



aTmCam: A Simple Atmospheric Transmission Monitoring Camera For Sub 1% Photometric Precision

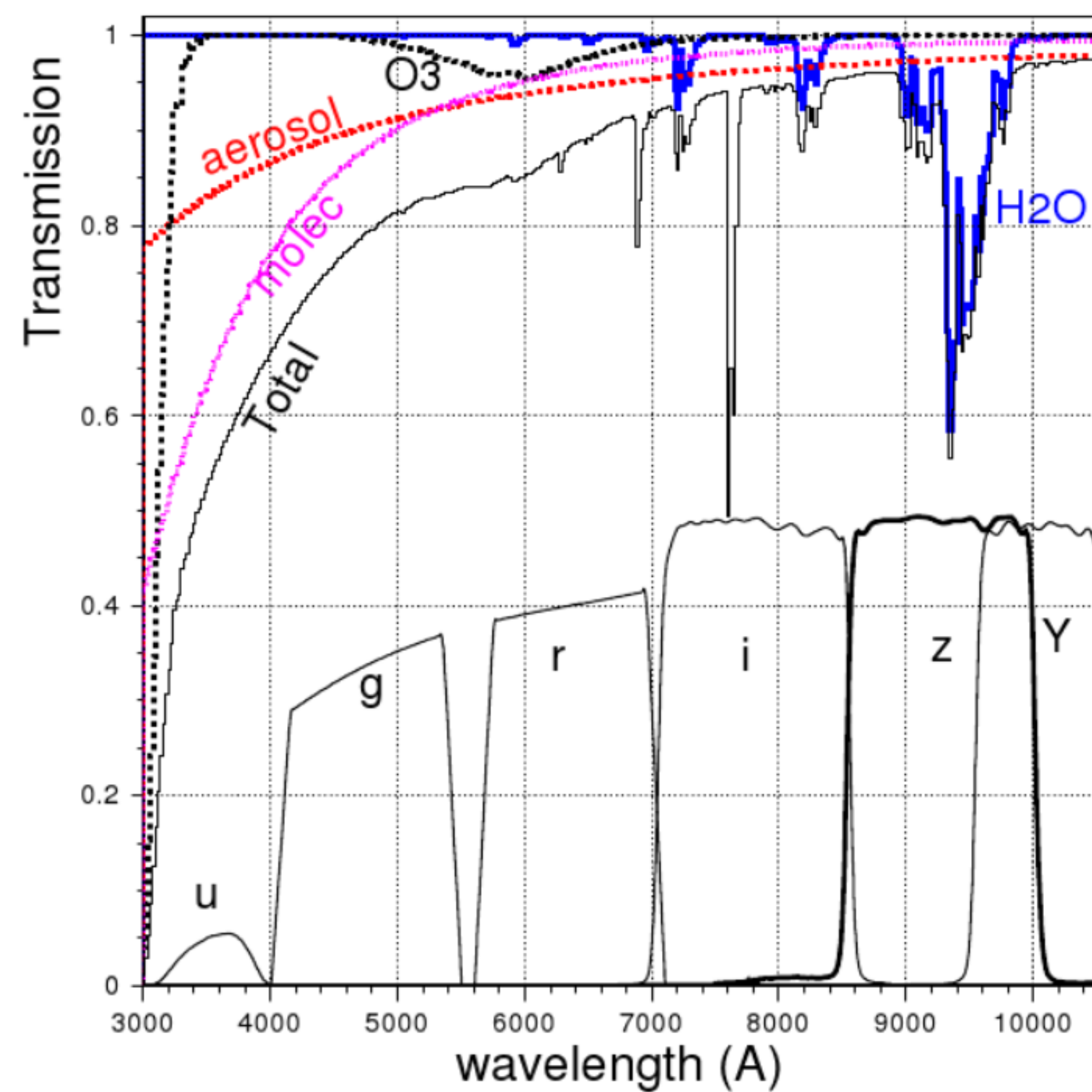
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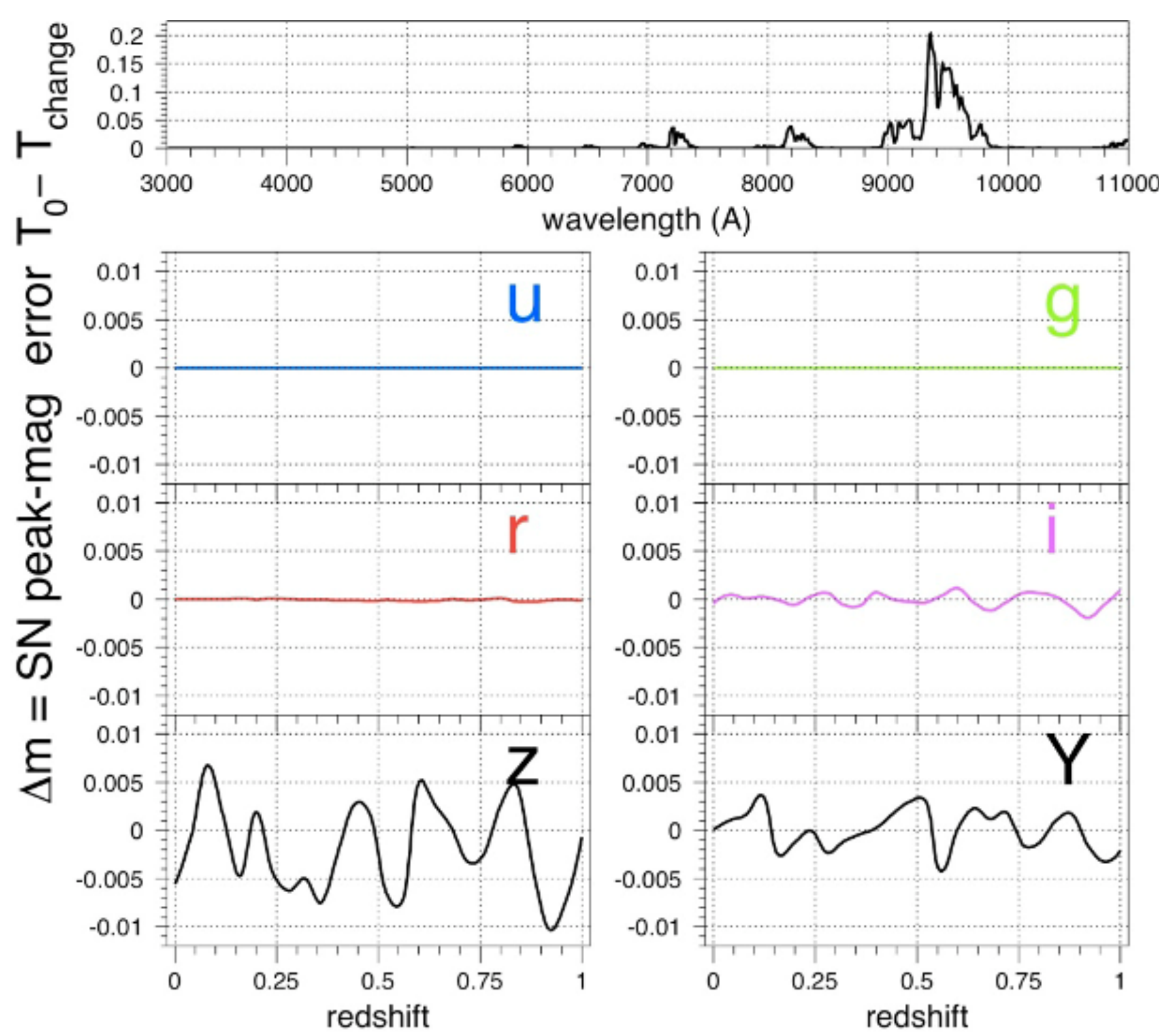


