{{Infobox GRB

| name = GRB 970508

| image = [[File:StisI.gif|200px|center]]

| caption = GRB 970508爆發一個月後拍攝。

| credit =

| detected = 21:24 [[UTC]]</br>[[1997年]][[5月8日]]

| detected\_by = [[BeppoSAX衛星]]</br>[[康普頓伽瑪射線天文台]]</br>[[尤利西斯號]]

| duration = 15秒

| ra = {{RA|06|53|49}}<ref name="Djorgovski">[[#Djorgovski|Djorgovski 1997]]</ref>

| dec = {{DEC|+79|16|19.6}}<ref name="Djorgovski"/>

| z = 0.835 ≤ ''z'' ≤ 2.3

| dist\_ly = 6 × 10<sup>9</sup>[[光年]]

| host =

| appmag\_v = 19.6

| energy = 5 × 10<sup>50</sup>[[爾格]] (5 × 10<sup>43</sup>[[焦耳]])

| names =

}}

'''GRB 970508'''是一次於1997年5月8日21:42 UTC發生的[[伽瑪射線暴]]（GRB） 。伽瑪射線暴是一次伽瑪射線的瞬間增強，通常與遙遠星系的爆炸相關，放射出[[電磁波]]中能量最強的波頻：[[伽瑪射線]]，並且在之後的一段長時間內放射波長較短的“餘輝”（[[X射線]]、[[紅外線]]、[[可見光]]、[[紅外線]]和[[無線電波]]）。

GRB 970508是被安裝在[[X射線天文學]]衛星[[BeppoSAX衛星|BeppoSAX]]上的伽瑪射線暴監視系統探測到的。天文學家Mark Metzger斷定了GRB 970508的爆發點距離地球60億[[光年]]，這是人們第一次量度伽瑪射線暴的距離。

這次爆發前，天文學界並沒有一致認同伽瑪射線暴會在距離地球多遠的地方發生。一些學家認為它們發生在[[銀河系]]以內，但因為能量不高而顯得暗淡；其他學家則認為它們發生在宇宙[[物理宇宙學|大尺度]]距離上，並不發生在銀河系內，而且能量極高。儘管伽瑪射線暴可能有很多種，意味著兩種理論可以共存，但是這次量度出來的大距離明確地證明射線暴發生在銀河系外。

GRB 970508也是第一個探測到放射[[無線電波]]“餘輝”的伽瑪射線暴。天文學家Dale Frail利用無線電波強度的波動，得以算出其來源膨脹的速度幾乎達到[[光速]]。這提供了有力的證據，證明伽瑪射線暴是[[相對論]]性的爆炸。

==發現==

[[File:BeppoSAX.jpg|thumb|left|藝術家對BeppoSAX衛星的假想圖]]

第一個伽瑪射線暴是在1967年由[[維拉號]]人造衛星（一系列用於探測太空中核爆的衛星）。<ref>[[#Schilling|Schilling 2002]], pp. 12&ndash;16</ref>第一個被觀測到的伽瑪射線暴餘輝是[[GRB 970228]]的X射線餘輝，<ref>[[#Costa|Costa 1997]]</ref>由[[BeppoSAX衛星]]（一顆意大利—荷蘭人造衛星，主要任務是研究X射線）發現。<ref>[[#Schilling|Schilling 2002]], pp. 58&ndash;60</ref>

於1997年5月8日21:42 UTC，BeppoSAX衛星上的伽瑪射線監視儀器記錄到了一個伽瑪射線暴，其時長為15秒。<ref>[[#Pedersen|Pedersen 1997]]</ref><ref name=Sc115/>這次爆發也被研究太陽的[[尤利西斯號]]及[[康普頓伽瑪射線天文台]]上的“爆炸及瞬時爆發源實驗”探測到，<ref>[[#Kouveliotou|Kouveliotou 1997]]</ref>並位於BeppoSAX衛星兩個X射線廣角相機的拍攝範圍內。幾個小時以內，BeppoSAX衛星工作小組就將其位置固定在一個直徑大約10[[角分]]的誤差範圍內。<ref name=Sc115>[[#Schilling|Schilling 2002]], pp. 115&ndash;116</ref>

<br clear=all/><!---This formatting is in place for wide shallow screens. If you can't see what it does, then it doesn't apply on your screen. Leave it.--->

==觀測==

[[File:USA.NM.VeryLargeArray.02.jpg|thumb|left|位於[[新墨西哥州]]的[[甚大天線陣]]]]

確定好射線暴的粗略位置之後，BeppoSAX工作小組成員Enrico Costa聯絡了[[美國國家射電天文台]][[甚大天線陣]]的天文學家Dale Frail。Frail在01:30 UTC（發現後4小時內）開始於20厘米[[波長]]做觀測。<ref name=Sc116/>Frail在準備觀測的時候，聯絡了正在操作[[海爾望遠鏡]]的天文學家Stanislav Djorgovski。Djorgovski馬上對照了他的照片與[[數位巡天]]的較老照片，但並沒有發現誤差範圍以外的新信號。Djorgovski在[[加州理工學院]]的同事對數據進行了更多分析，但也找不到任何新信號。<ref name=Sc116>[[#Schilling|Schilling 2002]], pp. 116&ndash;117</ref>

