{{Starbox begin

| name=HDE 226868 }}

{{Starbox image

| image=[[Image:Cygnus constellation map.png|250px]]

| caption=在這幅天鵝座星圖上，HDE 226868（未標示）位于η星（中下）旁。<ref name=bernard/> }}

{{Starbox observe

| epoch=J2000

| ra={{RA|19|58|21.6756}}<ref name=SIMBAD>{{cite web

| author=Staff | date=March 3, 2003

| url=http://simbad.u-strasbg.fr/simbad/sim-id?protocol=html&Ident=HDE+226868

| title=V\* V1357 Cyg -- High Mass X-ray Binary

| publisher=Centre de Données astronomiques de Strasbourg

| accessdate=2008-03-03 }}</ref>

| dec={{DEC| +35|12|05.775}}<ref name=SIMBAD/>

| appmag\_v=8.95<ref name=SIMBAD/>

| constell=[[天鵝座]] }}

{{Starbox character

| class=O9.7Iab<ref name=SIMBAD/>

| b-v=+0.81<ref name=lob647>{{cite journal

| last=Bregman | first=J.

| coauthors=Butler, D.; Kemper, E.; Koski, A.; Kraft, R. P.; Stone, R. P. S.

| title=Colors, magnitudes, spectral types and distances for stars in the field of the X-ray source Cyg X-1

| journal=Lick Observatory Bulletin

| year=1973 | volume=647

| url=http://cdsads.u-strasbg.fr/cgi-bin/nph-bib\_query?1973LicOB..24....1B

| accessdate=2008-03-03 }}</ref>

| u-b=−0.30<ref name=lob647/>

| variable=[[Variable star|Ellipsoidal variable]] }}

{{Starbox astrometry

| radial\_v=−13<ref name=SIMBAD/>

| prop\_mo\_ra=−3.82<ref name=SIMBAD/>

| prop\_mo\_dec=−7.62<ref name=SIMBAD/>

| gal\_lat=+03.0668

| gal\_lon=071.3350

| parallax=0.58

| p\_error=1.01

| parallax\_footnote=<ref>{{cite journal

| author=Perryman, M.A.C. et al.

| title=The Hipparcos Catalogue

| journal=Astronomy & Astrophysics

| year=1997 | volume=323 | pages=L49–L52

| url=http://cdsads.u-strasbg.fr/cgi-bin/nph-bib\_query?1997A%26A...323L..49P

| accessdate=2008-03-03 }}</ref>

| absmag\_v=−6.5&nbsp;±&nbsp;0.2<ref name=apj321>{{cite journal

| last=Ninkov | first=Z. | coauthors=Walker, G. A. H.; Yang, S.

| title=The primary orbit and the absorption lines of HDE 226868 (Cygnus X-1)

| journal=Astrophysical Journal, Part 1

| year=1987 | volume=321 | pages=425–437

| url=http://adsabs.harvard.edu/abs/1987ApJ...321..425N

| accessdate=2008-05-02

| doi=10.1086/165641 }}</ref> }}

{{Starbox detail

| mass=20–40<ref name=iorio/>

| radius=20–22<ref name=MNRAS358/>

| luminosity=(3–4){{e|5}}<ref name=MNRAS358/>

| temperature=31,000<ref name=eas030610/>

| gravity=3.31&nbsp;±&nbsp;0.07<ref name=hadrava>{{cite conference

| first=Petr | last=Hadrava

| title=Optical spectroscopy of Cyg X-1

| booktitle=Proceedings of RAGtime 9: Workshops on black holes and neutron stars

| date=September 15–21, 2007

| location=Opava, Czech Republic

| url=http://adsabs.harvard.edu/abs/2007arXiv0710.0758H

| accessdate=2008-05-03 }}</ref>

| metal=

| rotation=

| age=5&nbsp;million<ref name=science300/>

}}

{{Starbox catalog

| names=[[Astronomische Gesellschaft Katalog|AG (or AGK2)]]+35&nbsp;1910, [[Bonner Durchmusterung|BD]]+34 3815, [[Henry Draper catalogue|HD (or HDE)]]&nbsp;226868, [[Hipparcos catalogue|HIP]]&nbsp;98298, [[Smithsonian Astrophysical Observatory|SAO]]&nbsp;69181, V1357&nbsp;Cyg.<ref name=SIMBAD/> }}

{{Starbox end}}

'''天鵝座X-1'''（簡稱'''Cyg X-1'''）<ref name=science3656/>是一個位于[[天鵝座]]的星系，是著名的[[X射線源]]。<ref>{{cite news

| author=Staff | date=2004-11-05 | publisher=ESA

| title=Observations: Seeing in X-ray wavelengths

| url=http://www.esa.int/esaSC/SEMTA2T1VED\_index\_0.html

| accessdate=2008-08-12

}}</ref>它在1964年的一次[[火箭]]彈道飛行時被發現，是從地球觀測最強的X射綫源之一，其頂峰X射綫[[通量]]為2.3{{e|−23}} [[瓦特|W]][[公分|m]]<sup>−2</sup>[[赫茲|Hz]]<sup>−1</sup><ref>{{cite book

| first=Walter | last=Lewin

| coauthors=Van Der Klis, Michiel | year=2006

| title=Compact Stellar X-ray Sources

| publisher=Cambridge University Press

| pages=159 | isbn=0521826594 }}</ref><ref>The following source:

:{{cite web

| title=2010 X-Ray Sources | publisher=U.S. Naval Observatory

| work=The Astronomical Almanac

| url=http://asa.usno.navy.mil/SecH/Xray.html

| accessdate=2009-08-04 }}

gives a range of {{nowrap|235–1320 μJy}} at energies of {{nowrap|2–10 kEv}}.</ref>天鵝座X-1是最先被廣泛承認為[[黑洞]]的候選[[星體]]，也是同類星體中最受研究關注的。現在估計其質量為[[太陽質量]]的8.7倍，<ref name=iorio/>而其密度之高使黑洞成爲唯一一種解釋。如果如此，它的[[事件視界]]半徑約為26公里。<ref>{{cite web

| last=Harko | first=T. | date=June 28, 2006

| url=http://www.physics.hku.hk/~astro/harko\_science.html

| title=Black Holes | publisher=University of Hong Kong

| accessdate=2008-03-28 }}</ref>

天鵝座X-1屬於一個[[X射線雙星#高質量X射線雙星|高質量X射線雙星]]系統，其距離[[太陽]]大約6,000[[光年]]，另一成員為一顆[[超巨星]][[變星]]，編號為HDE 226868。兩者相互圍繞公轉，距離為0.2天文單位，即地球和太陽間距離的20%。該星的[[星風]]為X射綫源的[[吸積盤]]提供物質。<ref name=apj304/>盤的内部溫度達到幾百萬[[開氏度|K]]，因此輻射出X射綫。<ref>{{cite web

| last=Nayakshin | first=Sergei | coauthors=James B. Dove

| date=November 3, 1998

| url=http://adsabs.harvard.edu/abs/1998astro.ph.11059N

| title=X-rays From Magnetic Flares In Cygnus X-1: The Role Of A Transition Layer

| publisher=Cornell University | accessdate=2008-03-29 }}</ref><ref name=mnras325/>兩條垂直于吸積盤的[[相對論性噴流]]將被吸進的物質噴射出星際空間。<ref>{{cite journal

| last=Gallo | first=Elena | coauthors=Fender, Rob

| title=Accretion modes and jet production in black hole X-ray binaries

| journal=Memorie della Società Astronomica Italiana

| year=2005 | volume=75 | pages=282–290

| url=http://arxiv.org/abs/astro-ph?papernum=0509172

| accessdate=2008-03-29 }}</ref>

這個系統可能屬於一個名為天鵝座OB3的[[星協]]，意味著天鵝座X-1的年齡超過500萬年，並源于一顆質量大於40個太陽質量的原星。這顆原星的大部分質量都散失了，很可能是以星風的形式。如果該星以[[超新星]]的形式爆炸，則其威力足以將剩餘物質噴射出這個系統。因此它可能直接坍縮成一個黑洞。<ref name=science300/>

