TXS 1206+549: a γ-ray detected narrow-line Seyfert 1 galaxy at z=1.34

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ABSTRACT

Here, we report the identification of a new γ-ray emitting candidate NLS1 TXS 1206+549 at z = 1.344. A near-infrared spectrum taken with Subaru MOIRCS making use of the newly developed LightSmyth gratings showed the presence of the Hβ line with a FWHM of 1200 ± 77 km/s and [O III] emission but no significant optical Fe II lines within the limited wavelength coverage. The source is very radio-loud, unresolved in the VLBA 5GHz, and has a flat radio spectrum. The broadband spectral energy distribution (SED) of the source has the typical two hump structure shown by blazars and other γ-NLS1s. The source exhibits strong variability at all wavelengths such as the optical, infrared, and γ-ray bands. The source may suggest a smooth transition for higher luminosity NLS1s into the flat-spectrum radio quasar branch of blazars. At a redshift of z = 1.344, TXS 1206+549 is the most distant γ-NLS1 known to date if confirmed by future spectroscopic observations.

New high performance LightSmyth grism for SUBARU MOIRCS

✱ **MOIRCS** Multi-Object Near-Infrared Camera and Spectrograph on the Subaru 8.2-m Telescope.

✱ The Medium-Resolution VPH Grisms have several Issues: Peaky Transmission Curve and strong dependence on angle of incidence

✱ New gratings covering J-band H-band made by LightSmyth Technologies introduced:to MOIRCS (details presented in SPIE series by Tanaka et al.): Overall great performance: Most notable characteristics are: Very high peak efficiency (20% higher than VPH in the H-band), Wide Spectral Coverage with flat efficiency characteristics as shown in the lab measurements below in Fig 1.

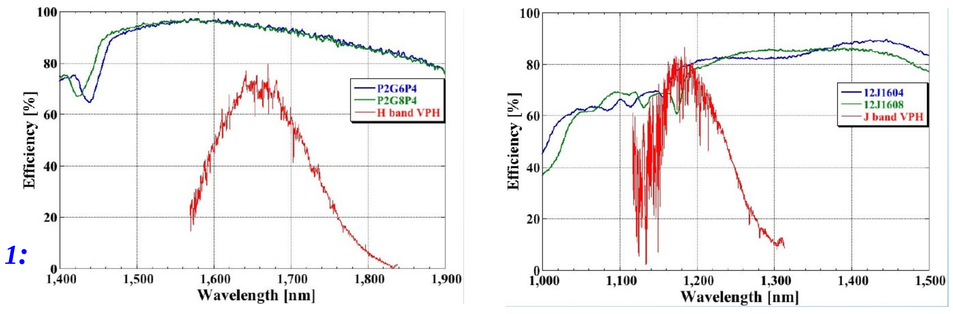


FIGURE 1:

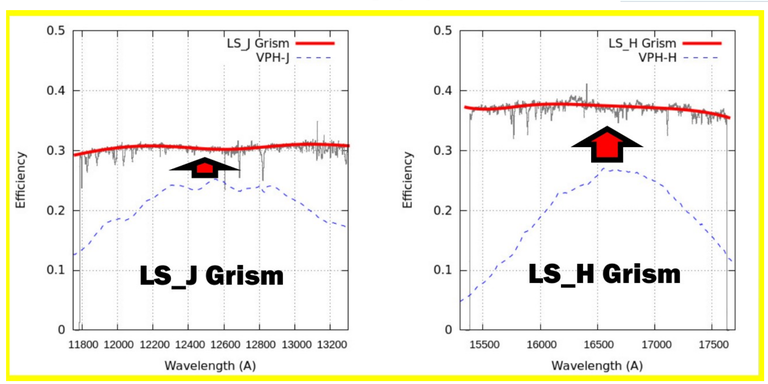


FIGURE 2:
On-Sky performance test from July 2020. Flat Efficiency curve over the entire wavelength region with clear performance improvement over the VPH grisms. Typical resolution for 0.5'' slit R~3400

