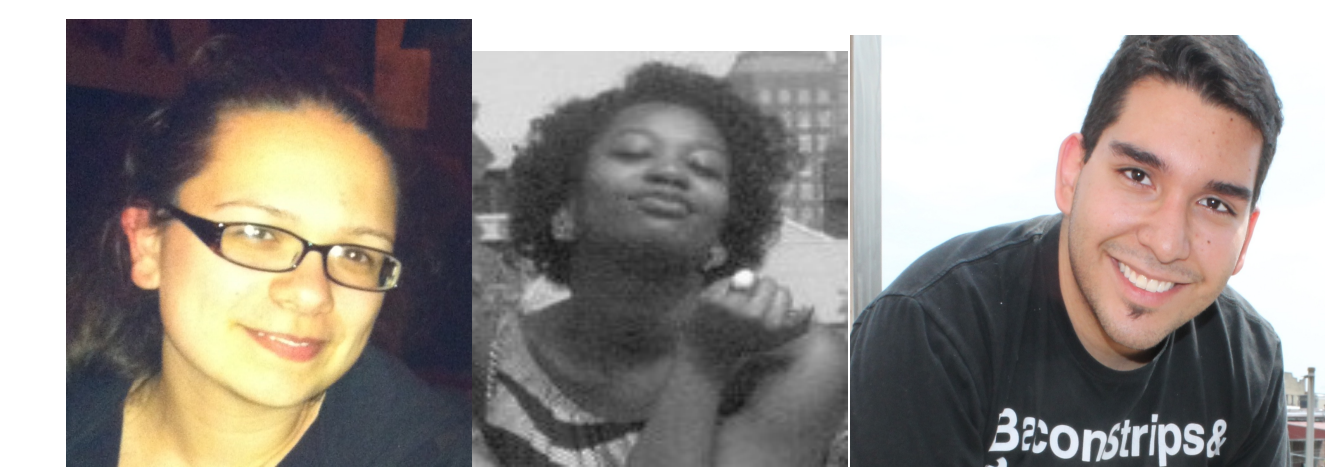


# SED $T_{\text{eff}}$ for Kepler Cool Planet Hosts

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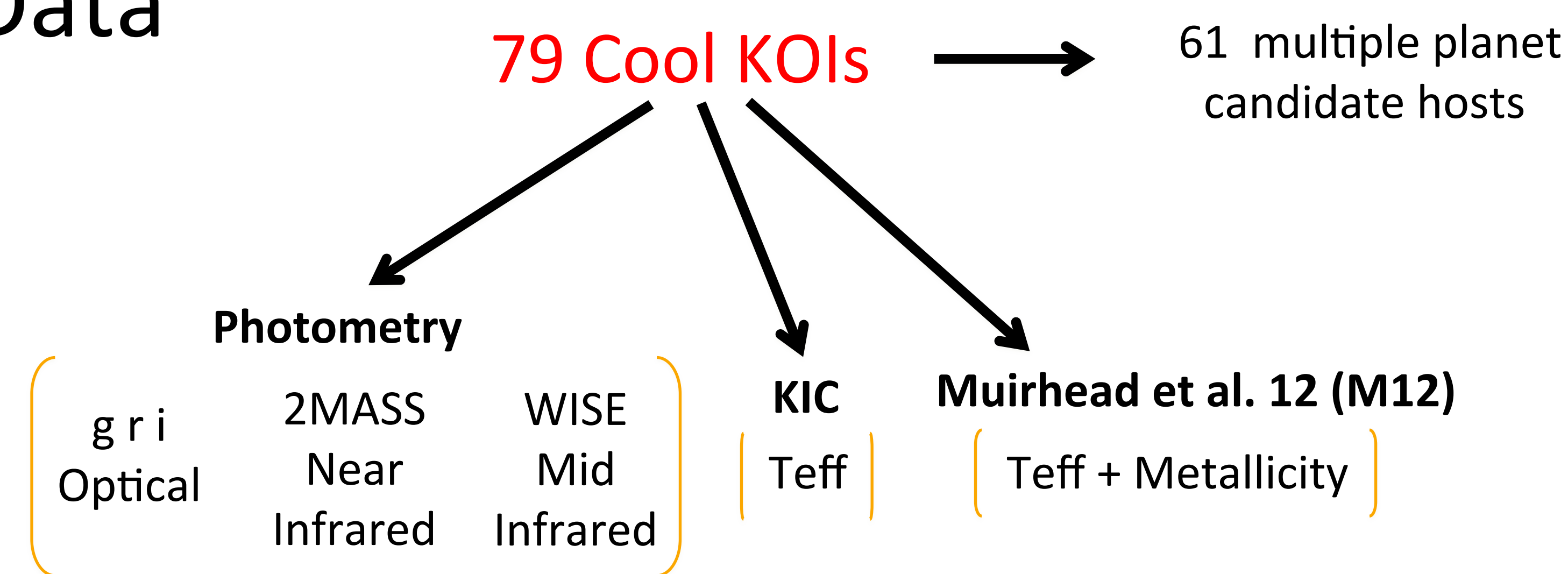


