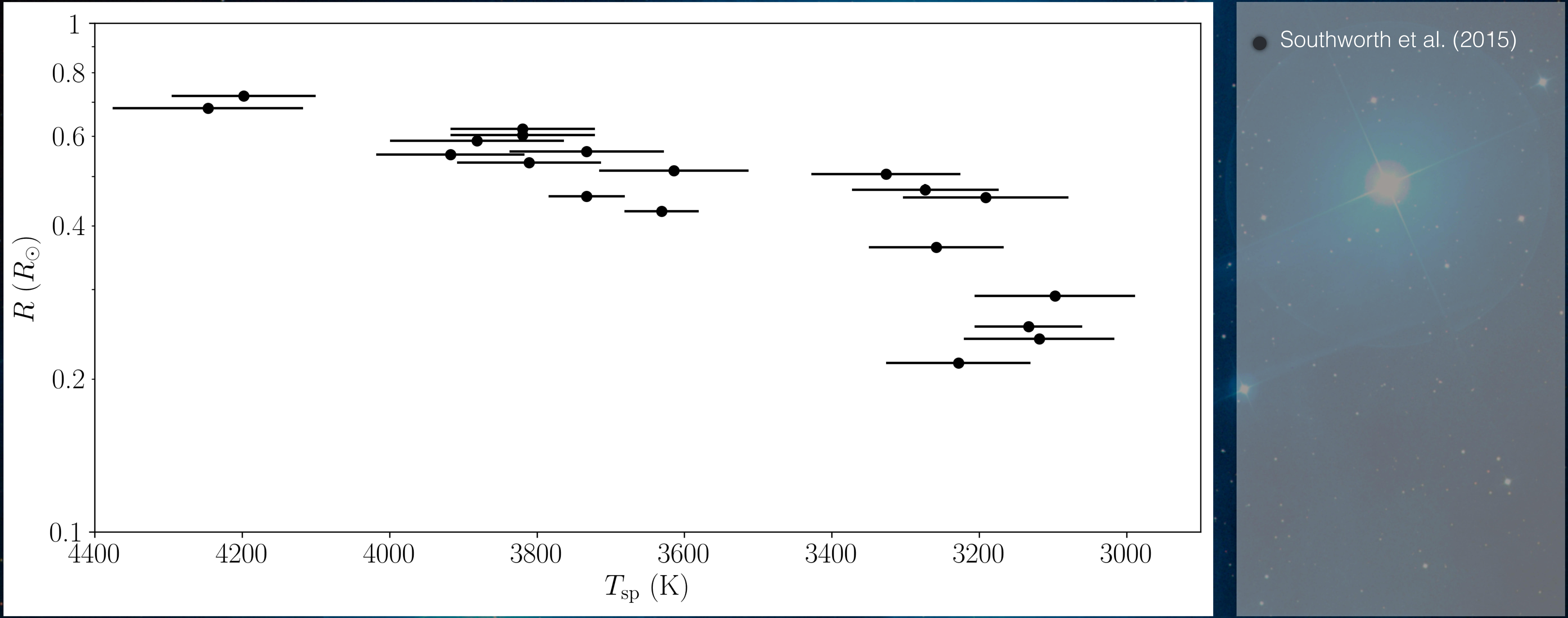
The Radii of Main Sequence M Dwarfs

Sam Morrell, Tim Naylor
Email: smorrell@astro.exeter.ac.uk

Cool Stars 20, Boston - 30th July 2018

Image Credit: NASA, ESA and AURA/Caltech

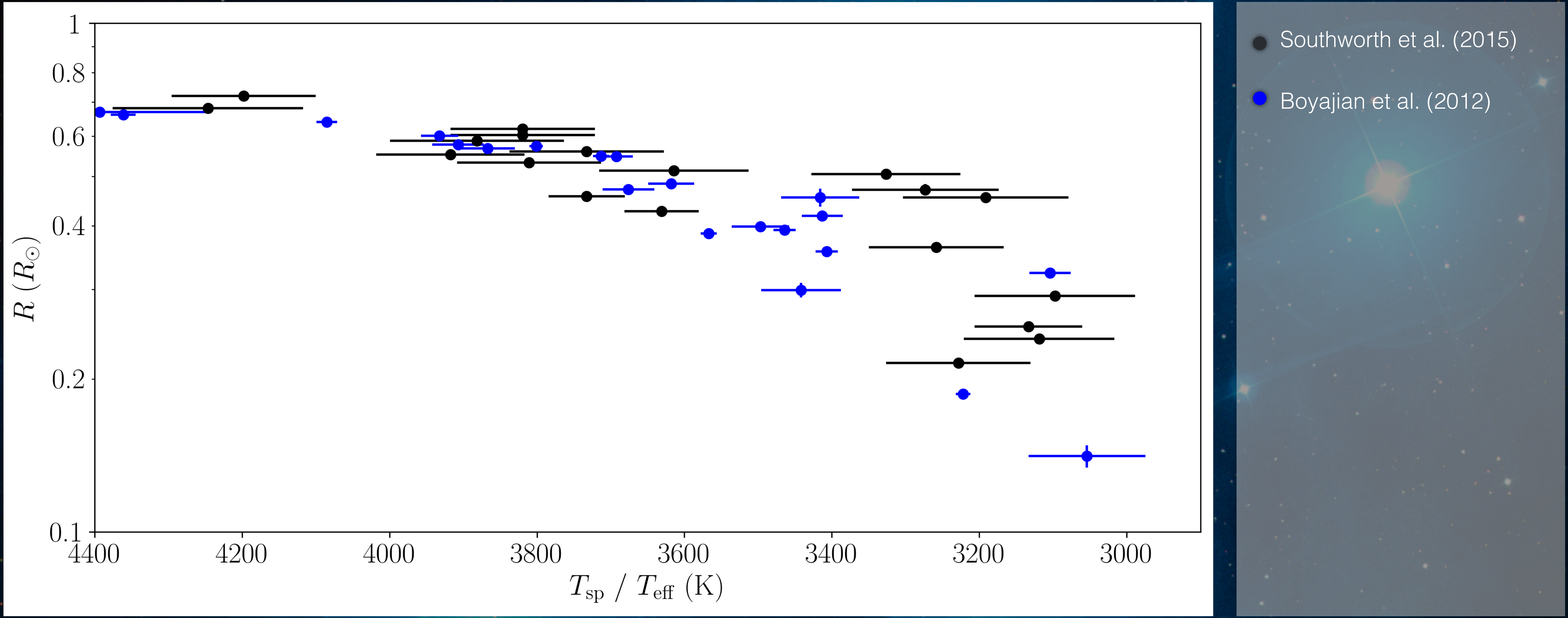
Detached Eclipsing Binaries



Southworth (2015)

