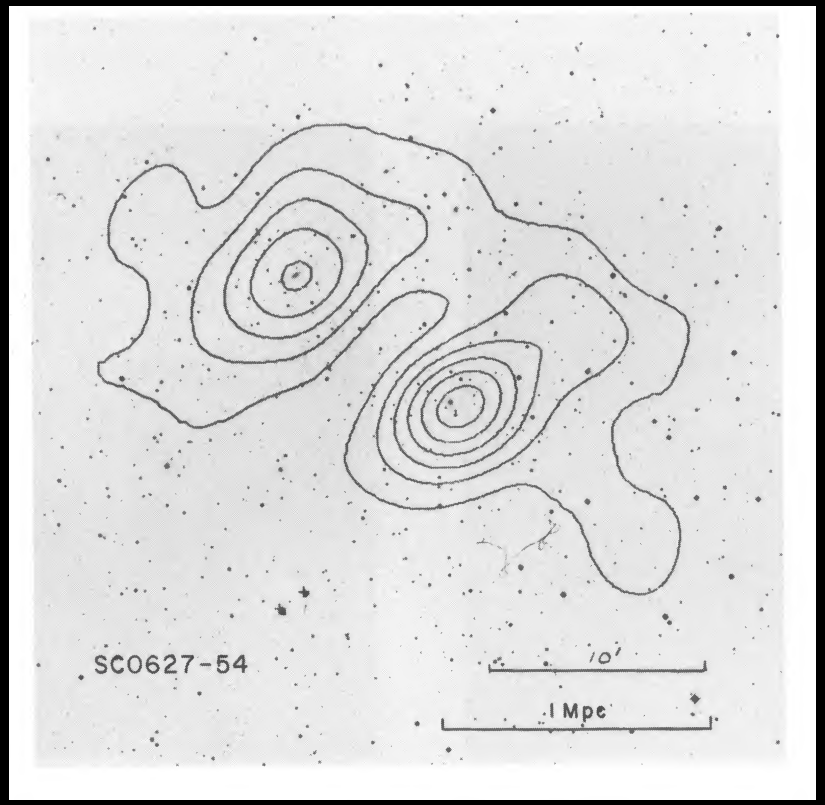
(with Chandra, Luo+ (2017) resolve 81(+/- 4)% of 0.5-2 keV bkgd)

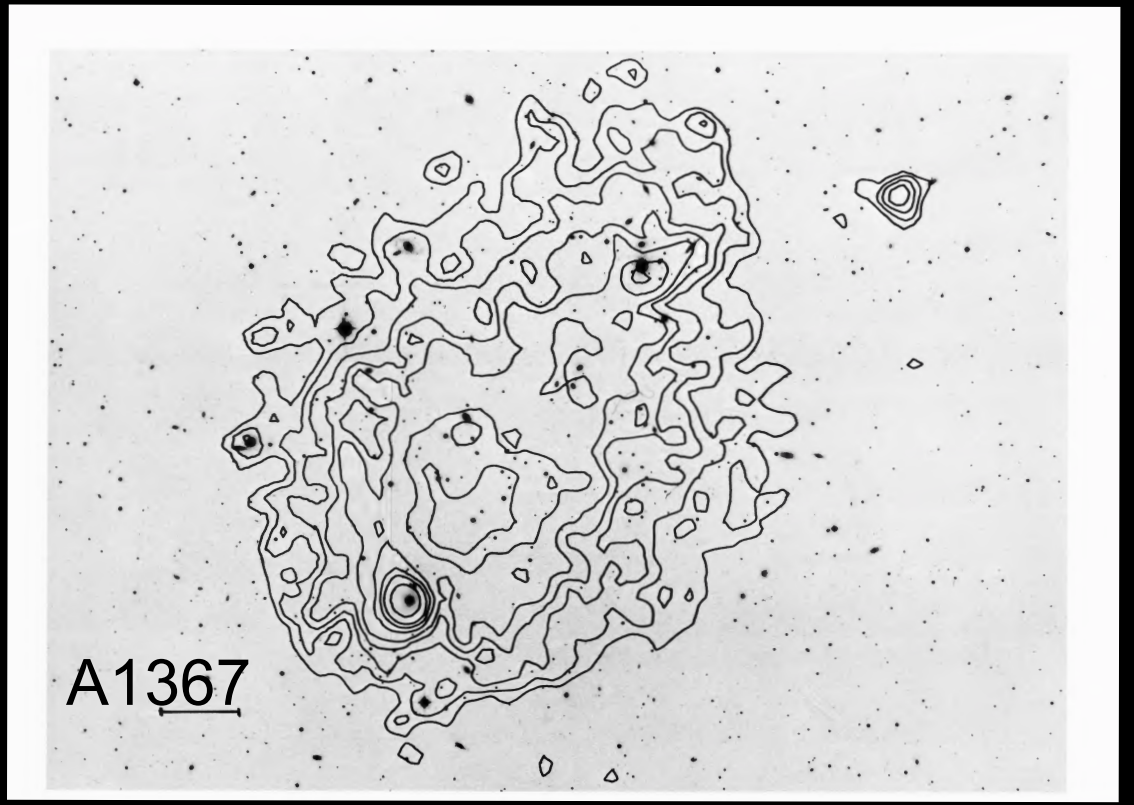
Selected Discoveries from the Einstein Observatory II



