

BECOMING AND BEING A  
SCIENTIST: MY PERSPECTIVE  
&  
OUTSTANDING SCIENCE  
WITH A GREAT  
OBSERVATORY

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# Overview

- ▣ Why did I become a scientist anyway?
  - The Oberlin College years
- ▣ Graduate School – Why Brandeis?
- ▣ Why did I go into X-Ray Astronomy?
  - The Columbia University years
- ▣ Why join NASA?
  - The building of a scientific cathedral

# Oberlin College

- ▣ What do I want to be?
- ▣ Poet's physics course
  - Discovered my uncle!
- ▣ Grades!
- ▣ Working in the laboratory

# Brandeis University

- ▣ The influence of my uncle on my choice
- ▣ Team experience
- ▣ That wonderful feeling of being the first person on earth to know something that no one has known before!

# My Introduction to X-Ray Astronomy

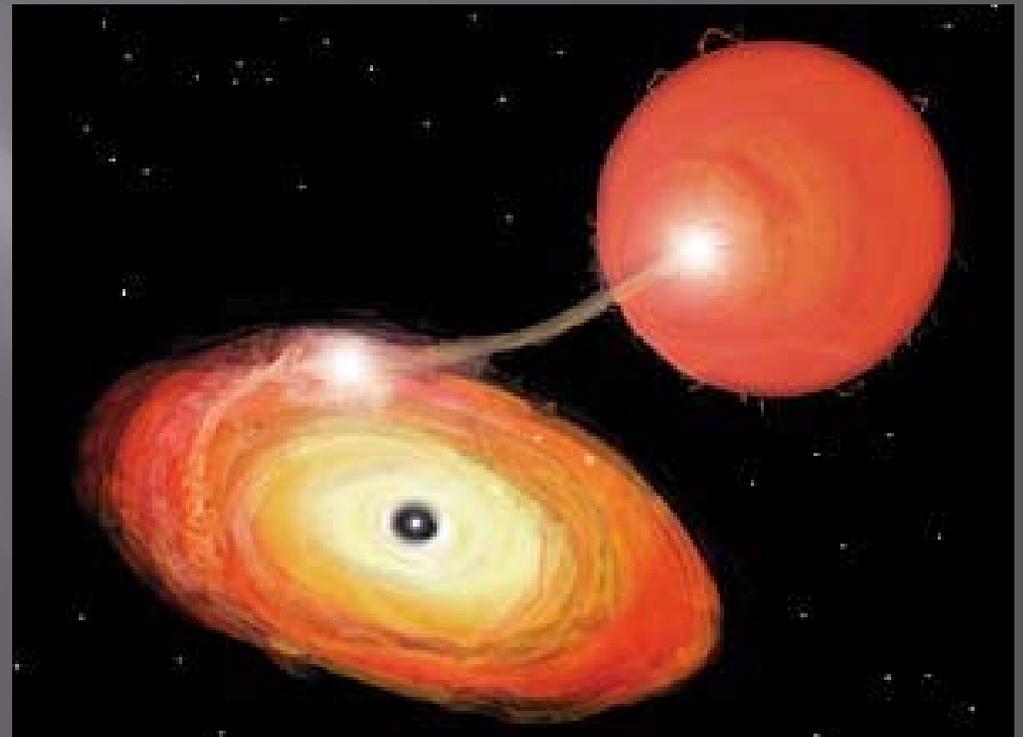
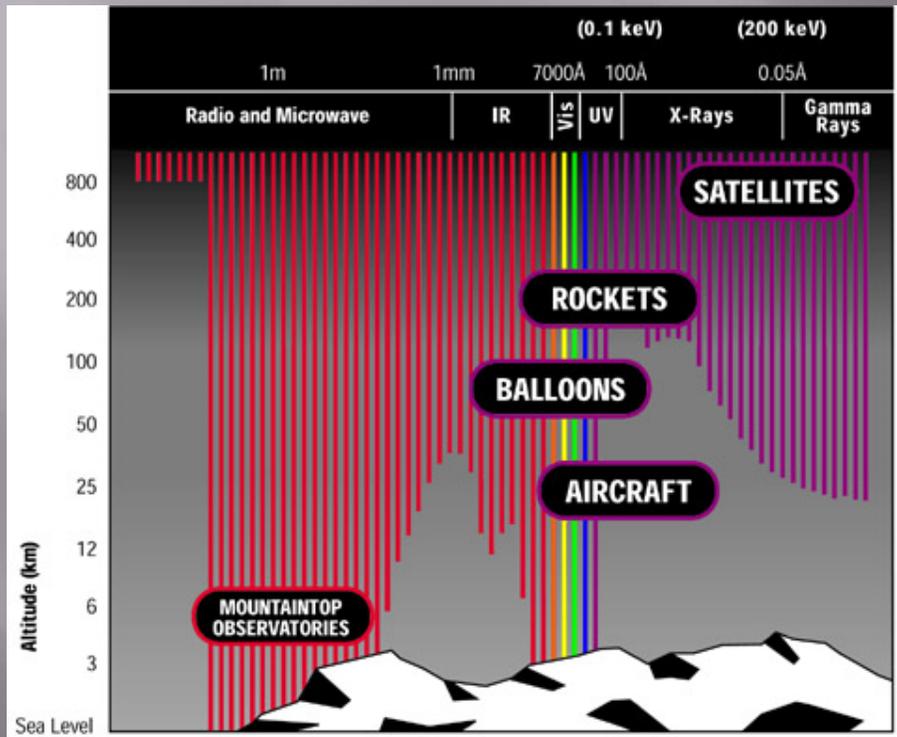
## "SEX" & the "PIG"