Motivation

Unmonitored atmospheric variations in the atmospheric throughput limit photometric precision of large surveys to ~ 0.01 - 0.02 mag.



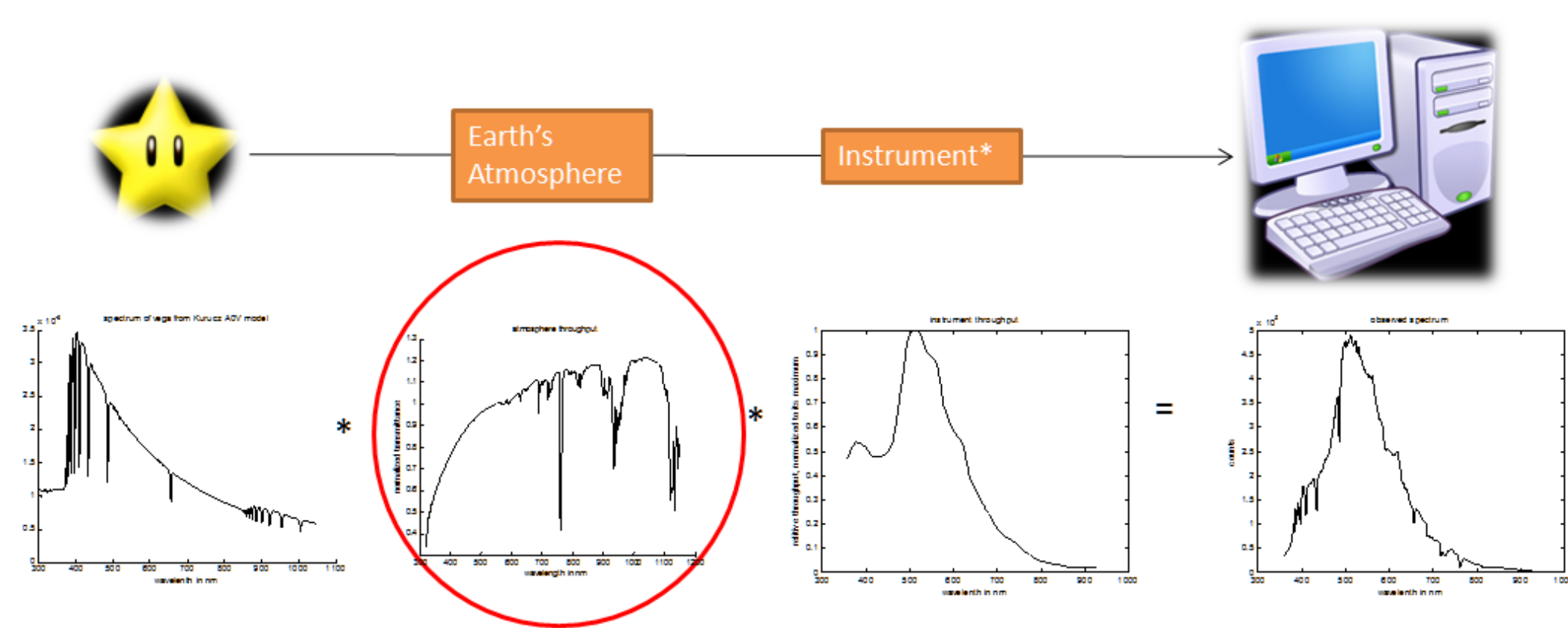
DES filters and the atmospheric throughput with major sources of attenuation



Systematic error introduced by the change of precipitable water in the atmosphere