[[物理學家]][[史蒂芬·霍金]]和[[基普·索恩]]曾拿天鵝座X-1作了一場科學的賭局。當中霍金賭天鵝座X-1不是一顆黑洞。1990年霍金讓步，因爲觀測證據顯示這個系統中存在著[[引力奇點]]。<ref>{{cite news

| author=Staff | date=February 27, 2004

| title=Galaxy Entree or Main Course?

| publisher=Swinburne University

| url=http://astronomy.swin.edu.au/sao/astronomynews/astronews2004s1.xml

| accessdate=2008-03-31 }}</ref>

==發現及觀測==

通過對X射綫源的觀測，[[天文學家]]能研究涉及到幾百萬度熾熱氣體的天文現象。但由於X射綫被地球的[[大氣層]]遮擋了，因此[[X射綫天文學|對X射綫源的觀測]]不能在地表進行，而需要將儀器運送到有足夠X射綫能穿透的高度。<ref>{{cite book

| first=Friedman | last=Herbert | year=2002

| chapter=From the ionosphere to high energy astronomy&nbsp;– a personal experience

| title=The Century of Space Science

| publisher=Springer | isbn=0792371968 }}</ref><ref name=apj611/>發現天鵝座X-1的儀器是從[[新墨西哥州]][[白沙導彈靶場]]由火箭發射到彈道軌道。1964年時正進行一項觀測，目的是找出這些X射綫源。兩個空蜂火箭（Aerobee）彈道火箭運載著[[蓋革計數器]]升空，測量天空中8.4°範圍内[[波長]]從1至15[[埃|Å]]的X射綫源。<ref name=science3656/>

這項觀測發現了8個新的X射綫源，包括天鵝座的Cyg XR-1（後名Cyg X-1）。其[[天球坐標]]估計為[[赤經]]19<sup>h</sup>53<sup>m</sup>、[[赤緯]]34.6°。該X射綫源處並沒有明顯的[[無綫電天文學|無綫電]]或[[可見光]]源。<ref name=science3656>{{cite journal

| last=Bowyer | first=S. | coauthors=Byram, E. T.; Chubb, T. A.; Friedman, H.

| title=Cosmic X-ray Sources | journal=Science

| year=1965 | volume=147 | issue=3656 | pages=394–398

| url=http://www.sciencemag.org/cgi/content/abstract/147/3656/394

| accessdate=2008-03-10

| doi=10.1126/science.147.3656.394

| pmid=17832788 }}</ref>

由於需要更長時間的觀測研究，1963年[[里卡尔多·贾科尼]]和[[赫伯特·格斯基]]提出了首個研究X射綫源的軌道衛星。[[美國太空總署]]於1970年發射了[[乌呼鲁卫星]]，<ref>{{cite web

| author=Staff | date=June 26, 2003

| url=http://heasarc.gsfc.nasa.gov/docs/uhuru/uhuru.html

| title=The Uhuru Satellite | publisher=NASA

| accessdate=2008-05-09 }}</ref>進而發現了300個新X射綫源。<ref>{{cite web

| last=Giacconi | first=Riccardo

| date=December 8, 2002

| url=http://nobelprize.org/nobel\_prizes/physics/laureates/2002/giacconi-lecture.html

| title=The Dawn of X-Ray Astronomy

| publisher=The Nobel Foundation

| accessdate=2008-03-24 }}</ref>它對天鵝座X-1的長期觀測發現其X光強度有波動，頻率為每秒數次。<ref>{{cite journal

| last=Oda | first=M.

| coauthors=Gorenstein, P.; Gursky, H.; Kellogg, E.; Schreier, E.; Tananbaum, H.; Giacconi, R.

| title=X-Ray Pulsations from Cygnus X-1 Observed from UHURU

| journal=The Astrophysical Journal

| year=1999 | volume=166 | pages=L1–L7

| url=http://adsabs.harvard.edu/abs/1971ApJ...166L...1O

| accessdate=2008-03-11

| doi=10.1086/180726 }}</ref>如此快速的變動顯示，能量一定在很小的範圍内產生，大小約為10<sup>5</sup>公里<ref>這相當於光在三分之一秒内所走的距離。</ref>，因爲[[光速]]的限制使訊息不可能在更遠的範圍裏相互傳遞。作爲對比，[[太陽]]的直徑約為1.4{{e|6}}公里。

1971年四月至五月，[[萊登天文臺]]的Luc Braes和George Miley與[[美國國家射電天文臺]]的Robert M. Hjellming和Campbell Wade<ref>{{cite journal

| last=Kristian | first=J. | coauthors=Brucato, R.; Visvanathan, N.; Lanning, H.; Sandage, A.

| title=On the Optical Identification of Cygnus&nbsp;X-1

| url=http://adsabs.harvard.edu/abs/1971ApJ...168L..91K

| journal=The Astrophysical Journal

| year=1971 | volume=168 | pages=L91–L93 | accessdate=2008-03-10

| doi=10.1086/180790 }}</ref>獨立探測到來自天鵝座X-1的無綫電射綫，射綫源的準確位置指向AGK2&nbsp;+35 1910 = HDE&nbsp;226868。<ref>{{cite journal

| last=Braes | first=L.L.E. | coauthors=Miley, G.K.| date=July 23, 1971

| title=Physical Sciences: Detection of Radio Emission from Cygnus&nbsp;X-1

| journal=Nature

| volume=232 | pages=246

| doi=10.1038/232246a0 | bibcode=1971Natur.232Q.246B

| pmid=16062947

| issue=5308}}</ref><ref>{{cite journal

| last=Braes | first=L.L.E. | coauthors=Miley, G.K.

| year=1971

| title=Variable Radio Emission from X-Ray Sources

| journal=Veröffentlichungen Remeis-Sternwarte Bamberg

| volume=9 | issue=100 | pages=173

| publisher=(IAU Colloquium No.15, Bamberg, Germany, August 31-September 3, 1971. Bibcode: 1972VeBam.100......)}}</ref>