SEX = Super EXplorer

PIG = Principal Investigator Group

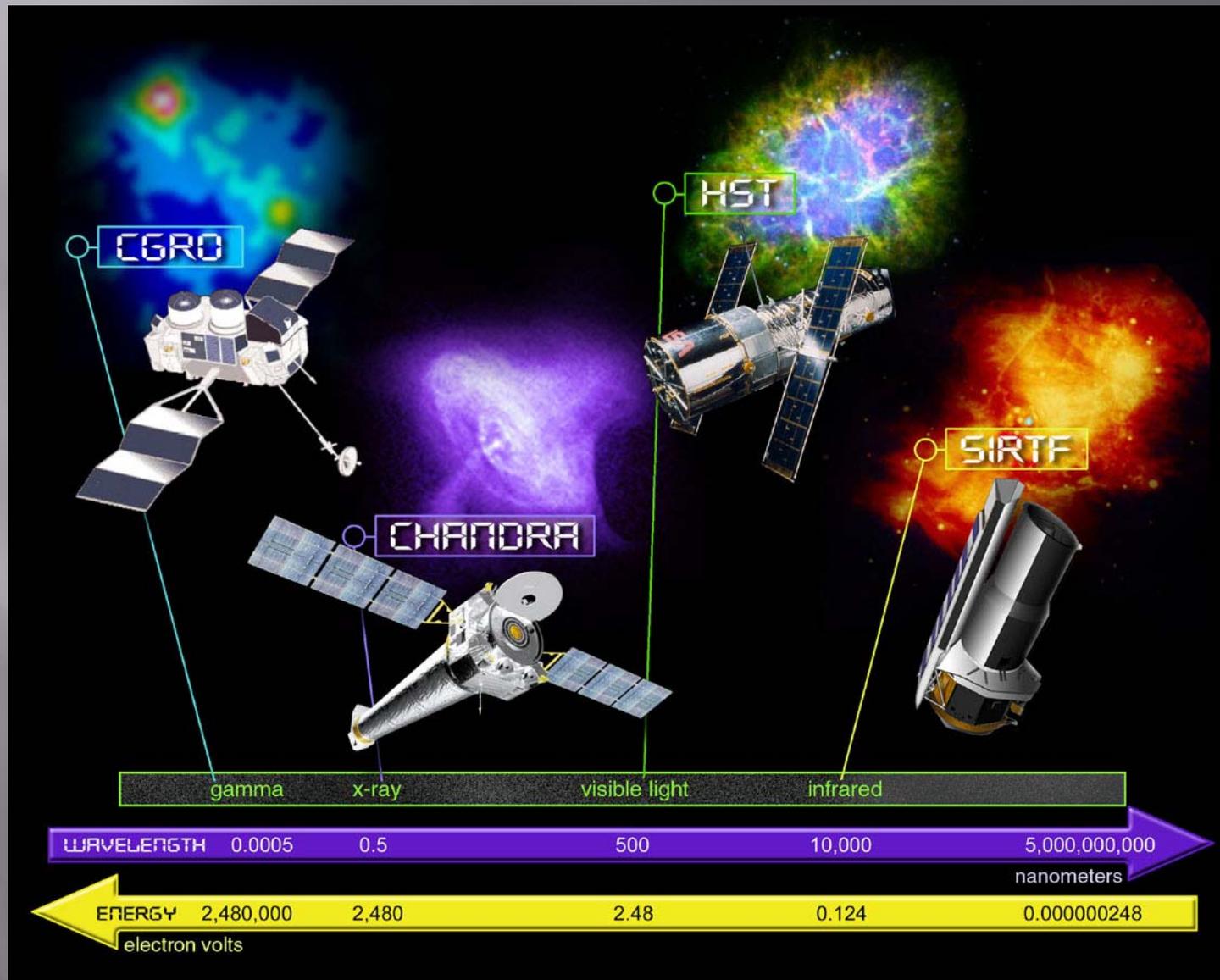
# Columbia University

- Why do post graduate work there?
- The excitement of opening a new field



- Learning how to “be” a scientist