## 1) Motivation

Having the correct stellar temperature can determine whether the planet orbiting the star is in the habitable zone and with this determine if the planet could have life.

Measuring the effective temperatures of low mass stars is quite challenging due to their intrinsic faintness and the presence of molecular absorption in their atmospheres. The Kepler Input Catalog (KIC) provides effective temperatures for the Cool Kepler Objects of Interest (KOIs) based on matching colors to stellar atmosphere models, which may not be accurate for these stars. We decided to look at all the photometric data available for these stars and test if a simple “black-body fitting” method based only on empirical data could provide reliable temperatures for these stars.

## 2) Data



## 3) Spectral Energy Distributions (SEDs)

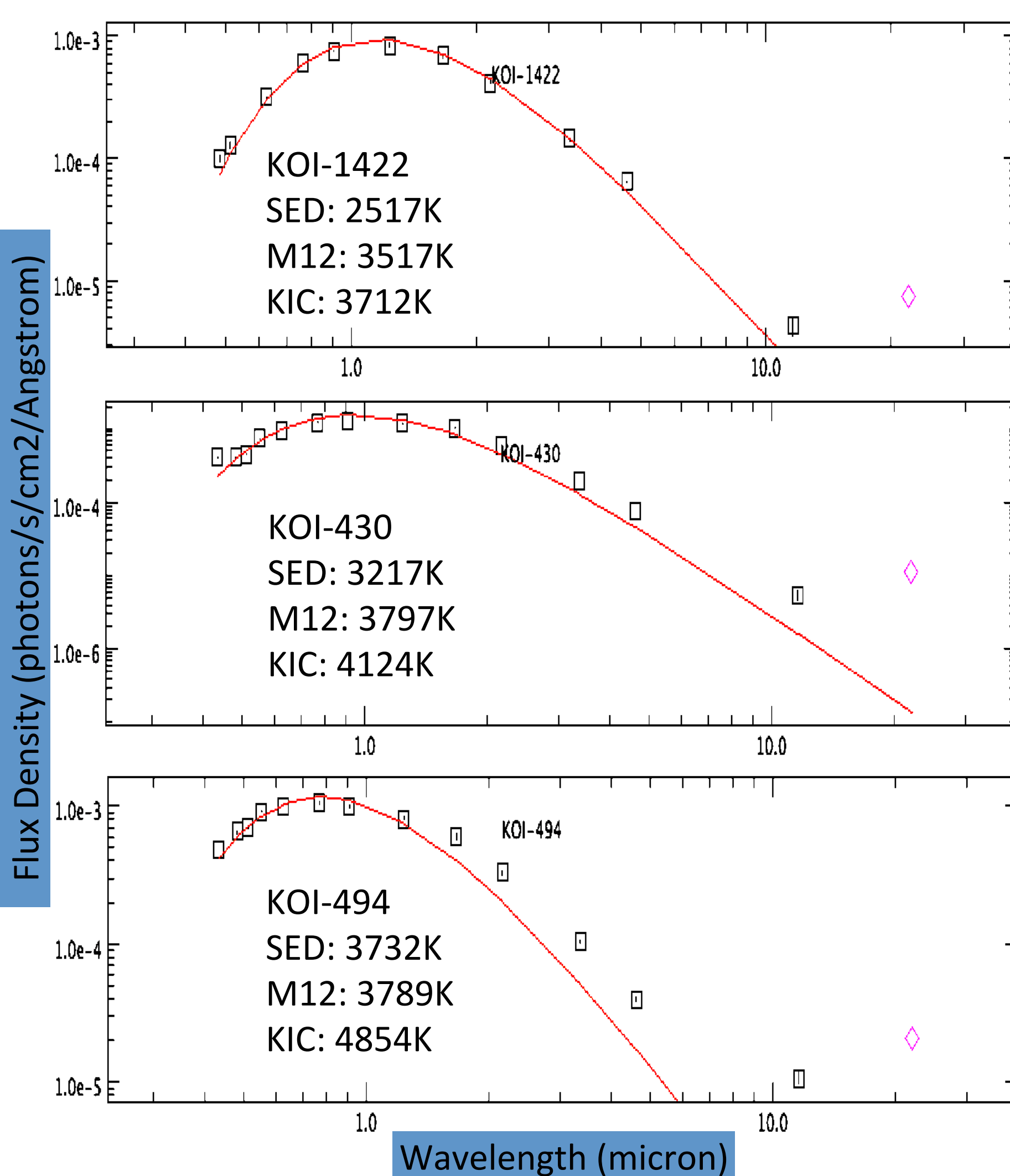


Figure 1: SEDs of three Cool KOIs

Using the SED analysis tool *Iris* (from VAO), for each star, we converted each filter data point into flux density and using the effective wavelength of each filter plotted SEDs. Once completed, we fitted a black body function over the points.

Top: KOI-1422, Exactly 1000K difference from Muirhead et al. 12 and 1195K difference from the KIC.

Middle: KOI-430, about 580K from Muirhead et al. 12 and 907K difference from KIC.

Bottom: KOI-494, the black body curve does not fit the infrared fluxes. The temperature derived from this black body fit is comparable to Muirhead et al. 12 and difference with KIC.