Figures provided by I. Tanaka

TXS 1206+549 a candidate γ-NLSy1 at z=1.334

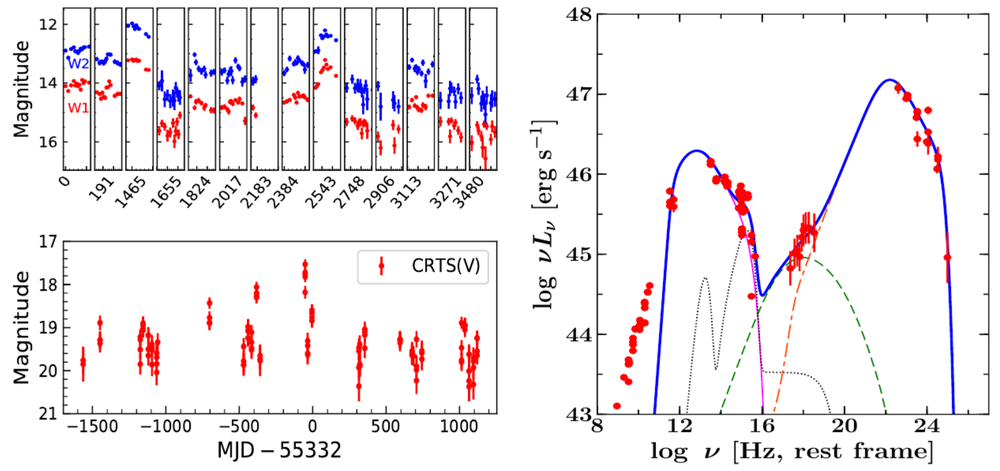


FIGURE 3: **Left Panel - Top: WISE light curve of TXS 1206+549 in 3.4μm (W1) and 4.6μm (W2) bands with each box representing a duration of 1.2 days. Bottom: optical photometric light curve from CRTS (V -band). Right Panel: Rest frame multiwavelength SED of TXS 1206+549 along with the results of the leptonic radiative modeling. Pink thin solid, green dashed, and orange dash-dash-dot lines represent synchrotron, SSC, and EC processes, respectively. Thermal emission from the dusty torus, accretion disk, and corona is shown with the black dotted line. Blue thick solid line refers to the sum of all the radiative components.**

✱ TXS 1206+549 is detected over the entire spectrum from Gamma-rays to Radio

✱ Typical double hump structure similar to blazars. Object is classified as a flat spectrum radio quasar (FSRQ) see Tan et al. 2020) SED fit by synchrotron inverse Compton radiative model

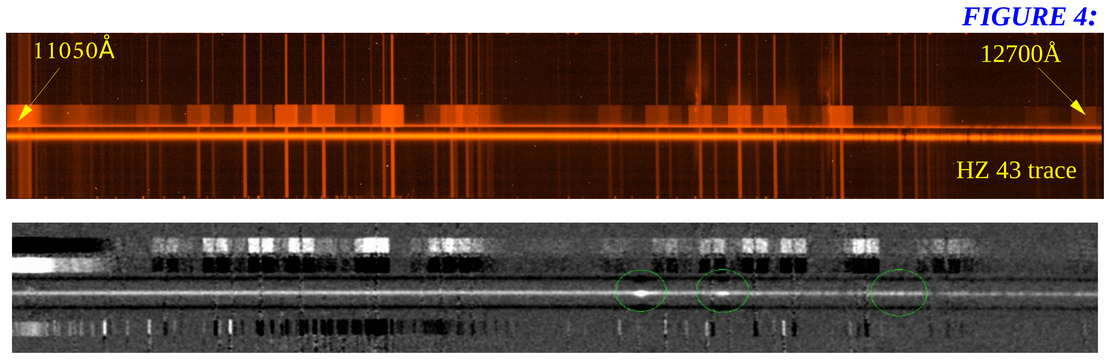
✱ High-frequency radio to optical-UV spectrum is well explained by synchrotron emission with a minor contribution from the accretion disk. The X- and γ-ray spectra are reproduced by a combination of the synchrotron self Compton (SSC) and external Compton (EC) processes