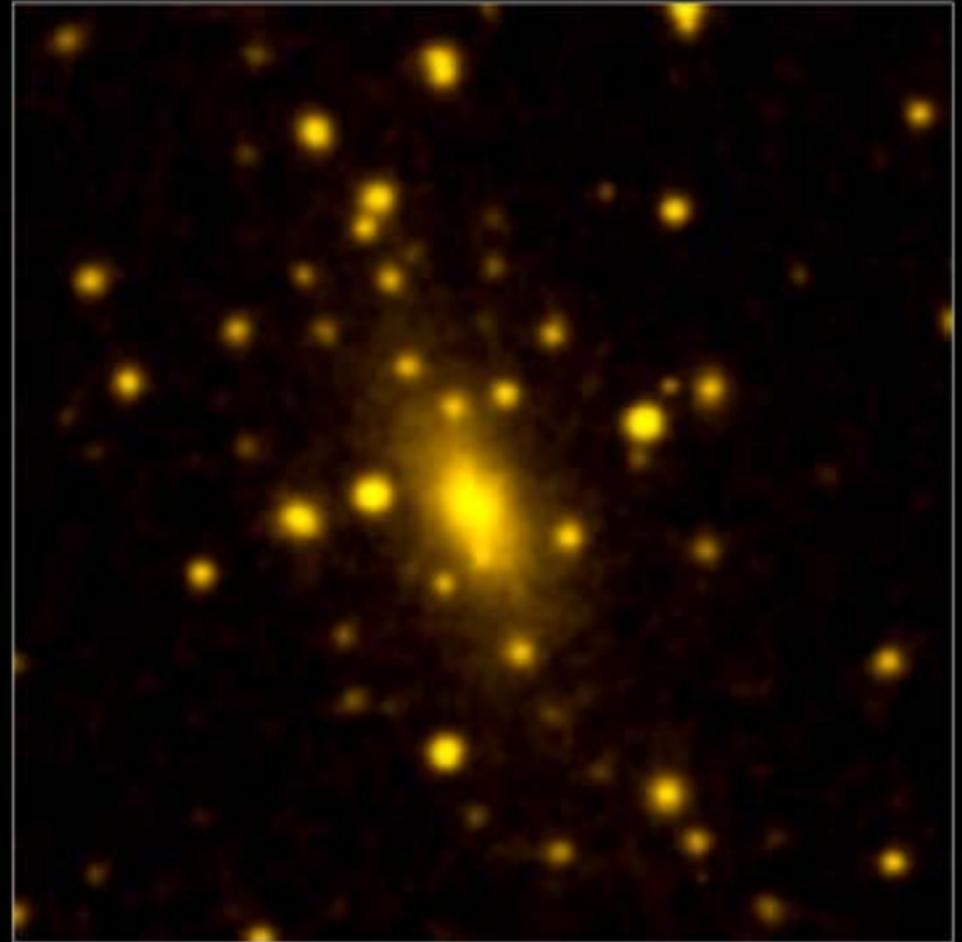
# The NASA years: Building a Scientific Cathedral



# The Importance of X-Ray Astronomy



CHANDRA X-RAY

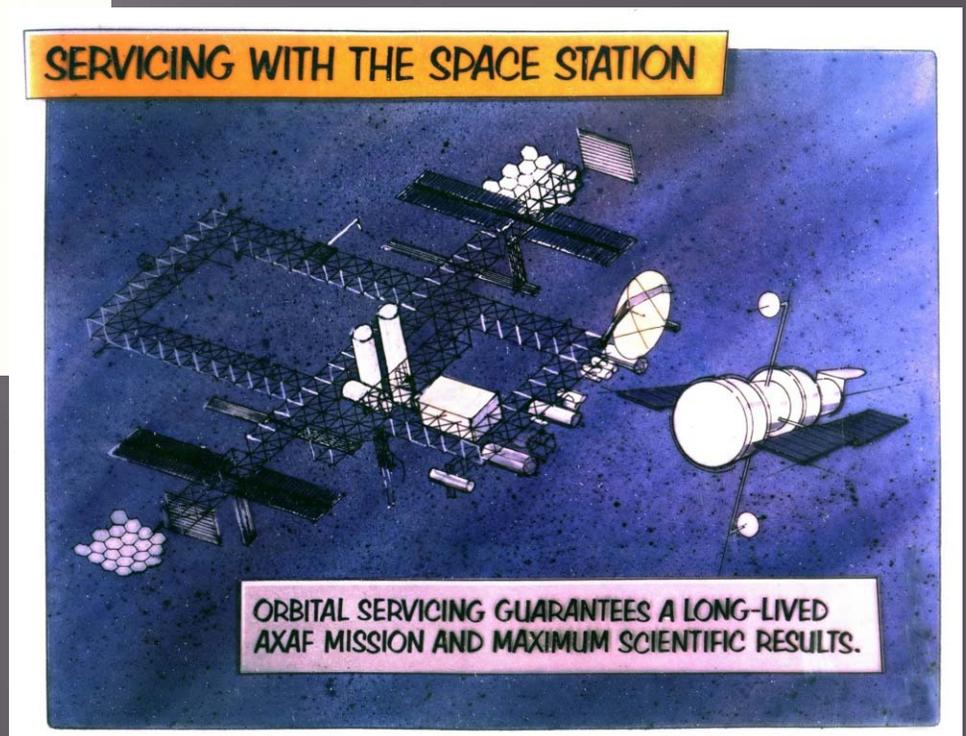
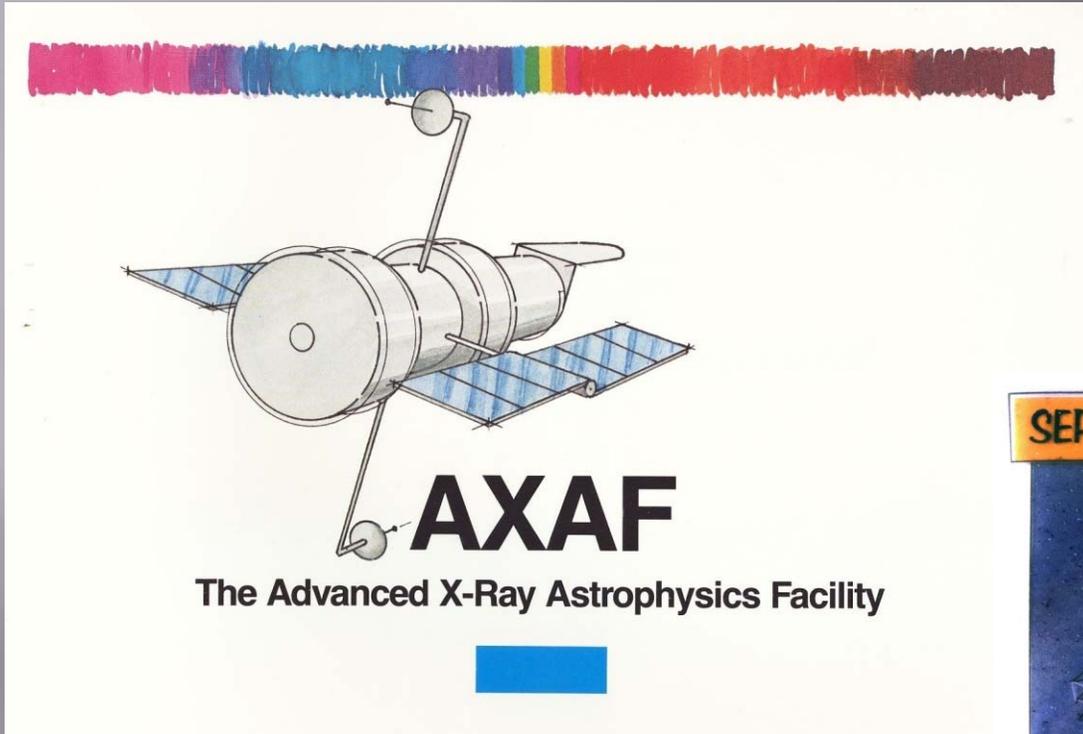