## 4) Comparison of Temperatures

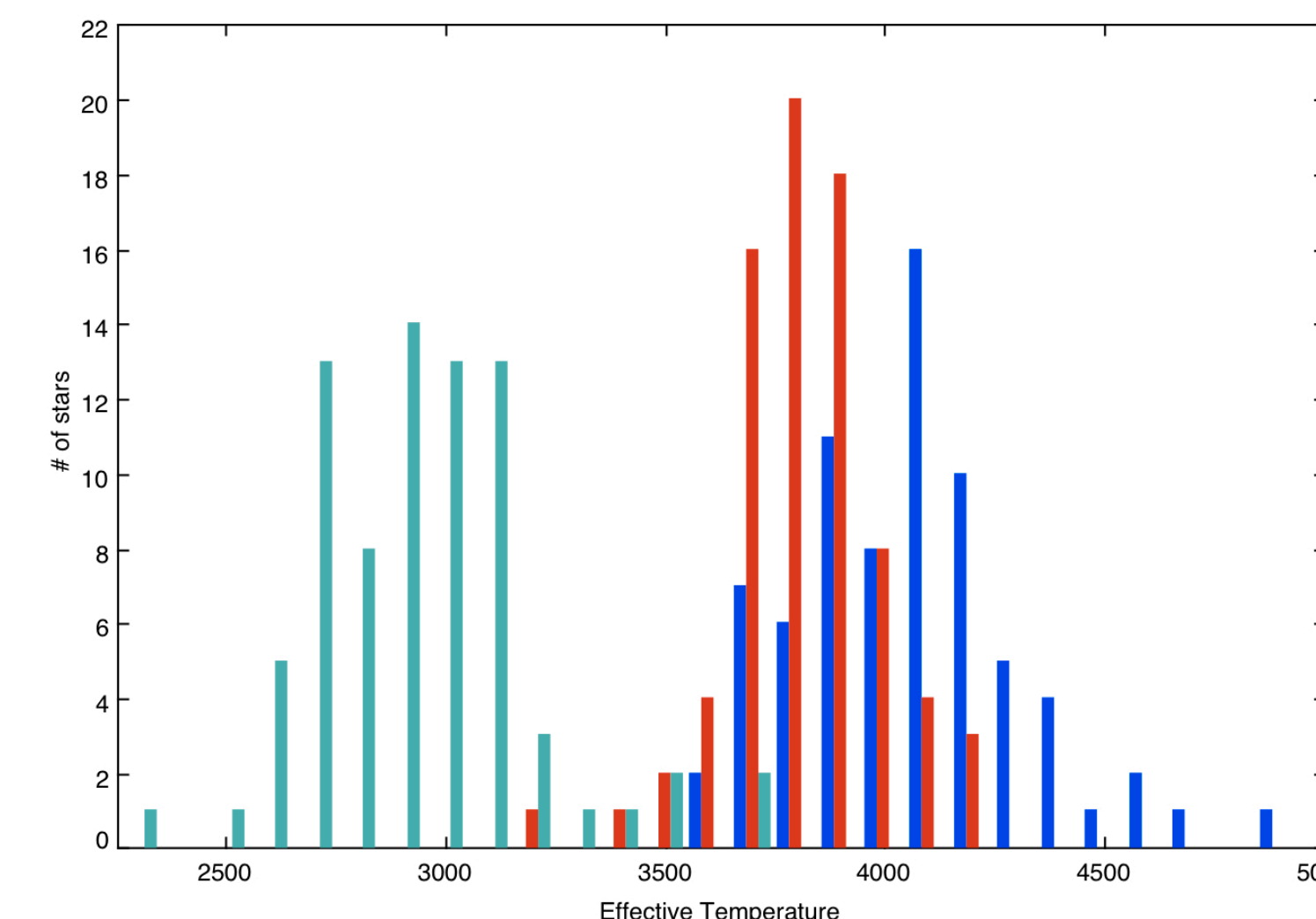


Figure 2: Distribution of temperatures for the 3 techniques: KIC (blue), M12 (red), and SED (green). The SED temperatures are cooler than the KIC and M12 temperatures.