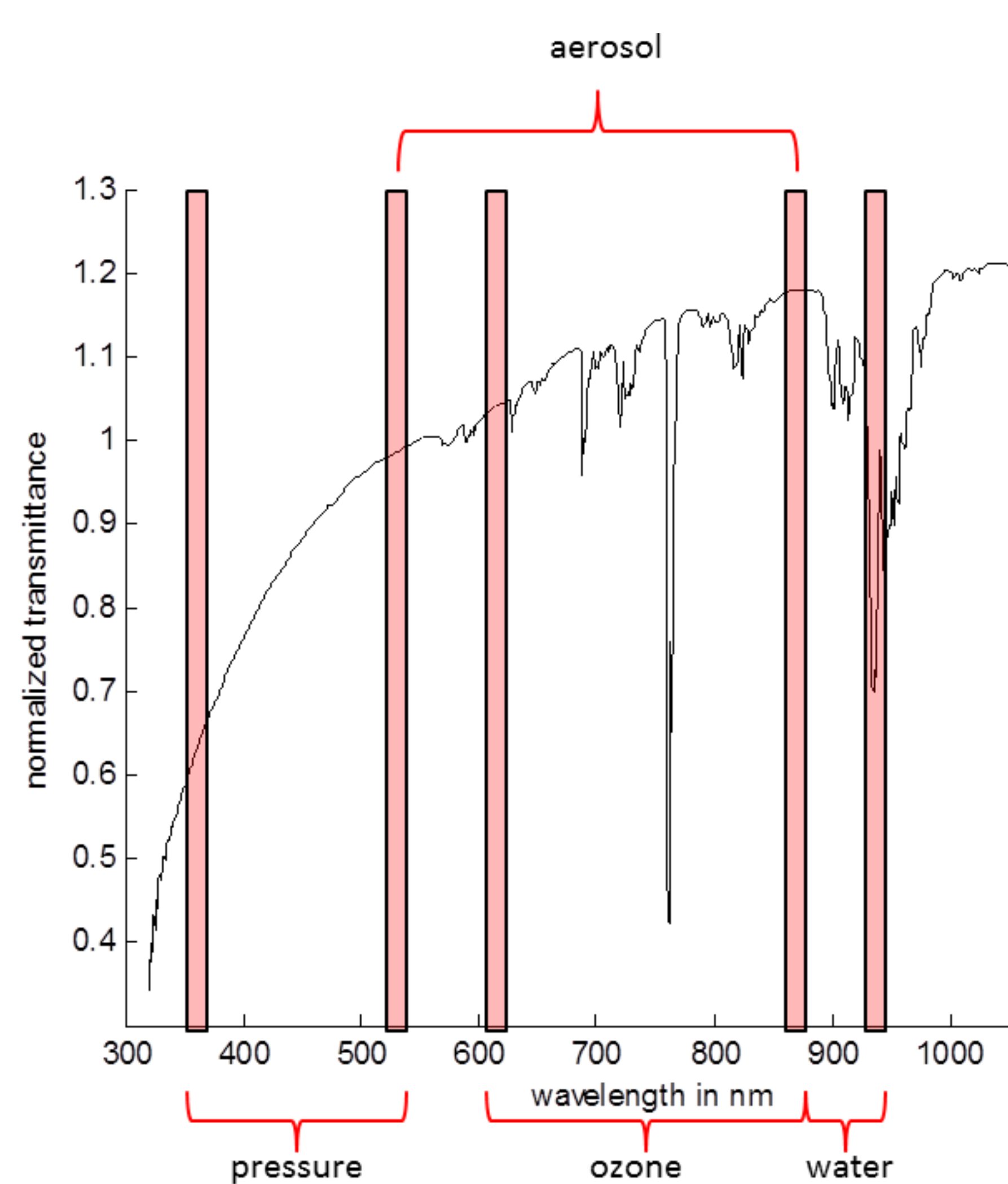
Method

The spectrum of an astronomical object observed from Earth is the spectral energy distribution (SED) of the object convolved with both the atmospheric throughput and the instrument response function. We therefore can derive the atmospheric transmission with suitable observations of calibration stars using well-calibrated instrumentation.



Abstract

Traditional color and airmass corrections can typically achieve ~ 0.02 mag precision in photometric observing conditions. A major limiting factor is the variability in atmospheric throughput, which changes on timescales of less than a night. We present preliminary results for a system to monitor the throughput of the atmosphere, which should enable photometric precision when coupled to more traditional techniques of less than 1% in photometric conditions. The system, aTmCam, consists of a set of imagers each with a narrow-band filter that monitors the brightness of suitable standard stars. Each narrowband filter is selected to monitor a different wavelength region of the atmospheric transmission, including regions dominated by the precipitable water, aerosol optical depth, etc. We have built a prototype system to test the notion that an atmospheric model derived from a few color index measurements can be an accurate representation of the true atmospheric transmission. We have measured the atmospheric transmission with both narrowband photometric measurements and spectroscopic measurements; we show that the narrowband imaging approach can predict the changes in the throughput of the atmosphere to better than $\sim 10\%$ across a broad wavelength range, so as to achieve photometric precision less than 0.01 mag.



Proposed System

We advocate a simpler system, the Atmospheric Transmission Monitoring Camera (aTmCam). This system uses a set of imagers with different narrow-band filters that monitor the brightness of suitable calibration stars. The imagers will have a field-of-view and aperture large enough to enable automatic pointing and tracking of a catalog of stars (i.e. robotic operation). Each narrowband filter will be selected to be most sensitive to one atmospheric component of the atmospheric transmission.