Image Credit: NASA, ESA and AURA/Caltech

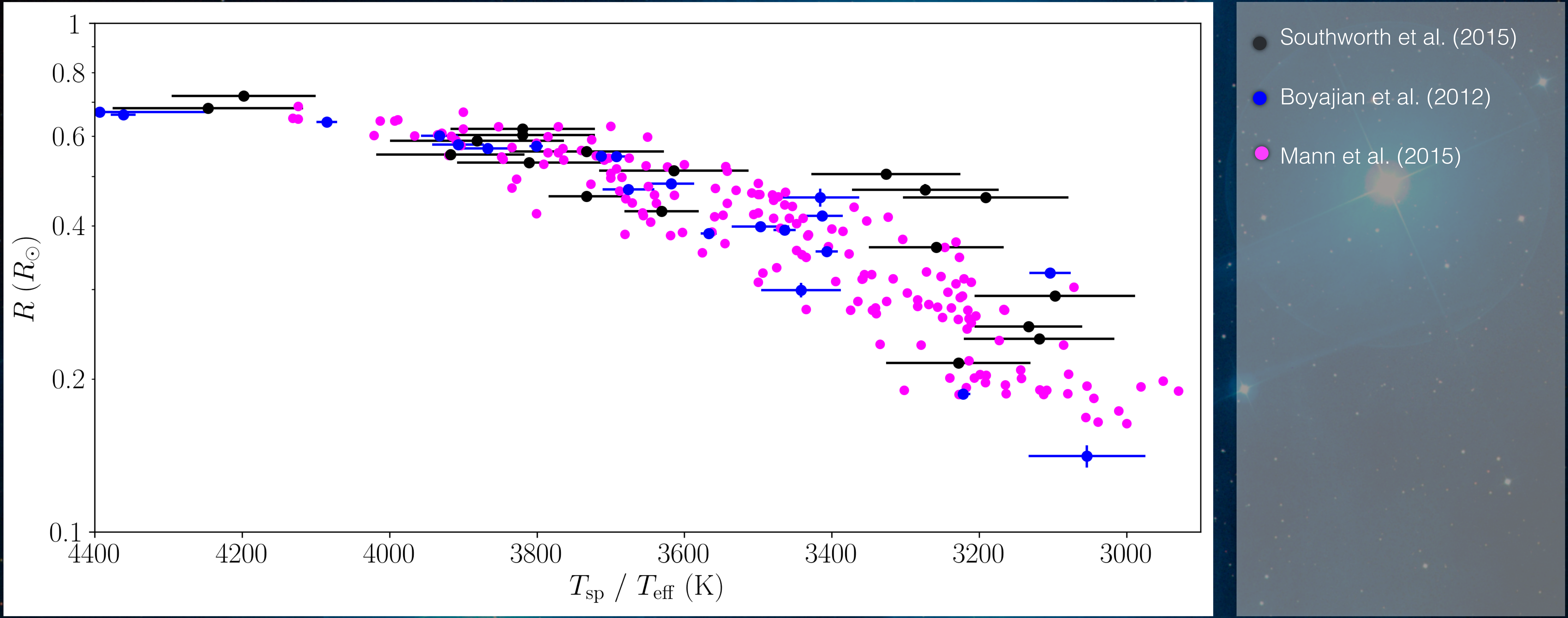
Interferometric Radii



Southworth (2015)
Boyajian et al. (2012)

Image Credit: NASA, ESA and AURA/Caltech

Mann et al. 2015



Southworth (2015)
Boyajian et al. (2012)
Morrell & Naylor (in prep)

Image Credit: NASA, ESA and AURA/Caltech

Distances

- This experiment is now possible, thanks to the Gaia DR2 parallaxes.
- We use the geometric distances of Bailer-Jones et al. (2018), as they do a Bayesian treatment using reasonable priors and correctly deal with asymmetries in uncertainties.

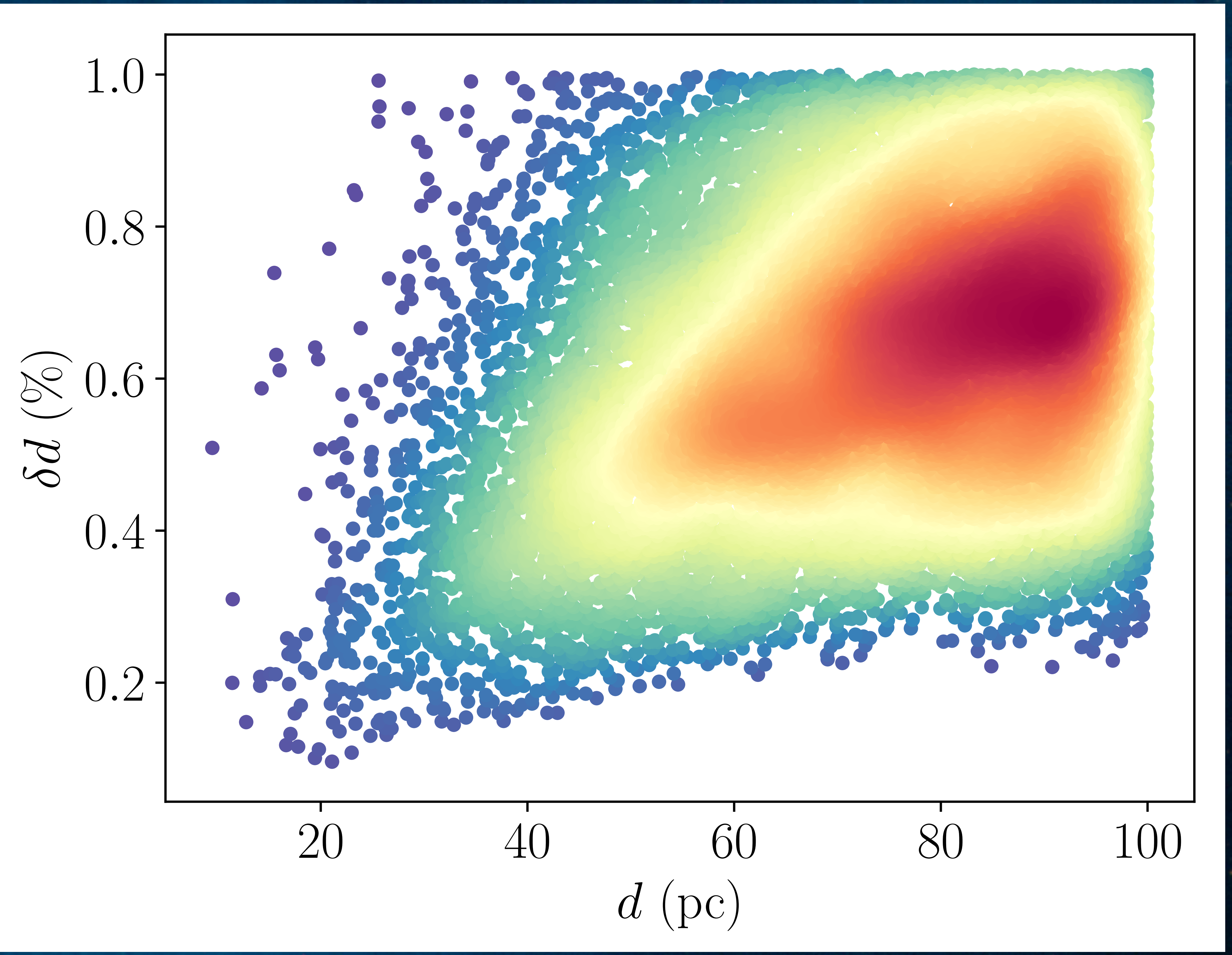
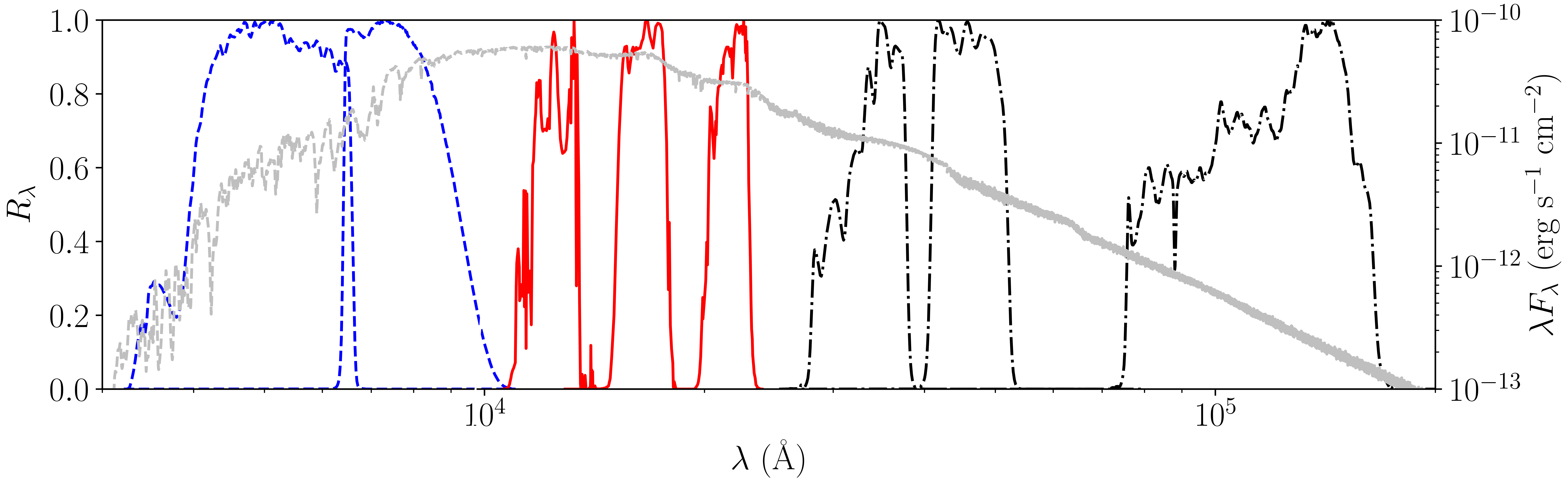