[[天球]]上，這顆星與[[視星等]]為4級的[[天鵝座η]]相距半度。<ref name=bernard>{{cite book

| first=Bernard | last=Abrams | coauthors=Stecker, Michael

| title=Structures in Space: Hidden Secrets of the Deep Sky

| year=1999 | pages=91 | publisher=Springer

| isbn=1852331658 |quote=Eta Cygni is 25 arc minutes to the

west-south-west of this star.}}</ref>它是一顆[[超巨星]]，本身並不能發射所觀測到的X射綫。因此，此星必定有一顆能够將氣體加熱到幾百萬度的伴星，才可放射在天鵝座X-1觀測到的輻射。

[[皇家格林威治天文台]]的Louise Webster和Paul Murdin與<ref>{{cite journal

| last=Webster | first=B. Louise | coauthors=Murdin, Paul

| title=Cygnus X-1—a Spectroscopic Binary with a Heavy Companion?

| journal=Nature | year=1972

| volume=235 | issue=2 | pages=37–38

| url=http://www.nature.com/nature/journal/v235/n5332/abs/235037a0.html

| accessdate=2008-03-10 | doi=10.1038/235037a0 }}</ref>單獨在[[多倫多大學]][[大衛·鄧拉普天文台]]工作的 Charles Thomas Bolton<ref>{{cite journal

| last=Bolton | first=C. T. | year=1972

| title=Identification of Cygnus X-1 with HDE 226868

| journal=Nature | volume=235 | issue=2 | pages=271–273

| url=http://www.nature.com/nature/journal/v235/n5336/abs/235271b0.html

| accessdate=2008-03-10 | doi=10.1038/235271b0 }}</ref>於1971年公佈了HDE 226868巨型伴星的發現消息。該星光譜的[[多普勒效應]]顯示了其伴星的存在，人們也能根據軌道數據間接地測量其質量。<ref name=luminet>{{cite book

| first=Jean-Pierre | last=Luminet | year=1992

| title=Black Holes | publisher=Cambridge University Press

| isbn=0521409063 }}</ref>由於該天體質量很高，他們推測它可能是一個[[黑洞]]。因為最大的[[中子星]]也不可能超過3個[[太陽質量]]。<ref>{{cite journal

| last=Bombaci | first=I.

| title=The maximum mass of a neutron star

| journal=Astronomy and Astrophysics

| year=1996 | volume=305 | pages=871–877

| url=http://adsabs.harvard.edu/abs/1996A&A...305..871B

| accessdate=2008-03-11

| doi=10.1088/1367-2630/7/1/199 }}</ref>

隨著更多觀測證據的發現，到了1973年末，天文學界的普遍結論為天鵝座X-1最大可能為一黑洞。<ref>{{cite web

| last=Rolston | first=Bruce | date=November 10, 1997

| url=http://news.utoronto.ca/bin/bulletin/nov10\_97/art4.htm

| title=The First Black Hole | publisher=University of Toronto

| accessdate=2008-03-11 }}

</ref><ref>{{cite journal

| last=Shipman | first=H. L.

| title=The implausible history of triple star models for Cygnus X-1 Evidence for a black hole

| journal=Astrophysical Letters

| year=1975 | volume=16 | issue=1 | pages=9–12

| url=http://adsabs.harvard.edu/abs/1975ApL....16....9S

| accessdate=2008-03-11 }}</ref>對天鵝座X-1更精確的測量顯示出小至1毫秒的變化。這個間距與黑洞[[吸積盤]]物質的亂流相符。持續三分之一秒的X射線爆符合物質掉進黑洞預測所需的時間。<ref name=apj189>{{cite journal

| last=Rothschild | first=R. E.

| coauthors=Boldt, E. A.; Holt, S. S.; Serlemitsos, P. J.

| title=Millisecond Temporal Structure in Cygnus X-1

| journal=The Astrophysical Journal

| year=1974 | volume=189 | pages=77–115

| url=http://adsabs.harvard.edu/abs/1974ApJ...189L..13R

| accessdate=2008-03-11

| doi=10.1086/181452 }}</ref>

[[Image:Cygnus x1 xray.jpg|right|thumb|這張天鵝座X-1的X射線照片由高能複層式可見光天文望遠鏡（HERO）經氣球升空拍攝。''圖片由美國太空總署提供'']]

至今天鵝座X-1已被多部軌道及地面觀測儀器長期觀測。<ref name=SIMBAD/>X射線雙星（如HDE 226868/天鵝座X-1）和[[活動星系核]]間有眾多相似之處，顯示它們有共同的運行原理：黑洞、旋轉中的吸積盤和[[相對論性噴流|噴流]]。<ref>{{cite journal

| last=Koerding | first=Elmar

| coauthors=Jester, Sebastian; Fender, Rob

| title=Accretion states and radio loudness in Active Galactic Nuclei: analogies with X-ray binaries

| journal=Monthly Notices of the Royal Astronomical Society

| year=2006 | volume=372 | pages=1366–1378

| url=http://arxiv.org/abs/astro-ph/0608628

| accessdate=2007-03-24

| doi=10.1111/j.1365-2966.2006.10954.x }}</ref>因此，天鵝座X-1被歸於一類稱為[[微類星體]]的雙星系統。對諸如HDE 226868/天鵝座X-1的雙星系統的科學研究能使科學家對[[活動星系]]的運動原理有更深入的認知。<ref>{{cite web

| last=Brainerd | first=Jim | date=July 20, 2005

| url=http://www.astrophysicsspectator.com/topics/observation/XRayAGN.html

| title=X-rays from AGNs | publisher=The Astrophysics Spectator

| accessdate=2008-03-24 }}</ref>

==恆星系統==

天鵝座X-1中的[[緻密星]]和[[藍超巨星]]組成一個[[雙星系統]]，以{{nowrap|5.599829 ± 0.000016天}}的周期繞質心公轉。<ref>{{cite journal

| last=Brocksopp | first=C.

| coauthors=Tarasov, A. E.; Lyuty, V. M.; Roche, P.

| title=An Improved Orbital Ephemeris for Cygnus X-1

| journal=Astronomy & Astrophysics

| year=1999 | volume=343 | pages=861–864

| url=http://arxiv.org/abs/astro-ph/9812077

| accessdate=2008-03-18 }}</ref>從地球的角度觀看，那顆緻密星從不運行到其伴星後，也就是這個系統不會發生[[掩星]]。不過，其[[軌道傾角]]與地球視線的角度仍然是未知的，估值為27°至65°。一項2007年的研究估計角度為{{nowrap|48.0 ± 6.8°}}，也就是軌道[[半長軸]]為0.2[[天文單位]]（地球與太陽距離的20%）。[[軌道離心率]]為約{{nowrap|0.06 ± 0.01}}，幾乎為正圓形。<ref name=iorio/><ref name="apj200">{{cite journal

| last=Bolton | first=C. T.

| title=Optical observations and model for Cygnus X-1

| journal=The Astrophysical Journal

| year=1975 | volume=200 | pages=269–277

| url=http://adsabs.harvard.edu/abs/1975ApJ...200..269B

| accessdate=2008-03-12

| doi=10.1086/153785 }}</ref>[[依巴谷衛星]]測量出地球距離該系統約2,000[[秒差距]]（6,000[[光年]]），但這個數據的相對誤差較大。<ref name=SIMBAD/>

