2002年諾貝爾物理獎(2/2)

成功大學 物理學系
Department of Physics, NCKU

X-ray telescope & X-ray Universe

"The Birth and the current status of X-ray Astronomy"

-- Riccardo Giacconi的研究工作

報告人：許瑞榮 (成大物理系 天文實驗室)

“for pioneering contributions to astrophysics, which have led to the discovery of cosmic X-ray sources”

Riccardo Giacconi

(1931~，生於義大利，現為美國公民)

：X光天文學之父

- President of Associated Universities,Inc.
- Research Professor at John Hopkins University

Giacconi**的諾貝爾獎獎章**

Giacconi的主要貢獻:

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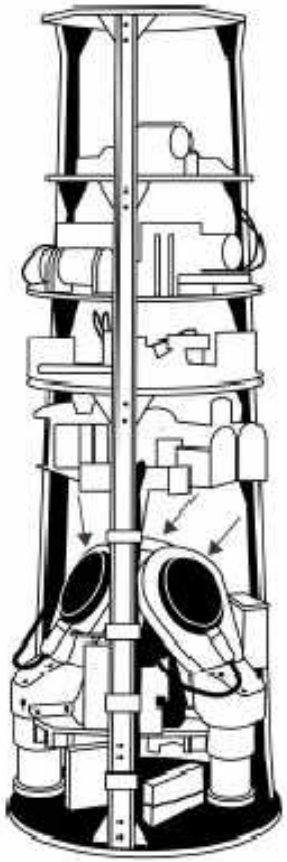
1. Giacconi **與它所帶領的團隊發現了第一個不是來自於太陽的宇宙**X**光源**(1962)



Aerobee rocket

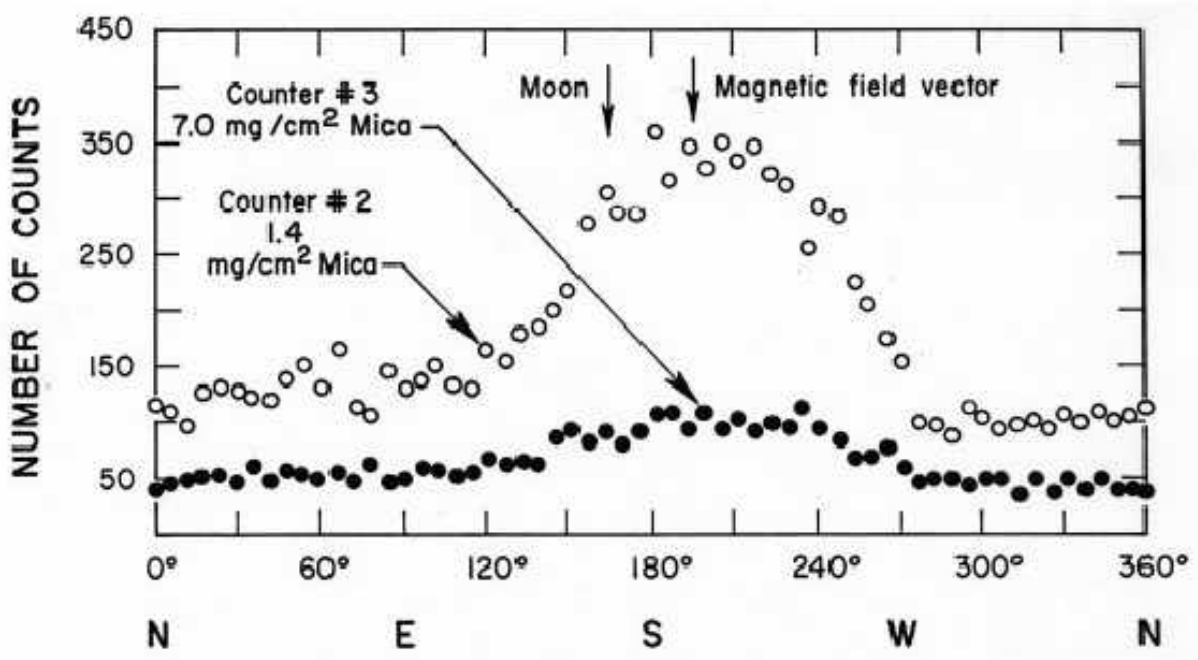


Fig. 8 Recorded counts from the Geiger counters of the payload in fig. 7. The count for two different counters, with different thickness of their Mica-windows, are shown. The results indicate the presence of an X-ray source, different from the Moon. A cosmic background radiation is also suggested.

X-光天文學的開創年代

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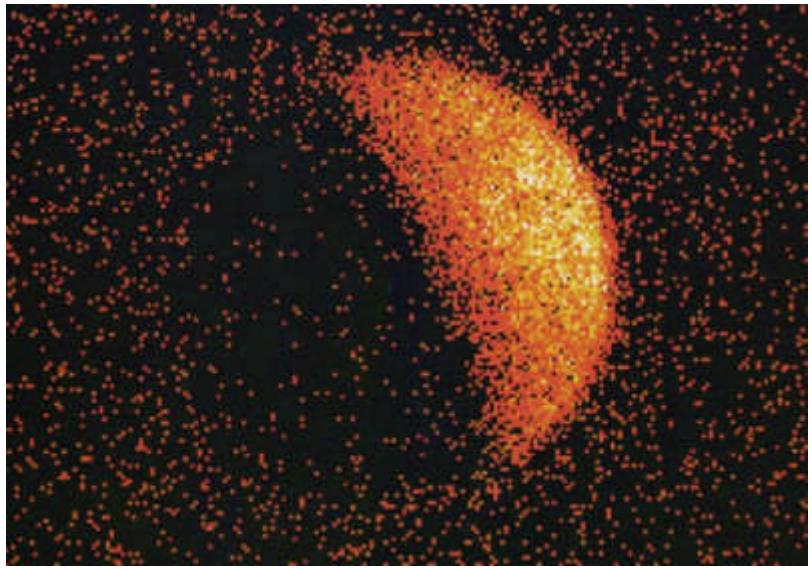
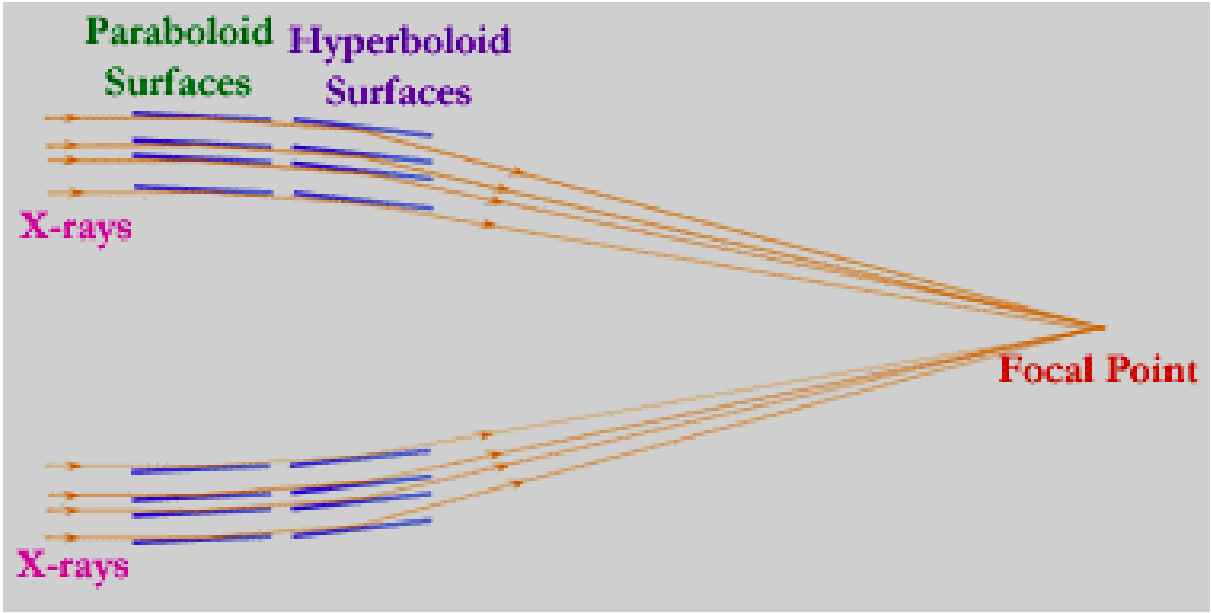
- 1949年，H. Friedman與他在NRL(US Naval Research Laboratory)的研究群，利用德國所發展的V2火箭，載著蓋格計升空，發現了太陽會輻射X-光。
- 1958年，NRL研究群利用日食的機會，驗證了太陽的X-光是來自於日冕與太陽黑子。



- 1962年，Giacconi的研究群，以載有三個蓋格計的Aerobee 火箭，探測月球表面的太陽X-光反射光。經過兩次的失敗，在第三次發射中，除了觀測到月球表面的反射X-光之外，也意外的發現來自於太陽以外的宇宙X-光源Scorpius X-1.

2. X光望遠鏡的研發

- 1959年，Giacconi受僱於私人公司AS&E，從事太空科學研究工作。主要是與MIT的知名宇宙射線學家B. Rossi共同發展X-光天文學。
- 1960年，Giacconi與Rossi共同發表建造X-光望遠鏡的構想。之後，Giacconi與他的研究群繼續從事X-光望遠鏡的研發與試驗。



X光的折射率~1

The implementation of focusing optics was a very important step to image the X-ray sky. Giacconi was the main driving force in this development.

