A Quasar caught in the act of turning off

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Changing-look quasars are a new class of recently identified object in which the strong UV continuum and broad optical hydrogen emission lines associated with unobscured quasars either appear or disappear on timescales of years ????. The physical processes responsible for this behaviour are still debated, but changes in the black hole accretion rate or accretion disk structure appear more likely than changes in obscuration??. Here we report on three epochs of spectroscopy of SDSS J110057.70-005304.5, a quasar whose UV continuum and broad hydrogen emission lines have dramatically faded over the past 20 years. An archival spectrum of this quasar from 2010 shows an intermediate phase of the transition during which the flux below rest-frame 340nm has collapsed. This is unique compared to previously published examples of changing-look quasars, and is best explained by dramatic changes in the innermostÂăregions of the accretion disk. The optical continuum has been rising again since mid-2016, leading to a prediction of a rise in hydrogen emission line flux in the next few months. If our model is confirmed, the physics of 'changing look' quasars are governed by processes at the innermost stable circular orbit (ISCO) around the black hole, and the structure of the innermost disk. Thus, the easily identifiably and monitored Changing Look Quasars would then provide a new probe of the strong gravity regime.

The "Changing-Look" quasar phenomenon, where the dramatic disappearance, or appearance, of prominent broad optical emission lines is seen on year timescales, is now widely observed, **??????**. yet poorly understood. **?** find a polarization degree compatible with null polarization suggesting that the observed change of look is not due to a change of obscuration hiding the continuum source and the broad line region. Meanwhile, **?** using the mid-infrared luminosity during the transitions in 10 changing-look AGNs from the Wide-field Infrared Survey Explorer (WISE) and find that the CL behavior of their sample cannot be a result of the changes in obscuration. However, it is clear that the CLQs are a key laboratory into understanding accretion physics and the nature of the AGN broad line region (BLR).

The famous $\alpha-$disk model **?** for a optically thick, geometrically thin disk (h/R) $\ll 1$; where h is the vertical scale height of the disk) is known to have serious short-comings e.g. **???** AGN seem to be cooler than they ought to be (**?**, e.g.,) with the SEDs of AGN showing a universal near-UV shape, reaching a maximum in νS_ν around 1100Å , Such a peak suggests a characteristic temperature of T$\sim$30 000K, wheres for a thermal model, the characteristic temperature should be roughly T$\sim$100 000K. Moreover, constraints from microlensing observartions for the size of the optical emission region (**????**, e.g.,) suggestion this region is larger than the one predicted by the standard Shakura-Sunyaev disk.

CLQs have traditionally been discovered by looking for large, $|\Delta m| > 1$ magnitude changes in the optical light curves (e.g. in the g-band). However, we have taken advantage of the ongoing Near-Earth Object WISE Reactivation

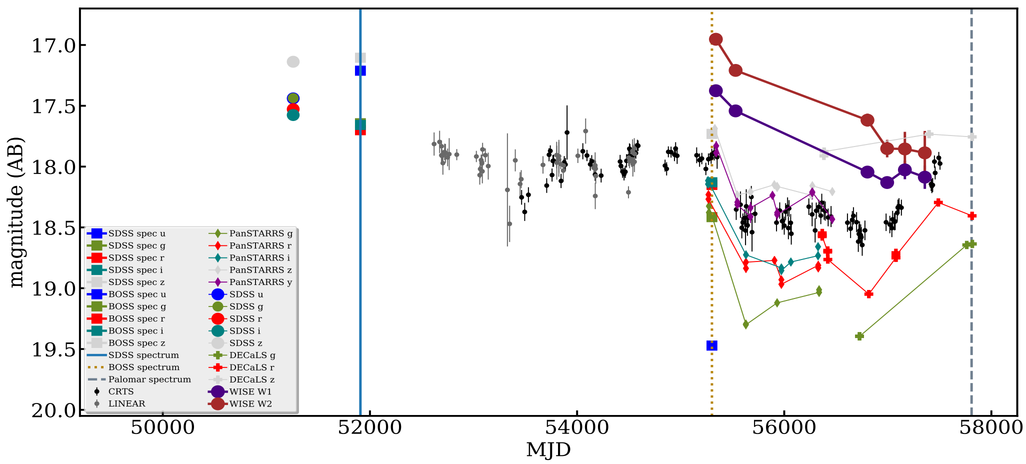

Figure 1 The light curve of J110057. SDSS, DECaLS and PanSTARRS give the optical photometery. The WISE IR light curves are shown and their dramatic decrease led to the identification of J110057. The three spectral epochs are shown by the vertical lines.

mission (NEOWISE-R)**???**, as well as the Dark Energy Camera Legacy Survey (DECaLS[1]) in order to discover new CLQs. Our team is the first to extend this selection to the infrared using NEOWISE-R mission data. Indeed, we have found a sample of SDSS quasars that show *dramatic decreases in their IR flux over the course of a few years.* These changes are on timescales too short to be considered due to changes in obscuration, so a new explanation is needed.