天鵝座OB3是一個包含大型恆星的星協，距離太陽2,000秒差距。HDE 226868/天鵝座X-1系統與天鵝座OB3有著相同的直線運動速度及方向，意味著它們可能在同一時期同一地區形成。這樣，該系統的年齡就是約{{nowrap|500 ± 150萬年}}。HDE 226868相對天鵝座OB3的運動速度為9 ± 3公里每秒，是星協中隨機運動的典型速度。HDE 226868距離星協中心約60秒差距，要達到這個距離可能需要{{nowrap|700 ± 200萬年}}，粗略符合該星協的估計年齡。<ref name=science300>{{cite journal

| last=Mirabel | first=I. Félix | coauthors=Rodrigues, Irapuan

| title=Formation of a Black Hole in the Dark

| journal=Science | year=2003 | volume=300

| issue=5622 | pages=1119–1120

| url=http://www.sciencemag.org/cgi/content/full/300/5622/1119

| accessdate=2008-03-15 | doi=10.1126/science.1083451

| pmid=12714674 }}</ref>

With a [[galactic latitude]] of 4 degrees and [[galactic longitude]] 71 degrees,<ref name=SIMBAD/> this system lies inward along the same [[Orion Spur]] in which the Sun is located within the [[Milky Way]],<ref>{{cite journal

| last=Gursky | first=H. | year=1971

| coauthors=Gorenstein, P.; Kerr, F. J.; Grayzeck, E. J.

| url=http://adsabs.harvard.edu/abs/1971ApJ...167L..15G

| title=The Estimated Distance to Cygnus X-1 Based on its Low-Energy X-Ray Spectrum

| journal=Astrophysical Journal | volume=167 | pages=L15

| accessdate=2008-06-29

| doi=10.1086/180751 }}</ref> near where the spur approaches the [[Sagittarius Arm]]. Cygnus X-1 has been described as belonging to the Sagittarius Arm,<ref>{{cite web

| url=http://www.vectorsite.net/tastgal\_07.html

| title=7.0 The Milky Way Galaxy

| first=Greg | last=Goebel | publisher=In The Public Domain

| accessdate=2008-06-29 }}</ref> though the structure of the Milky Way is not well established.

===Compact object===

There is some uncertainty about the mass of the compact object. Stellar evolutionary models suggest a mass of {{nowrap|20 ± 5 [[solar mass]]es}},<ref name=MNRAS358>{{cite journal

| last=Ziółkowski | first=J.

| title=Evolutionary constraints on the masses of the components of HDE 226868/Cyg X-1 binary system

| journal=Monthly Notices of the Royal Astronomical Society

| year=2005 | volume=358 | pages=851–859

| url=http://arxiv.org/abs/astro-ph/0501102

| doi=10.1111/j.1365-2966.2005.08796.x

| accessdate=2008-03-04 }} Note: for radius and luminosity, see Table 1 with ''d''=2&nbsp;kpc.</ref> while other techniques resulted in 10 solar masses. Measuring periodicities in the X-ray emission near the object has yielded a more precise value of {{nowrap|8.7 ± 0.8 solar masses}}. In all cases, the object is most likely a black hole<ref name=iorio>{{cite journal

| last=Iorio | first=Lorenzo

| date=July 24, 2007 | journal=E-print

| title=On the orbital and physical parameters of the HDE 226868/Cygnus X-1 binary system

| url=http://adsabs.harvard.edu/abs/2007arXiv0707.3525I

| accessdate=2008-03-14

| doi=10.1007/s10509-008-9839-y

| volume=315

| pages=335

}}</ref><ref name=esa070516>{{cite web

| last=Strohmayer | first=Tod | date=May 16, 2007

| coauthors=Shaposhnikov, Nikolai; Schartel, Norbert

| url=http://www.esa.int/esaCP/SEMDMAV681F\_index\_0.html

| title=New technique for ‘weighing’ black holes

| publisher=[[European Space Agency|ESA]] | accessdate=2008-03-10 }}</ref>&mdash;a region of space with a [[gravity|gravitational field]] that is strong enough to prevent the escape of [[electromagnetic radiation]] from the interior. The boundary of this region is called the [[event horizon]] and the surface lies at a distance from the center called the [[Schwarzschild radius]], which is about 26&nbsp;km for Cygnus&nbsp;X-1.<ref>{{cite journal

| last=Rössler | first=O. E.

| coauthors=Kuypers, H.; Diebner, H. H.

| title=Almost-Black-Holes: an old—new paradigm

| journal=Chaos, Solitons & Fractals

| year=1998 | volume=9 | issue=7 | pages=1025–1034

| doi=10.1016/S0960-0779(98)80004-0

}}</ref> Anything (including [[matter]] and [[photon]]s) that passes through this boundary is unable to escape.<ref>{{cite web

| author=Staff | date=January 9, 2006

| url=http://web.mit.edu/newsoffice/2006/blackhole1.html

| title=Scientists find black hole's 'point of no return'

| publisher=Massachusetts Institute of Technology

| accessdate=2008-03-28 }}</ref>

Evidence of just such an event horizon may have been detected in 1992 using [[ultraviolet]] (UV) observations with the [[High Speed Photometer]] on the [[Hubble Space Telescope]]. As self-luminous clumps of matter spiral into a black hole, their radiation will be emitted in a series of pulses that are subject to [[gravitational redshift]] as the material approaches the horizon. That is, the [[wavelength]]s of the radiation will steadily increase, as predicted by [[General Relativity]]. Matter impacting against a solid, compact object would emit a final burst of energy, whereas material passing through an event horizon would not. Two such "dying pulse trains" were observed, which is consistent with the existence of a black hole.<ref name=pasp113>{{cite journal

| last=Dolan | first=Joseph F.

| title=Dying Pulse Trains in Cygnus XR-1: Evidence for an Event Horizon?

| journal=The Publications of the Astronomical Society of the Pacific

| year=2001 | volume=113 | issue=786 | pages=974–982

| url=http://adsabs.harvard.edu/abs/2001PASP..113..974D

| accessdate=2008-03-20

| doi=10.1086/322917 }}</ref>

[[File:381549main cygX1 final 665.jpg|thumb|right|Chandra image of Cygnus X-1.]]