Chandra X-ray Observatory

Schematic of Grazing Incidence, X-ray Mirrors

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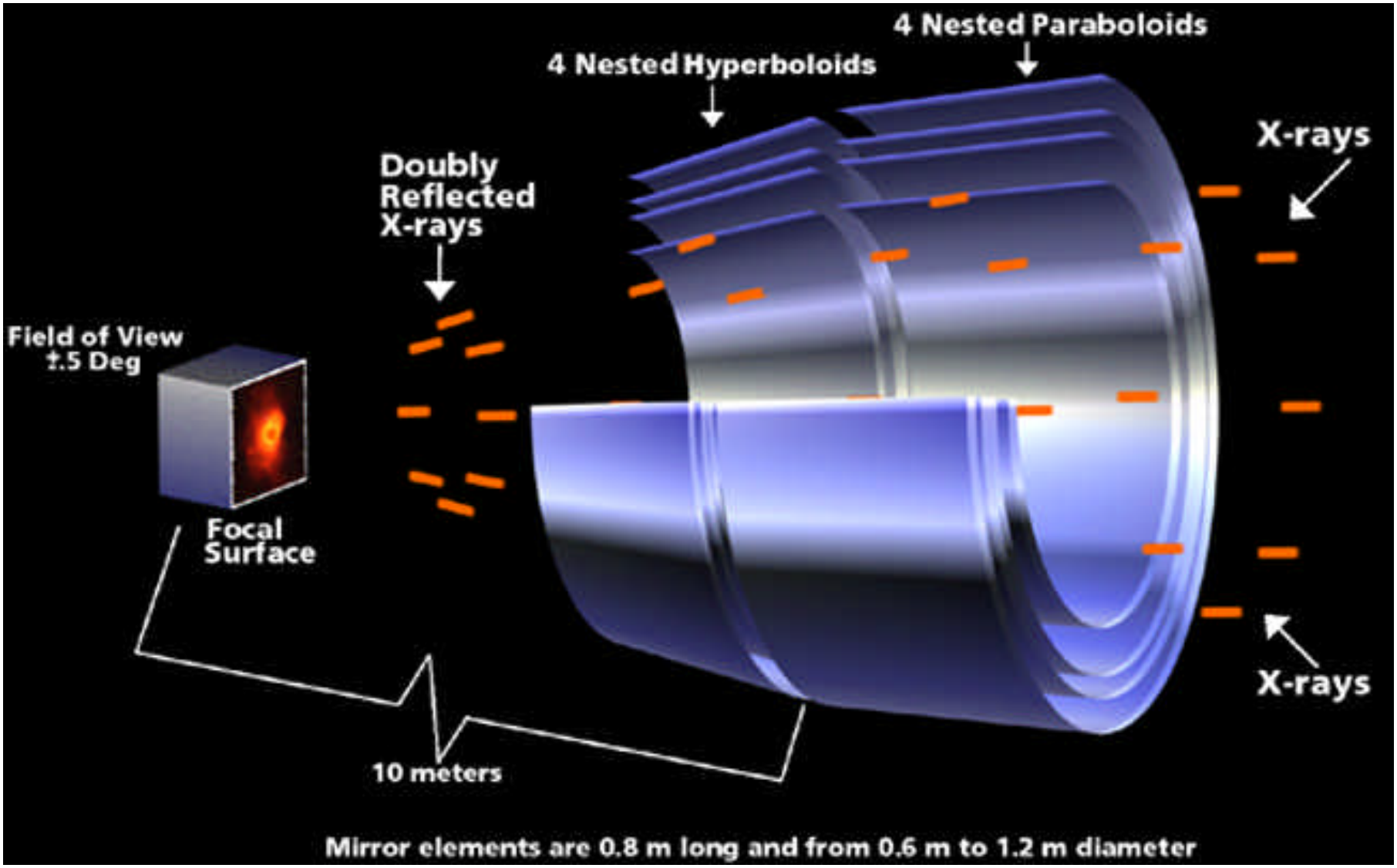
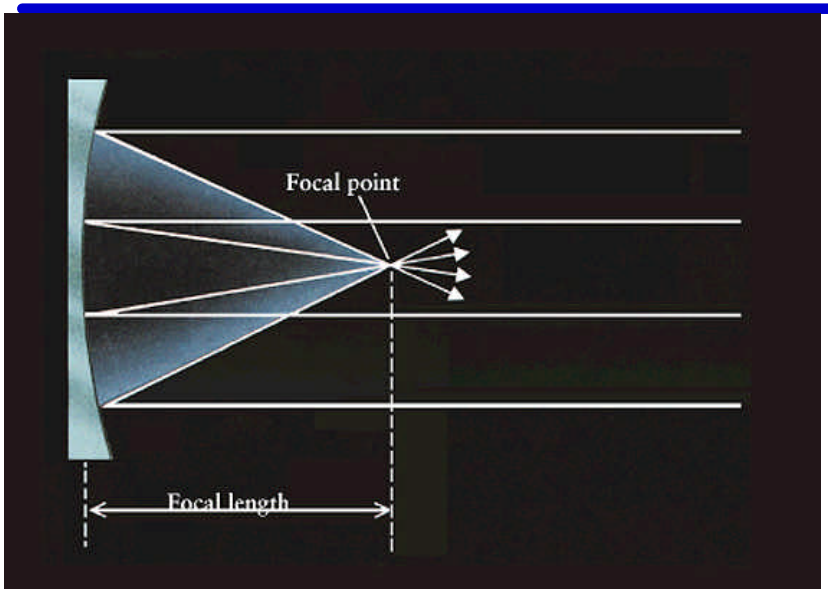
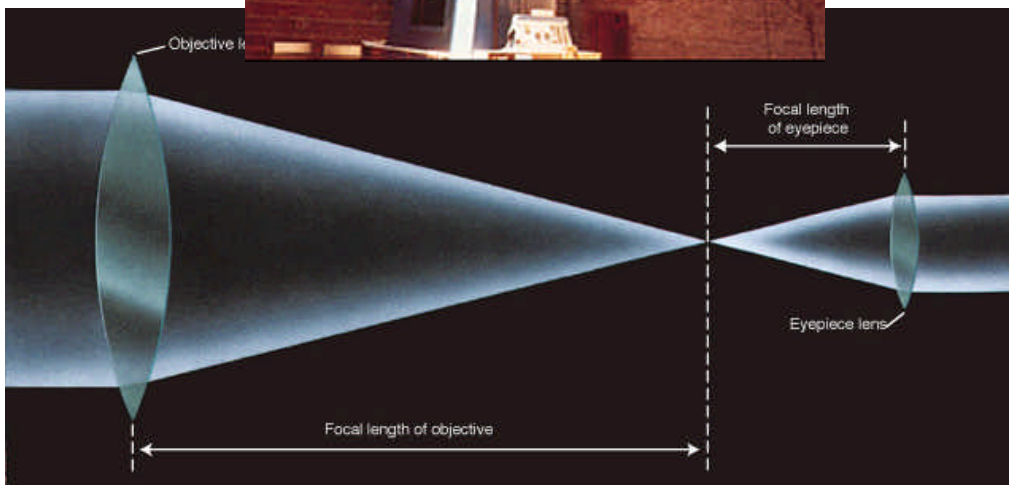
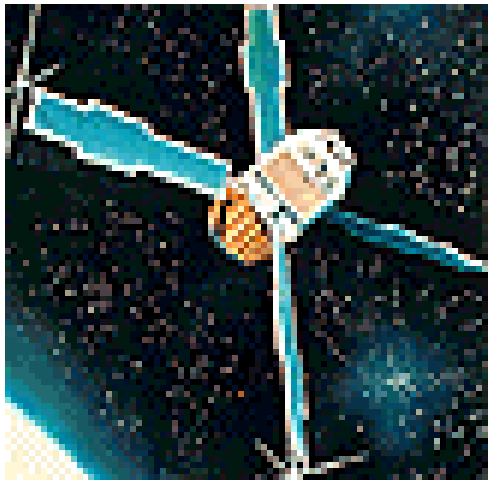