In this article we present the $z = 0.378$ quasar SDSS J110057.70-005304.5 that we have observed transitioning from a blue continuum sloped object to become a regular galaxy. However, along with the changes in the BELs, we see a major change to the disk interior to $150R_g$.

1 Results

Matching the SDSS/BOSS Data Release 12 Quasar catalog (Paris et al. (2017) to the NEOWISE-R IR data (W1 is 3.4μm, W2 is 4.6μm) our team found $\approx$200 objects with fading light IR light curves. These objects were identified by a factor of 2 or more drop in the observed WISE W1 and W2 bands.

Figure 1 gives the optical light curve of J110057. Figure 2 shows the three optical spectra of J110057.

Checking the data archives we found there was no source within 30 arcsec in the VLA FIRST, i.e., at 21 cm radio frequencies. None of the *Hubble Space Telescope*, the *Spitzer Space Telescope* or the *Kepler* Mission has observed J110057 patch of sky. It is also not in the HSC DR1 footprint. There is a detection in ROSAT, using the 2nd all-sky survey (2RXS; Boller et al. 2016, A&A, 588, 103) as 2RXS J110058.1-005259 with 27.00 counts (count error

[1] `legacysurvey.org/decamls/`

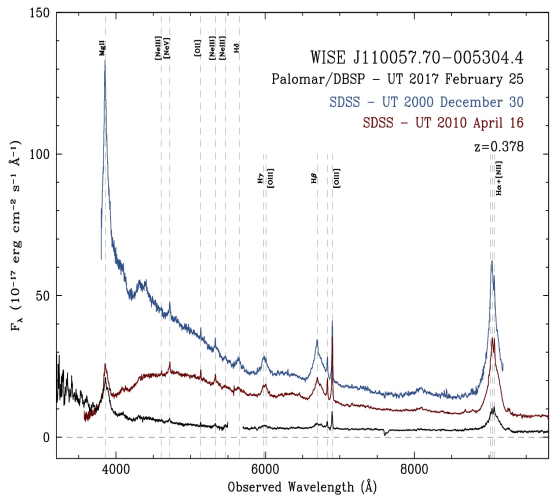

Figure 2 Three spectra of J110057.

6.14), count rate= 0.06±0.01 and an exposure time of = 431.95 seconds. The NED gives J110057 as $1.27 \pm 0.28 \times^{-12}$ erg/cm^2/s in the 0.1-2.4 keV range (unabsorbed flux). J110057Neither *Chandra* or *XMM-Newton*.

2 Discussion

Our preliminary models (Fig. 3) of emission from a multicolor disk imply changes from the innermost stable circular orbit (ISCO) to ∼few tens-100 R_g are required to suppress flux into the observed *g*-band. In particular, we suggest a physical collapse of the disk scale height due to a cooling front propagating outward from the ISCO. If the inner accretion disk is usually inflated (see e.g. Sirko & Goodman 2003, Thompson et al. 2005, Hopkins & Quataert 2011), such a cooling front will naturally produce: 1) a collapse in the scale height of the disk; 2) a decrease in flux moving from UV to longer optical wavelengths; 3) a temporarily thicker scattering atmosphere, further decreasing flux at short wavelengths. *This model implies changes to the optical emission moving from shorter to longer wavelengths (as the radius of the cooling front increases), on months-to-years-long timescales.* It also predicts a longer time to recover the original flux (compared to the initial collapse, as a front will move more slowly in a thinner disk (see Fig. 2). A decrease in the UV flux would also be expected to cause a decrease in IR flux, as the heating of the IR-emitting dusty torus is reduced; however, there should also be a delay due to light travel time.

Using Ford et al and Sirko & Goodman 2003, Figure **??** shows a model for a $M_{\rm BH} = 3 \times 10^8 M_\odot$, radiative efficiency of $\varepsilon = 0.1$, accretion rate in units of Eddington accretion, $\dot{M} = 0.032$, inner and outer disk radii in units of r_g of SMBH of radius$_{\rm in}$=6.0, radius$_{\rm out}$=1.0×10^4.

? observed a similar event to J110057, with SDSS J231742.60 +000535.1. However, their object provided an ambiguous case, as the IR brightness of their source did not decline. However this is consistent with our model, as their cooling event is relatively brief.

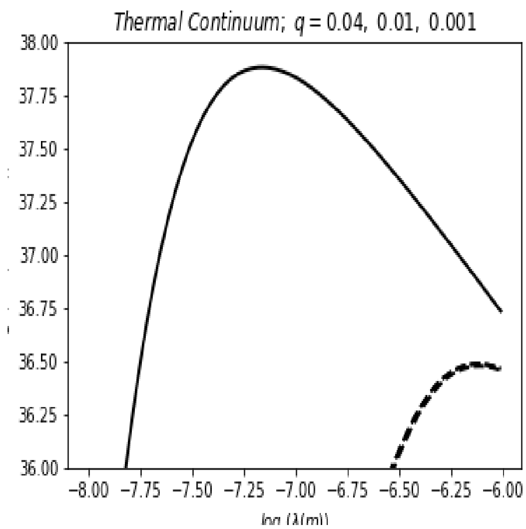

Figure 3 Model spectra of J110057.