DSS OPTICAL

# Chandra Designed to Address Many Questions

- ▣ How does one create x-ray emitting stellar coronae?
- ▣ To understand the evolution of quasars and clusters of galaxies
- ▣ To measure key cosmological parameters such as the Hubble Constant independently of traditional (optical) approaches
- ▣ To understand the life cycle of stars, with emphasis on neutron stars and stellar mass black holes

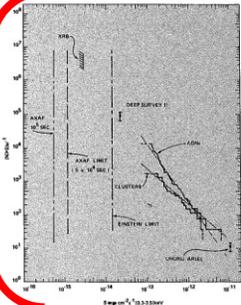
# Brochure Writing & Other Skills



# Brochure Writing & Other Skills

## The X-Ray Background

20



This figure shows the number of extragalactic X-ray sources with intensity greater than a given brightness  $S$  as a function of  $S$ . If the sources are uniformly distributed in a Euclidean universe, this number will be proportional to  $S^{-3/2}$ . The integrated contributions, however, cannot exceed the diffuse X-ray background. The limiting sensitivity of AXAF will take these observations to significantly weaker sources. Studies of the luminosity function of known objects (active galaxies and quasars) can explain much but not all of the diffuse X-ray background. The potential for discovery here is guaranteed as one must uncover either the evolutionary characteristics of known objects, and/or new classes of objects, and/or a truly diffuse component.

The first X-ray astronomy experiment discovered that the brightest X-ray source in the sky was an unexpected one: the sky itself. The entire Universe was aglow with X-rays. Everywhere we looked, we saw a diffuse X-ray background.

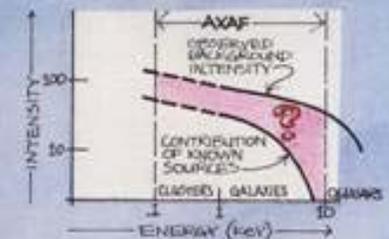
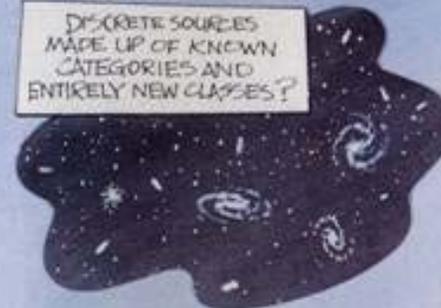
Today, almost 25 years later, we still do not know whether this background glow has a truly diffuse component or is a consequence of looking at many distant X-ray sources with an out-of-focus camera. The X-ray background cannot be caused entirely by known kinds of X-ray sources because there are not enough of them and they do not have the right spectral characteristics. Therefore, studying the background with AXAF guarantees profound discoveries.

The AXAF cameras will produce 10 times the detail seen in any previous X-ray pictures and will be able to detect sources 100 times fainter. If the X-ray background is due to the cumulative effect of many weak individual sources, these will be evident in high-quality, long-exposure AXAF images. These will have to be new types of X-ray sources or younger (more distant or fainter) versions of categories that we know but with different characteristics in order to produce the correct X-ray spectrum. If few sources appear in these images, then much of the X-ray background must be truly diffuse in origin, or evidence for even another new class of objects existing in the early stages of the Universe, or some combination. AXAF spectra will be a good indicator of the physical process that produces the X-ray background and will help us further understand any unresolved component.

One result is certain: AXAF's ability to probe the diffuse X-ray background will lead to discoveries.

## WHAT PRODUCES THE X-RAY BACKGROUND?

DISCRETE SOURCES MADE UP OF KNOWN CATEGORIES AND ENTIRELY NEW CLASSES?



DISCRETE SOURCES FILL A TRULY DIFFUSE COMPONENT?