可見光望遠鏡


Focal point
Focal length


Focal length
of eyepiece
Eyepiece lens
Focal length of objective

3. 設計並主導NASA的自由號X光人造衛星(Uhuru X-ray satellite) 進而發現第一個黑洞存在的證據。



Uhuru X-ray satellite

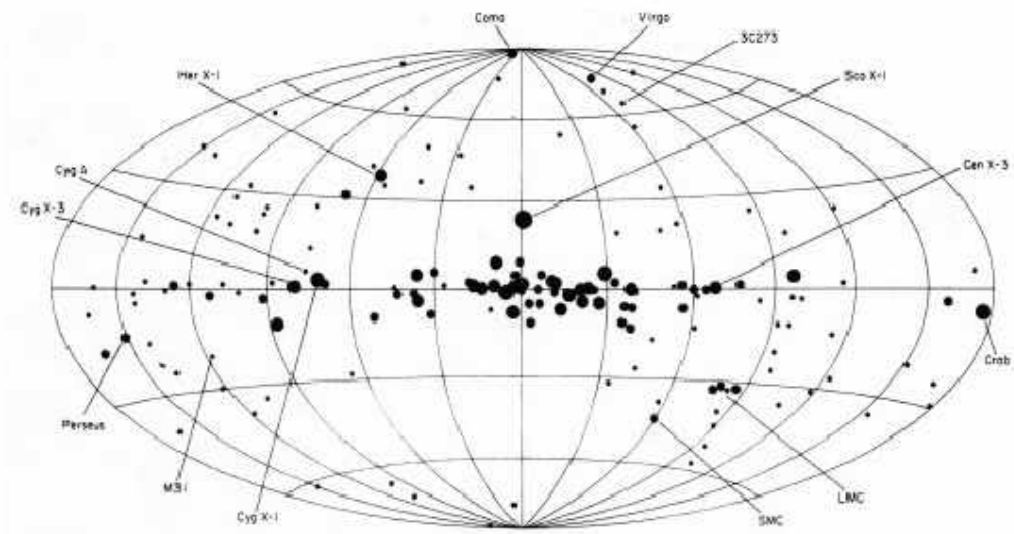
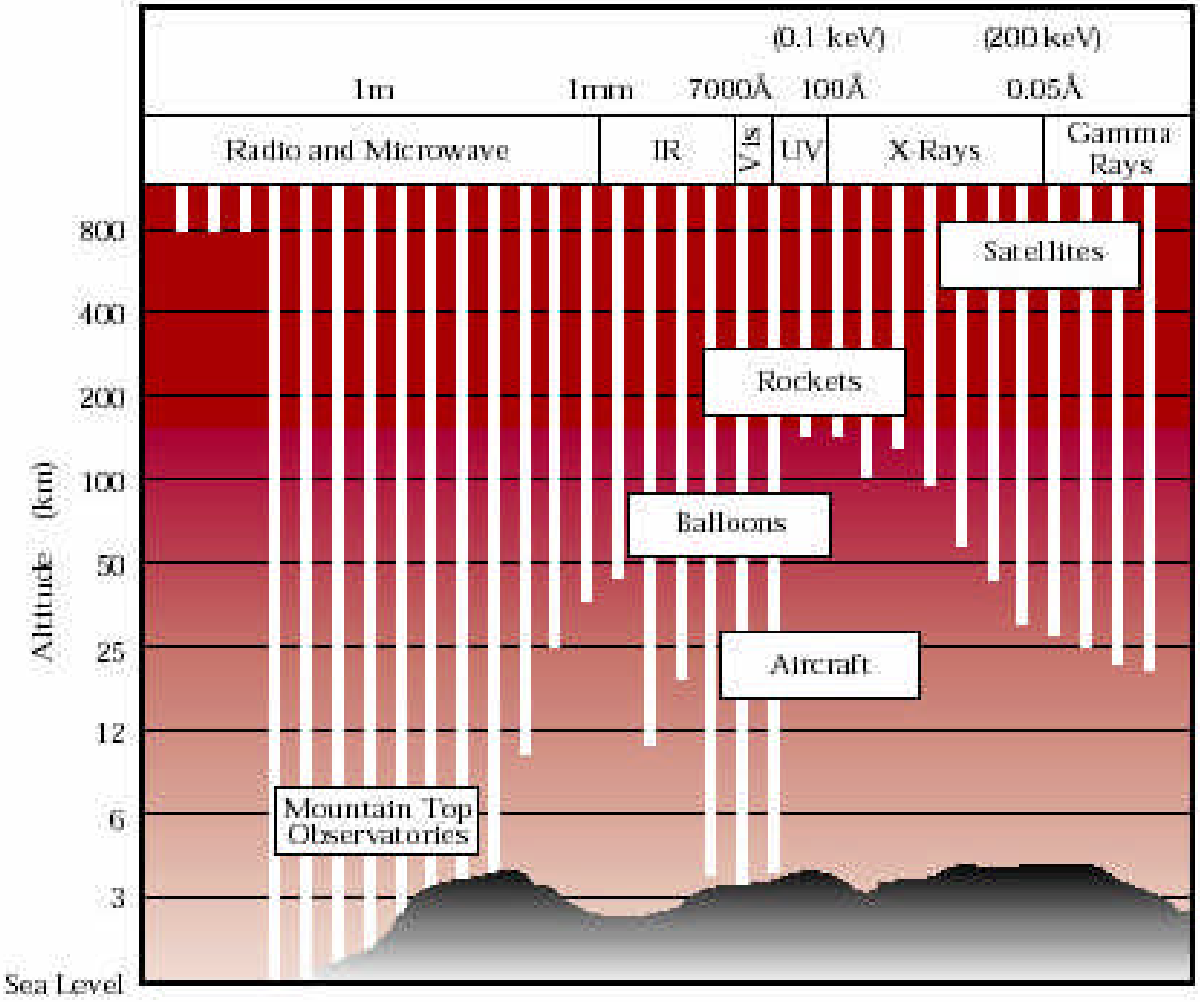


Fig. 9 A map of the X-ray sky in galactic coordinates derived from the 3U Catalog, based on UHURU data. The location of each X-ray source is approximately shown. The size of the dots is proportionate to the logarithm of the intensity. Several of the sources of outstanding astrophysical interest are shown.

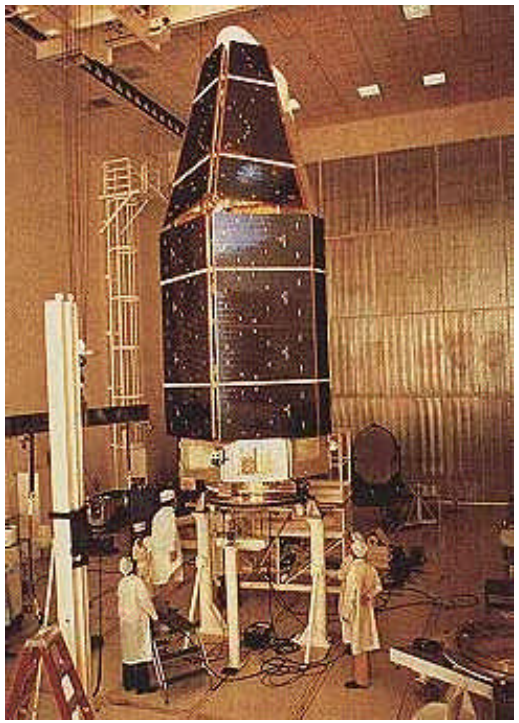


The absorption of X rays by the earth's atmosphere restricts ground-based observations to radio, near infrared, and visible wavelengths. X rays are absorbed high above the earth.

Atmospheric Window

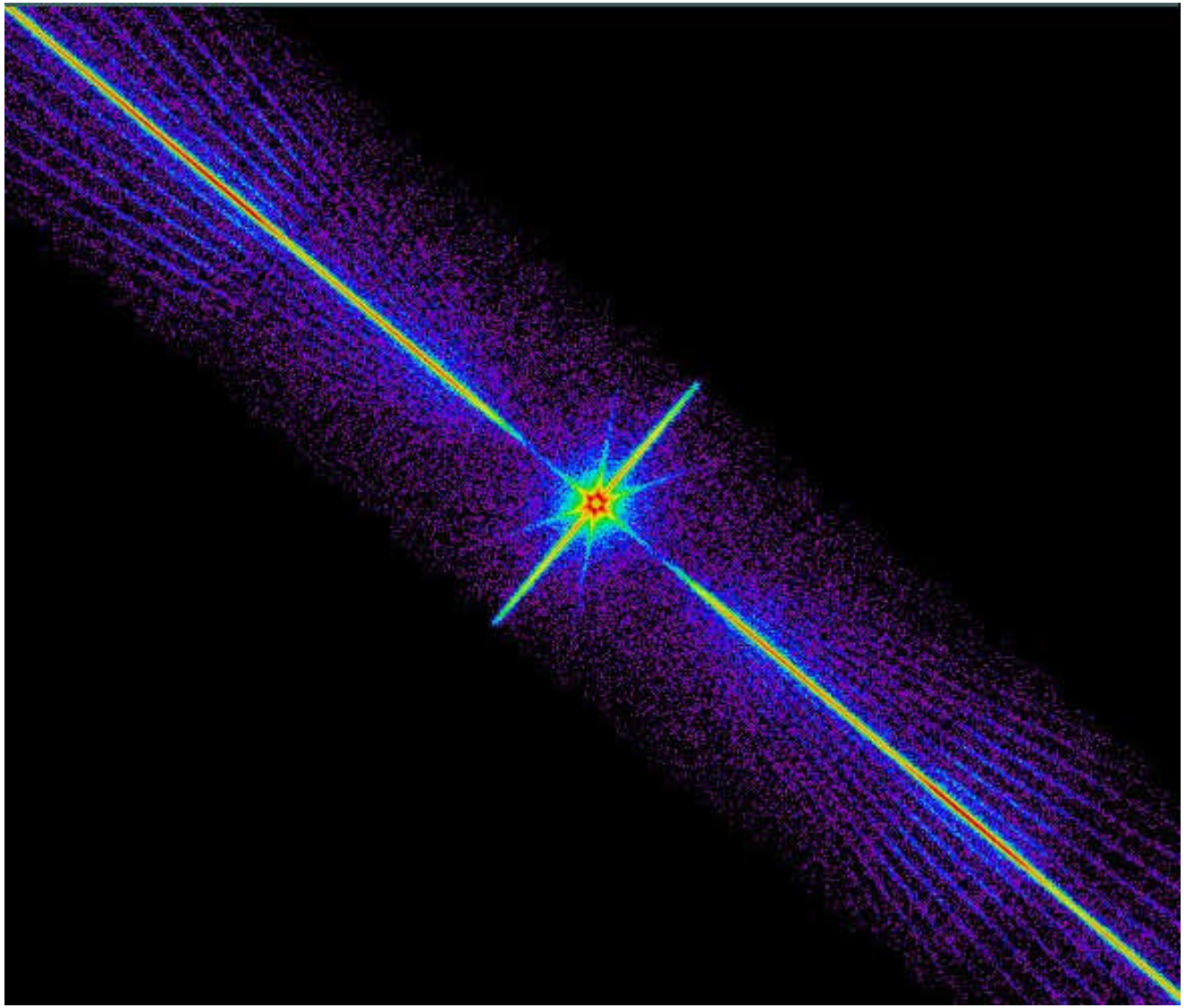
4. The Einstein X-ray Observatory(HEAO 2), the first imaging X-ray telescope, was also a product of Giacconi's team.

