Making a Light Curve for AGN CXOJ190741+070650*

Abram J. Rodriguez '26 and Steven D. Bloom

Department of Physics and Astronomy, Hampden-Sydney College, Hampden-Sydney, VA 23943

Abstract

Previous research on CXOJ190741+070650 produced inconclusive results on the kind of AGN this object could be. The inconclusive results were due to its optical spectrum being reminiscent of a Blazar type AGN with its featureless continuum. This prompted an investigation to measure the variability of this object. In short, this object is probably an optically variable source. Light curves show variability of ~1 mag or so over the course of about a month within reasonable error, being around ±0.5 mag.

Background Information

Here is a reference image to look at of CXO J190741+070650 and SNR 3c-397. This was made using DS9 and the lowest energy values are in red while the higher energy values are in blue.

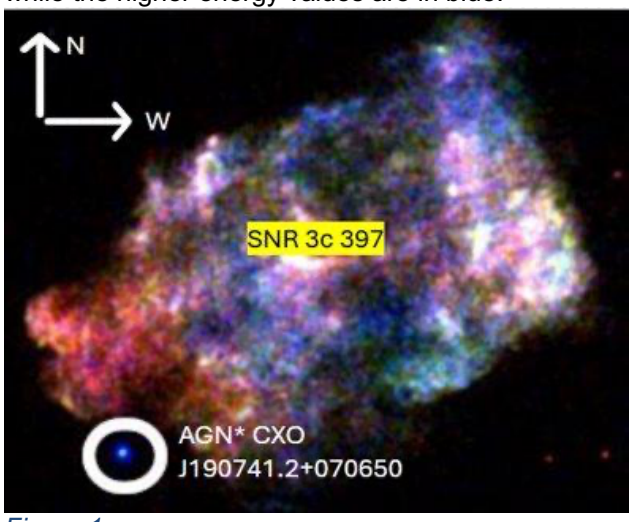

Figure 1.

As said before, research was done on this object last summer, but mainly its AGN type. The conclusion was unclear as the optical spectrum and X-ray spectrum did not agree on the type of AGN CXO J190741+070650 could be. The object's X-ray spectrum suggested a Seyfert II type AGN due to its strong iron line ~ 6.4 keV and heavily absorbed spectrum. However, the optical spectrum lacked any distinct features, which is more common of a blazar. (Fig. 2 is the optical spectrum and Fig. 3 is the X-ray spectrum).

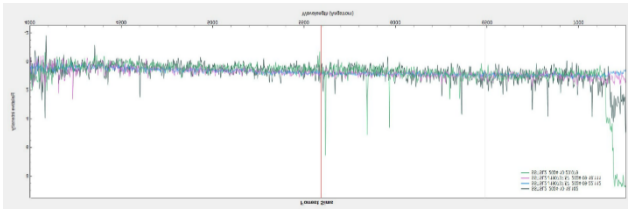

Figure 2

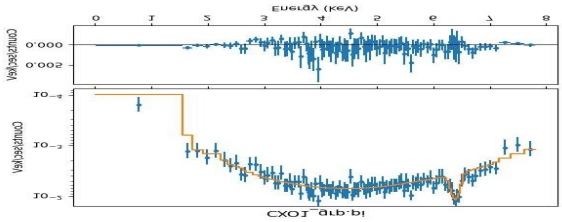

Figure 3

Regardless, this object is almost certainly a non-stellar source and unrelated to the SNR 3c 397. This is due to the following known qualities of CXO J190741+070650:

Blazar-Like Optical Spectra	True
Calculated Distance	$40Mpc \pm 20Mpc$ (3c 397 is ~ 8Kpc)
Column Density	$\sim 5 \cdot 10^{-22} cm^{-2}$ (3c 397 is $\sim 3 \cdot 10^{-22} cm^{-2}$)
Non-Stellar X-ray Spectra	True
Dissimilar Velocity Compared to 3c 397	True

Table 1

Materials and Methods

Light curves can be made using excel and MaximDL. There were two methods that were used to produce light curves for CXO J190741+070650. The first method involved selecting known reference stars (all reference stars were found in the SIMBAD database) in the FOV and simply plotting the light curve in MaximDL. These light curves were then compared to the object of interest. That data can then be selected with other parameters and exported as a CSV file where it can be displayed in Excel. The data can also be selected and graphed in Excel with the error selected which was given from the CSV file. This method is not as stringent on error.

The second method uses linear regression to produce a light curve. Intensity values from MaximDL of each reference star and the source of interest were

recorded onto Excel. This can also be done from selected data from a CSV file to save time. Essentially, the reference stars are used to make a linear curve with a calculated slope and intercept. Since this is in the linear format, $y = mx + b$, the value of intensity is x, and the resultant magnitude is y. This method also allows for error to be propagated more accurately.