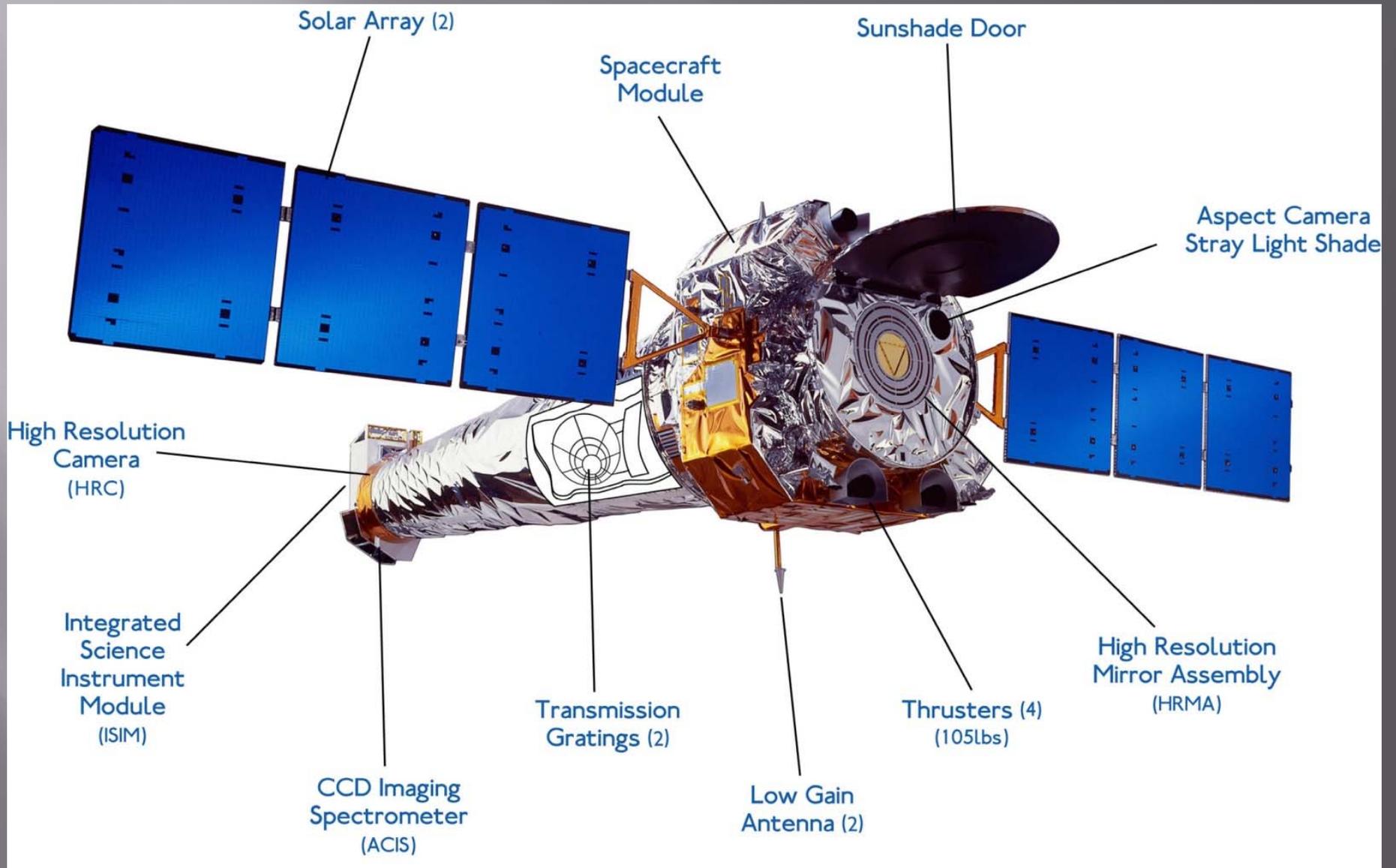


AXAF WILL BRING THE X-RAY BACKGROUND INTO SHARP FOCUS ENABLING US TO DETERMINE AND EXAMINE ITS COMPOSITION.