The space-based [[Chandra X-ray Observatory]] was used to measure the [[absorption line|spectral signature]] of [[iron]] atoms orbiting near the object. A rotating black hole drags the nearby space around with it, which allows atoms to orbit closer to the event horizon. In the case of Cygnus&nbsp;X-1, none of the atoms were found orbiting closer than 160&nbsp;km. Hence, if this object is a black hole, then this data shows it is not rotating to any significant degree.<ref>{{cite conference

| last=Miller | first=J. M.

| coauthors=Fabian, A. C.; Nowak, M. A.; Lewin, W. H. G.

| title=Relativistic Iron Lines in Galactic Black Holes: Recent Results and Lines in the ASCA Archive

| booktitle=Proceedings of the 10th Annual Marcel Grossmann Meeting on General Relativity

| location=Rio de Janeiro, Brazil | date=July 20–26, 2003

| url=http://arxiv.org/abs/astro-ph/0402101

| accessdate = 2008-03-11 }}

</ref><ref>{{cite news

| last=Roy | first=Steve | coauthors=Watzke, Megan

| date=September 17, 2003

| title="Iron-Clad" Evidence For Spinning Black Hole

| publisher=Chandra press Room

| url=http://chandra.harvard.edu/press/03\_releases/press\_091703.html

| accessdate=2008-03-11 }}</ref>

====Formation====

The largest star in the Cygnus OB3 association has a mass 40&nbsp;times that of the Sun. As more massive stars evolve more rapidly, this implies that the progenitor star for Cygnus&nbsp;X-1 had more than 40 solar masses. Given the current estimated mass of the black hole, the progenitor star must have lost over 30 solar masses of material. Part of this mass may have been lost to HDE&nbsp;226868, while the remainder was most likely expelled by a strong stellar wind. The [[helium]] enrichment of HDE&nbsp;226868's outer atmosphere may be evidence for this mass transfer.<ref>{{cite journal

| last=Podsiadlowski | first=Philipp

| coauthors=Saul, Rappaport; Han, Zhanwen

| title=On the formation and evolution of black-hole binaries

| journal=Monthly Notices of the Royal Astronomical Society

| year=2002 | issue=2 | volume=341 | pages=385–404

| url=http://arxiv.org/abs/astro-ph/0207153

| accessdate=2008-03-24

| doi=10.1046/j.1365-8711.2003.06464.x }}</ref> Possibly the progenitor may have evolved into a [[Wolf-Rayet star]], which ejects a substantial proportion of its atmosphere using just such a powerful stellar wind.<ref name=science300/>

If the progenitor star had exploded as a [[supernova]], then observations of similar objects show that the remnant would most likely have been ejected from the system at a relatively high velocity. As the object remained in orbit, this indicates that the progenitor may have collapsed directly into a black hole without exploding (or at most produced only a relatively modest explosion).<ref name=science300/>

====Accretion disk====

[[Image:Cygx1 spectrum.jpg|right|thumb|A [[Chandra X-ray Observatory|Chandra]] X-ray spectrum of Cygnus X-1 showing a characteristic peak near 6.4&nbsp;[[Electron volt|keV]] due to [[ion]]ized [[iron]] in the accretion disk, but the peak is gravitationally red-shifted, broadened by the [[Doppler effect]], and skewed toward lower energies.<ref>{{cite web

| author=Staff | date=August 30, 2006

| url=http://chandra.harvard.edu/photo/2003/bhspin/more.html

| title=More Images of Cygnus X-1, XTE J1650-500 & GX 339-4

| publisher=Harvard-Smithsonian Center for Astrophysics/Chandra X-ray Center

| accessdate=2008-03-30 }}</ref>]]

The compact object is thought to be orbited by a thin, flat disk of accreting matter known as an [[accretion disk]]. This disk is intensely heated by friction between ionized gas in faster-moving inner orbits and that in slower outer ones. It is divided into a hot inner region with a relatively high level of ionization—forming a [[Plasma (physics)|plasma]]—and a cooler, less ionized outer region that extends to an estimated 500&nbsp;times the Schwarzschild radius,<ref name=mnras325>{{cite journal

| last=Young | first=A. J.

| coauthors=Fabian, A. C.; Ross, R. R.; Tanaka, Y.

| title=A Complete Relativistic Ionized Accretion Disc in Cygnus X-1

| journal=Monthly Notices of the Royal Astronomical Society

| year=2001 | volume=325 | pages=1045–1052

| url=http://arxiv.org/abs/astro-ph/0103214

| accessdate=2008-03-13

| doi=10.1046/j.1365-8711.2001.04498.x }}</ref> or about 15,000&nbsp;km.

Though highly and erratically variable, Cygnus X-1 is typically the brightest persistent source of [[hard X-ray]]s—those with energies from about 30 up to several hundred keV—in the sky.<ref name=apj611>{{cite journal

| last=Liu | first=C. Z. | coauthors=Li, T. P.

| title=X-Ray Spectral Variability in Cygnus X-1

| journal=The Astrophysical Journal

| year=1999 | volume=611 | pages=1084–1090

| url=http://www.journals.uchicago.edu/doi/abs/10.1086/422209

| accessdate=2008-03-28 | doi=10.1086/422209 }}</ref> The X-rays are produced as lower energy photons in the thin inner accretion disk, then given more energy through [[Compton scattering]] with very high temperature [[electron]]s in a geometrically thicker, but nearly transparent [[corona]] enveloping it, as well as by some further reflection from the surface of the thin disk.<ref>{{cite journal

| last=Ling | first=J. C.

| coauthors=Wheaton, Wm. A.; Wallyn, P.; Mahoney, W. A., et al.

| title=Gamma-Ray Spectra and Variability of Cygnus X-1 Observed by BATSE

| journal=The Astrophysical Journal

| year=1997 | volume=484 | pages=375–382

| url=http://www.journals.uchicago.edu/doi/abs/10.1086/304323

| accessdate=2008-03-04 | doi=10.1086/304323 }}</ref> An alternative possibility is that the X-rays may be Compton scattered by the base of a jet instead of a disk corona.<ref>{{cite journal

| last=Kylafis | first=N. | coauthors=Giannios, D.; Psaltis, D.

| title=Spectra and time variability of black-hole binaries in the low/hard state

| journal=Advances in Space Research

| year=2006 | volume=38 | issue=12 | pages=2810–2812

| url=http://linkinghub.elsevier.com/retrieve/pii/S0273117705014286

| accessdate=2007-02-04 | doi=10.1016/j.asr.2005.09.045 }}</ref>

The X-ray emission from Cygnus X-1 can vary in a somewhat repetitive pattern called [[quasi-periodic oscillations]] (QPO). The mass of the compact object appears to determine the distance at which the surrounding plasma begins to emit these QPOs, with the emission radius decreasing as the mass decreases. This technique has been used to estimate the mass of Cygnus&nbsp;X-1, providing a cross-check with other mass derivations.<ref>{{cite web

| last=Titarchuk | first=Lev | coauthors=Shaposhnikov, Nikolai

| title=On the nature of the variability power decay towards soft spectral states in X-ray binaries. Case study in Cyg X-1

| date=February 9, 2008

| url=http://arxiv.org/abs/0802.1278

| work=The Astrophysical Journal

| accessdate=2008-04-02 }}</ref>

Pulsations with a stable period, similar to those resulting from the spin of a neutron star, have never been seen from Cygnus X-1.<ref>{{cite journal

| last=Fabian | first=A. C. | coauthors=Miller, J. M.

| title=Black Holes Reveal Their Innermost Secrets

| journal=Science | date=August 9, 2002

| volume=297 | issue=5583 | pages=947&ndash;948

| url=http://www.sciencemag.org/cgi/content/full/297/5583/947

| accessdate=2008-03-29

| doi=10.1126/science.1074957

| pmid=12169716 }}

</ref><ref>{{cite web

| last=Wen | first=Han Chin | month=March | year=1998

| url=http://adsabs.harvard.edu/abs/1997PhDT.........6W

| title=Ten Microsecond Time Resolution Studies of Cygnus X-1

| publisher=Stanford University | accessdate=2008-03-29 }}</ref> The pulsations from neutron stars are caused by the neutron star's magnetic field and the [[no hair theorem]] guarantees that black holes do not have magnetic poles. For example, the X-ray binary [[V 0332+53]] was thought to be a possible black hole until pulsations were found.<ref>{{cite journal

| last=Stella | first=L.

