EUROPEAN SOUTHERN OBSERVATORY

Organisation Européenne pour des Recherches Astronomiques dans l'Hémisphère Austral
Europäische Organisation für astronomische Forschung in der südlichen Hemisphäre

VISITING ASTRONOMERS SECTION • Karl-Schwarzschild-Straße 2 • D-85748 Garching bei München • e-mail: visas@eso.org • Tel.: +49-89-32 00 64 73

APPLICATION FOR OBSERVING TIME PERIOD: **78A**

Important Notice:

By submitting this proposal, the PI takes full responsibility for the content of the proposal, in particular with regard to the names of COIs and the agreement to act according to the ESO policy and regulations, should observing time be granted

1. Title Category: **A–1**

High resolution imaging of high redshift galaxies

2. Abstract

We propose to take very high resolution imaging of high redshift galaxies to understand their physical conditions. These observations will be taken at the diffraction limit of the telescope (6,8,10 milli-arcsec in J, H, K for a 42m telescope). The resolution will be approximately 60 pc in physical length, and will be of comparable quality 1 arcsec imaging on VIRGO galaxies. They will give typically > 100 resolution elements over the galaxies, and produce detailed information about the morphology, dynamical state, and variations in physical parameters across the galaxy. These observations will image galaxies beyond the Balmer break up to $z = 4.5$, enabling the separation of old and young stars. High contrast observations of QSOs will produce host morphologies, colors, and physical properties.

3.

Run	Period	Instrument	Time	Month	Moon	Seeing	Sky Trans.	Obs.Mode
A	79	FORS2	300h	any	d	$\leq 0.4''$	PHO	v
B	79	FORS2	300h	any	d	$\leq 0.4''$	PHO	v
C	79	FORS2	300h	any	d	$\leq 0.4''$	PHO	v

4. Number of nights/hours Telescope(s) Amount of time

a) already awarded to this project:

b) still required to complete this project:

5. Special remarks:

In order to establish feasibility simulations are needed to verify integration time.

6. Principal Investigator: Marijn Franx (Leiden University, NL, franx@strw.leidenuniv.nl)

CoI(s): The Rest (Elsewhere, ESO)

7. Is this proposal linked to a PhD thesis preparation? State role of PhD student in this project

8. Description of the proposed programme

A) Scientific Rationale: The physics of high redshift galaxies is still an enigma. Most galaxies look irregular in current imaging (either from space or from the ground); their dynamical state is not well defined, and it is not well understood what processes drive their evolution.
High resolution imaging of these galaxies will be crucial for a proper understanding. Their typical sizes are on the order of 0.2-0.3 arcsec at redshifts 2-4, decreasing at higher redshift (roughly like 1/(1+z) at fixed restframe luminosity), and decreasing with smaller luminosity (roughly like $L^{0.5}$). HST imaging generally gives very few resolution elements, at a level of 10 within an effective radius. This is equivalent to imaging of Virgo galaxies with a seeing of 10 arcsec !
It is clear that high resolution imaging will provide direct insight into the dynamical state of the galaxies, and allows us insight into the processes that drive these galaxies. As an example, recent work based on HST imaging has indicated that a fair fraction of z=2-3 galaxies may be mergers. However, the resolution is truely poor to establish this well. High resolution imaging should be able to provide details about the occurence of double nuclei, tidal effects in the main body of the galaxies, and the occurance of tidal arms.

B) Immediate Objective:
We will image high redshift galaxies in well studied "deep fields", including the HDF-South, UDF, Goods, and other areas for which multi-wavelength studies have been made. We will want to image about 1e4 L* galaxies at redshifts between 2 and 5. Given the number density of a few/sq arcmin, we'll need an area of 2000 sq arcmin in total.
The resolution should be close to the diffraction limit, and constant over the field. An MCAO system with a wide-field imager would be appropriate for these observations.
We will also image QSO hosts. Some of these will fall automatically on the fields; but it may be better to actually image these systems with LTAO. This requires careful simulations. LTAO will provide better psf, but it may be hard to know it. MCAO will give worse psf, but better stability - and hence knowledge.

C) Telescope Justification: The ELT is needed for both the spatial resolution and the faintness of the galaxies.

D) Observing Mode Justification (visitor or service):

E) Strategy for Data Reduction and Analysis:

9. Justification of requested observing time and lunar phase

Lunar Phase Justification: We require the maximum sensitivity and photometric accuracy possible which means dark time.

Time Justification: (including seeing overhead) We used the ETC (May 2007) to calculate the required integration time. We assumed that we want to observe a galaxy with Hab=23 and a size of 0.2 arcsec. We used the "surface brightness" option of the ETC. The surface brightness of these galaxies is about 20.2 in AB, or 18.8 in Johnson. According to the ETC, this should give a S/N per 5mas pixel of about 25 in 10 hours . To reach this, I had took S/N(1x1arcsec)/sqrt(pixels in1x1 arcsec) = 5000/200= 25. It is not clear whether this is correct.
The number of L* galaxies per arcmin is at a level of 5-10. Hence, to image 1000 L* galaxies, we like to image at least 100 sq arc min. This requires 10hours*(100/instantaneous FOV). For an MCAO system, this might lead to acceptable total integration time if the coverage is > 1 arcmin. We'll assume 2arcmin FOV, leading to about 500 hours integration time/band. We'll need at least 2 filters, hence 1000 hours total.
Notice that this will image many more galaxies than a 1000, but many are far below L*. For example, UDF has 2300 galaxies to AB=29 with z¿2 in a field of 6 sq arcmin - hence this will give 4e4 galaxies.
Careful simulations are needed of the QSO hosts. The ETC is cannot be used without such simulations.

Calibration Request: Special Calibration - Regular observations of standard star fields (!)

10. Report on the use of ESO facilities during the last 2 years

Report on the use of the ESO facilities during the last 2 years (4 observing periods). Describe the status of the data obtained and the scientific output generated.

11. Applicant's publications related to the subject of this application during the last 2 years

12. List of targets proposed in this programme

Run	Target/Field	α(J2000)	δ(J2000)	ToT	Mag.	Diam.	Additional info	Reference star
A	name	RA	DEC	time(hrs)	mag	DM	ang diam(')	note
A	COSMOS	10	+2:12	300	26-28	45	90	COSMOS FIELD
B	CDFS	03 32 28	-27 48 30	300	26-28	45	90	cdf-south
C	HDFS	22 32 56	-60 33 02	300	26-28	45	90	hdf-south

Target Notes: The targets in run A and the main ones for this exercise; the targets in run B give a more general impression of the types of (large) galaxy we might like to observe with an ELT with the same requirements as run A.
Number of points per field listed with time, I, K mags listed. Angular diameter is the total size of the entire galaxy not always necessary to observe the entire galaxy.

12b. ESO Archive - Are the data requested by this proposal in the ESO Archive (http://archive.eso.org)? If yes, explain why the need for new data.

13. Scheduling requirements

14. Instrument configuration

Period	Instrument	Run ID	Parameter	Value or list
79	FORS2	A	IMG	VIJHK
79	FORS2	B	IMG	VIJHK