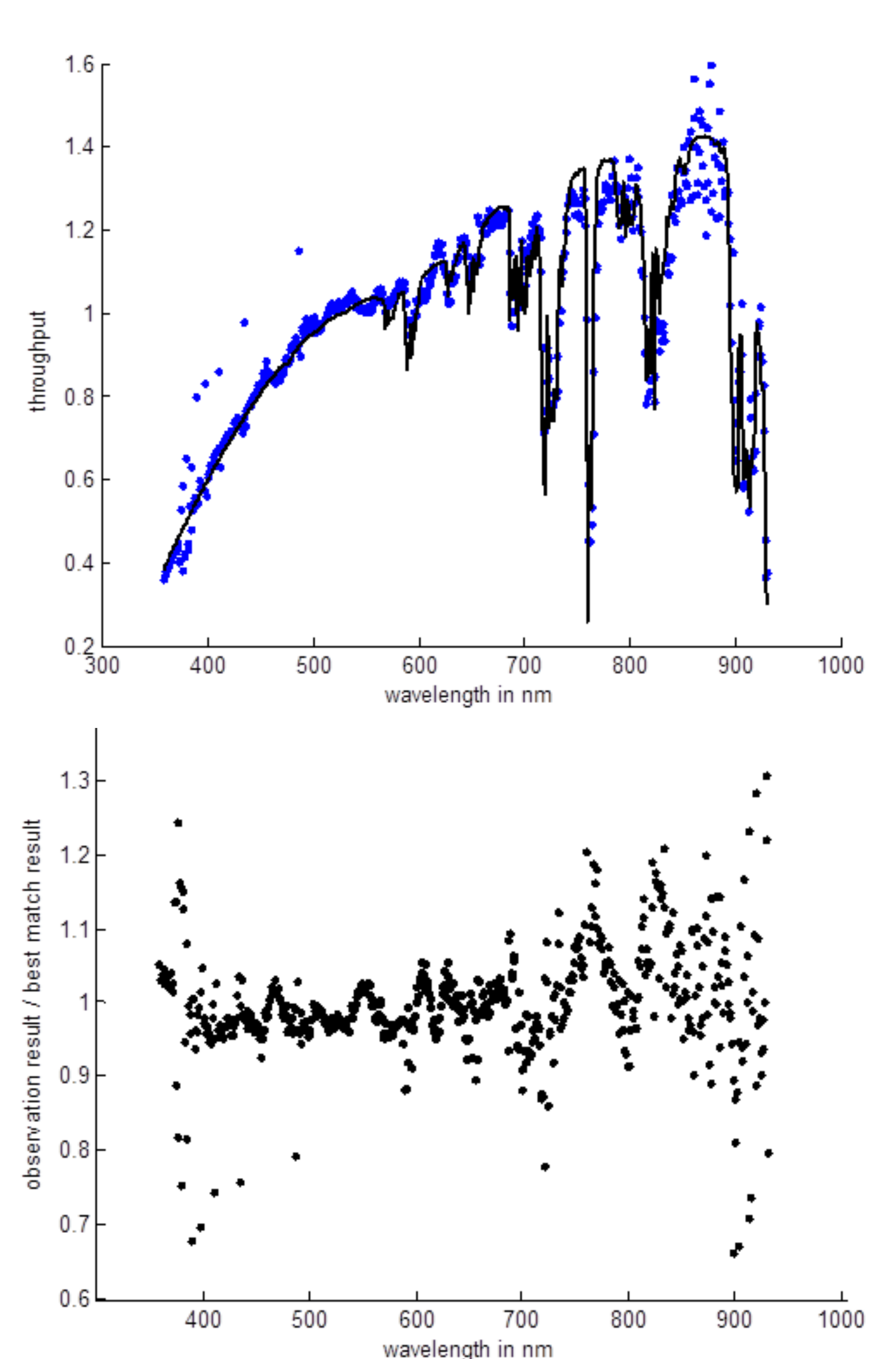
Prototype

We have deployed a prototype system to test the notion that an atmospheric model derived from a few color index measurements of stars with known spectral energy distributions can be an accurate representation of the true atmospheric transmission.



Results

We couple the measurements of the stellar narrowband photometry with simultaneous observations of the spectrum of the same star; we get the atmospheric throughput from these two independent measurements. The two were found

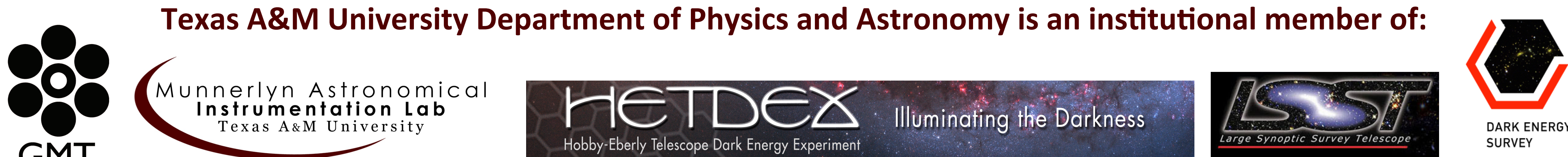


Conclusion

Understanding atmospheric variation is an important step toward 1% photometry. We propose a relatively simple narrowband imaging system that should allow derivation of an atmospheric transmission model that could improve photometric precision to less than 1%. We have tested a prototype of the system and confirmed, using simultaneous spectroscopic measurements, that the principle works adequately well. We plan to test our improved aTmCam Prototype at CTIO in Fall 2012.

Acknowledgments

Texas A&M University thanks Charles R. '62 and Judith G. Munneryn, George P. '40 and Cynthia Woods Mitchell, and their families for support of astronomical instrumentation activities in the Department of Physics and Astronomy.



ASTRONOMY

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