| coauthors=White, N. E.; Davelaar, J.; Parmar, A. N.; Blissett, R. J.; van der Klis, M.

| title=The discovery of 4.4 second X-ray pulsations from the rapidly variable X-ray transient V0332 + 53

| journal=Astrophysical Journal, Part 2 - Letters to the Editor

| year=1985 | volume=288 | pages=L45–L49

| url=http://adsabs.harvard.edu/abs/1985ApJ...288L..45S

| accessdate=2008-07-28

| doi=10.1086/184419 }}</ref> Cygnus X-1 has also never displayed X-ray bursts similar to those seen from neutron stars.<ref>{{cite journal

| last=Narayan | first=Ramesh

| title=Evidence for the black hole event horizon

| journal=Astronomy & Geophysics | year=2003

| volume=44 | issue=6 | pages=77–115

| url=http://www3.interscience.wiley.com/journal/118896663/abstract?CRETRY=1&SRETRY=0

| accessdate=2008-07-28 }}</ref>

Cygnus X-1 unpredictably changes between two X-ray states, although the X-rays may vary continuously between those states as well. In the most common state, the X-rays are "hard", which means that more of the X-rays have high energy. In the less common state, the X-rays are "soft", with more of the X-rays having lower energy. The soft state also shows greater variability. The hard state is believed to originate in a corona surrounding the inner part of the more opaque accretion disk. The soft state occurs when the disk draws closer to the compact object (possibly as close as 150&nbsp;km), accompanied by cooling or ejection of the corona. When a new corona is generated, Cygnus&nbsp;X-1 transitions back to the hard state.<ref name=apj626/>

The X-ray flux from Cygnus X-1 varies periodically every 5.6&nbsp;days, especially during [[superior conjunction]] when the orbiting objects are most closely aligned with the Earth and the compact source is the more distant. This indicates that the emissions are being partially blocked by circumstellar matter, which may be the stellar wind from the star HDE&nbsp;226868. There is a roughly 300&nbsp;day periodicity in the emission that could be caused by the [[precession]] of the accretion disk.<ref name=apj531>{{cite journal

| last=Kitamoto | first=S.

| coauthors=E. Wataru, E.; Miyamoto, S.; Tsunemi, H.; Ling, J. C.; Wheaton, W. A.; Paul, B.

| title=''GINGA'' All-Sky Monitor Observations of Cygnus X-1

| journal=The Astrophysical Journal | year=2000 | volume=531

| pages=546–552 | doi=10.1086/308423 }}</ref>

====Jets====

As accreted matter falls toward the compact object, it loses gravitational [[potential energy]]. Part of this released energy is dissipated by [[Relativistic jet|jets]] of particles, aligned [[perpendicular]] to the accretion disk, that flow outward with [[Special relativity|relativistic]] velocities. (That is, the particles are moving at a significant fraction of the [[speed of light]].) This pair of jets provide a means for an accretion disk to shed excess energy and [[angular momentum]]. They may be created by [[magnetic field]]s within the gas that surrounds the compact object.<ref>{{cite journal

| last=Begelman | first=Mitchell C.

| title=Evidence for Black Holes | pages=1898–1903

| journal=Science | year=2003 | volume=300 | issue=5627

| url=http://www.sciencemag.org/cgi/content/full/300/5627/1898

| accessdate=2008-04-28 | doi=10.1126/science.1085334

| pmid=12817138 }}</ref>

The Cygnus X-1 jets are inefficient radiators and so release only a small proportion of their energy in the [[electromagnetic spectrum]]. That is, they appear "dark". The estimated angle of the jets to the line of sight is 30° and they may be [[Precession|precessing]].<ref name=apj626>{{cite journal

| last=Torres | first=Diego F.

| coauthors=Romero, Gustavo E.; Barcons, Xavier; Lu, Youjun

| title=Probing the Precession of the Inner Accretion Disk in Cygnus X-1

| journal=The Astrophysics Journal

| year=2005 | volume=626 | pages=1015–1019

| url=http://arxiv.org/abs/astro-ph/0503186

| accessdate=2008-03-21

| doi=10.1086/430125 }}</ref> One of the jets is colliding with a relatively dense part of the [[interstellar medium]] (ISM), forming an energized ring that can be detected by its radio emission. This collision appears to be forming a [[nebula]] that has been observed in the [[Visible spectrum|optical wavelengths]]. To produce this nebula, the jet must have an estimated average power of (4–14){{e|36}}&nbsp;[[erg]]/s, or (9&nbsp;±&nbsp;5){{e|29}}&nbsp;[[watt]]s.<ref>{{cite journal

| last=Russell | first=D. M.

| coauthors=Fender, R. P.; Gallo, E.; Kaiser, C. R.

| title=The jet-powered optical nebula of Cygnus X-1

| journal=Monthly Notices of the Royal Astronomical Society

| year=2007 | volume=376 | issue=3 | pages=1341–1349

| url=http://arxiv.org/abs/astro-ph/0701645

| accessdate=2008-03-19

| doi=10.1111/j.1365-2966.2007.11539.x }}</ref> This is more than 1,000&nbsp;times the power emitted by the Sun.<ref>{{cite journal

| last=Sackmann | first=I.-Juliana

| coauthors=Boothroyd, Arnold I.; Kraemer, Kathleen E.

| title=Our Sun. III. Present and Future

| journal=The Astrophysical Journal

| year=1993 | volume=418 | pages=457–468

| url=http://adsabs.harvard.edu/abs/1993ApJ...418..457S

| accessdate=2008-03-19

| doi=10.1086/173407 }}</ref> There is no corresponding ring in the opposite direction because that jet is facing a lower density region of the ISM.<ref>{{cite journal

| last=Gallo | first=E. | coauthors=Fender, Rob; Kaiser, Christian; Russell, David; Morganti, Raffaella; Oosterloo, Tom; Heinz, Sebastian

| title=A dark jet dominates the power output of the stellar black hole Cygnus X-1

| journal=Nature | year=2005 | volume=436

| issue=7052 | pages=819–821

| url=http://arxiv.org/abs/astro-ph/0508228

| accessdate=2008-03-19

| doi=10.1038/nature03879

| pmid=16094361 }}</ref>

In 2006, Cygnus X-1 became the first stellar mass black hole candidate found to display evidence of [[gamma ray]] emission in the very high energy band, above 100&nbsp;GeV. The signal was observed at the same time as a flare of hard X-rays, suggesting a link between the events. The X-ray flare may have been produced at the base of the jet while the gamma rays could have been generated where the jet interacts with the stellar wind of HDE&nbsp;226868.<ref>{{cite journal

| author=Albert, J. ''et al.''

| title=Very High Energy Gamma-ray Radiation from the Stellar-mass Black Hole Cygnus X-1

| journal=Astrophysical Journal Letters

| year=2007 | volume=665 | pages=L51–L54

| url=http://arxiv.org/abs/0706.1505

| accessdate=2008-03-04 | doi = 10.1086/521145

}}</ref>

===HDE 226868===

[[Image:Cygnus\_X-1.png|right|thumb|An artist's impression of the HDE 226868–Cygnus X-1 binary system. ''ESA/Hubble illustration.'']]