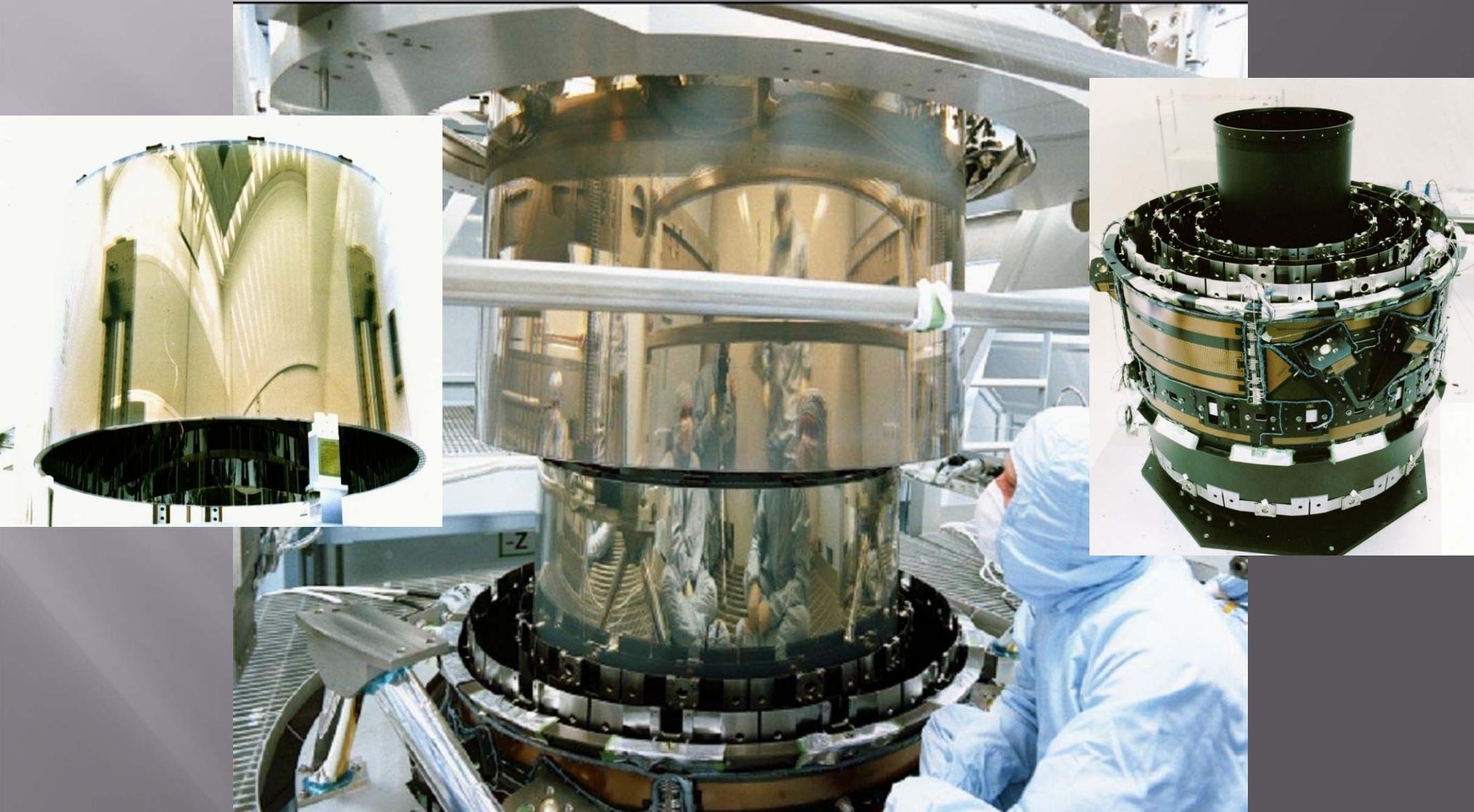
# Big \$ Astrophysics is not easy

- ▣ Chandra was recommended #1 priority in the 1980 National Academy Decadal Survey
- ▣ The burden of HST
- ▣ The imposed tests
  - Technology demonstration
  - Full mirror test
- ▣ Major descoping
  - Remove servicing
- ▣ Chandra launches in 1999!