Einstein X-ray telescope

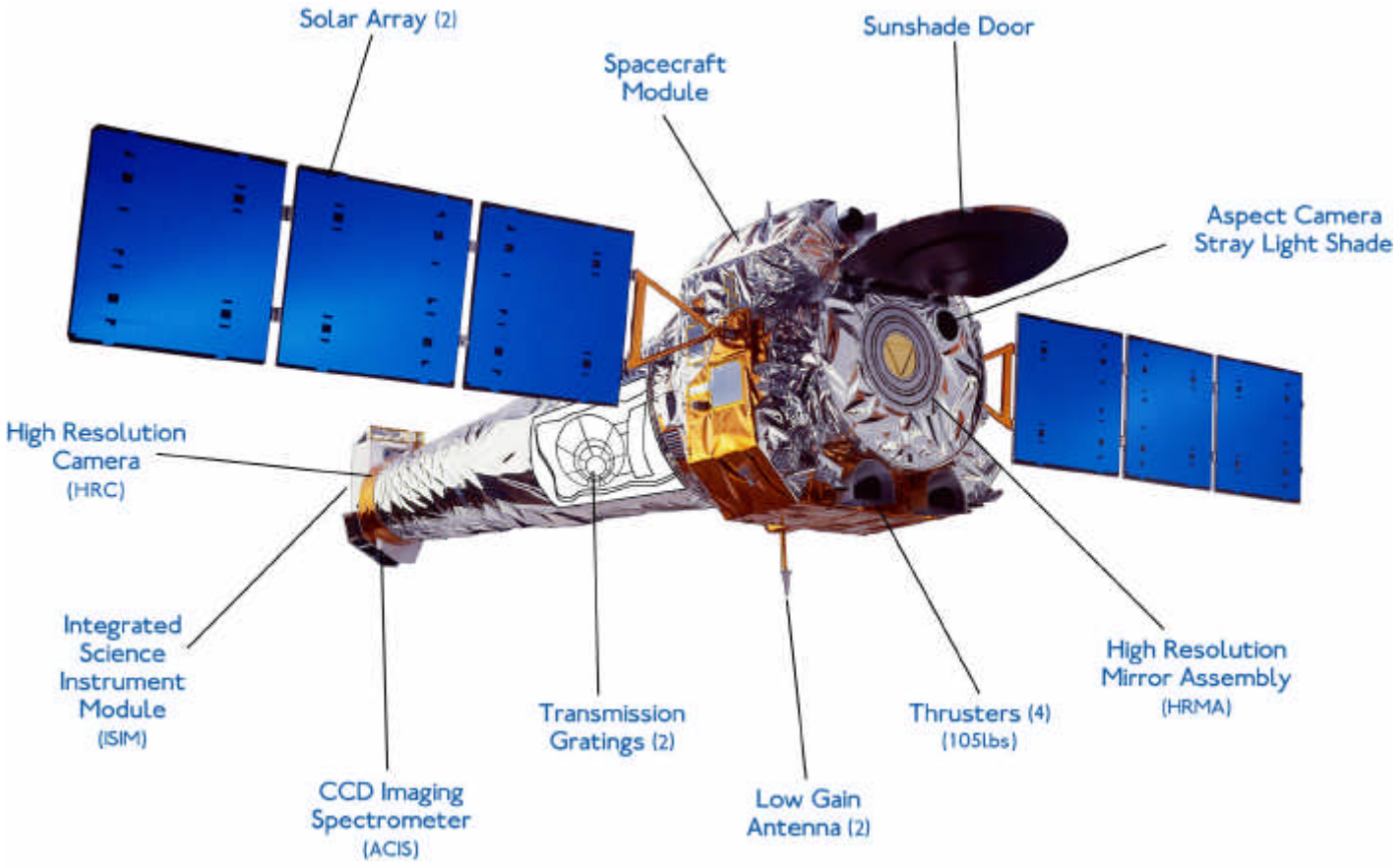


•1000 times higher sensitivity than UHURU

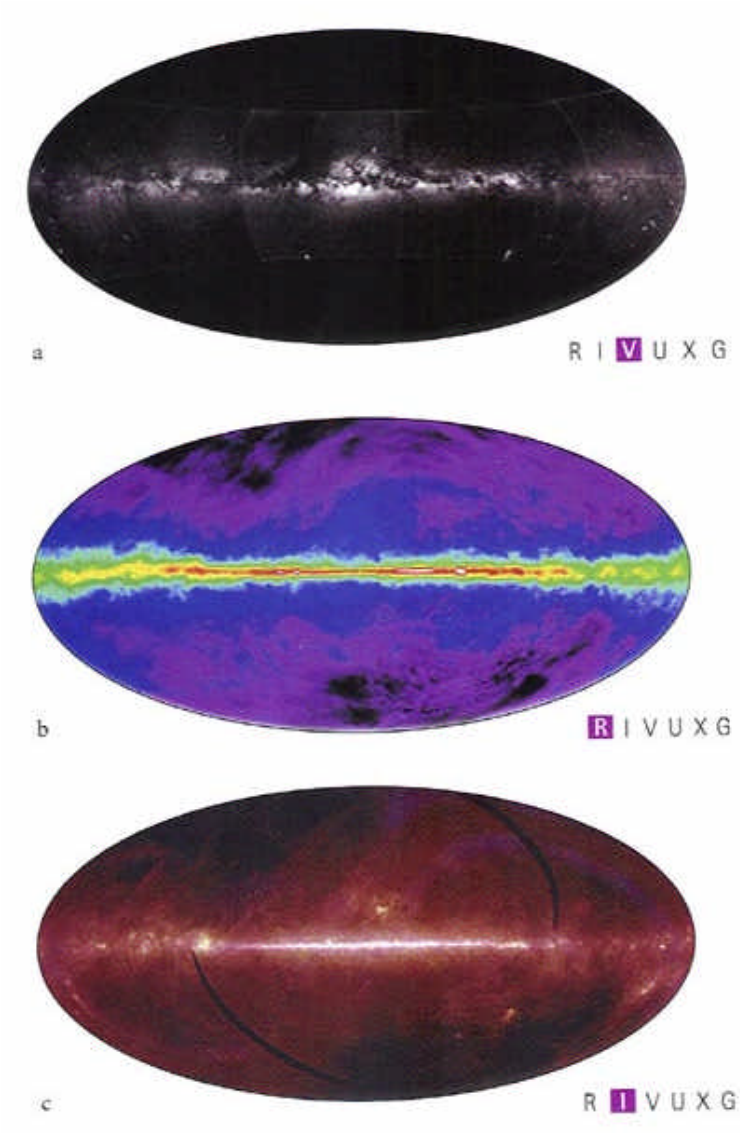
X-ray spectroscopy

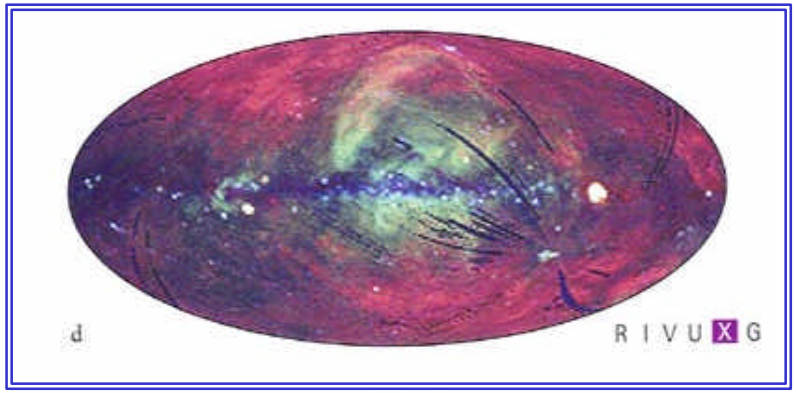


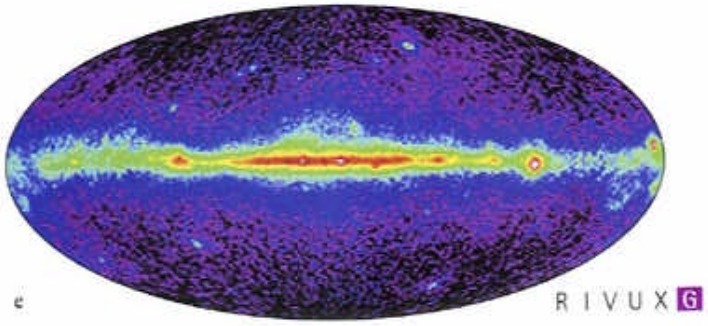
5. Giacconi along with Harvey Tananbaum, now director of the Chandra X-ray Center, submitted a proposal letter to NASA that began the process that led to the development of the Chandra X-ray Observatory.



