MAD Science Demonstration Proposal

The Large Magellanic Cloud

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Abstract:

We propose to observe again a region in the Large Magellanic Cloud, where a suitable asterism exists, to obtain deep IR Colour-Magnitude Diagrams (CMDs) in a crowded region reaching down to the oldest Main Sequence Turnoffs (MSTOs). These data will provide the deepest IR CMDs of the resolved stellar population in a nearby galaxy.

We have already collected images on part of the 2′x 2′ FoV coverable by MAD in the JHK bands during the second observing run of MAD Science Demonstration time. Unfortunately our K images were collected in November with very bad seeing conditions , as it reported in the log file of the observation ("Conditions variable and not always good.") and demonstrated by large variation in the Point Spread Function on the frame in comparison with H and J images taken in January.

Because of its really "ideal" asterism and its very crowded field we realized that this LMC field, in the neighbourhood of NGC 1928, is a very favorable target to test the performance of the new software for crowded Stellar fields analysis, developed by one of us: StarFinder (Diolaiti et al. 2000). StarFinder has been already tested to perform photometry by using classical Adaptive Optic correction (by only one natural guide star, Diolaiti et al 2000) and has shown its effectiveness in analyzing crowded stellar field. This proposal will allow us to test the updated version of this code designed "ad hoc" to perform the deep analysis of crowded stellar fields of images corrected by using the new Multi Conjugate Adaptive Optics (MCAO) with high and low Strehl ratio.

Scientific Case:

There is much that we can learn about galaxy formation and evolution back to the earliest times from the *archaeological* evidence in the properties of individual stars. Stars provide an accurate and detailed measure of how the rate of star formation and chemical composition of a galaxy varies from its formation to the present and thus how galaxies evolve. To accurately determine these properties detailed CMDs of resolved stellar populations are required in combination with modelling and analysis techniques; providing the link between the local universe, high redshift surveys and theoretical simulations of galaxy formation and evolution (e.g., Tosi et al. 1991, AJ, 102, 951; Tolstoy et al. 1998 AJ, 116, 1244; Aparicio & Gallart 2004 AJ, 128, 1465).

The most accurate CMDs include stars down to the oldest MSTOs ($M_I \sim +3.5$), because this is the

region where the old populations are distinct from each other, and not overlapping, unlike on the Red Giant Branch. We would like to push as deep as possible in a reasonable amount of time (∼1 hour, on each target pointing plus over heads). From the ISAAC ETC we assume this to be about 2 hours of telescope time per pointing, including the sky observation, and this should reach the oldest MSTOs in the Magellanic Clouds in K with a reasonable S/N (∼ 15).
NGC1928 is a well studied LMC globular cluster for which optical HST/ACS data exist (Mackey & Gilmore 2004 MNRAS, 352, 153). We are combining MAD photometry with existing optical imaging to compare our results to more established analysis and to confirm the accuracy of the MAD photometry at faint levels. We request the K IR broad band filter to improve our photometry in this filter, because in principle (with same seeing condition) it should be the one with the best MCAO correction.
A number of ELT science cases assume that accurate photometry can be carried out at very faint levels over relatively wide fields of view. It is very important to test this assumption as far as possible with currently available facilities. A useful generally applicable case is the photometry of point sources in crowded stellar fields, which provide natural, accurate probes of photometric sensitivity and depth. AO currently only works at IR wavelengths and this is likely to remain the case for an ELT in the future and hence this necessitates adapting current analysis techniques, which are almost exclusively carried out at optical wavelengths. These changes bring several challenges to be able to interpret these new kinds of data sets and the first step is to gain useful *training* data sets. There are accurate and detailed CMDs of stellar systems with standard (single guide star) AO IR instrumentation (e.g., Diolaiti 2000 A&AS, 147, 335; Olsen et al. 2006 AJ, 132, 271) but this has so far been done with short integrations over tiny fields of view concentrating on IR bright stars, such as AGB and carbon stars. A coordinated effort needs to be made to define the requirements for accurate photometry of faint stars in crowded wide field images to understand the true sensitivity of AO systems for these kinds of studies.

Targets and integration time

Target	**RA**	**DEC**	**Filter**	**Magnitudes**	**Total integration time** (sec)	**Field** (arcmin)
LMC field close NGC1928	05 21 48	-69 24 09	K	22	4 hrs	2x(1'x1')

Guide stars list and positions

Target: NGC 1928			
GS1	+15	-1	10.2
GS2	+50	+45	10.4
GS3	+55	-55	11.1

Time Justification:
The aim of this proposal is to improve existing photometry in the K band of a crowded LMC field close the globular cluster NGC1928. On the basis of the data we already collected, we plan to reach the old MSTO (K=22) with S/N=15 in 1.5 hours for each pointing. We plan to observe two fields, and this means a total of 4 hours, including overhead. For our target we would like to get our previous pointing, the closer one to the GC NGC1928 and another one situated in the center of the asterism. In this way we will be able to study the dependence of the MCAO correction on both the seeing condition as well as the distance of the asterism center. With this kind of study we will be able to obtain many useful information about the performances that we would desire to obtain by ELT.