HDE 226868 is a supergiant star with a [[spectral class]] of O9.7&nbsp;Iab,<ref name=SIMBAD/> which is on the borderline between class O and class B stars. It has an estimated surface temperature of 31,000&nbsp;[[kelvin]]<ref name=eas030610>{{cite web

| author=Staff | date=June 10, 2003

| url=http://hubble.esa.int/science-e/www/object/index.cfm?fobjectid=32700

| title=Integral's view of Cygnus X-1 | publisher=ESA

| accessdate=2008-03-20 }}</ref> and mass approximately 20–40&nbsp;times the [[solar mass|mass of the Sun]]. Based on a stellar evolutionary model, at the estimated distance of 2,000 parsecs this star may have a radius equal to about 20–22&nbsp;times the [[solar radius]]

and is approximately 300,000–400,000&nbsp;times the [[solar luminosity|luminosity of the Sun]].<ref name=iorio/><ref name=MNRAS358/> For comparison, the compact object is estimated to be orbiting HDE 226868 at a distance of about 40 solar radii, or twice the radius of this star.<ref name=apj620/>

The surface of HDE 226868 is being [[Tidal force|tidally]] distorted by the [[gravity]] of the massive companion, forming a tear-drop shape that is further distorted by rotation. This causes the optical brightness of the star to vary by 0.06&nbsp;magnitudes during each 5.6-day binary orbit, with the minimum magnitude occurring when the system is aligned with the line of sight.<ref name=caballero>{{cite conference

| first=M. D. | last=Caballero

| title=OMC-INTEGRAL: Optical Observations of X-Ray Sources

| booktitle=Proceedings of the 5th INTEGRAL Workshop on the INTEGRAL Universe

| pages=875–878 | publisher=ESA

| date=16–20 February 2004 | location=Munich, Germany

| url=http://adsabs.harvard.edu/abs/2004ESASP.552..875C

| accessdate=2008-03-17 }}</ref> The "ellipsoidal" pattern of light variation results from the [[limb darkening]] and [[gravity darkening]] of the star's surface.<ref>{{cite book

| first=Arthur C. | last=Cox | year=2001 | pages=407

| title=Allen's Astrophysical Quantities

| publisher=Springer | id=ISBN 038795189X }}</ref>

When the spectrum of HDE 226868 is compared to the similar star [[Epsilon Orionis]], the former shows an overabundance of [[helium]] and an underabundance of [[carbon]] in its atmosphere.<ref>{{cite journal

| last=Canalizo | first=G.

| coauthors=Koenigsberger, G.; Peña, D.; Ruiz, E.

| title=Spectral variations and a classical curve-of-growth analysis of HDE 226868 (Cyg X-1)

| journal=Rev. Mex. Astron. Astrofis.

| year=1995 | volume=31 | issue=1

| pages=63–86

| url=http://adsabs.harvard.edu/abs/1995RMxAA..31...63C

| accessdate=2008-03-20 }}</ref> The [[ultraviolet]] and [[Hydrogen alpha]] spectral lines of HDE&nbsp;226868 show profiles similar to the star [[P Cygni]], which indicates that the star is surrounded by a gaseous envelope that is being accelerated away from the star at speeds of about 1500&nbsp;[[Metre per second|kilometers per second]].<ref>{{cite journal

| last=Conti | first=P. S.

| title=Stellar parameters of five early type companions of X-ray sources

| journal=Astronomy and Astrophysics

| year=1978 | volume=63 | pages=1–2

| url=http://adsabs.harvard.edu/abs/1978A%26A....63..225C

| accessdate=2008-03-18 }}

</ref><ref>{{cite journal

| last=Sowers | first=J. W.

| coauthors=Gies, D. R.; Bagnuolo, W. G.; Shafter, A. W.; Wiemker, R.; Wiggs, M. S.

| title=Tomographic Analysis of Hα Profiles in HDE 226868/Cygnus X-1

| journal=The Astrophysical Journal

| year=1998 | volume=506

| issue=1 | pages=424–430

| url=http://adsabs.harvard.edu/abs/1998ApJ...506..424S

| accessdate=2008-03-20

| doi=10.1086/306246 }}</ref>

Like other stars of its spectral type, HDE&nbsp;226868 is thought to be shedding mass in a [[stellar wind]] at an estimated rate of 2.5{{e|-6}}&nbsp;solar masses per year.<ref>{{cite journal

| last=Hutchings | first=J. B.

| title=Stellar winds from hot supergiants

| journal=The Astrophysical Journal

| year=1976 | volume=203 | pages=438–447

| url=http://adsabs.harvard.edu/abs/1976ApJ...203..438H

| accessdate=2007-02-04

| doi=10.1086/154095 }}</ref> This is the equivalent of losing a mass equal to the Sun's every 400,000&nbsp;years. The gravitational influence of the compact object appears to be reshaping this stellar wind, producing a focused wind geometry rather than a spherically symmetrical wind.<ref name=apj620>{{cite journal

| last=Miller | first=J. M.

| coauthors=Wojdowski, P.; Schulz, N. S.; Marshall, H. L.; Fabian, A. C.; Remillard, R. A.; Wijnands, R.; Lewin, W. H. G.

| title=Revealing the Focused Companion Wind in Cygnus X-1 with ''Chandra''

| journal=The Astrophysical Journal

| year=2005 | volume=620 | pages=398–404

| doi=10.1086/426701 }}</ref> X-rays from the region surrounding the compact object heat and ionize this stellar wind. As the object moves through different regions of the stellar wind during its 5.6-day orbit, the UV lines,<ref>{{cite journal

| last=Vrtilek | first=Saeqa D.

| coauthors=Hunacek, A.; Boroson, B. S.

| title=X-Ray Ionization Effects on the Stellar Wind of Cygnus X-1

| journal=Bulletin of the American Astronomical Society

| year=2006 | volume=38 | pages=334

| url=http://adsabs.harvard.edu/abs/2006HEAD....9.0131V

| accessdate=2008-03-28

}}</ref> the radio emission,<ref>{{cite journal

| last=Pooley | first=G. G.

| coauthors=Fender, R. P.; Brocksopp, C.

| title=Orbital modulation and longer-term variability in the radio emission from Cygnus X-1

| journal=Monthly Notices of the Royal Astronomical Society

| year=1999 | volume=302 | issue=1 | pages=L1–L5

| url=http://arxiv.org/abs/astro-ph/9809305v1

| accessdate=2008-03-28

| doi=10.1046/j.1365-8711.1999.02225.x }}</ref> and the X-rays themselves all vary.<ref>{{cite journal

| last=Gies | first=D. R.

| coauthors=Bolton, C. T.; Thomson, J. R.; Huang, W.; McSwain, M. V.; Riddle, R. L.; Wang, Z.; Wiita, P. J.; Wingert, D. W.; Csák, B.; Kiss, L. L.