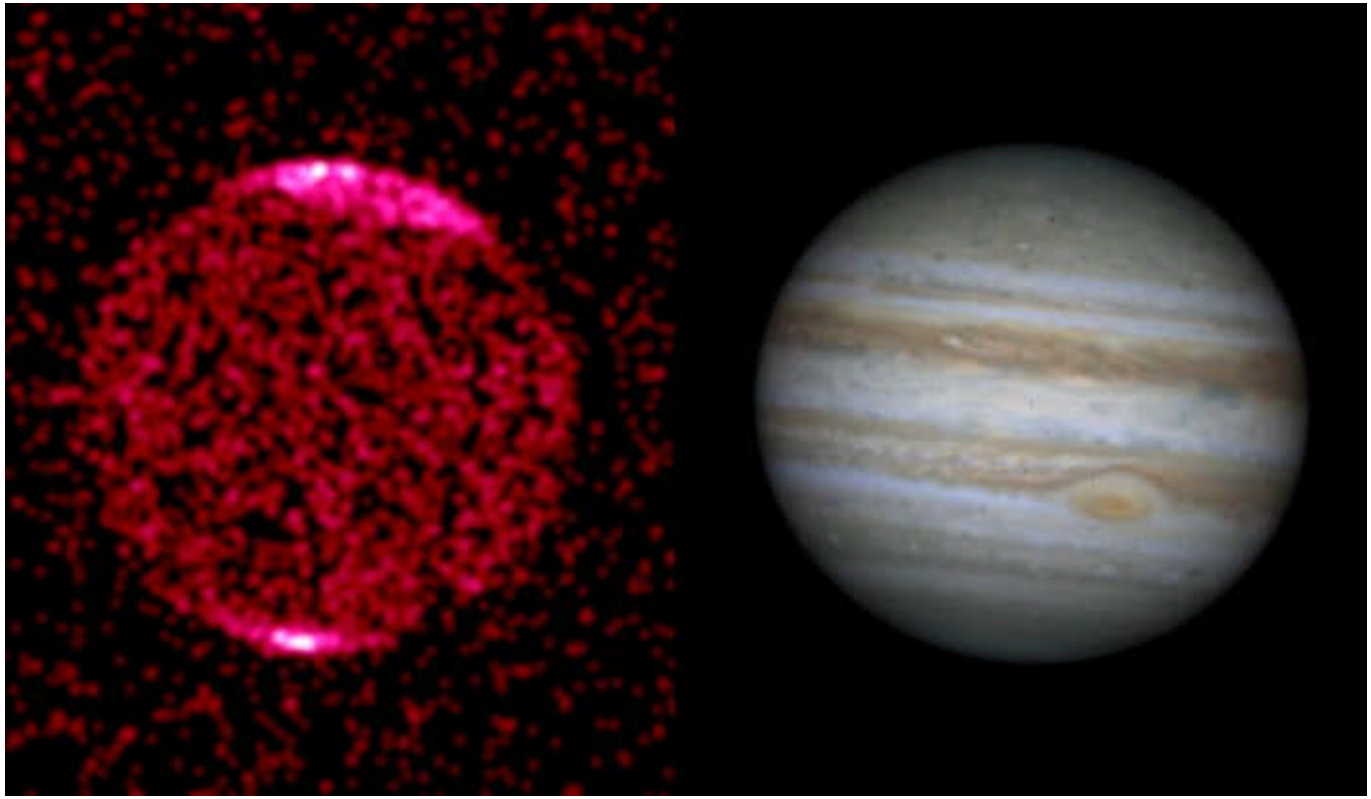
Universe at different wavelengths





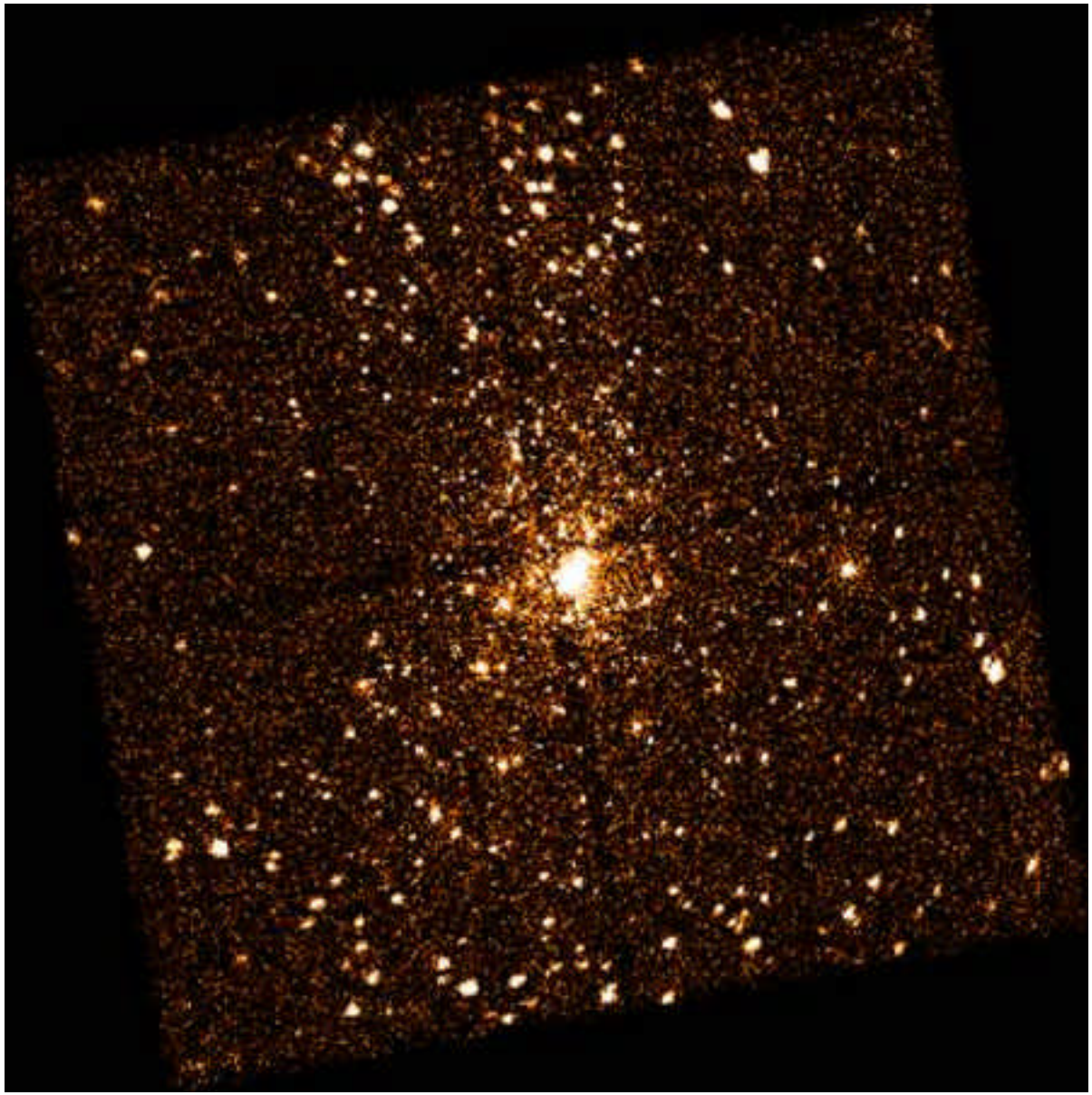


X-ray emission from planets



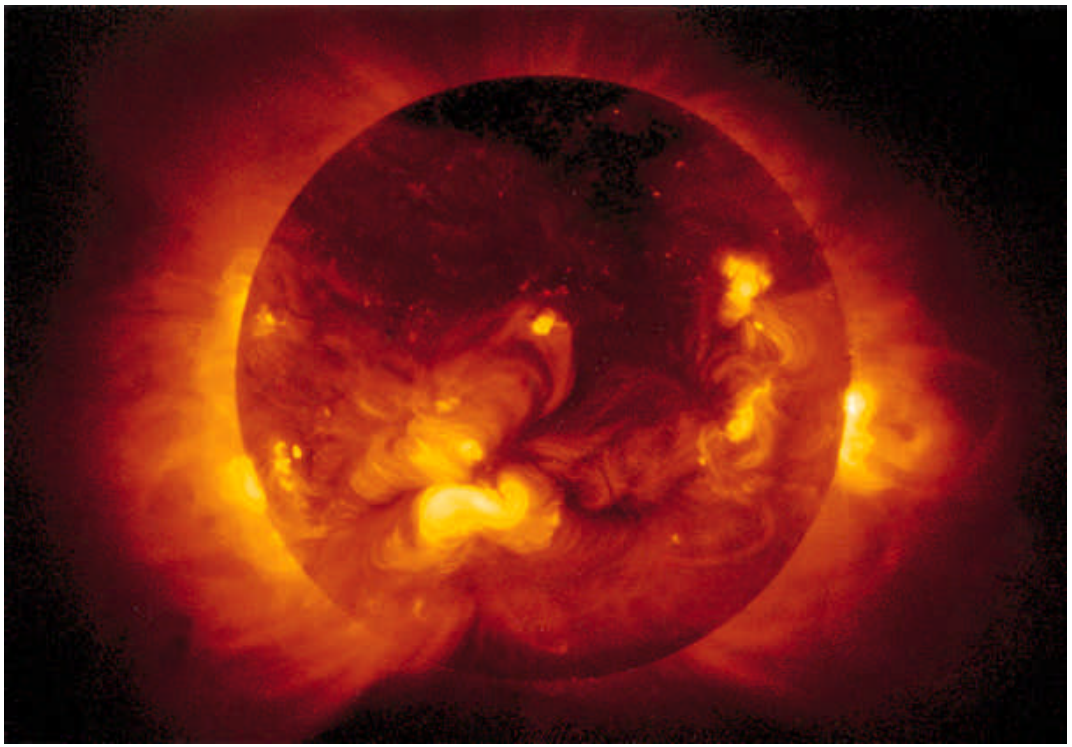
Jupiter

X-ray emission during star birth



