GEMINI OBSERVATORY

observing time request summary

Semester: 2011B

Observing Mode: queue

Instruments:
NIRI,NIFS,Michelle

Gemini Reference:

Time Awarded:

Thesis:
Yes

Band 3 Acceptable:
Yes

Title: **A sub-arcsecond study of the z~2.284 galaxy IRAS F10214+4724**

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Roger Deane: University of Oxford,
Pat Roche: University of Oxford,
Steve Rawlings: University of Oxford,

Partner Submission Details *(multiple entries for joint proposals)*

				NTAC			
Partner	**Partner Lead Scientist**	**Time Requested**	**Minimum Time Requested**	**Reference Number**	**Reco-mmended Time**	**Minimum Time Reco-mmended**	**Rank**
	Total Time						

Abstract *(207 words)*

Since it's discovery in 1991 IRAS F10214+4724, has been one of the most heavily investigated extragalactic sources in the Universe. This hyperluminous infrared galaxy has been long known to be strongly gravitationally lensed and is thought to be composite system hosting both a (super-)starburst and an AGN. Despite its notoriety, relatively little is known at high spatial resolution where the magnification due to lensing of the host galaxy allows the structure to be studied in detail. Recently, we have uncovered observational evidence that F10214's starburst and AGN components undergo differential magnification in the radio, a finding that is confirmed by our best fit radiative transfer models of its IR SED. We therefore propose a short NIR and MIR program to deliver near diffraction limited observations of this source (0.1" & 0.4"). The proposed stellar conitnuum measurements will allow us to directly measure its stellar mass. The IFS observations of nebular gas diagnostics (Halpha+NII, Hbeta and OIII) will allow us to decouple broad and narrow emission components in

this galaxy, assess spatially resolved metallicities and extinction. We may then test how the dynamics and substructures seen in the radio, CO, HCN, or CI maps are related to the stellar continuum and disentangle the nature of this complex system.

Science Justification *(1142 words)*

IRAS F10214+4724 (hereafter F10214), was the first "hyperluminous" infrared galaxy discovered. At a redshift of z~2.284 its strong 60 and 100um flux suggested an infrared luminosity in excess of >1e14 Lsol. Being the most luminous target discovered in IRAS' faint source catalogue, it's extreme nature has sparked numerous scientific investigations. Its mammoth flux was soon revealed to be due to lensing by a foreground galaxy or group of galaxies at z~0.9 [BL95,G96,L98] with wavelength dependent magnification estimated to be in the range of 5-100 (e.g. BL95,D95,S95,T95]. Despite two decades of active research we are still intrigued by this object, and we are fast approaching a deep understanding of its complex nature. At the time of its discovery F10214 was a rare object, however a plethora of sensitive surveys with ISO, Spitzer, AKARI, SCUBA and Herschel many more hyperlumionous object are now known. Rather than be rare isolated incidents, the number density of IR-luminous galaxies increases to high-redshift coinciding with the peak of activity seen in the star-formation hostory of the universe. The IR-luminous phenomenon at high-z pin-points the most massive dark matter halos, and is plausibly a ubiquitous stage in the evolution of massive present-day galaxies. In addition the IR-luminous phase is also argued to be a stepping stone between the transitions from major mergers of gas rich disks - to quasars - to present-day massive galaxies. Thus studying the nature of IR luminous galaxies is key to our understanding of the evolution of the most massive galaxies. F10214 continues to be a benchmark template to study the inner workings of IR-luminous galaxies, and shed light. The amplification and magnification due to lensing allows us to study to fainter intirinsic depths and to access greater spatial resolution than would normally be possible.

Since its discovery, F10214 has been known to host coeval starburst and AGN components that were both required to explain its FIR SED. The AGN alone could not be responsble for the all the IR emission, rather components of cool "cirrus" dust and ongoing star formation are necesary to explain the galaxy's FIR-mm SED. This is corroborated by the large mass of molecular and atomic gas in this galaxy [V04,], providing ample fuel for the intense starburst. Furthermore, rest-frame optical spectra and UV polarised light clearly showed signatures of an Seyfert 2 nucleus which is shieded from view. However, Spitzer IRS spectra revealed for the first-time the presence of silicate emission in F10214. This feature is typically assocaited to type 1 AGN where the system is viewed 'face-on' such that the hot dust emission from either the inner edge of the dusty (clumpy) torus are in view, rather than shielded from view in the 'edge-on' scenario. The diffiulty in reconciling the Seyfert 2 optical signature with the silicate emission feature has led us to form a new model for the emission of F10214 in the IR. Together with new data from Spitzer and Herschel, we are now able to reproduce the full 1-1000um rest-frame SED with multiple components that suggest a discrete distribution of hot dust resonsible for the silicate feature, with an underlying starburst component responsible for the longer wavelength emission.