Light Curves.

Images were taken using the HSC observatory and Cerro Tololo observatory through Skynet, a software program that lets one observe participating telescopes around the world. During October of 2024 data was collected on the HSC telescope, with all data taken after this date deemed unusable. The Cerro Tololo Prompt 2 scope has taken and will continue to take data starting from early June.

The first light curves (Fig. 4 and Fig. 5) contain data from October of 2024. The first graph was a CSV file exported directly from MaximDL. The second one was made using the linear regression method. Both methods tend to agree on when variability occurred and on the maximum magnitude of CXO J190741+070650 during these observations. Error is clearly more visible in Fig. 5 where it tends to vary by about ±0.5 mag. Overall, magnitude tends to vary by about a magnitude or so for the r prime filters and around 2 magnitudes for the g filters over the course of about less than a month.

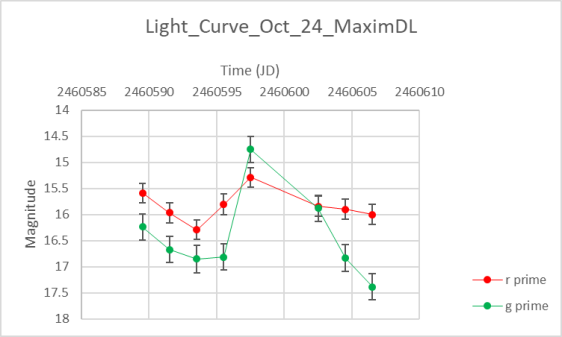

Figure 4

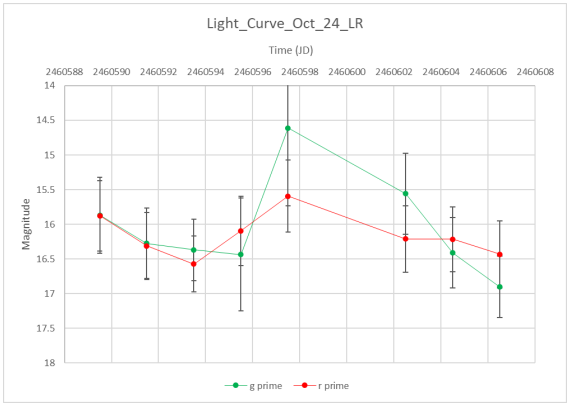

Figure 5

Fig. 6 contains newer data (June) taken over a similar time frame as the data from Oct. 24. This was done using MaximDL with no linear regression involved. Variability is on the order of a magnitude or so.

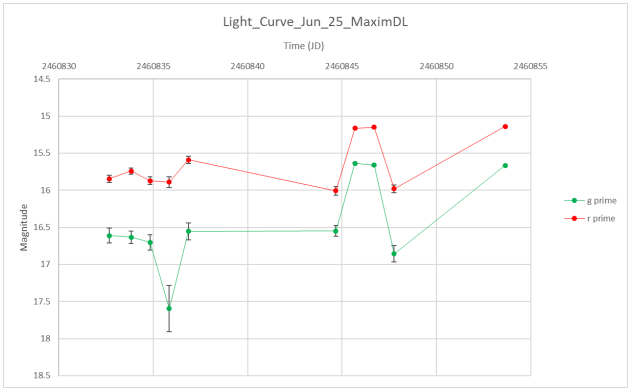

Figure 6

Discussion

Findings.

CXO J190741+070650 is a variable source. However, I was unable to get a Fortran program to work based on the lack of data. This program would have shown how often this source varies. Furthermore, a more statistically concrete conclusion would be plausible if there was more data to rely on. More observations on CXO J190741+070650 are currently scheduled to occur on the HSC telescope and Prompt 2 telescope (the research in this paper will become my senior project). The goal for this further research is to get a time scale for variability of CXO J190741+070650.

Observation time on a bigger optical telescope with a spectrograph is something that is also being worked on as of now. The current optical spectrum of CXO J190741+070650 was taken on a Planewave CDK 17, a small diameter scope. The data from the Planewave CDK 17 resulted in a noisy spectrum with no true emission or absorption lines discernable.

For the possible types of AGNs CXO J190741+070650 could be, evidence still points to a Seyfert II type AGN. The object was also compared to other radio-weak Blazars in a Massaro paper as they tend to fall into a particular category with their color-color plot. The object falls off on color-color plot of the radio-week Blazars, as do most Seyfert II type AGNs. This evidence further points to the object being a Seyfert II type AGN.

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