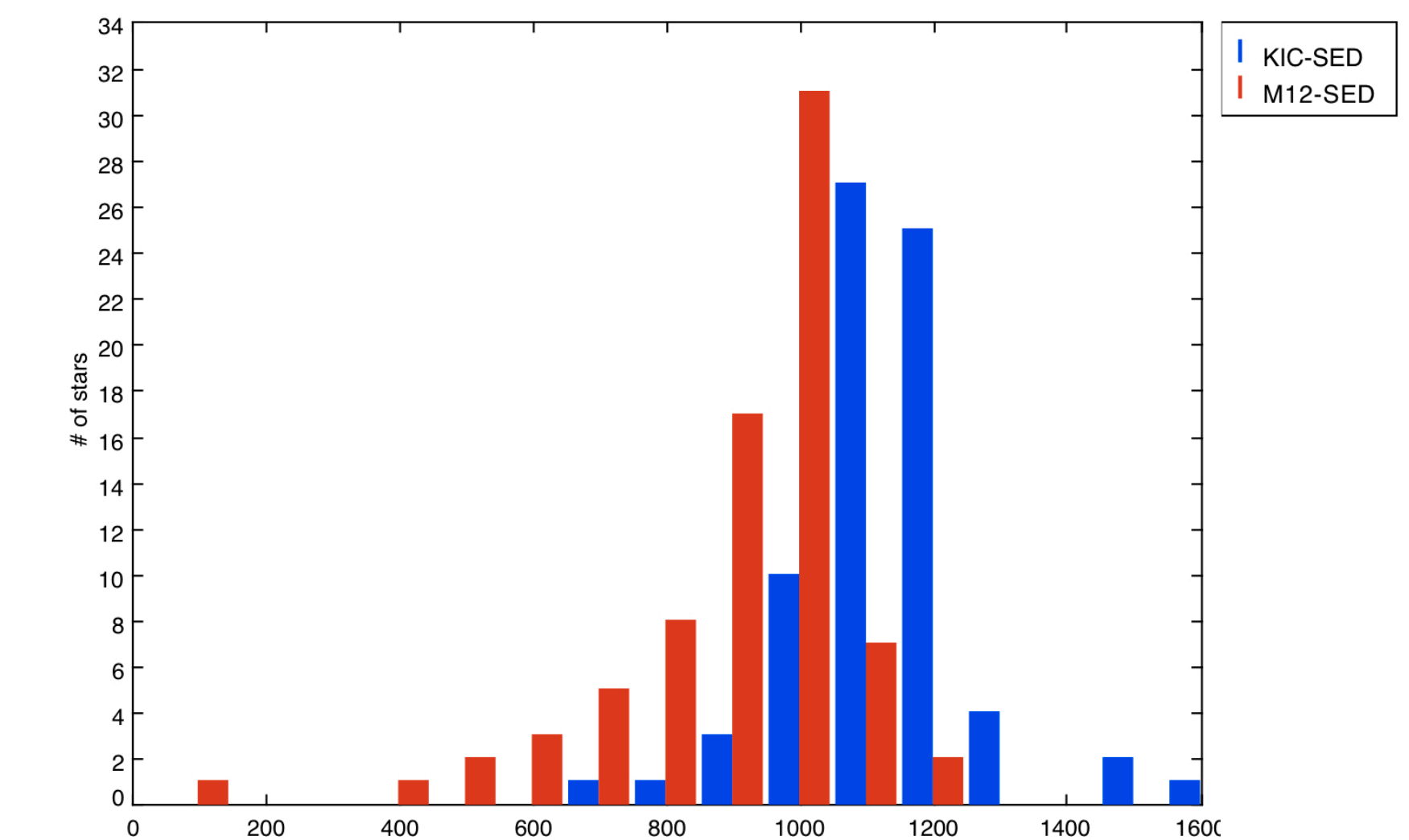


Figure 3: The temperature difference distributions between KIC-SED and M12-SED. In average, the SED temperatures are about ~1000K and ~1150K cooler than M12 and KIC temperatures, respectively.