| title=Wind Accretion and State Transitions in Cygnus X-1

| journal=The Astrophysical Journal

| year=2003 | volume=583 | pages=424–436 | doi = 10.1086/345345

}}</ref>

The [[Roche lobe]] of HDE&nbsp;226868 defines the region of space around the star where orbiting material remains gravitationally bound. Material that passes beyond this lobe may fall toward the orbiting companion. This Roche lobe is believed to be close to the surface of HDE&nbsp;226868 but not overflowing, so the material at the stellar surface is not being stripped away by its companion. However, a significant proportion of the stellar wind emitted by the star is being drawn onto the compact object's accretion disk after passing beyond this lobe.<ref name=apj304>{{cite journal

| last=Gies | first=D. R. | coauthors=Bolton, C. T.

| title=The optical spectrum of HDE 226868 = Cygnus X-1. II&nbsp;— Spectrophotometry and mass estimates

| journal=The Astrophysical Journal, Part 1

| year=1986 | volume=304 | pages=371–393

| url=http://adsabs.harvard.edu/abs/1986ApJ...304..371G

| accessdate=2008-03-18

| doi=10.1086/164171 }}</ref>

The gas and dust between the Sun and HDE 226868 results in a reduction in the apparent magnitude of the star as well as a reddening of the hue—red light can more effectively penetrate the dust in the interstellar medium. The estimated value of the interstellar [[Extinction (astronomy)|extinction]] (A<sub>V</sub>) is 3.3 [[Apparent magnitude|magnitudes]].<ref>{{cite journal

| last=Margon | first=Bruce

| coauthors=Bowyer, Stuart; Stone, Remington P. S.

| title=On the Distance to Cygnus X-1

| journal=The Astrophysical Journal

| year=1973 | volume=185 | issue=2 | pages=L113–L116

| url=http://articles.adsabs.harvard.edu/abs/1973ApJ...185L.113M

| accessdate=2008-03-19

| doi=10.1086/181333 }}</ref> Without the intervening matter, HDE&nbsp;226868 would be a fifth magnitude star<ref>{{cite web

| url=http://astronomy.swin.edu.au/cosmos/I/Interstellar+Reddening

| title=Interstellar Reddening

| publisher=Swinburne University of Technology

| accessdate=2006-08-10

}}</ref> and thus visible to the unaided eye.<ref>{{cite web

| last=Kaler | first=Jim

| url=http://www.astro.uiuc.edu/~kaler/sow/cygx1.html

| title=Cygnus X-1 | publisher=University of Illinois

| accessdate=2008-03-19 }}</ref>

==Stephen Hawking and Kip Thorne==

Cygnus X-1 was the subject of the bet between physicists [[Stephen Hawking]] and [[Kip Thorne]], in which Hawking bet against the existence of black holes in the region. Hawking later described this as an "insurance policy" of sorts. To quote from his book, ''[[A Brief History of Time]]'', {{cquote|This was a form of insurance policy for me. I have done a lot of work on black holes, and it would all be wasted if it turned out that black holes do not exist. But in that case, I would have the consolation of winning my bet, which would win me four years of the magazine ''[[Private Eye]]''. If black holes do exist, Kip will get one year of ''[[Penthouse (magazine)|Penthouse]]''. When we made the bet in 1975, we were 80% certain that Cygnus was a black hole. By now [1988], I would say that we are about 95% certain, but the bet has yet to be settled.<ref>{{cite book

| first=Stephen | last=Hawking | year=1988

| title=A Brief History of Time | publisher=Bantam Books

| isbn=0-553-05340-X }}</ref>}}

According to the updated 10th anniversary edition of ''A Brief History of Time'', Hawking has conceded the bet ("to the outrage of Kip's liberated wife")<ref>{{cite book

| first=Stephen | last=Hawking | year=1998

| title=A Brief History of Time

| edition=Updated and Expanded Tenth Anniversary

| publisher=Bantam Doubleday Dell Publishing Group

| isbn=0553380168 }}</ref> due to subsequent observational data in favor of black holes. In his own book, ''[[Black Holes and Time Warps]]'', Thorne reports that Hawking conceded the bet by breaking into Thorne's office while he was in [[Russia]], finding the framed bet, and signing it.<ref>{{cite book

| last=Thorne | first=Kip | year=1994

| title=Black Holes and Time Warps: Einstein's Outrageous Legacy

| publisher=W. W. Norton & Company

| isbn = 0-393-31276-3}}</ref>

==See also==

\* [[Stellar black hole]]

\*[[Cygnus X-1 duology]] Canadian Progressive Rock band Rush's Cygnus X-1 Duology tells a story of the black hole.

==References==

{{reflist|2}}

==External links==

\*{{cite web

| author=Staff | date=June 10, 2005 | url=http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=32709

| title=Artist's impression of Cygnus X-1

| publisher=ESA | accessdate=2008-03-24 }}

\*{{cite web

| author=Staff | date=April 1, 1996

| url=http://www.oa.uj.edu.pl/research/cygx1.html

| title=Cygnus X-1, the black hole

| publisher=Astronomical Observatory of the Jagiellonian University

| accessdate=2008-03-24 }}

\*{{cite web

| last=Cyrmon | first=W. | date=December 18, 2002

| coauthors=Aigner, C.; Bruckmueller, E.; Kernegger, R. | url=http://www.eso.org/public/outreach/eduoff/cas/cas2002/cas-projects/austria\_cygnus\_1/

| title=Black Hole in Cygnus | publisher=ESA

| accessdate=2008-03-29 }}

\*{{cite web

| title=Possible Jet Blown Shells Near Microquasar Cygnus X-1 | last=Cullen | first=Steve | date=June 8, 2009

| url=http://apod.nasa.gov/apod/ap090608.html

| publisher=APOD | accessdate=2009-06-08 }}

\*{{WikiSky|z=8}}

{{featured article}}

{{Sky|19|58|21.6756|+|35|12|05.775|6000}}

[[Category:Binary stars]]

[[Category:O-type supergiants]]

[[Category:Cygnus constellation]]

[[Category:Henry Draper Catalogue objects|226868]]

[[Category:Stellar mass black holes]]

[[Category:X-ray binaries]]

{{Link FA|fa}}

[[af:Cygnus X-1]]

[[ar:نجم الدجاجة إكس-1]]

[[br:Cygnus X-1]]

[[ca:Cygnus X-1]]

[[cs:Cygnus X-1]]

[[de:Cygnus X-1]]

[[es:Cygnus X-1]]

[[fa:ماکیان ایکس یک]]

[[fr:Cygnus X-1]]

[[ko:고니자리 X-1]]

[[it:Cygnus X-1]]

[[lv:Gulbis X-1]]

[[nl:Cygnus X-1]]

[[ja:はくちょう座X-1]]

[[pl:Cygnus X-1]]

[[pt:Cygnus X-1]]

[[ru:Лебедь X-1]]

[[simple:Cygnus X-1]]

[[sk:Cygnus X-1]]

[[fi:Cygnus X-1]]

[[sv:Cygnus X-1]]

[[tr:Cygnus X-1]]

[[zh:天鵝座X-1]]