MOIRCS spectrum using LS-J grism

✱ We observed TXS 1206+549 on July 20, 2020 under good seeing conditions (0.8'' seeing) using the LS-J grism covering the rest-frame optical region around Hbeta and [OIII]. We used and exposure time of 300 sec 12-times multi-sampling in standard A-B dither (4'' dither length)

✱ For calibration purpose we observed the standard star HZ43(2d raw spectrum is shown below in Fig. 4). The spectrum shows good sensitivity over the entire wavelength region.

FIGURE 4:



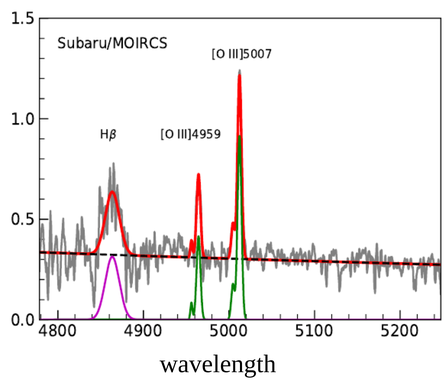


FIGURE 5: **Top: Final combined 2d spectrum of TXS 120+549 (J=19.5 mag) observed for 6x300s covering the region around rest-frame Hbeta. Both [OIII] 5007 & 4960 emission lines are clearly visible as well as the faint Hbeta line (marked with green circles). The SN of the final unbinned spectrum ranges from SN~7 redward of [OIII] and SN~3.5 on the blue side. The final 1d spectrum is smoothed by a pixel box-car to increase the SN for the line fitting**
Left: Decomposition of the Hbeta+[OIII] emission line region: FWHM Hbeta = 1200 km/s.

Discussion & Final Remarks

✱ TXS 1206+549 shows characteristics o NLSy1 (1) FWHM of Hbeta 1200 km/s and (2) flux ratio of [O III]5007 to HBeta is low (~ 0.7):

✱ Caveat: However, our spectrum still has low S/N and limited wavelength coverage. We find only weak optical Fe II emission → In terms of optical properties, it shows similarities with PKS 2004-447 having weak Fe II emission rather than 1H 0324+3410

✱ log L5100 = 44.8 erg/s → MBH = 2.8 × 10^7 Msun using Hbeta FWHM and line luminosity With a bolometric correction factor of 9.26 the Eddington ratio is found to be 1.5 suggesting super Eddington accretion.

✱ using Mg II line MBH = 2.97 × 10^8 Msun is found However, black hole mass estimation based on continuum luminosity is likely to be uncertain, due to the non-thermal emission from the jet that contributes to the observed continuum flux. The Mg II line equivalent width decreases by a factor of 3 between MJD = 52672 to 57430 almost no line flux change but large continuum variability → non-thermal component

✱ TXS 1206+549 is a radio-loud source showing a compact radio emission. The high amplitude of infrared variability in time scale of months to days suggests emission region is compact and significant non-thermal contribution from jet in the infrared

✱ From our SED model fits we found magnetic field strength and bulk Lorentz factor of 3.2 Gauss and 11 respectively, similar to Tan et al. (2020). The magnetic field found for TXS 1206+549 is similar to that of other γ-ray emitting NLS1s (Paliya et al. 2019a). However, with the discovery of more γ-ray detected NLS1s at high-z and higher luminosity such as TXS 1206+549, they smoothly join the FSRQ branch of blazars.

✱ Overall successful on-sky test of the new MOIRCS LS grisms on the currently highest redshift (z=1.334) γ-ray emitting NLS1

REFERENCES

Based on Rakshit et al. 2021 submitted to MNRAS, Tan, C. et al. 2020, The Astrophysical Journal Supplement Series, 248, 27, Paliya, V. et al. 2019a, ApJ, 872, 169