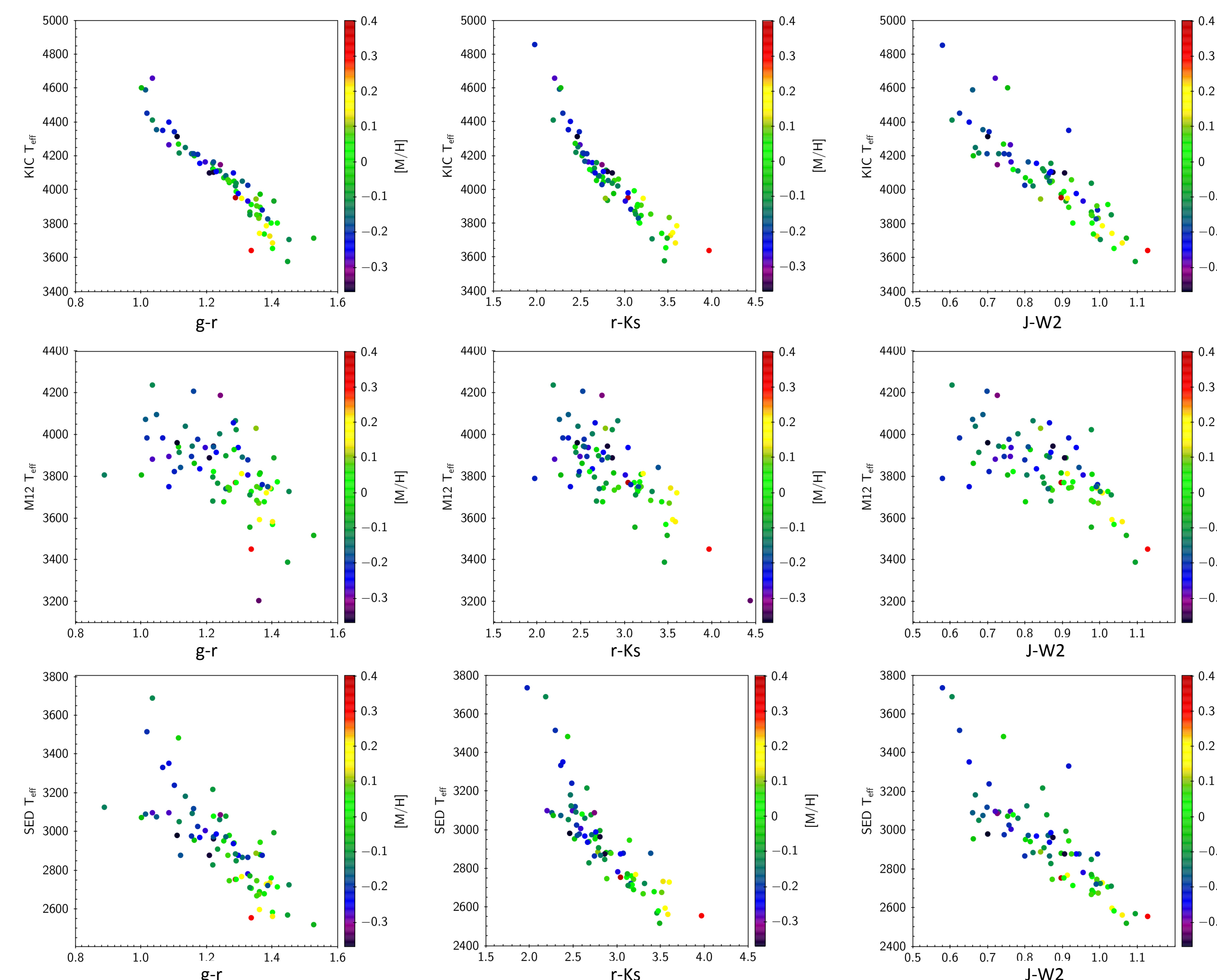


Figure 4: For each of the 3 techniques, temperature vs. colors (g-r, r-Ks, and J-W2) color-coded by the metallicity ([M/H]) estimate by Muirhead et al. 12.

M12 used spectroscopy to estimate  $T_{\text{eff}}$  and [M/H]. The best temperature to color correspondence is r-Ks, which takes into account the optical and infrared fluxes. There is less scatter on these plots than on the other colors.

Most of the hottest stars in the sample are metal poor, while the cooler stars have solar and super-solar metallicities. The lower values in metallicity for the hotter stars could be due to the use of an M dwarf metallicity technique in K dwarfs by Muirhead et al. 12.

## 5) Conclusion

The SED estimated temperatures were about 1000K lower than Muirhead et al. 12 and the ones provided in the KIC. The reason for this might be that the *Iris* program fixes the peak of the black body fit on a data point, when actually the peak is between filters, therefore giving the star a lower temperature. The relationship we have between  $T_{\text{eff}}$  and color are similar to the KIC (ignoring the ~1000K difference), while the Muirhead et al. 12 relations saturate for the hotter objects.

## Acknowledgements

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## Reference

KIC: <http://archive.stsci.edu/kepler/kic.html>  
M12: <http://adsabs.harvard.edu/abs/2012ApJ...750L..37M>  
IRIS: <http://www.usvao.org/science-tools-services/iris-sed-analysis-tool/>  
2MASS: <http://vizier.u-strasbg.fr/cgi-bin/VizieR?-source=B/2mass>  
WISE: <http://vizier.u-strasbg.fr/cgi-bin/VizieR?-source=WISE>