Image Credit: NASA, ESA and AURA/Caltech

Photometry



Gaia DR2

- $G_{BP} - G_{RP} > 1.5$

2MASS

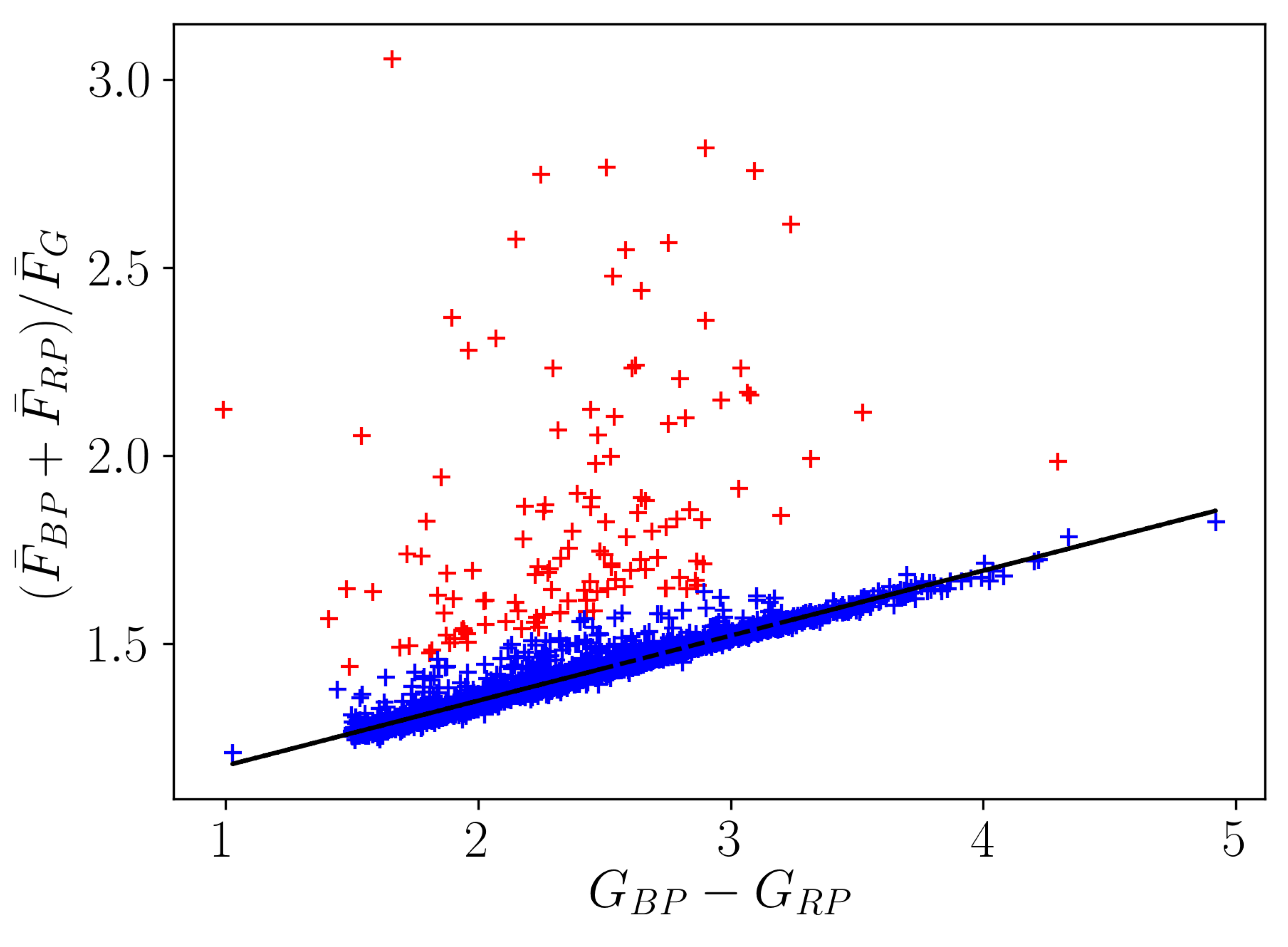
- $SNR_J \geq 10$
- $SNR_H \geq 10$
- $SNR_{Ks} \geq 10$

AllWISE

- Contamination Free
- Point Source
- $\delta W3 < 5\%$
- $SNR_{W1} > 3$
- $SNR_{W2} > 3$
- $SNR_{W3} > 3$

Flagging

- Further to stringent cuts on source catalogues. We assemble flags using Gaia data to further constrain the sample.
- We flag poor photometry using the by sigma clipping in the flux excess ratio space (right).
- We also account poor astrometry by flagging those with large values of astrometric χ^2.
- This removes a further 307 sources.



Final Input Catalogue

- Robust distances with uncertainties <1%.
- Stringent cuts on photometry to ensure reliability.
- Post processing flags to further cut down the sample.
- When removing flagged stars, the final catalogue totals 15,350 stars.