Orion nebula

X-ray emission form our Sun



X-ray emission from supernova remnants

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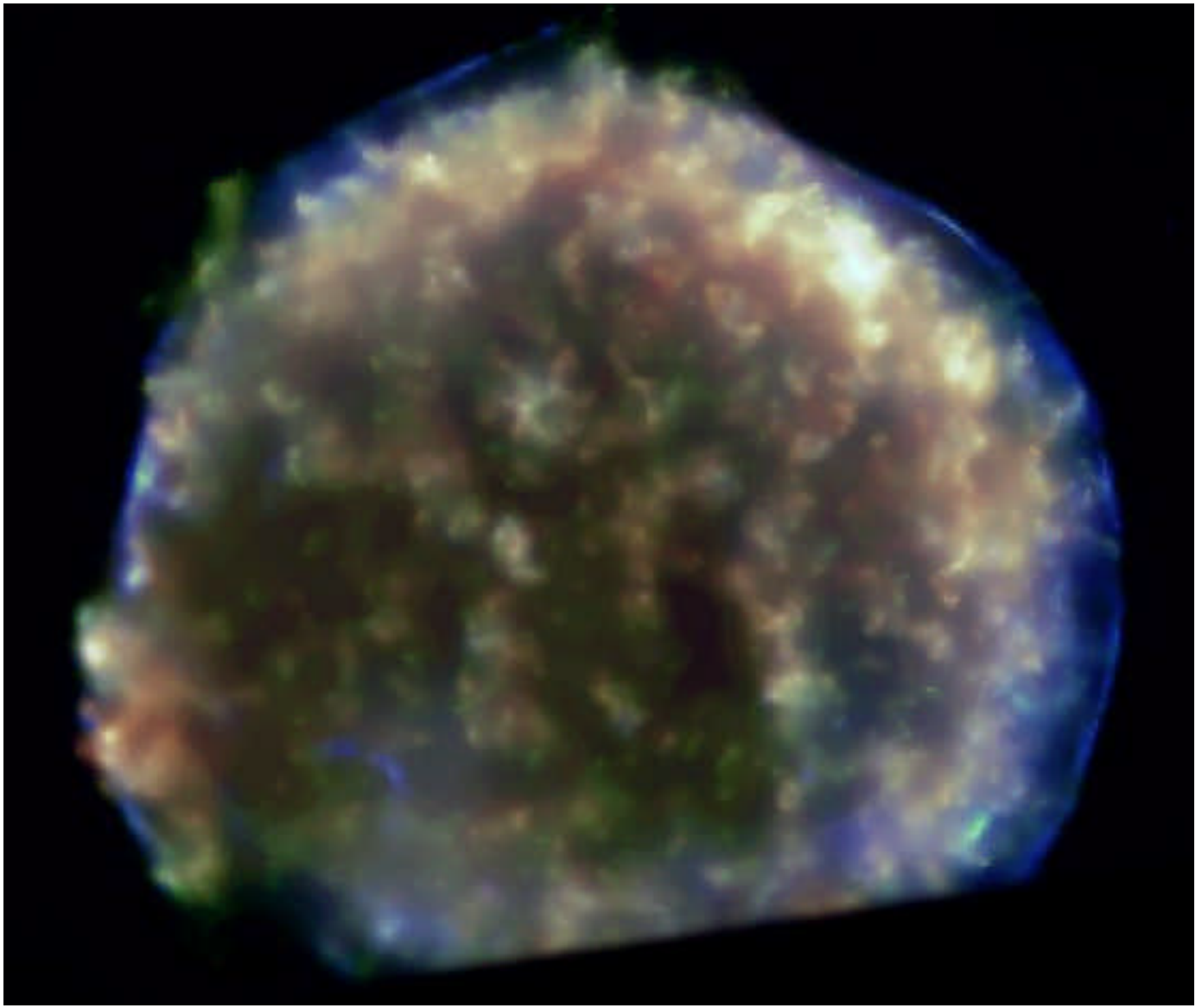
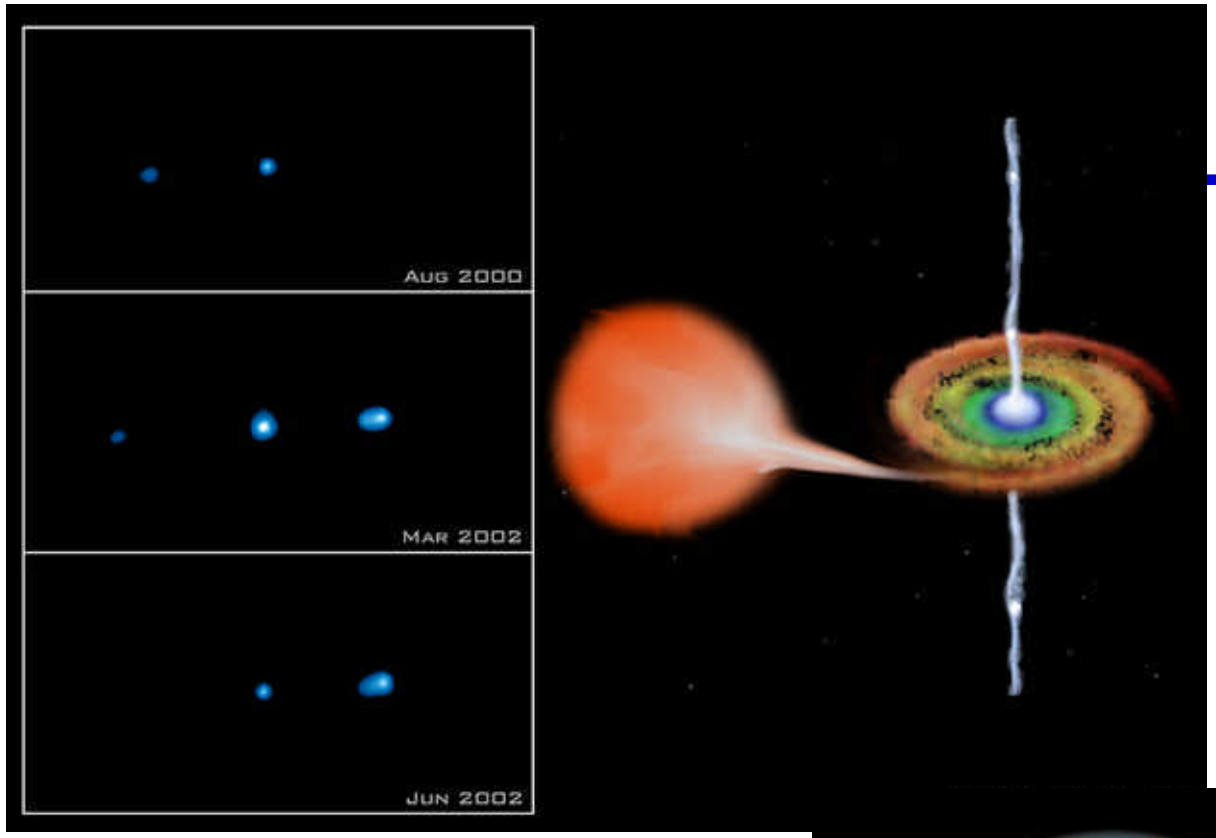