# The Observatory



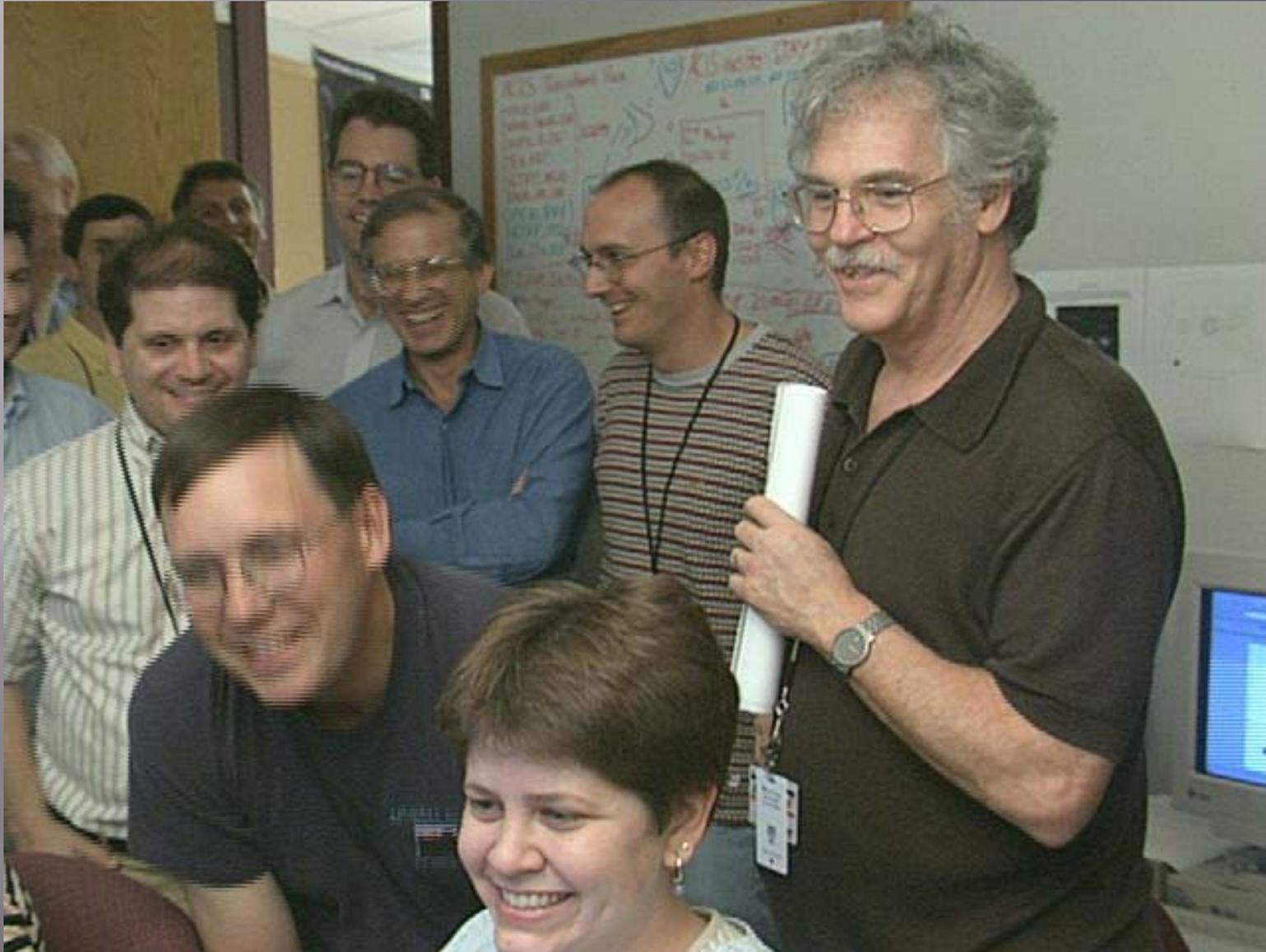
# The Optics



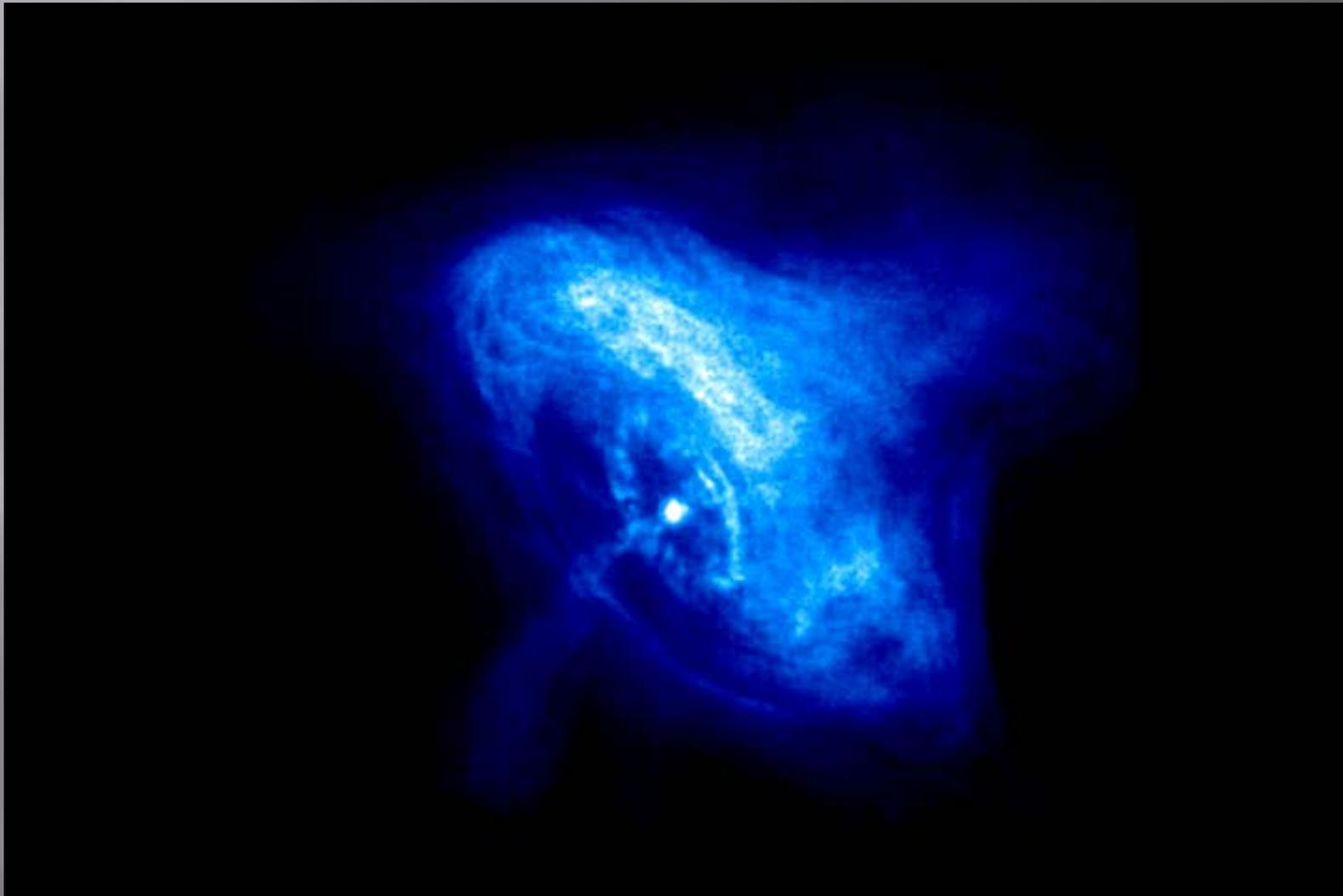
# The Test Facility



# Chandra is a major success!



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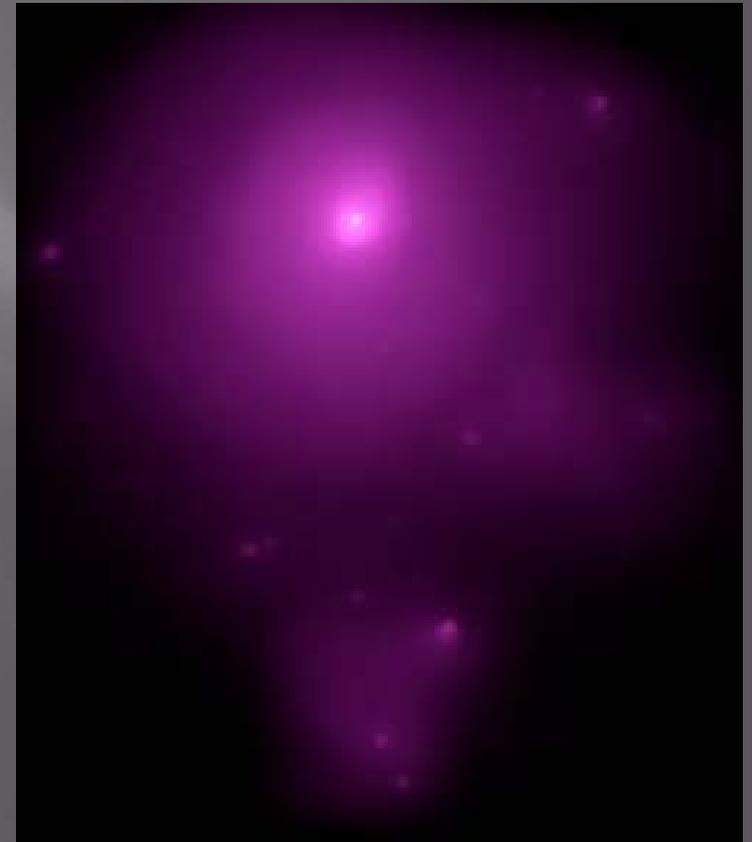
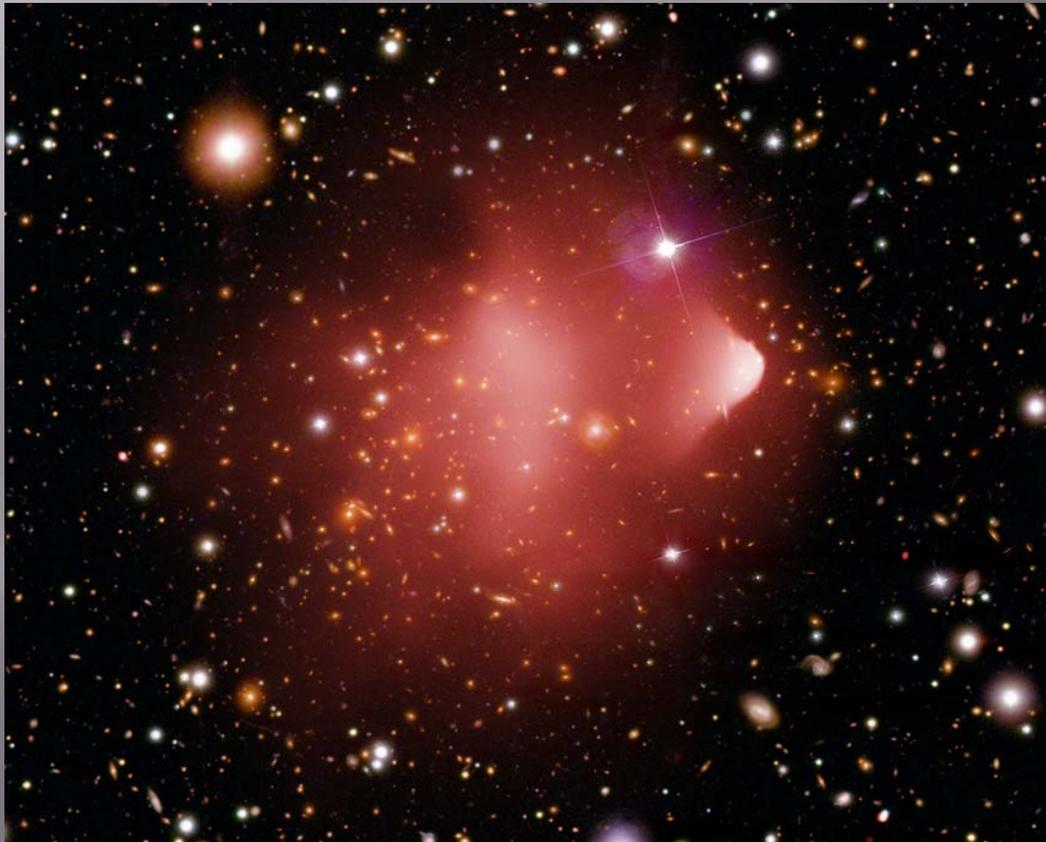


# Chandra is a major success!

Telescope	Citations	Papers	Cites/paper
Chandra	16936	723.5	23.41
HST	15390	1063.1	14.48
VLA	8478	582.2	14.60
Keck	8122	356.6	23.33
XMM-Newton	7993	332.0	24.08
VLT	5696	345.5	16.49
AAT	4592	170.2	26.98

# Capable of addressing the new questions

- ▣ What is dark matter?
- ▣ What is dark energy?



# Chandra is a major success!