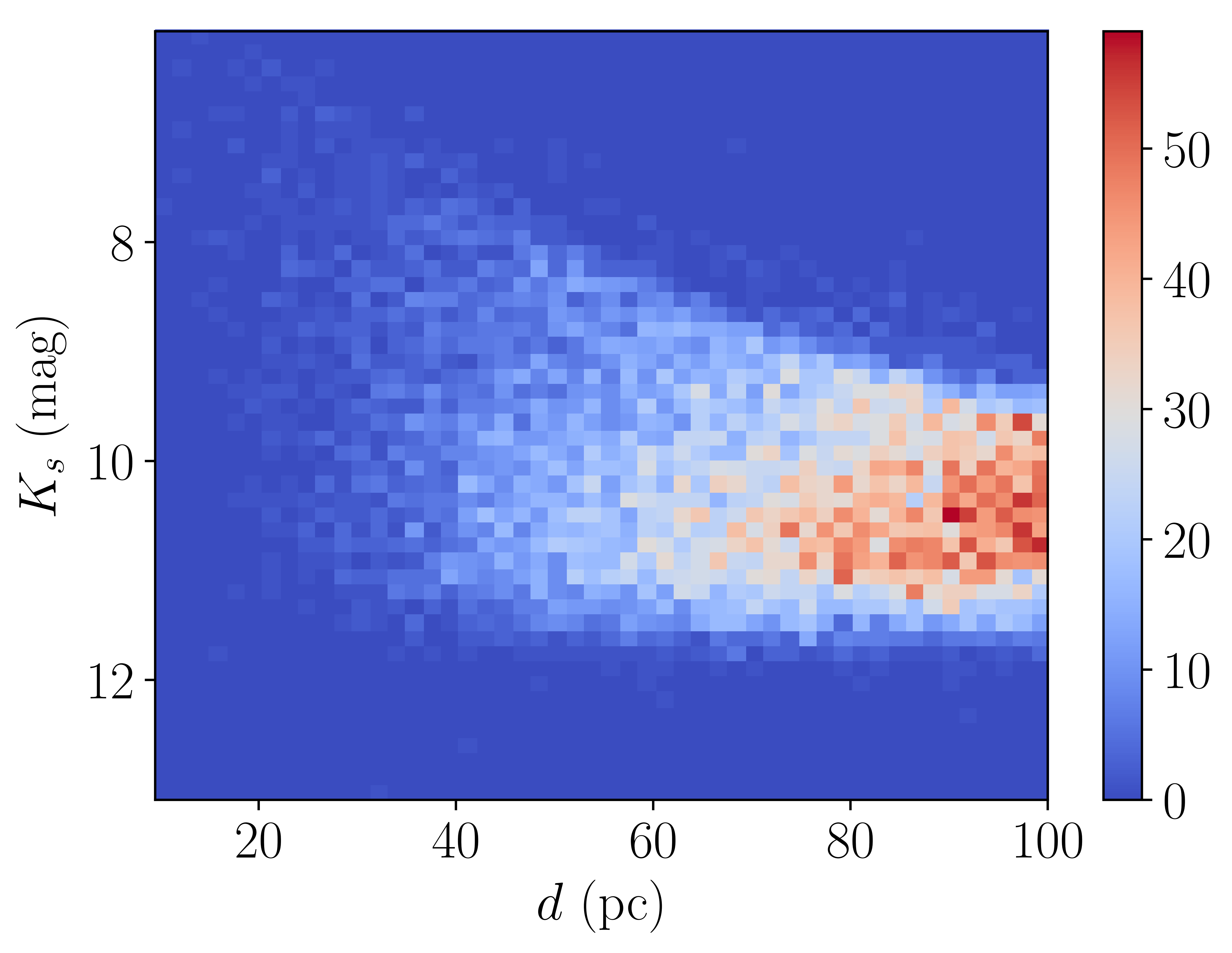
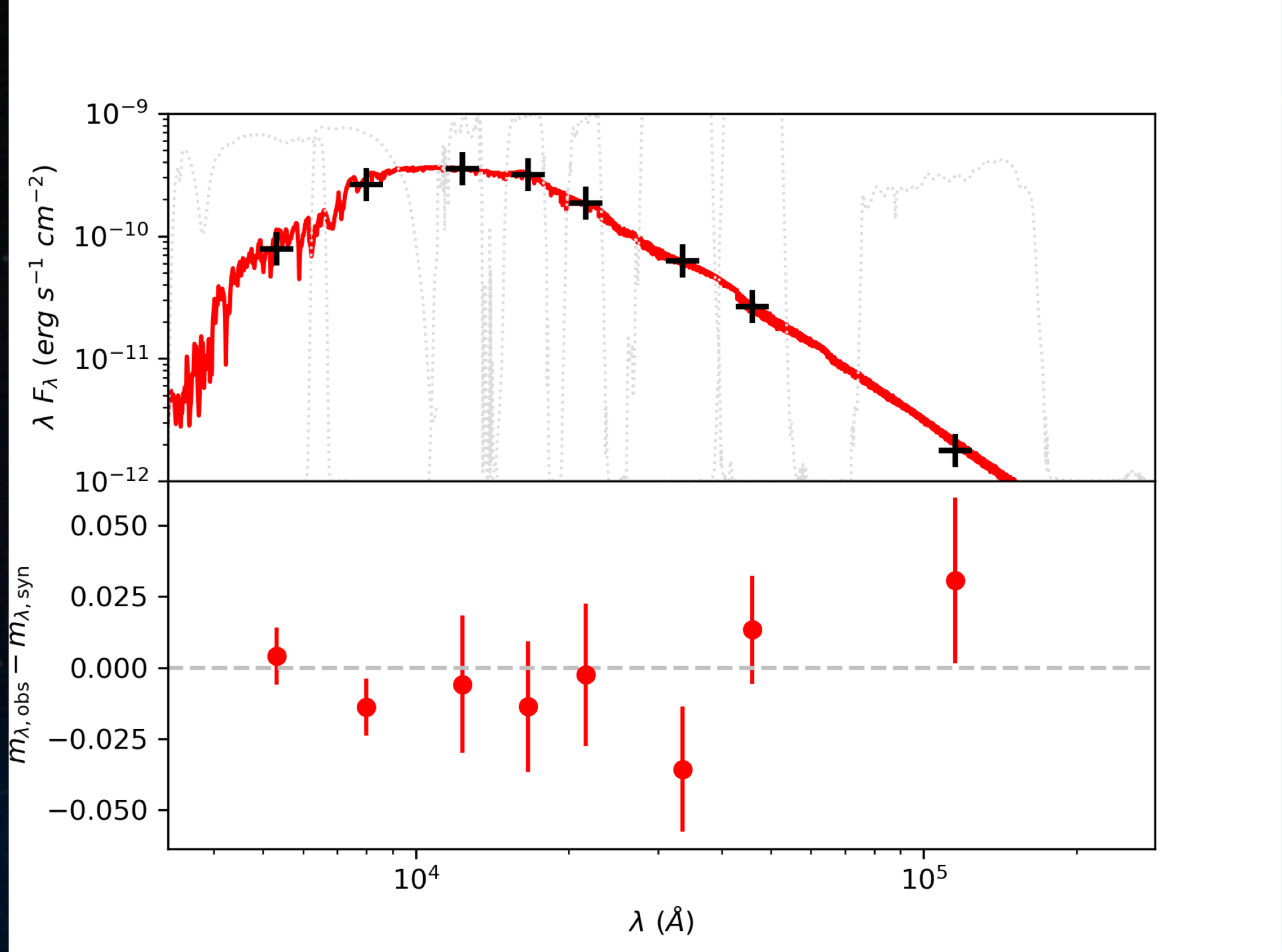
