Author's Reply: MN-18-1820-MJ, Ross et al.

We very much thank the Reviewer for (what the author's felt!) was a quick reply and a sincere reading of our paper. We taken on board the comments raised, and have updated our manuscript accordingly to address each one of these. Our changes are in **bold font** in the text.

1. Too much credit is given to Sirko & Goodman 2003. That paper was mainly concerned with the implications of self-gravity for the spectrum emitted by the outer parts of the disc $r \gg r_g$. Little if any consideration was given to the boundary conditions at the inner edge of the disc (zero vs. nonzero torque).

> This is a good point from the referee and is well noted. We have removed the egregious reference in the caption of Figure 2 where we incorrectly linked Sirko & Goodman 2003 to the NZT ISCO model. Upon checking the rest of the manuscript, we see no other instance where the Sirko & Goodman 2003 model is over credited.

2. Because the present authors are concerned with inner parts of the disc, they should be more careful in considering relativistic effects. In particular, the ISCO probably lies at $r < 6GM/c^2 = 3r_{\rm S}$ because AGN black holes have significant rotation (e.g., Reynolds 214, SSRv 183, 277; Capellupo et al. 2016, MN 460, 212). The specific binding energy at the ISCO is therefore probably larger than $1 - \sqrt{8/9} \approx 0.057$, so that even if there were no torque at the ISCO, the ratio of the bolometric luminosity to the monochromatic luminosity at any point in their spectra (e.g. $\lambda = 5100$Å) would be larger than they suppose even in a steadily accreting thin disc. Naturally, however, the ISCO would not be expected to change on human timescales.

> We note the point raised by the referee, and have added this caveat to the end of Section 3.2.

3. Although I agree that a thermal or viscous instability is a more plausible interpretation of their data, the arguments given here against transient absorption/obscuration are not wholly convincing and could be improved. For the authors values of the black-hole mass ($7 \times 10^8 M_\odot$) and Eddington ratio (0.07), the rest- frame emission at $\lambda \leq 5100$Å) comes from $r \leq 0.01$pc ($\approx 225 r_g$, as they estimate). An obscuring cloud just large enough to block our view of this region, but in circular orbit at the sublimation radius (0.4 pc) would cross its own diameter in approximately six years, which is comparable to the time interval spanned by the spectroscopic observations ($\approx$7.7 yr). However, were the "UV collapse" caused by absorption, there would be other implications. The authors should determine what (non-grey) reddening law would be needed to explain the differences among the spectra, and whether, for any reasonable gas-to-dust ratio and turbulent broadening, the absorber would produce transient optical absorption lines (since the optical emission is obscured by only a factor $\sim$2); and finally, whether such a small absorber could affect the infrared flux (probably not).

> We note this point raised by the referee, and indeed point 4 raised below. As such, we have modified Figure 2 and Figure 3, as well as added a new table (Table 3). We discuss and present the different models, *including non-grey reddening laws*, that we use and that are acceptable descriptions of the data (now given in Figure 2) and poor fits to the data (now given in Figure 3).
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> We also now discuss whether such a small absorber could affect the infrared flux, but note that this physical scenario won't work for the Guo et al. (2016) objects due to those very short timescales. This calculations is now included at the end of Section 3.1.

4. The bald statement (p. 8, col. 2) "The 2010 spectrum can not be fit with...a simple MTB model with an alternate temperature profile" requires justification. Really? The continua cannot be fit even if $T_{\rm eff}(r)$ is a completely free function? Why not? Of course no superposition of local blackbodies will explain the emission lines, but that is already a known limitation of thin-disc models for "ordinary" QSOs.

We note this good point from the referee and now plot the dashed dotted black line in Figure 3.

5. The authors are too quick to dismiss thermal instabilty along the lines of the works by Hameury, Lasota, and colleagues for dwarf novae and X-ray binaries. It is known that radiation-pressure-dominated discs are thermally unstable (Lightman & Eardley 1974; Jiang, Stone, & Davis 2013). Whereas the authors consider (and then dismiss in favour of cold absorbers) simple thermal instability in the hot directionleading to an RIAFit could equally go in the opposite direction, leading to a cold, low-$\dot{M}$, gas-pressure-dominated state, since the growth rates of linear instabilities are independent of the sign of their initial perturbations. The thermal timescale $(\alpha\Omega)^{-1}$ at $225rg$ is $\sim$4 yr, in the right range to explain these observations. Admittedly, it is worth asking why all QSOs do not undergo propagating thermal instabilities of this sort. But perhaps they do: it would be interesting to compare the numbers of changing-look QSOs with what might be expected on such a model. To do this, however, would be beyond the scope of the present paper.

We very much like the suggestion of what the various models, including the ISCO Cooling Front propagation model we propose here, would mean for e.g. detection and observation rates of the CLQs. Indeed, we are exploring just this issue in our 'demographic' paper (Graham et al. 2018 in prep.).

We slightly disagree with the referee, that we are too quick to dismiss thermal instabilty along the lines of the works by Hameury, as we have this noted already in the current text and Discussion [the paragraph starting, "By 2014, the PanSTARRS green and red fluxes begin recovery. This may be associated with the inward propagation of a heating instability (Hameury 2009)."].

Other minor changes::

- Updated Figure 2 with the emission line at ≈4718Å observed being [Ne V] and not [Ne III] .
- In the Introduction: "... changes in the wider accretion disk, including major structural changes out to $\approx 225 r_g$" to be consistent with the models and discussions later in the paper.
- Caption for Figure 2: "The dotted red line shows a modified zero-torque model where the thermal disk emission interior to $40 r_{\rm g}$ is suppressed by a factor of 10."