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WORKING GROUP ON INFRARED ASTRONOMY
(GROUPE DE TRAVAIL POUR L'ASTRONOMIE INFRAROUGE)

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1. INTRODUCTION & BACKGROUND

In 1988, a Joint Commission (9 and 25) meeting on the causes of the well-known limitations on the precision of infrared astronomy led to several suggestions to improve matters (see Milone 1989). These included better reporting of the photometric systems in use by practitioners, redesign of the infrared passbands to be more optimally placed inside the atmospheric windows, and development of a method to ascertain the water vapor content of the atmosphere when the astronomical infrared measurements were being made. An Infrared Astronomy Working Group was formed to look into the matter. Advice and suggestions were solicited from the community at large. All who volunteered information became, de facto, members of the Working Group. A small subgroup composed of Andrew Young, Chris Stagg, and Milone set to work on the central of the recommendations: improvement of the passbands. Young, Milone, & Stagg (1994) (hereafter **YMS**) summarized the work: existing $JHKLMN$ and Q infrared passbands were found to be both far from standardized, and all too frequently defined, to various degrees, by the water vapor and other components of the terrestrial atmosphere. Following extensive numerical simulations with a MODTRAN 3 terrestrial-atmospheres model package, and Kurucz stellar atmospheres, we suggested a set of improved infrared passbands designed explicitly to fit within, and not be defined by, the terrestrial atmospheric windows; however, we sought to optimize them so as to get the maximum throughput consistent with plausible limitations on precision of manufacture of the filters. In 1995 and again in 1997, a number of improvements were made in the code with which the improved passbands were designed. While they do not much affect the optimization trials and thus the passband recommendations, they have been used to extend the modeling.

2. NEW SIMULATIONS

The improvements consist of (1) replacement of the MODTRAN 3.0 terrestrial atmosphere modeling package by MODTRAN 3.7; and (2) computation of atmospheric emission through the passbands so that, in effect, a signal-to-noise ratio could be calculated. With these improvements, a new set of simulations have been carried out over the past two years.

The following atmosphere models have been used: 4.2 km (tropical); 2.1 km (U.S. standard atmosphere), 1.0 km (summer, mid-latitude), 0.0 km (summer, mid-latitude). The passbands studied include the iz, iJ, iH, iK, iL, iLp, iM, in, iN, and iQ, and the profiles of the corresponding filters manufactured by Custom Scientific Inc., of Tucson, which alone, of all the filter manufacturers solicited, agreed to make these filters to our specifications. We also tested a set of more conventional filters (the original Johnson set and a modern set in use at the Rothney Astrophysical Observatory) as well as the new rationalized set of Doug Simons and Alan Tokunaga. As expected, although the latter set was explicitly designed for the Mauna Kea terrestrial atmosphere model on the basis of our transmission data, they are better than most previous wide-band passbands for infrared work, except for our more finely optimized passbands. The full set of extinction curves and a full description of current work is in preparation (Milone & Young 2000)

3. OBSERVATIONAL TESTS

The ciz, ciJ, ciH, ciK, cil, and $cilp$ filters produced by Custom Scientific were installed in T. A. Clark's infrared photometer in 1997 which has been used on the 1.8-m Alexander R. Cross Telescope (ARCT) of the Rothney Astrophysical Observatory for the past summer. The results obtained thus far—all but the cil and $cilp$ which have not been tested yet—indicate that when the sky is not actually cloudy, the flux observed in the new passbands is much less dependent on water vapour than that in other filters less-well separated from the (largely) water vapour bands that define the atmospheric windows. The flux passed by ciz, for example, is essentially independent of zenith angle, as predicted from numerical experiments. Although the number of usable nights in which clouds or aurorae were completely absent has not been large, it is sufficient for us to be able to provide a preliminary list of standards in these new filters.

4. FUTURE PROSPECTS

Several tasks remain to be done: the numerical exploration (and perhaps re-optimization trials) for conditions with various levels of aerosols; observational testing of the improved iL and iLp passbands; manufacture and testing of the iM, in, iN, and iQ passbands. Custom Scientific has indicated a willingness to make all of these filters at reasonable cost. Additional members of the Working Group are always welcome, especially if they are willing to purchase any of these filters and otherwise help with the work!

Eugene F. Milone
Chairperson of the Working Group

References

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Milone, E. F., and Young, A. T. 2000, PASP: *in preparation*

Young, A. T., Milone, E. F., and Stagg, C. R. 1994, Astron. Astrophys. Supp. Ser. **105**, 259-279 (**YMS**)