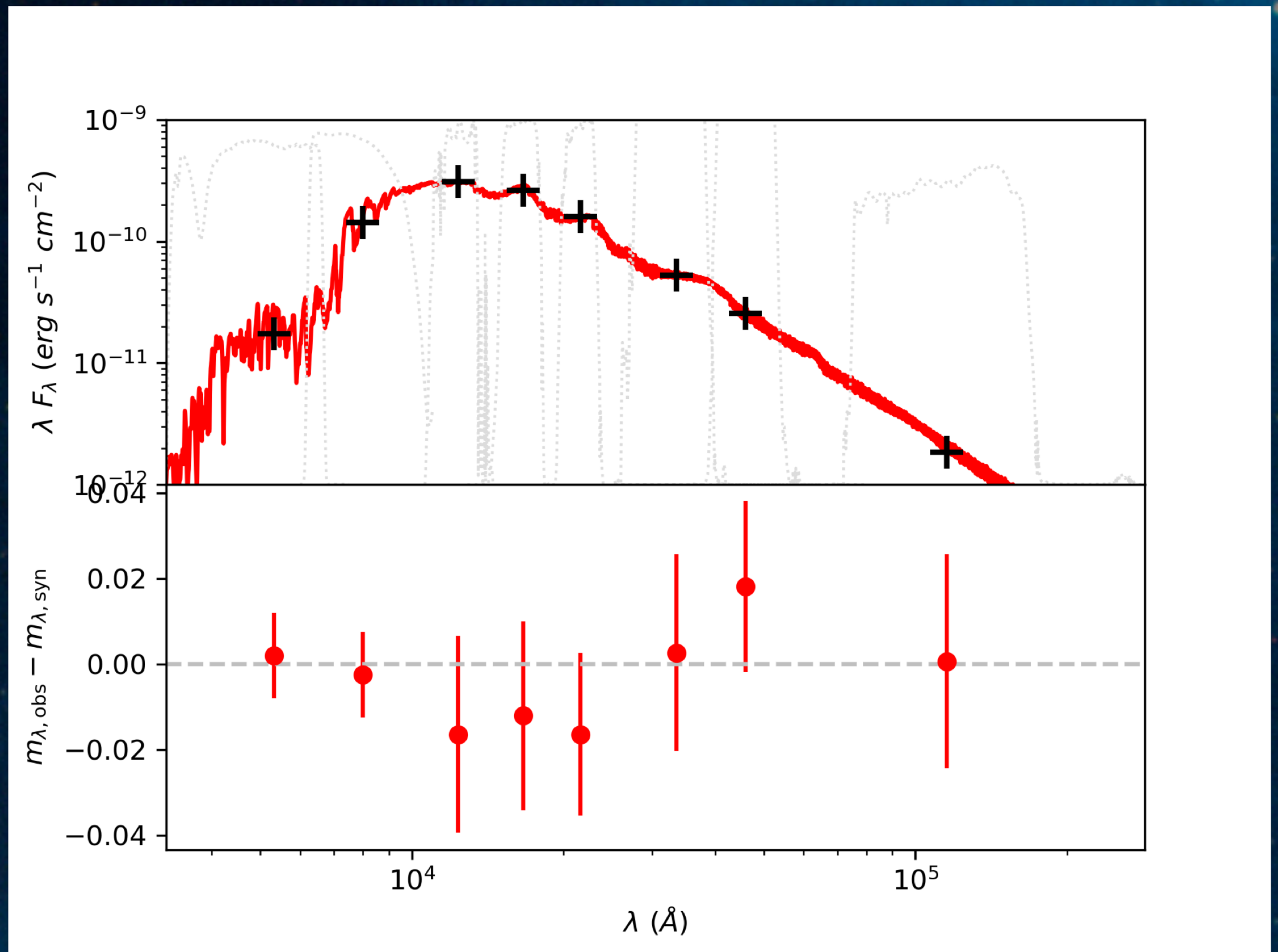
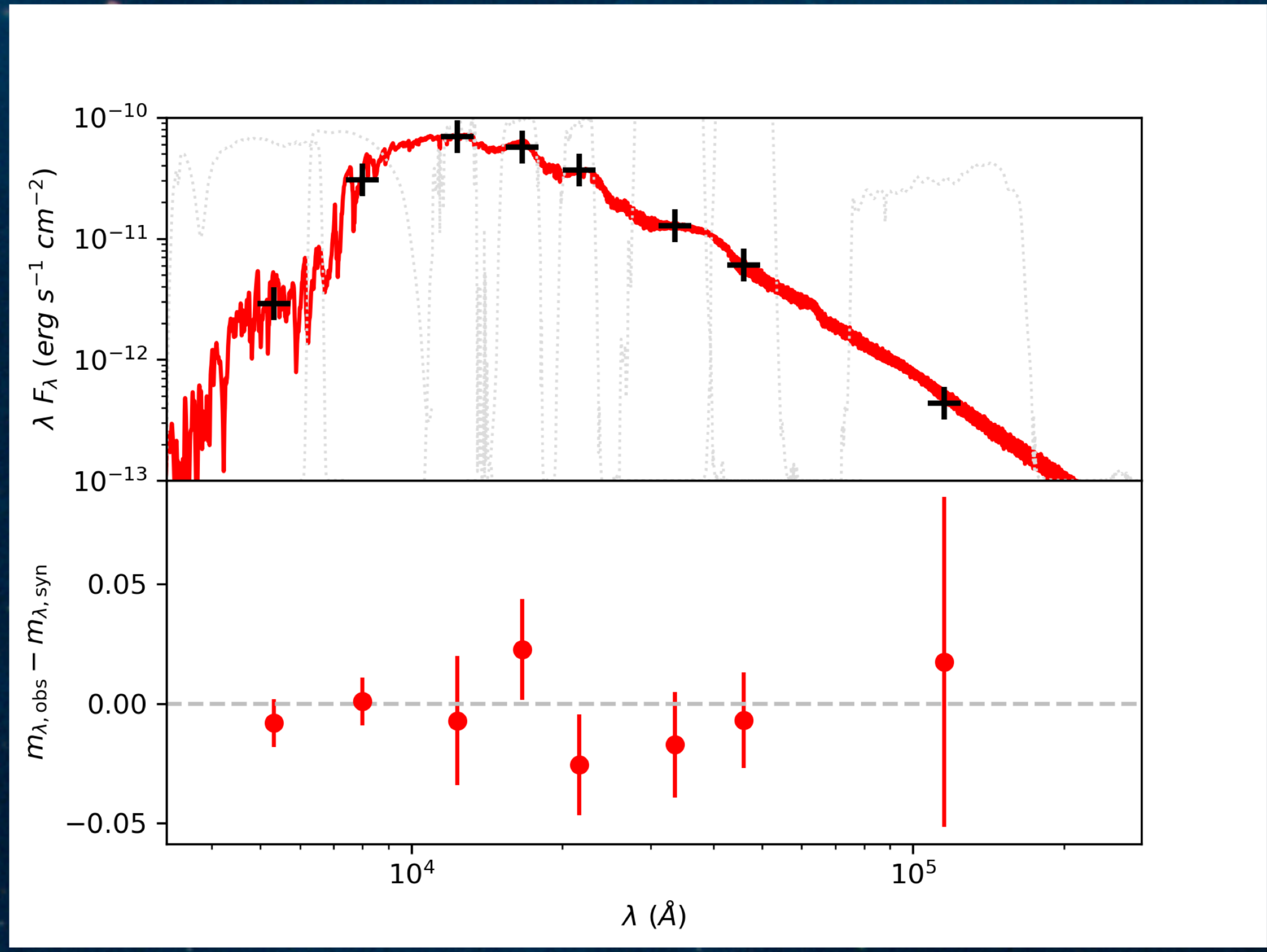