Heavy elements



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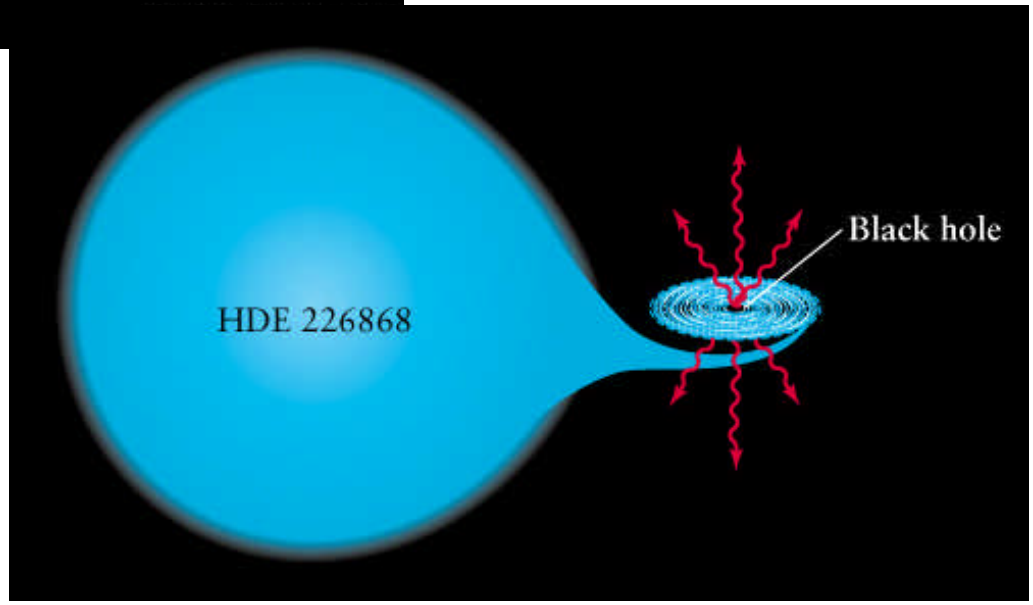
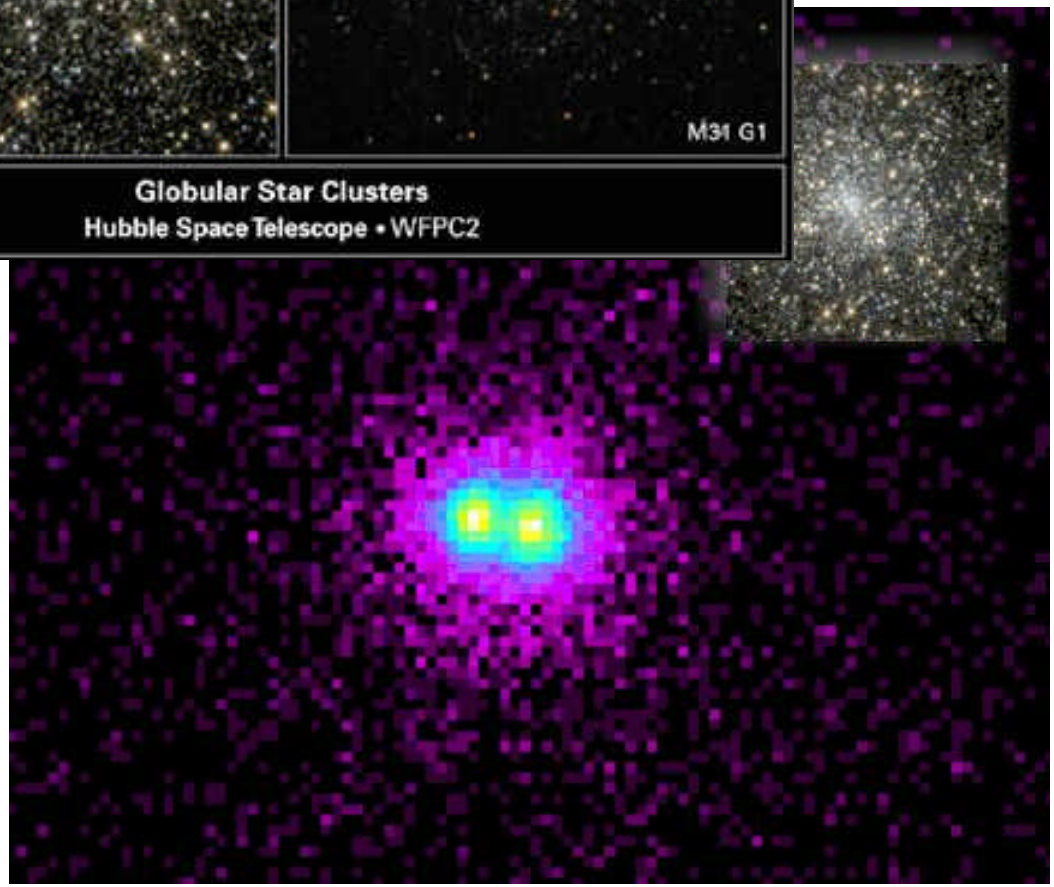
X-ray binary

Neutron star,
Black Hole



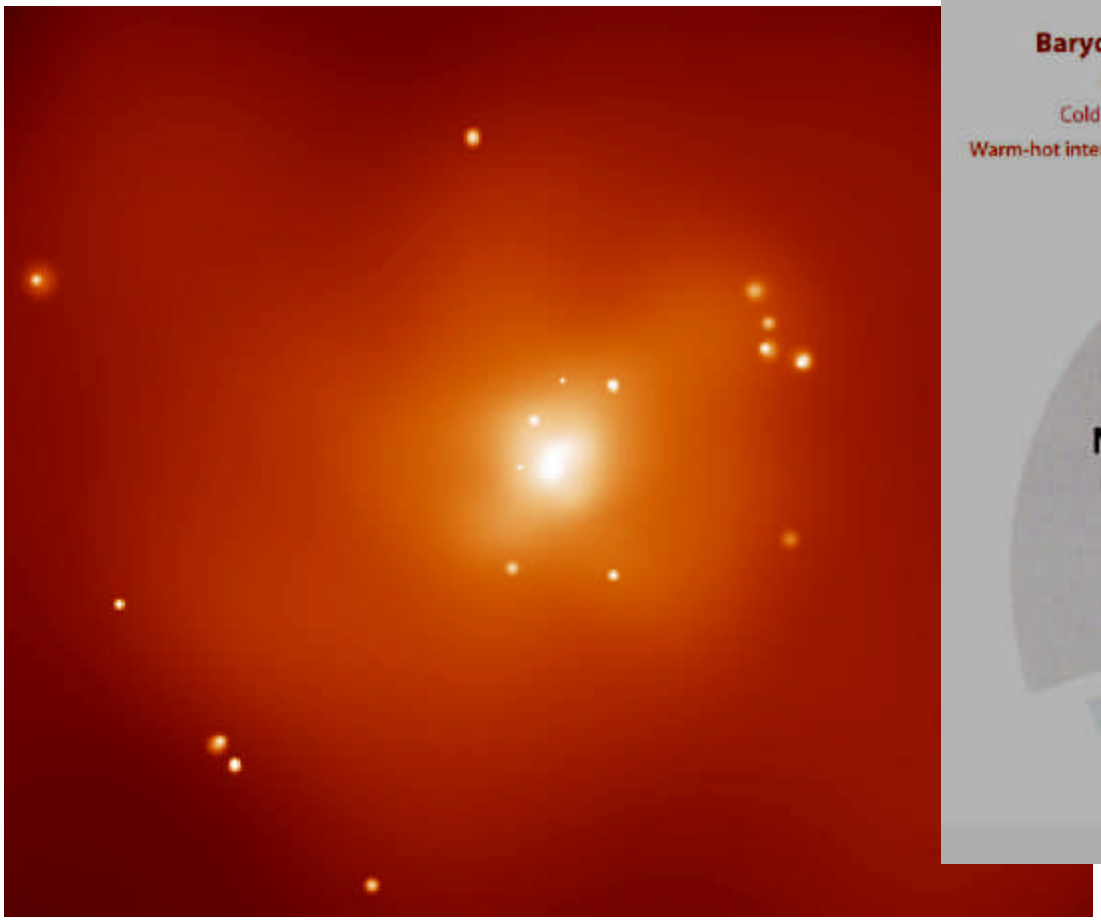
Medium size black hole in M15

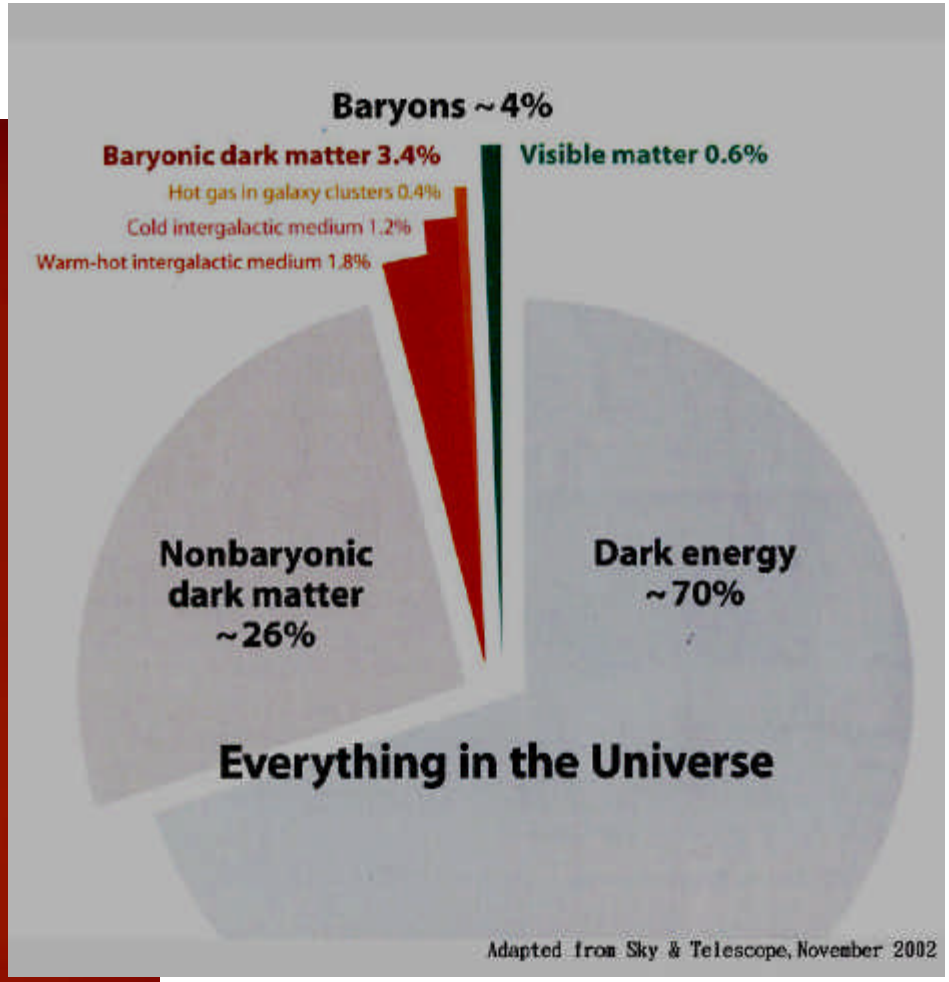


(2002.09.18)美國哈伯太空望遠鏡在仙女星系與飛馬座內的M15與G1球狀星團內發現兩個「中型黑洞」，其質量分別相當於四千個太陽與二萬個太陽。過去曾發現質量相當於五到十個太陽的小型「星型黑洞」，與相當於數百萬甚至數十億個太陽的「超大質量黑洞」，這兩個中型黑洞的發現，找到了黑洞族譜中的「失落環節」。(美聯社)