第二晚，Djorgovski再次觀測同一區域。他比較了兩晚的圖片，但沒有天體在5月8日至9日明顯減弱了光度。ut the error box contained no objects that had decreased in luminosity between May 8 and May 9.<ref name="teams"/> Metzger noticed one object that had increased in luminosity, but he assumed it was a [[variable star]] rather than the GRB afterglow. [[Titus Galama]] and [[Paul Groot]], members of a research team in [[Amsterdam]] led by [[Jan van Paradijs]], compared images taken by the [[WIYN Telescope]] on May 8 and the [[William Herschel Telescope]] on May 9. They were also unable to find any light sources which had faded during that time.<ref name="teams"/>

After discovering the burst's X-ray afterglow, the BeppoSAX team provided a more accurate localization, and what Metzger had assumed to be a variable star was still present in this smaller error box. Both the Caltech team and the Amsterdam team were hesitant to publish any conclusions on the variable object. On May 10 [[Howard Bond]] of the [[Space Telescope Science Institute]] published his discovery,<ref>[[#Bond|Bond 1997]]</ref> which was later confirmed to be the burst's optical afterglow.<ref name="teams">[[#Schilling|Schilling 2002]], pp. 118&ndash;120</ref>

On the night between May 10 and May 11, 1997, Metzger's colleague [[Charles Steidel]] recorded the [[spectrum]] of the variable object at the [[W. M. Keck Observatory]].<ref name="S121"/> He then sent the data to Metzger, who after identifying a system of [[absorption lines]] associated with [[magnesium]] and [[iron]] determined a [[redshift]] of ''z'' = 0.8349 ± 0.0002,<ref>[[#Varendoff|Varendoff 2001]], p. 383</ref><ref name="MetzCircular">[[#MetzCircular|Metzger 1997a]]</ref><ref name="MetzJournal">[[#MetzJournal|Metzger 1997b]]</ref> indicating that light from the burst had been absorbed by matter roughly 6 billion [[light-year]]s from Earth.<ref>[[#Katz|Katz 2002]], p. 148</ref> Although the redshift of the burst itself had not been determined, the absorbent matter was necessarily located between the burst and the Earth, implying that the burst itself was at least as far away.<ref name="S121">[[#Schilling|Schilling 2002]], pp. 121–123</ref><ref>[[#Katz|Katz 2002]], p. 149</ref> The absence of [[Lyman-alpha forest]] features in the spectra constrained the redshift to ''z'' ≤ 2.3,<ref name="MetzCircular"/><ref name="MetzJournal"/> while further investigation by [[Daniel E. Reichart]] of the [[University of Chicago]] suggested a redshift of ''z'' ≈ 1.09.<!--Lyman-alpha forest needs a short explanation.--> This was the first instance in which scientists were able to measure the redshift of a GRB.<ref>[[#Schilling|Schilling 2002]], p. 120</ref><ref>[[#Reichart|Reichart 1998]]</ref> Several optical spectra were also obtained at the [[Calar Alto Observatory]] at wavelength ranges of {{convert|4300|-|7100|Å|nm|lk=on|abbr=on}} and {{convert|3500|-|8000|Å|nm|abbr=on}}, but no emission lines were identified.<ref name="Castro">[[#Castro|Castro-Tirado 1998]]</ref>

On May 13, five days after the first detection of GRB 970508, Frail resumed his observations with the Very Large Array.<ref name="Sch124"/> He made observations of the burst's position at a wavelength of 3.5 [[centimeter|cm]] and immediately detected a strong signal.<ref name="Sch124"/> After 24 hours, the 3.5 cm signal became significantly stronger, and he also detected signals at the 6 and 21 cm wavelengths.<ref name="Sch124"/> This was the first confirmed observation of a radio afterglow of a GRB.<ref name="Sch124">[[#Schilling|Schilling 2002]], p. 124</ref><ref name="Katz147">[[#Katz|Katz 2002]], p. 147</ref><ref>[[#NRAO|NRAO 1997]]</ref>

Over the next month, Frail observed that the luminosity of the radio source fluctuated significantly from day to day but increased on average. The fluctuations did not occur simultaneously along all of the observed wavelengths, which [[Jeremy Goodman]] of [[Princeton University]] explained as being the result of the radio waves being bent by interstellar [[plasma (physics)|plasma]] in the Milky Way.<ref name="Katz147"/><ref name="Sch125"/> Such [[radio scintillation]]s (rapid variations in the radio luminosity of an object) occur only when the source has an apparent diameter of less than 3 microarcseconds.<ref name="Sch125">[[#Schilling|Schilling 2002]], p. 125</ref><!--"explained as being" is awkward.-->

