Quasi-Stellar Objects (Quasars)

Ashwin Srikrishna, Rebekkah Cazalas

June 28, 2006

Duke TIP Field Study in Astronomy, Physics, and Astrobiology at

Pisgah Astronomical Research Institute

Abstract:

Quasars were found using quasar catalogs, and observed using a 26-meter radio telescope. The quasars' power law were determined by observing the quasars under two frequencies and using a power equation. The power law is the relationship between the intensity and the frequency. After determining the power laws of the quasars, we determined the relative magnetic field strength in relation to Cygnus A; a quasar we observed.

Introduction:

The purpose of the research was to calculate the power law of various quasars and determine their relative magnetic field strength to the observed quasar Cygnus A. Quasars are very far away and they are extremely luminous for their distance from Earth. The quasars were found by using a radio telescope to find the coordinates to find the quasar and track how many photons hit the dish at two different frequencies. With this done, the power law can be determined from the graph of the amounts of power that the quasar emits at certain frequencies. The graphs of all the quasars and their power laws is the final product.

Method:

Quasar Catalogs (given by Dr. Castelaz) were used to find the locations and brightness of quasars. Multiple catalogs were used to find the locations of the quasars as each catalog had different pieces of information (one had location, the other had brightness in Janskies) that were needed to observe the quasars. There were certain requirements for the quasars : the flux > 1 Jansky, the Sun is at 6 ∀ 1 hour Right Ascension, and there is no observing between 12 and 9 AM.

A 26 - meter radio telescope was used in conjunction with a spectrometer to track the number of photons that hit the dish at two frequencies: 1.420406 GHz and 4.8 GHz. The spectrometer was also used to record other pieces of data that were needed to find the amount of power of the quasar at the aforementioned frequencies. Using the equation given by Dr. Castelaz (eq. 1), the power is determined using the information that was taken off of the spectrometer.

Eq.1

$$\text{Power} = \left((\text{counts}/\text{gain}) + \text{offset} \right) / \left(10^{\left((\text{If Gain} - \text{attenuation}) / 10 \right)}\right)$$

To make sure that the object that was recorded in the spectrometer wasn’t a fluke, the scan was run multiple times. Quasars were checked a multitude of times to confirm their brightness and location in the celestial sphere (Right Ascension and Declination). There was a limited time to the usage of the radio telescope at PARI, and the weather lead to a decrease in the productivity of the project.

Once the coordinates of the quasars were found, they were inserted into the computer that connected to the telescope. After the telescope moved to the inputted location, a hand paddle was used to search the area around the coordinates in space and find the quasar. The spectrometer found a source, so was let to run a few more times to make sure that it found the correct object. The next time that the spectrometer found the source, certain measurements were taken (see the info in eq. 1) off the spectrometer.

However, certain problems were run into when the radio telescope was used, as the only quasar that was located was Cygnus A. As a result, we only used the data from Cygnus A and used catalogs to find data to use to compare the magnetic field strengths to Cygnus A.

Results and Discussion:

After determining the power law of each quasar, we then compared the power of each quasar's magnetic field to the magnetic field power of the observed quasar, Cygnus A. The higher the power law was, the higher the strength of the magnetic field. The results are as listed:

Quasar Name	Power Law	Relative Magentic Field Strength
S5 0014+81	-11.2868525896414	1863.7
TEX0004+171	-11.0517928286853	1531.9
UM 46	-9.13147410358566	339.8
UM 30	-7.73705179282869	114.2
PKS 0035+23	-7.25099601593626	77.8
UM 18	-6.50597609561753	43.5
3C 9.0	-5.82470119521912	25.3
4C 09.01	-5.80876494023904	25.1
PKS 0045-000	-5.72111553784861	23.4
PKS 0038-019	-5.61752988047809	21.7
PKS 0010-408	-5.0597609561753	13.9
PKS 0027-426	-4.9003984063745	12.3
PKS 0006+014	-4.8406374501992	11.7
PKS 0041+001	-3.97609561752988	5.9
NAB 0024+22	-3.65737051792829	4.7
PKS 0035-252	-3.56972111553785	4.3
PKS 0005-239	-3.50597609561753	4.1
3C 14.0	-3.41832669322709	3.9
PKS 0013-00	-3.12350597609562	3.1
PKS 0000-17	-2.05179282868526	1.3
Cygnus A	-1.7381308411215	1
OB 565	-1.64940239043825	0.9
PKS 0008+171	-1.63745019920319	0.9
PKS 0038-020	-1.53784860557769	0.8
PKS 0008-264	-1.12749003984064	0.6

Cygnus A has a value of 1, because all of the quasars were compared to the strength of its magnetic field.

As seen in the table above, the values that were calculated had a large range between highest and lowest; from 0.6 to 1864. It can be concluded that the strength of quasars' magnetic fields can vary greatly, and that the power law is directly proportionate to the strength of the magnetic field. Weather complications prevented us from observing any other quasars that we could've used as a main subject.