Image Credit: NASA, ESA and AURA/Caltech

SED Fitting

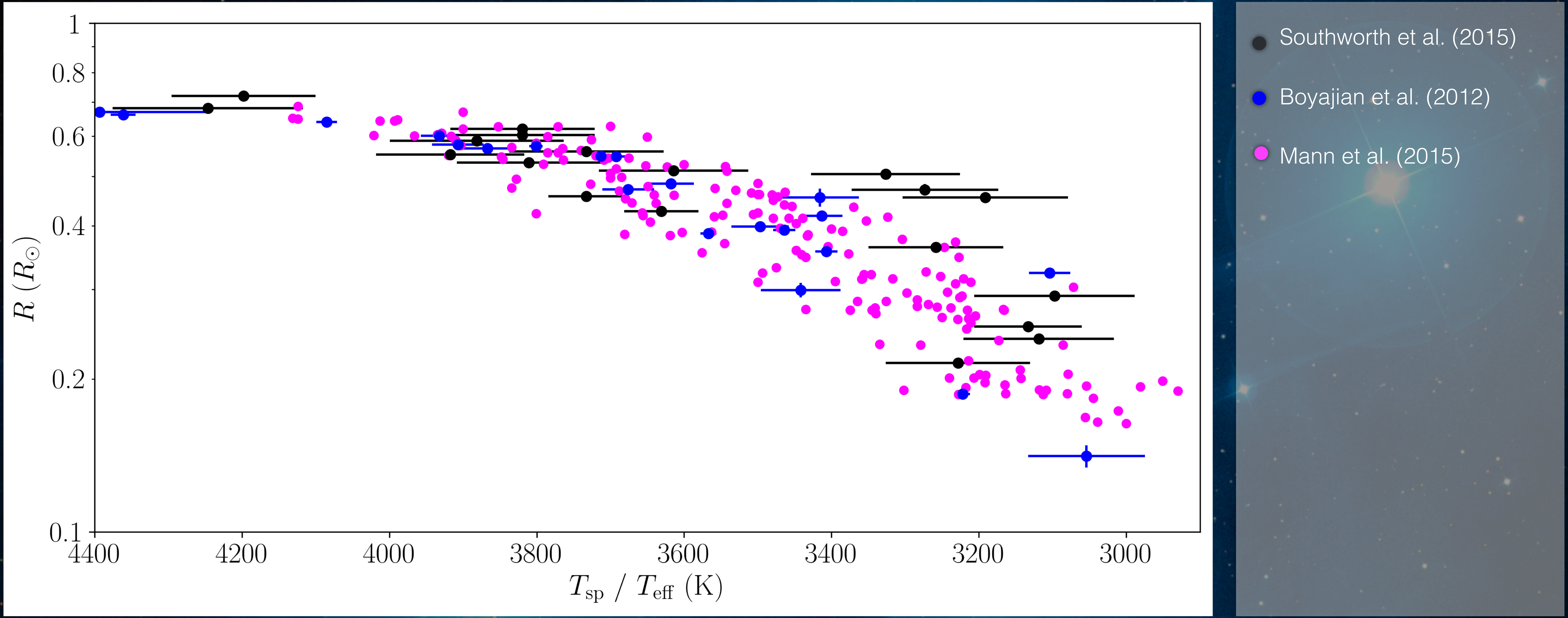






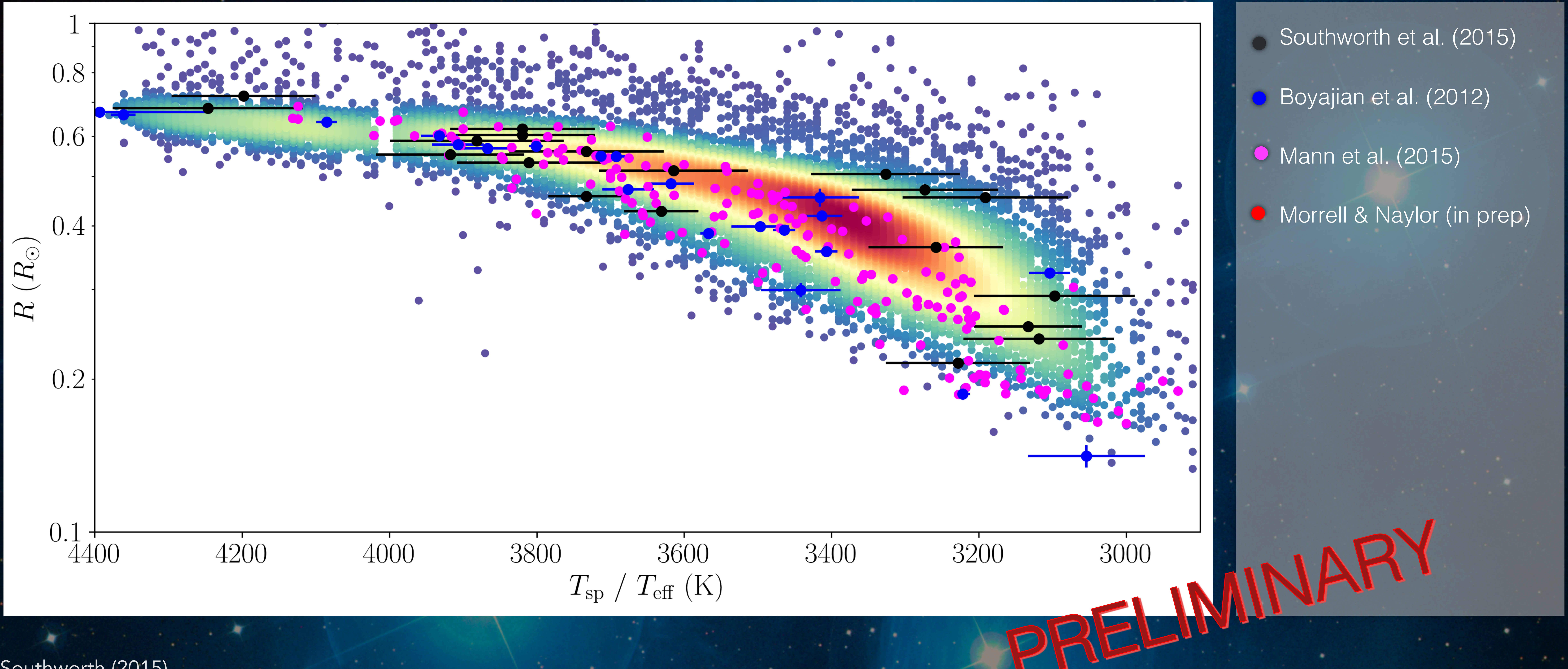
- The bands that we adopt allow us to fit in the optical with Gaia DR2 photometry, the blackbody peak with 2MASS and the Rayleigh-Jeans tail with AllWISE.

