PHOENIX models (Section 3.4.2. The maximum difference between the significance of these slopes for all of three stellar models is negligible, which suggests that any importance of stellar models vanishes somewhat when looking at the ratios. Nevertheless, we keep the results from the PHOENIX models (Section 3.4.2).

3.C Comparing effective temperatures with Schwartz & Cowan (2015)

Schwartz & Cowan (2015) measure the slope of the effective dayside temperature against the irradiation temperature. They note that their slope 0.87 ± 0.05 is significantly steeper than equilibrium temperature predictions (0.71), and that this increasing deviation could lower redistribution efficiencies in the hottest planets. We recreate their results with our expanded survey. We follow their method for calculating the effective temperature, which is the weighted mean of the brightness temperatures, and thus we call it $< T_B >= (T_{b_{3.6}}/\sigma^2_{3.6} + T_{b_{4.5}}/\sigma^2_{4.5})/2$. We then fit the resulting trends with an ODR (see Section 3.A.1. However, first we test their method of brightness temperature calculation of inverting the Planck function and using a blackbody for the star. Then we test our method using a stellar model and fully integrating the Planck function.

Figure 3.8 presents the results for weighted mean effective temperature using the PHOENIX model calculations of the brightness temperatures. We find a slope of 0.76 ± 0.05, which is consistent with equilibrium temperature (1σ) and inconsistent with the 0.87 ± 0.05 of Schwartz & Cowan (2015). However, with brightness temperatures calculated without integration over the bandpass and with blackbodies for the star we are able to retrieve a slope of 0.81 ± 0.05, which is in statistical agreement (0.9σ) with their trend.

Since we are able to retrieve the results using blackbodies, we conclude that the discrepancy is a result of careful use of stellar models and integration over the bandpasses and not of the differences in the sample sizes. More importantly, our findings do not support the findings presented in Schwartz & Cowan (2015) as we do not find that the effective temperature trend with irradiation temperature increases disproportionately. This means that we do not think the effective temperature calculated in this way tells us anything about the redistribution in the hottest planets. On the other hand, in Figure 3.3, we find that the 4.5 μm brightness temperature is deviating from equilibrium, likely due to the strong CO opacity appearing in emission. This does support the hypothesis that these hottest planets are exhibiting different behaviors, but it is not expected to be captured in the effective temperatures since the weighted mean of the two brightness temperatures is likely muting this deviation.

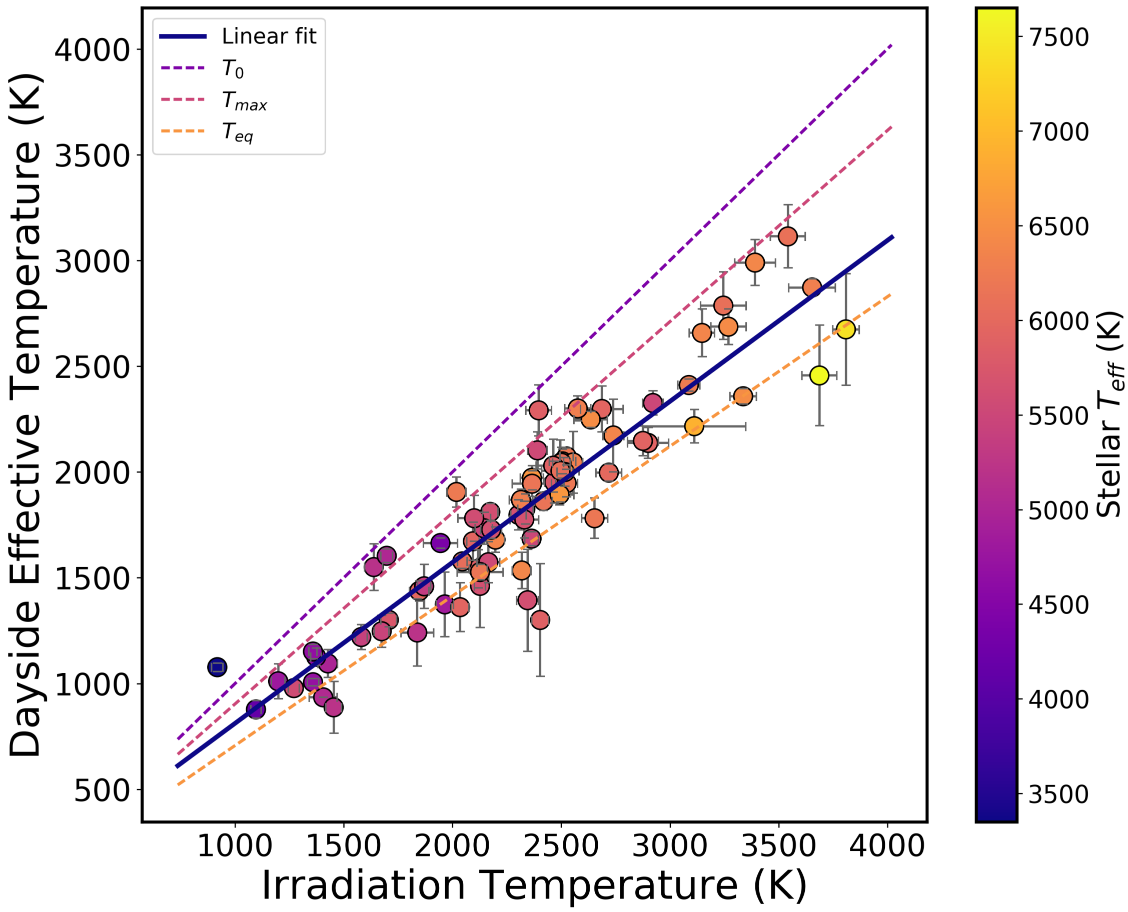

Fig. 3.8: Dayside effective temperature ($< T_B >$) vs the theoretical irradiation temperature (T_{eq}) with zero albedo and full redistribution, similar to Schwartz & Cowan (2015), but with 28 more planets. We also plot the expected irradiation temperature (T_0), the equilibrium temperature with zero albedo (T_{eq}), and the maximum dayside temperature (T_{max}). The color scale is the effective temperature of the host star in Kelvin.

3.D KELT-9b Eclipse: the hottest of the UHJs

A question arises of whether the trends presented in Section 3.5 hold at even higher temperatures. To test this we include the 4.5 μm eclipse depth of the hottest of the UHJs, KELT-9b (Gaudi et al. 2017). Significantly hotter than any other ultra-hot Jupiter, KELT-9b is the hottest gas giant planet known. A 1.48-day orbital period around its A-type host star of 10170K makes it the most highly irradiated planet with an equilibrium temperature of 4050K (Gaudi et al. 2017). At these temperatures, the planet itself is similar to a K4 star; its atmosphere is subject to molecular dissociation, leaving behind atomic metals such as iron and titanium (Hoeijmakers et al. 2018, 2019).

We analyse two 4.5 μm eclipses of KELT-9b. The data were taken from the phase curve survey, program ID 14059 lead by PI J Bean. We extracted the two secondary eclipses from