==Characteristics==

BeppoSAX's Gamma-Ray Burst Monitor, operating in the energy range of 40&ndash;700 [[Electron volt|keV]], recorded a [[fluence]] of (1.85 ± 0.3) × 10<sup>−6</sup> [[erg]]/cm<sup>2</sup> (1.85 ± 0.3 [[nanojoule|nJ]]/m<sup>2</sup>), and the Wide Field Camera (2&ndash;26 keV) recorded a fluence of (0.7 ± 0.1) × 10<sup>−6</sup> erg/cm<sup>2</sup> (0.7 ± 0.1 nJ/m<sup>2</sup>).<ref>[[#Galama|Galama 1998]]</ref> BATSE (20&ndash;1000 keV) recorded a fluence of (3.1 ± 0.2) × 10<sup>−6</sup> erg/cm<sup>2</sup> (3.1 ± 0.2 nJ/m<sup>2</sup>).<ref>[[#Kouveliotou|Kouveliotou 1997]]</ref>

About 5 hours after the burst the [[apparent magnitude]] of the object—a logarithmic measure of its brightness with a higher number indicating a fainter object—was 20.3 ± 0.3 in the [[Photometric system|U-band]] (the ultraviolet region of the spectrum) and 21.2 ± 0.1 in the R-band (the red region of the spectrum).<ref name="Castro"/> The afterglow reached its peak luminosity in both bands approximately 2 days after the burst was first detected—19.6 ± 0.3 in the U-band at 02:13 UTC on May 11, and 19.8 ± 0.2 in the R-band at 20:55 UTC on May 10.<ref name="Castro"/>

James E. Rhoads, an astronomer at the [[Kitt Peak National Observatory]], analyzed the burst and determined that it was not strongly [[Light beam|beamed]].<ref>[[#Rhoads|Rhoads 1999]]</ref><!--When did Rhoads become involved in studying the GRB? Who did he suggest this to?--> Further analysis by Frail and his colleagues indicated that the total energy released by the burst was approximately 5×10<sup>50</sup> ergs (5×10<sup>43</sup> J), and Rhoads determined that the total gamma-ray energy was approximately 3×10<sup>50</sup> erg (3×10<sup>43</sup> J).<ref name="Pac"/> This implied that the gamma-ray and kinetic energy of the burst's ejecta were comparable, effectively ruling out those GRB models which are relatively inefficient at producing gamma rays.<ref name="Pac">[[#Pac|Paczyński 1999]], p. 2</ref><!--"Effectively" sounds a little weaselly. Did it rule out the models? Did other astronomers agree that the models were invalidated?-->

==Distance scale and emission model==

Prior to this burst, astronomers had not reached consensus regarding how far away GRBs occur from Earth.<!--Awkward again--> Although the [[Isotropy|isotropic distribution]] of bursts suggested that they do not occur within the disk of the [[Milky Way]], some astronomers supported the idea that they occur within the Milky Way's [[Galactic spheroid|halo]], concluding that the bursts are visibly faint because they are not highly energetic. Others concluded that GRBs occur in other galaxies at [[Physical cosmology|cosmological]] distances and that they can be detected because they are extremely energetic. The distance measurement and the calculations of the burst's total energy release unequivocally supported the latter theory, effectively ending the debate.<ref>[[#Schilling|Schilling 2002]], p. 123</ref><!--This is a very confusing conclusion. Are there multiple types of GRBs, or did this end the debate in favor of one type? -->

Throughout the month of May the radio scintillations became less noticeable until they ceased altogether. This implies that the radio source significantly expanded in the time that had passed since the burst was detected. Using the known distance to the source and the elapsed time before the scintillation ended, Frail calculated that the radio source had expanded at almost the [[speed of light]].<ref>[[#Waxman|Waxman 1998]]</ref> While various existing models already encompassed the notion of a [[Theory of relativity|relativistically]] expanding fireball, this was the first strong evidence to support such a model.<ref>[[#Schilling|Schilling 2002]], p. 126</ref><ref>[[#Piran|Piran 1999]], p. 23</ref>

==Host galaxy==

[[File:GRB 970508 STIS August 1998.gif|thumb|right|Image of GRB 970508's host galaxy taken in August 1998]]

The afterglow of GRB 970508 reached a peak total luminosity 19.82 days after the burst was detected. It then faded with a [[power law]] slope over about 100 days.<ref name="Fruchter"/> The afterglow eventually disappeared, revealing the burst's host, an actively star-forming dwarf galaxy with an [[apparent magnitude]] of ''V'' = 25.4 ± 0.15.<ref>[[#Bloom|Bloom 1998]]</ref><ref name="Fruchter"/> The galaxy was well fitted by an [[exponential disk]] with an [[ellipticity]] of 0.70 ± 0.07.<ref name="Fruchter"/> The redshift of GRB 970508's optical afterglow, ''z'' = 0.835, agreed with the host galaxy's redshift of ''z'' = 0.83, suggesting that, unlike previously observed bursts, GRB 970508 may have been associated with an [[active galactic nucleus]].<ref name="Fruchter">[[#Fruchter|Fruchter 2000]]</ref>

==Notes==

{{reflist|colwidth=25em}}

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