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# FIRST STEPS OF THE GTC PHOTOMETRIC CALIBRATION PLAN

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**Large telescopes require a very precise calibration in order to maximize its scientific output. Current catalogues of standard stars are generally too bright for 10m telescopes. For GTC we are planning to produce a catalogue with calibration stars which are suitable for this telescope. In this paper we describe the first steps of the GTC calibration plan. This will require spectrophotometric calibration standards between 0.35 and 27 microns applicable to the GTC science instruments: OSIRIS (Optical System for Imaging low Resolution Integrated Spectroscopy), ELMER and EMIR (Espectrografo Multiobjeto Infrarrojo) as well as the Acquisition and Guiding boxes.**

## *Introduction*

The first step in the GTC calibration plan is based on the production of a catalogue standard stars for 10 meters telescopes. The goal of our work will be to provide photometric calibration from 0.3 to 25 $\mu$m which will be suitable for all GTC instruments. It must be done without errors in the conversion of magnitude to an isophotal flux. For that, we will use an absolute Vega spectrum from Cohen et al., which is based on a Kurucz model.

## *Strategy for the GTC*

The classical method for setting up photometric calibrators is to measure in each filter in an instrument a series of stars with magnitude ranges from 12 to 20 for broadband filters and the spectral types between A0 and M0. This is fine if there are only a few filters and the telescope is not over subscribed. However, for many of the instrument on the GTC this is not feasible as there may be 20 or 30 filters in a single instrument and the time needed to set up photometric calibrators may be longer than the actual observations.

For GTC, the aim is to provide list of standard of fields for each filter used by any of the instruments. The sources must cover the range from 0 to 7 magnitude for the mid-infrared and 12 to 22 for the visible and near infrared.

Before starting any calibration campaign it is important to have clear targets for the required accuracy:

- Zero Point Accuracy: the zero point should be accurate to 0.01 magnitudes in all filters.
- Linearity: The error in the magnitude scale up to 20th magnitudes should be no more 0.02 magnitudes.
- Change in the zero point between fields: The change in zero point between each calibration field should be less that 0.005 magnitudes.
- Errors in colours: The errors in colours should not rise above 0.015 magnitudes between two filters.
- Absolute flux calibration: The aim of this programme is not improve the accuracy of the conversion from magnitude to flux. The conversion from magnitude to flux will be taken as a definition and so gives no error. The important point though is that it must be clearly identified what the conversion is based on.

## *Calibration requirements*

For a good calibration the telescope requires that the calibrator is not variable, single and does not have an infrared excess if it is to be used in the infrared. The sources must also be sufficiently bright to give a high S/N in a few seconds as the calibration measurements should not take too long but any error in the calibration measurement is passed into the final measured flux for the source. We will use calibrations fields of 10 x 10 arc-minutes, containing tens of calibrated sources. There will be about 30 fields across the sky in a series of rings: 12 fields on or near the equator (at declination $-5°$ to $5°$), 12 fields at a declination of $25°$ to $35°$, 4 fields at a declination of $50°$ to $60°$ and a field at a declination of about $90°$. In Fig. 1 we show the distribution of field in Hour Angle vs. Airmass.

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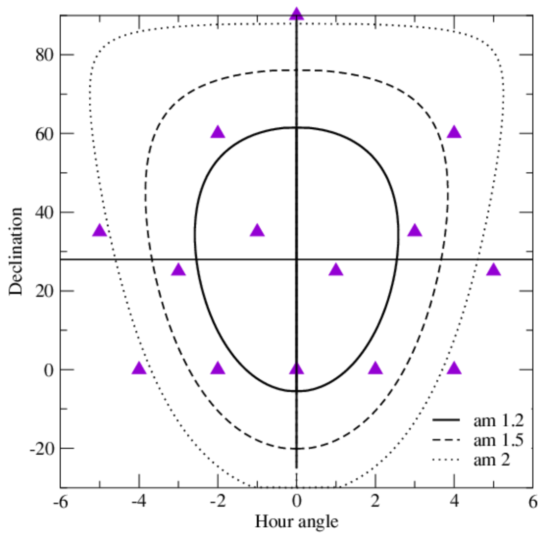


Fig. 1. The distribution of the fields with hour angle and declination. The contours are for airmass of 1.2, 1.5 and 2.

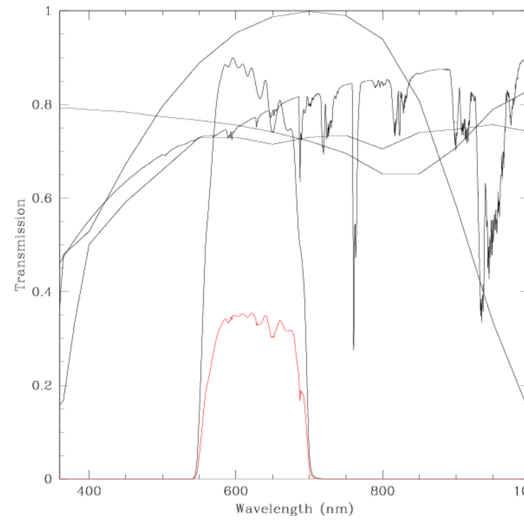


Fig. 2. The r'band total transmission for Elmer.

### *Problem of narrow band filters*

With so many narrow band filters it is impossible to directly calibrate each field in each filter as there are too many. So we propose to obtain photometry and spectroscopy of the calibration sources in each field that we will use to produce spectral energy distributions for each object covering all the spectral range. Then, we obtain the total instrument transmission in each filter and then, multiplying the transmission by the SED allows the isophotal flux for the calibration star to be determined.

### *Total transmission*

In order to make the in-band flux and isophotal flux calibrations it is important that the total transmissions are accurately known. This is: the terrestrial atmosphere, the telescope optics, the instrument optics, the filter profiles and the detector quantum efficiency curve. Fig. 2 shows the total transmission for a Sloan r' filter in Elmer. The different science instruments will provide similar transmission parameters for all their optical configuration modes.

### *Conclusions*

This paper proposes a strategy for the calibration of GTC in all spectral ranges. The most important point is to make a catalogue containing a set of properly calibrated standards covering the wavelength range of the GTC instruments. We expect to finish the catalogue before first light.