Crab Nebula - pulsar in "on" and "off" phases with HRI
Harnden & Seward 1984, ApJ 283, 279

Selected Discoveries from the Einstein Observatory III

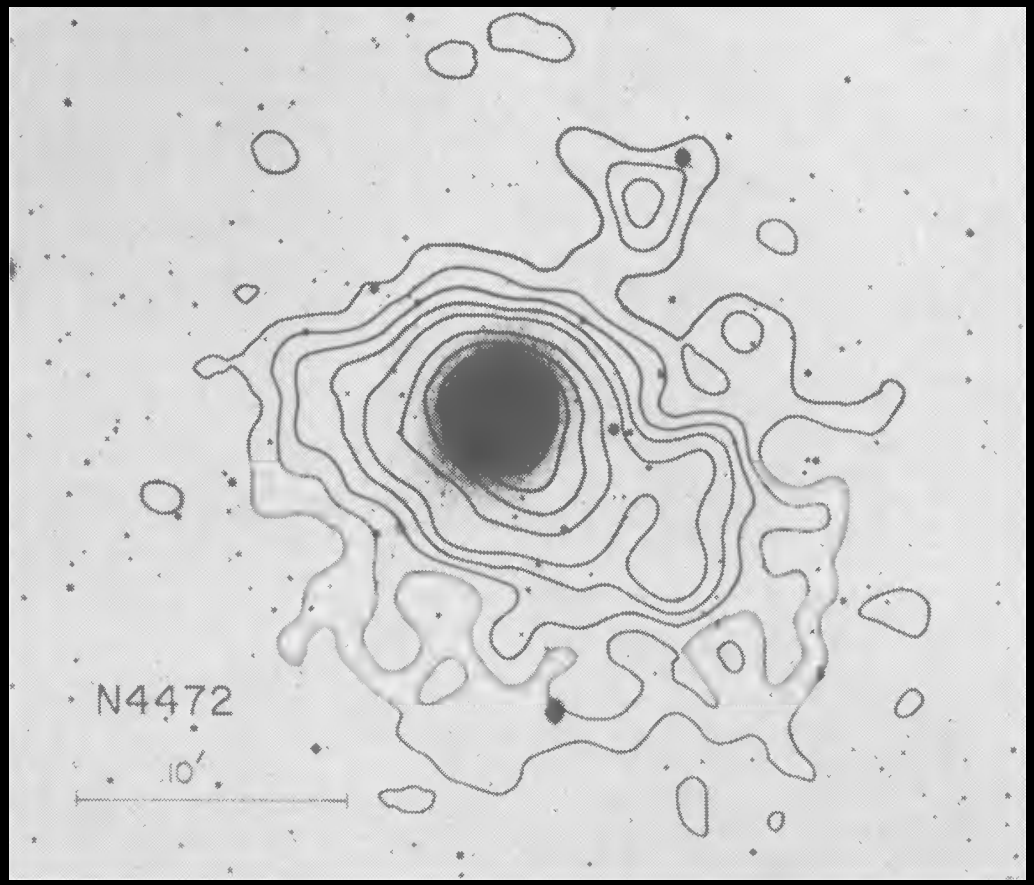


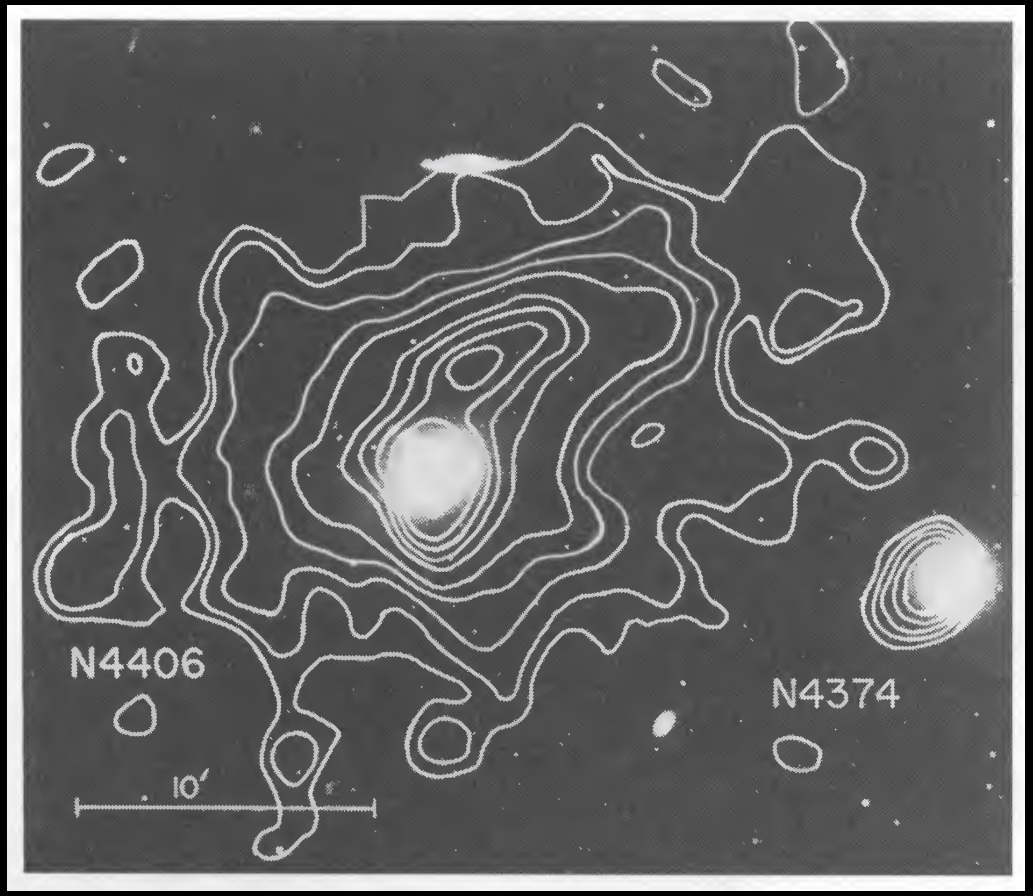


Most clusters of galaxies are not “old”, relaxed systems, but are dynamically “young” merging systems.

(Jones+ 1979 ApJ 234, L21; Jones & Forman 1984 ApJ 276, 38)

Selected Discoveries from the Einstein Observatory IV





Discovery of hot gaseous coronae in early type galaxies

(Forman, Jones and Tucker 1985 ApJ 293, 201)

Although Einstein was a PI mission, Riccardo recognized the importance of enabling Guest Observers, including distributing well-calibrated data to observers. After first year, 50% of time was available to Guest Observers. Fred Seward was the lead.

