**Investigating 3C273 with NuSTAR**

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**Abstract**

The results obtained from ten X-ray observations spanning 2015-2021 on the quasar 3C273 performed by NuSTAR are presented here. The aim of this paper is to study the short and long-term evolution of the spectrum of 3C273. Evidence of complex spectral features such as soft excess, Fe K emission line, flux and spectral correlated variability are presented. We explain these features as arising from the structure of the accretion disk and coronal emission. The combined spectrum is well-described by an exponentially cutoff power-law which self-consistently includes the iron line and a weak reflection component from cold, dense material (pexmon). By comparing each NuSTAR observation when fit with the pexmon model, we can investigate the spectral variability of 3C273 over time. At radio to millimeter and at gamma-ray energies, flares from the relativistic jet dominate the variability of 3C273. Considering Fermi and Bats observations on 3C273, it appears that jet activity affected the NuSTAR data in the X-ray band. Correlation studies on the source indicate a direct relationship between the cutoff energy and photon index as well as an inverse correlation between the flux and photon index. Finally, by examining the long-term trend of the spectral index of 3C273, we can see that the source has softened over time.

**Background**

**3C273 and the Relativistic Jet**

3C273 is one of the nearest and brightest quasars, featuring a relativistic jet showing superluminal motion. The jet is collimated from the radio to X-ray bands, allowing for a detailed study of the physical properties of the AGN at regions close to the supermassive blackhole. At a redshift of z = 0.158, 3C273 has been extensively studied since its discovery and is highly variable across all energies. The source has been actively monitored since its discovery in 1963 and exhibits a long-term spectral evolution as well as short term variations. 3C273 emits strongly in the γ-ray band and has been consistently observed by Fermi over the years. At γ-ray energies, flares from the jet dominate the variability of 3C273 and Fermi observations on the source reveal interesting γ-ray flares from the jet.

**Properties of an AGN**

The spectrum of 3C273 reveals complex spectral features including a weak reflection component and a weak neutral iron line. The accretion disc emits photons which are inverse Compton scattered by a corona of hot electrons surrounding a super massive black hole. These inverse Compton scattered photons are what form the primary X-ray continuum which can be fitted to a power-law. Reflection off an accretion disk or distant material gives rise to a weak reflection component. The reflection component presents an iron line at 6.4 keV. The continuum shows a high energy rollover which depends on the temperature and optical depth of the hot electron plasma composing the corona. Understanding these properties allows us to fit the spectrum to an appropriate model to further study the source.

**Fitting the Spectrum**

**\*\* OBSERVATION LOG**

**\*\* COMBINED SPECTRUM**

**\*\* TABLE OF STUFF**

**Objectives**

**Main Conclusions**

**Findings+ Results**

**Implications+relation+future**

**Methods??**

Methods. This section should be subdivided by short headings referring to the technique being used or the experiment being explained. This section is directed toward scientists in the author's field.

*Chart, histogram

Description automatically generated*

*NuSTAR Continuum Spectral Fits*

|  |  |
| --- | --- |
| Parameter | w/o jet |
| **zpowerlaw** | (3595 dof) |
| χ2red  Γ | 1.125  1.66± 0.003 |
| **pexrav** | (1928 dof) |
| χ2red  Γ  E cutoff  Relative reflection | 1.015  1.62± 0.01  218+34-26 keV  .104± 0.03 |
| **pexrav+zgauss** | (1926 dof) |
| χ2red  Γ  E cutoff  Relative reflection  Line Energy (fixed)  Line width σ | 1.010  1.62± 0.003  2183426  .099± 0.03  6.40 keV  .43+1.05-.32 |
| **pexmon** | (1928 dof) |
| χ2red  Γ  E cutoff  Relative Reflection | 1.010  1.62± 0.009  2163225  .063± 0.02 |