Mann et al. 2015



Southworth (2015)
Boyajian et al. (2012)
Morrell & Naylor (in prep)

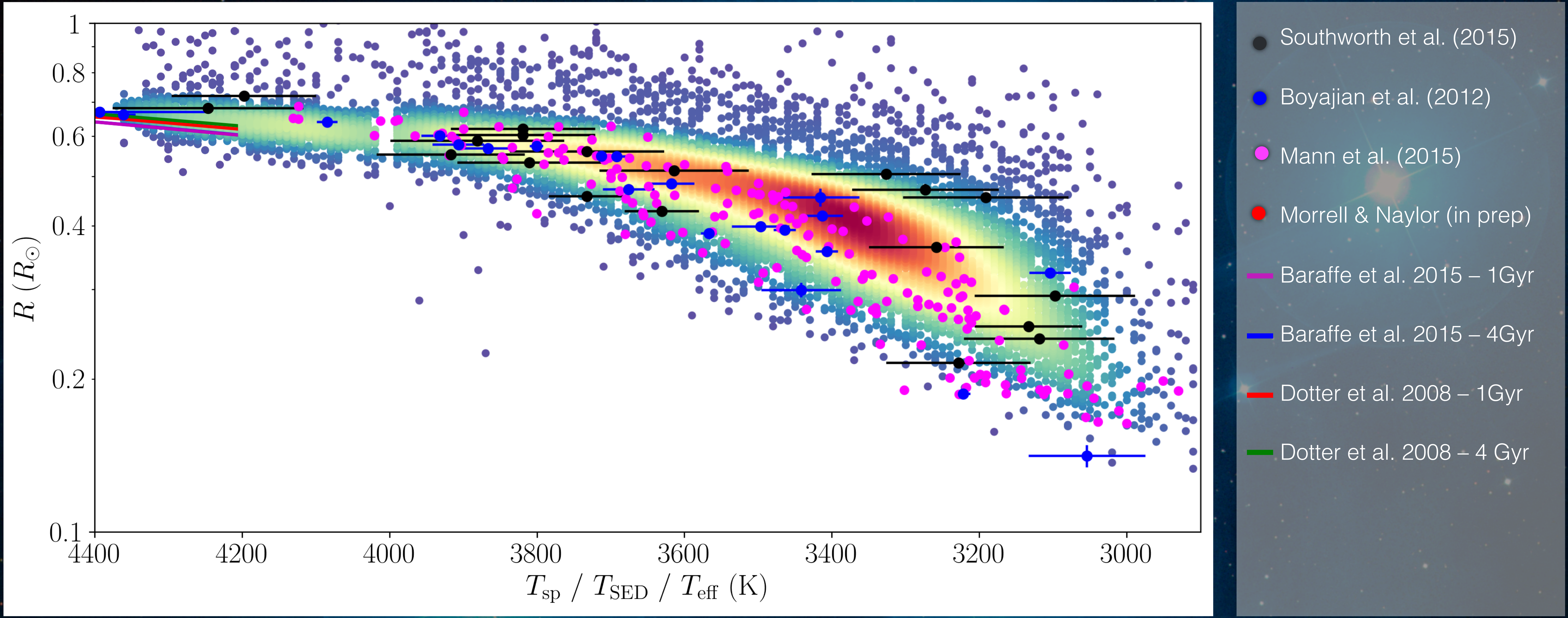
Our Sample



Southworth (2015)
Boyajian et al. (2012)
Morrell & Naylor (in prep)

Image Credit: NASA, ESA and AURA/Caltech

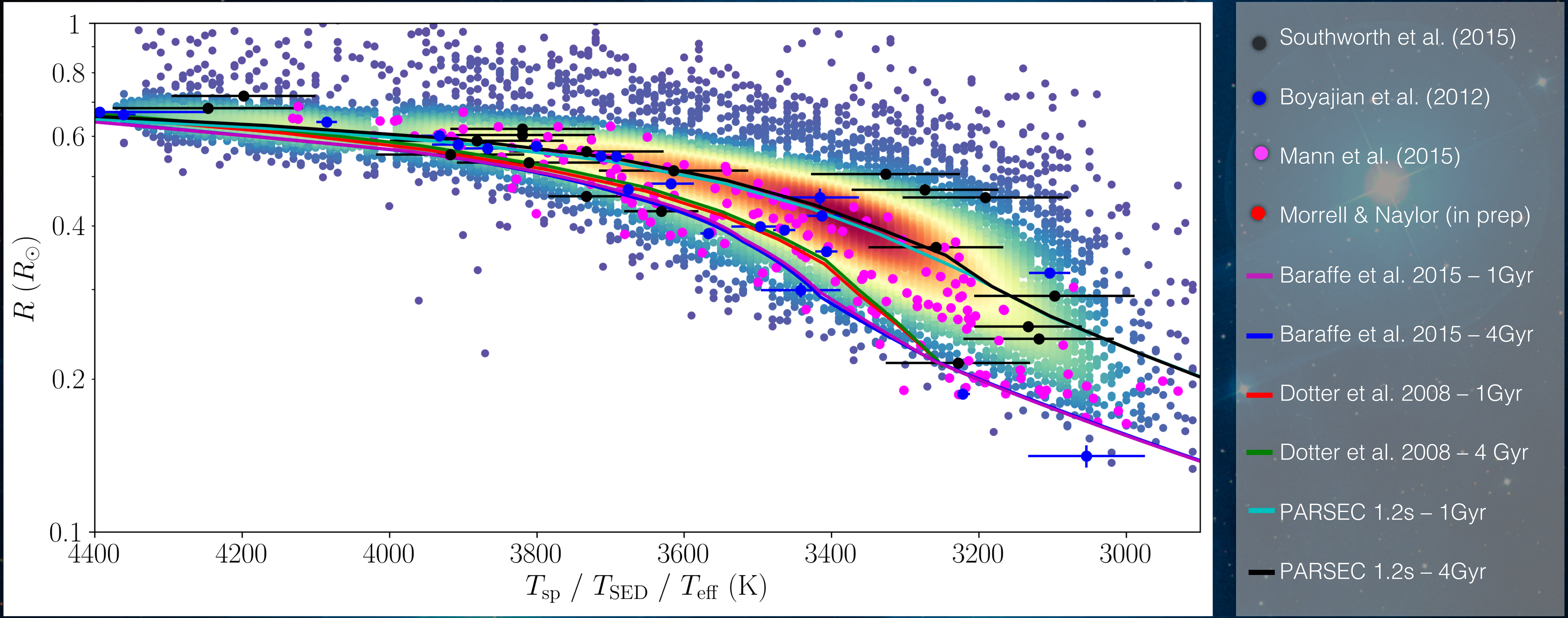
Isochrones



Southworth (2015)
Boyajian et al. (2012)
Mann et al. (2015)
Morrell & Naylor (in prep)

Baraffe et al. (2015)
Dotter et al. (2008)