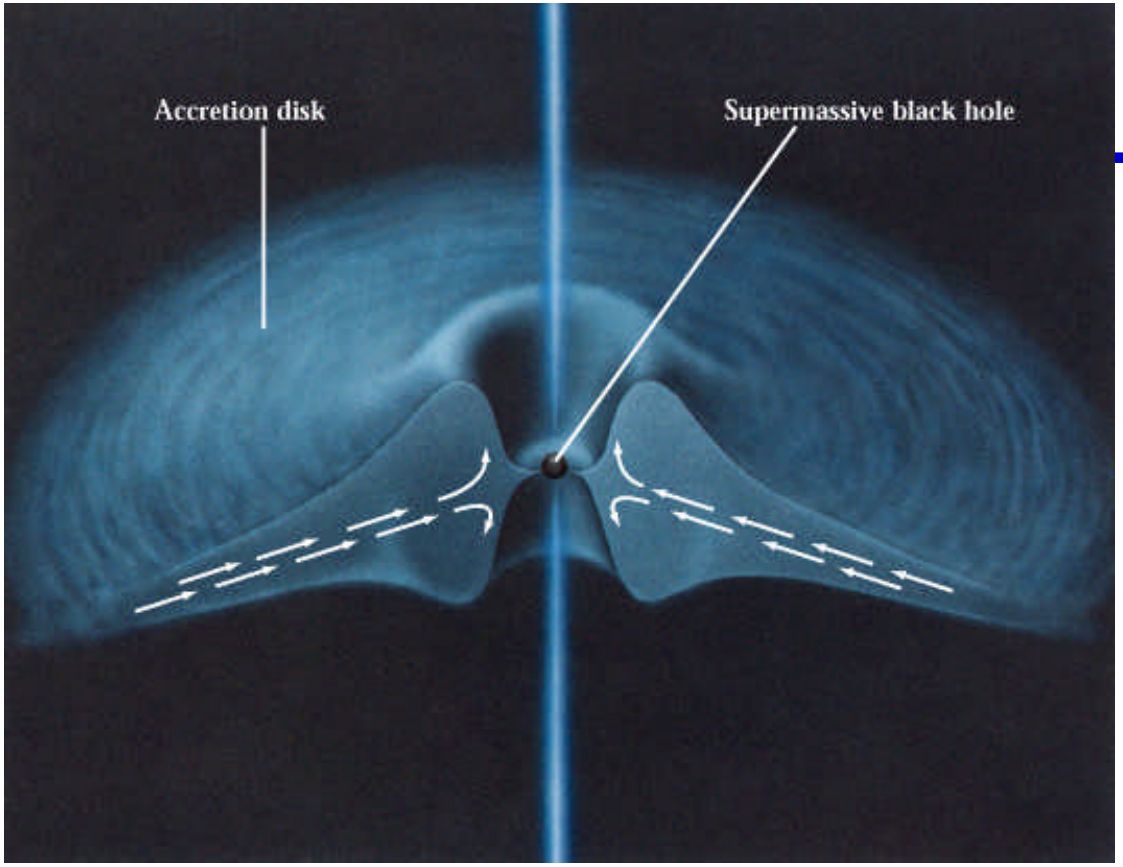
X-ray emission from NGC720

Intergalactic gas and dark matter



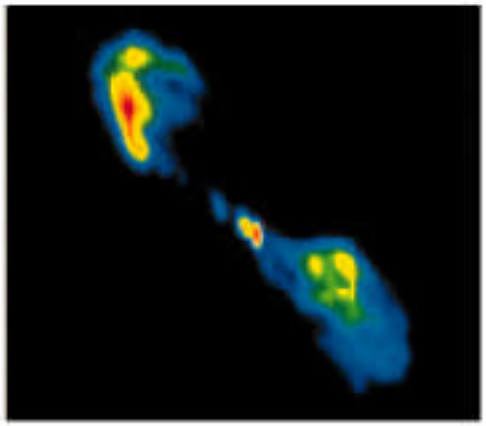


Galaxy, Galactic black hole



AGN
(active galactic nucleon)
活躍星系核心


a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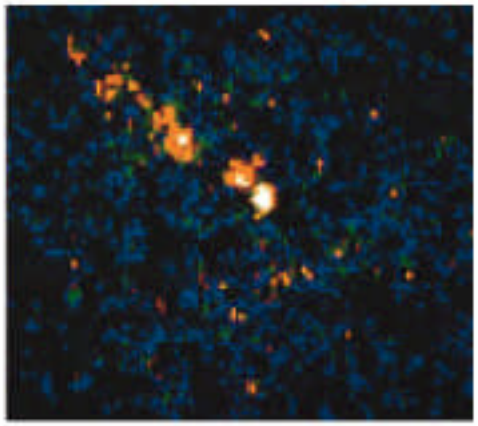
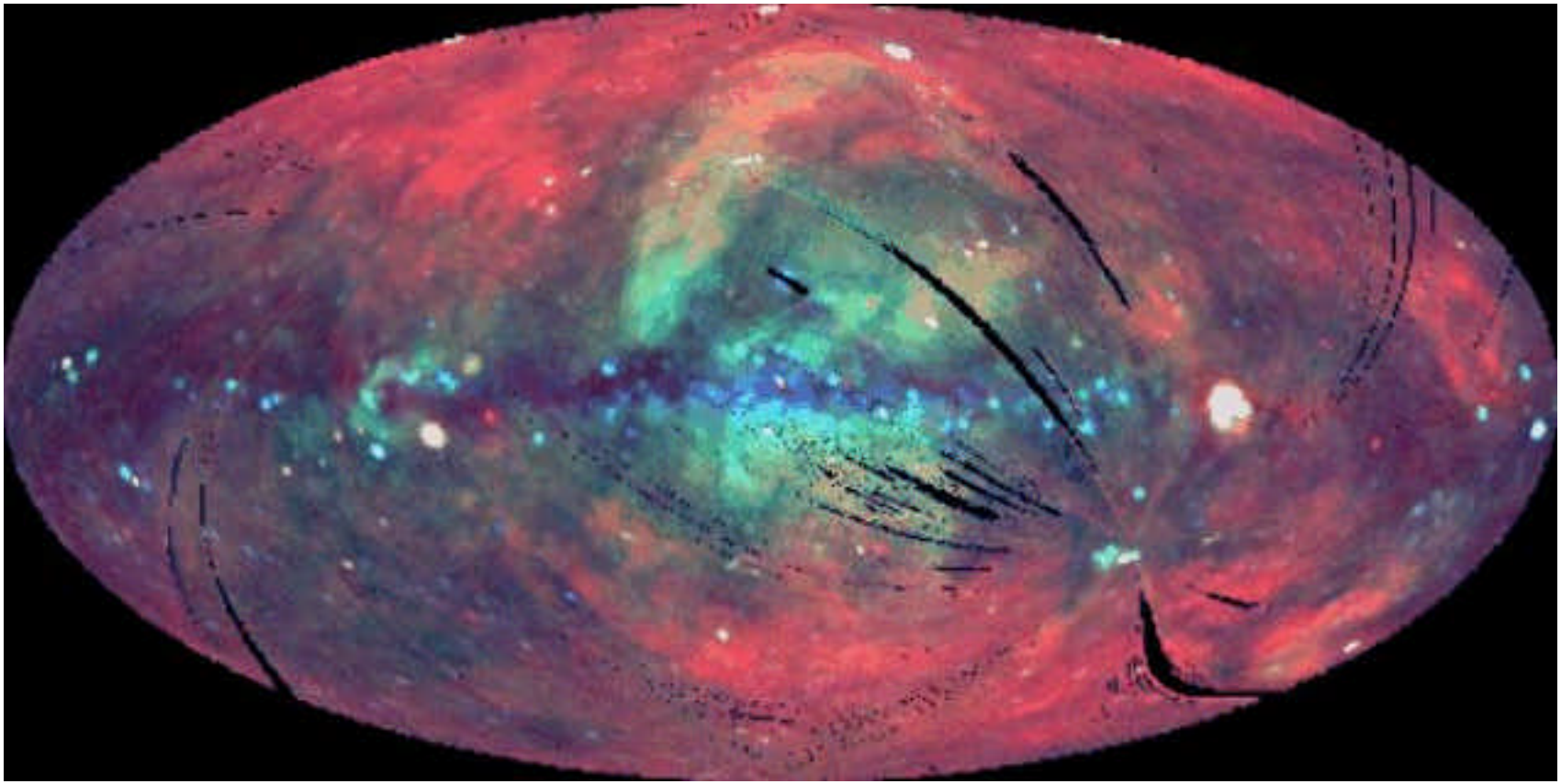

c

X-ray background radiation of cosmos



- X-ray astronomy is a young science; many new discoveries have been made with a new generation of X-ray telescopes (e.g. Chandra from NASA, XMM-Newton from ESA).
- A continued exploration of cosmic X-rays is necessary to extend our knowledge of collapsed massive objects, the origin and evolution of galaxies and galactic clusters, and dark matter.
- X-ray astronomy also offers promising possibilities to prove that black holes exist and to explore their nature.

成大物理系天文實驗室已投入人力，與中央大學天文所合作，使用鹿林山一米望遠鏡，從事X-ray binary**的監測工作。**

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