"We are convinced that participation by a broad segment of the astronomical community in the utilization of this facility will substantially enhance the scientific return of this mission." (R. Giacconi)

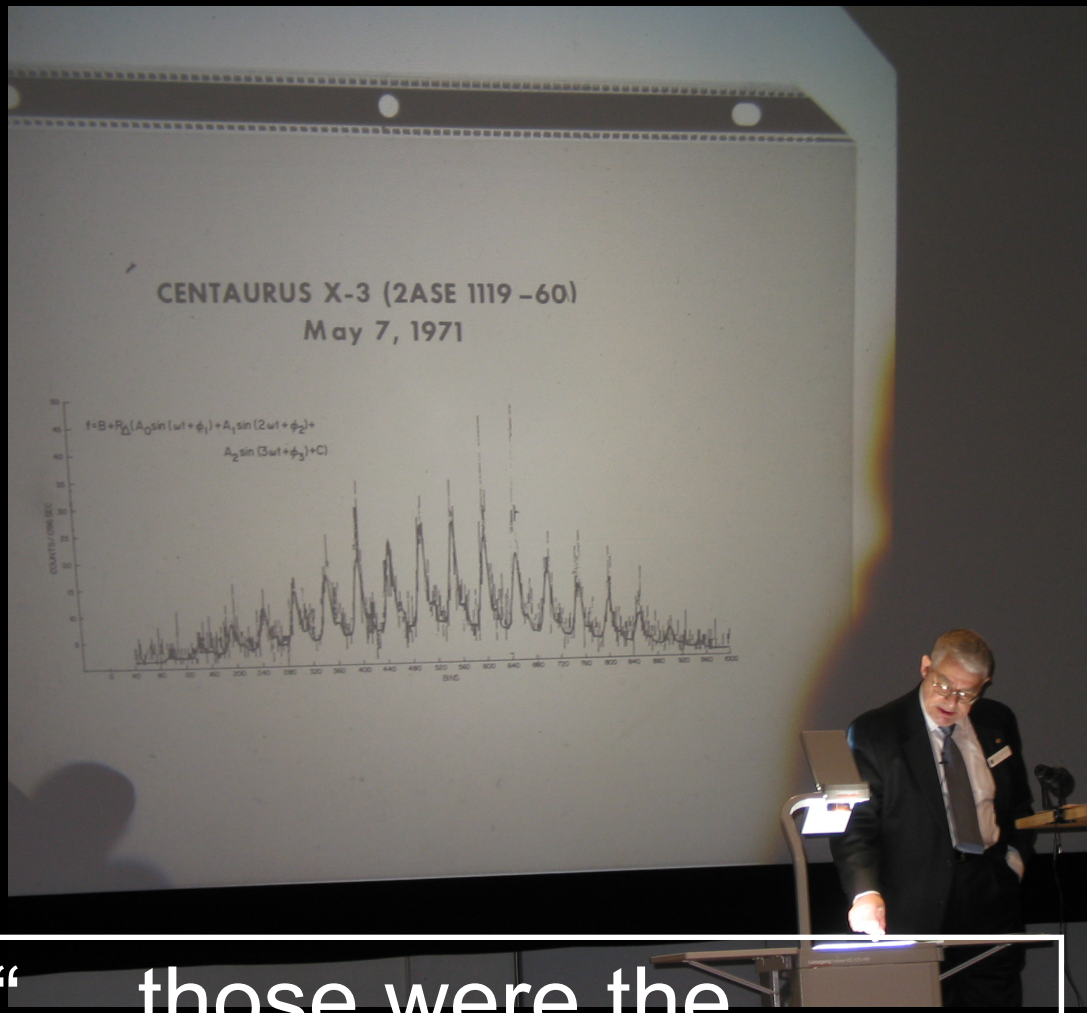
Few rules for proposals….

Recognition received through major awards

National Medal of Science 2003
for his pioneering research in X-ray astronomy and his leadership of major astronomy facilities

Nobel Prize Lecture 2002

Schreier, Gursky, Giacconi, Tananbaum



"… those were the happiest years of my life."

Many scientific meetings. Discussions/arguments.
Working late nights & weekends
Laughter. Good times.

Thanks