Executive Summary
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Modelling and Measuring Gamma-Ray Bursts

Introduction

Gamma-ray bursts are the brightest and most energetic events in the universe. And since their discovery in 1967, gamma-ray bursts have helped answer some of astronomy's toughest questions and raised some new ones.

History

In the 1960's, the United States began launching Vela satellites designed to detect gamma-ray radiation. The satellites were meant to look for signs of secret nuclear tests conducted by the Soviet Union, which would be in violation of the Nuclear Test Ban Treaty of 1963. In 1967, however, a gamma-ray pulse was detected, but did not match the signature of nuclear detonations. Over the course of the next several years, more similar observations were made and finally it was concluded that the bursts were not of terrestrial or solar origin. By 1991, it was shown that the bursts were not only not from our own system, but that they were not coming from the Milky Way galaxy. By 1997, scientists were able to begin measuring the distances of these bursts, and found that most of them are billions of light years away. They are caused by the most violent and energetic occurrences in the universe: the explosion and collapse of supernovas and the merging of neutron stars.

Measurements

Over the course of five decades, scientists have accumulated an enormous amount of information about gamma-ray bursts. Some of the basic types of data that various satellite missions and surface-based telescopes have recorded are

- Location of the gamma-ray burst (measured in Right Ascension and Declination, or RA and dec)
- Fluence, essentially the amount of energy recorded by the gamma-ray burst (measured in erg/cm^2)
- Redshift, the spectrographic recording of the light seen from the origin of the burst, which enables the calculation of how fast it is moving away from the observer, and consequently how far away it is.

Program Structure

This program will pull in gamma-ray bursts data from six different NASA catalogs:

- CGRO/BATSE
- Fermi GBM
- Fermi LAT 4-Year Point Source
- GRB Catalog
- BeppoSAX/GRBM
- Swift GRB

Specifically, this program will look at the following categories (not all datasets include all categories):

- Name of GRB
- Trigger time (date and time burst was recorded by detector)
- RA, dec (location)
- Fluence
- Redshift

The data will be combined from all six sources, and the user will be able to display GRB, fluence, and redshift data from a user-selected time period (any dates between 7/1967 to 11/2016). The user will also be able to plot the locations of gamma-ray bursts, the fluence v. redshift, and the redshift v. the age of the universe.

Redshift v. Age of the Universe

One of the most important and fascinating discoveries related to gamma-ray bursts is the recording of a burst's redshift. Not only can this be used to calculate the current distance from Earth of this object, but it allows scientists to calculate how old the universe was when the event occurred. And gamma-ray bursts have, in the past decade, allowed scientists to record some of the earliest moments of the universe, edging ever closer to the formation of the first stars in the universe.

Sources

- Data sets: http://heasarc.gsfc.nasa.gov/cgi-bin/W3Browse/w3catindex.pl'
- https://en.wikipedia.org/wiki/Gamma-ray_burst
- https://www.nasa.gov/mission_pages/swift/bursts/farthest_grb.html
- Gamma Ray Bursts and the Birth of Black Holes: https://www.youtube.com/watch?v=DtAWoC5BjoY
- Edo Berger: Gamma-ray Bursts: https://www.youtube.com/watch?v=ePo_EdgV764&t=3037s