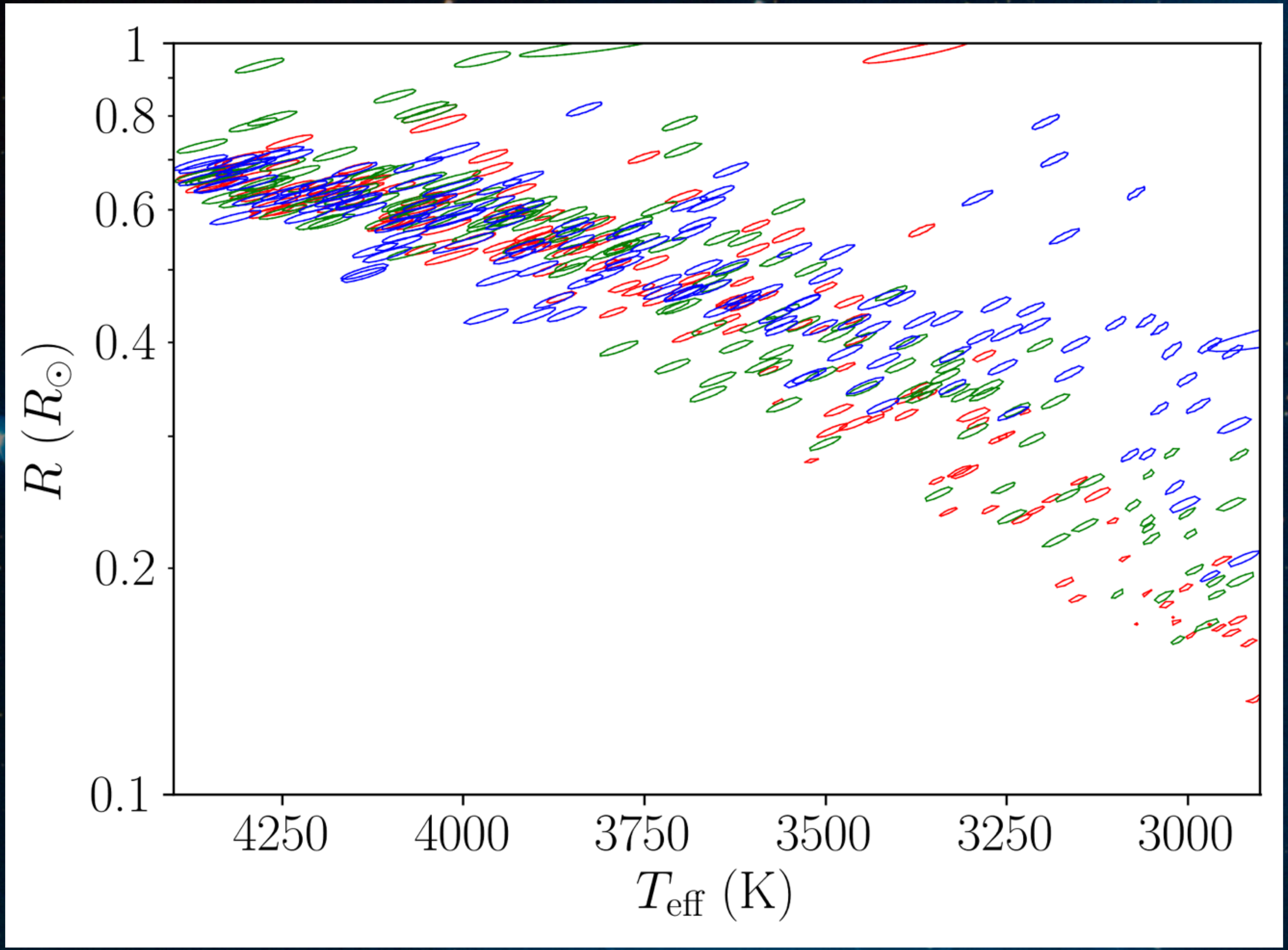
Isochrones



Southworth (2015)
Boyajian et al. (2012)
Mann et al. (2015)
Morrell & Naylor (in prep)

Baraffe et al. (2015)
Dotter et al. (2008)
Bressan et al. (2012); Marigo et al. (2017)

Correlation in the R – T_{SED} Plane



- There is a strong correlation in the R – T_{SED} plane.
- To determine true radius inflation, we need to transform to the L – T_{SED} plane.

Radius Inflation

- By plotting in the luminosity – radius plane, we avoid correlations between the axes, showing the true extent of the radius inflation.
- Radii of early main sequence M dwarfs are inflation by at least 10%.

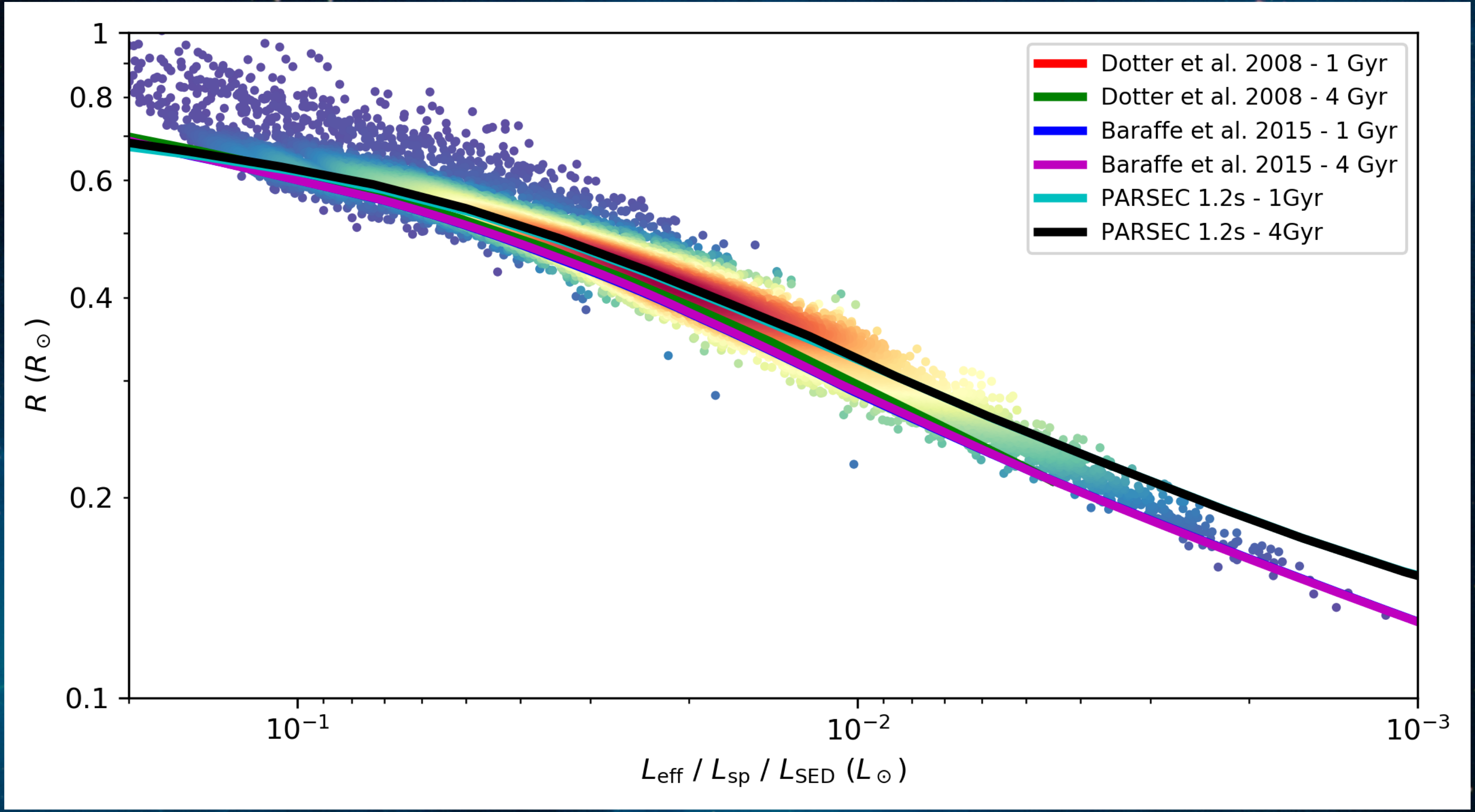


Image Credit: NASA, ESA and AURA/Caltech

Conclusions

- We present an all-sky catalogue of over 15,000 main sequence, M dwarf stars with determinations of T_{SED} and R.
- It does appear that the DEBs are over-inflated.
- The PARSEC isochrone's T-**τ** adjustment works well. (Surprising, as the DEBs are overinfalted).
- Our T_{SED} appears cooler than the T_{sp} from Mann et al. (2015), which is also surprising given the good correlation Mann et al. found between T_{sp} and T_{eff}.
- Come and see our poster on PMS M dwarfs for a demonstration of the agreement between T_{SED} and T_{sp}.

Thank you for listening

Any questions?