Is it possible to disentangle the emission from active star-froamtion and the elusive active nucleus? As well as the brightness amplification that lensing offers, the magnification of the structure makes this potentially intersting provding there is sufficient spatial resolution to differentiate the components. Several authors have suggested that the system is undergoing differential magnification [Lacy98,Evans99]. We have recently analysed high resolution radio and HST data that strongly corroborate this view. From the radio perspective XXX suggests that there is a ... A reanalysis of the HSRT NICMOS data clearly show excess emission N&S of the primary arc, suggesting the extended (starburst) component is differentially magnificed with respect to the compact nueclus that lies close to the caustic.

We therefore propose to corroborate these findings with high spatial resolution studies with Gemini. We aim to measure the stellar continuum using NIRI/MICHELLE. And perform spatially resolved integral field spectroscopy with NIFS to reveal both the compact nucleus and the extended starburst using near-diffraction limited performance with Gemini. Due to the presence of a suitable bright tip/tilt star withing 13.7" of the science target, we are able to exploit the gain in sensitivity though enhanced strehl ratios as well as the spatial resolution improvement with LGS-assisted observations.

IMAGING

While HST imaging is available in the archive, the brightness of F10214 means that Gemini is able to probe longer wavelengths than the HST, where the stellar continuum will be intrinscially brighter. We propose to image the galaxy with NIRI in the L'-band, corresponding to the rest-frame J-band a sensitive measure of the stellar continuum. The archival HST sata suggest that the rest-frame optical emission is dominated by scattered light from the obscured nucleus, in the NIR, the galaxy will dominate. (MT/RD ARE WE GOING TO BE ABLE TO RESOLVE THE LOWER STARBUST EXTENSION SEEN IN THE NICMOS IMAGE WITH 0.25" DIFFRACTION LIMITED PERFORMANCE WITH MICHELLE 10UM IS 3UM REST-FRAME, BUT DIFFLIM IS 0.26" AT 10UM, IQ - IQ=20% GIVES US 0.31-0.34" FWHM IQ=70 0.37"?) NIRI GIVES US 0.1" IN L' (1.15UM RES-FRAME) BUT THERE'S A BIG HIT IN SENSITIVITY BECUASE OF ALTAIR IN IQ=20% WE GET 0.35" FWHM WITH ALTAIR WE GET 0.1") WHAT DO WE WANT - BETTER IQ AND BETTER SENSITIVITY? WITH NIR TAKES 1HR WITHOUT AO, 1.5HR WITH AO OR BRIGHTER EMISSION BUT POORER SENSITIVITY WITH MICHELLE 1HR+OVERHEADS

IFS SPECTROSCOPY

IFS measurements of F10214 exist (K98), however these data were taken by me with the first IR IFS MPE-3D at Calor Alto in conditions of 1" and a spectral resolution of 1100. From these data it was only possible to analyse spatially integrated spectral line profiles (but despite the poor resoultion, these observations were able to demonstrate the nearby companions were likely not lensed images due to the lack of detections of Halpha+NII in any of the companions). These obs did reveal interesting differences in the line and continuum extents. Instead we propose to observe spatially resolved signatures in F10214 at higher spatial and spectral resolution. The data in K09 provide us with spectral line fluxes that effectively demonstrate that the experiment proposed here WILL deliver sufficient SNR that bypasses any study conducted on F10214 thus far, and will be sufficient to resolve the spectral signatures we are seeking. The redshift of F10214 places the galaxy in regions of the NIR bands that are free from bright sky lines and atmospheric absoroption features. MT ADD MORE PHYSICS HERE IE.E SPEARATAION OF BRAID AND NARROW LINE COMPONENTS ALREADY SHOWN IN KROHKER. RESOLVING HALPH/NII GIVES A METALLICITY ESTIMATE THAT KROKER COULDNT RESOLVE THE LINES. HBETA/HALPHA GIVES EXTINCTION. THEY KEY TIE IN IS WHETHER THE EXTENSION SEEN N/S IN THE NICMOS 160W IMAGE CAN BE RESOLVED FROM THE BRIGHTER PLAUSIBLY NUCLEAR ARC.

Technical Justification

Band 3 Information

Requested time in case of band 3 allocation: 0.0 hours

Minimum required time for a usable band 3 allocation: 0.0 hours

Use the following conditions for band 3 only:

Name	Image Quality	Sky Background	Water Vapor	Cloud Cover
Band 3 Observing Conditions	Any	Any	Any	Any

Observation Details

Observation	RA	Dec	Brightness	Total Time *(including overheads)*
IRAS F10214+4724	10:24:34.56	47:09:9.59	N~	
GSC0343500222(wfs)	10:24:00.991	47:08:43.19	13.34 mag	separation 5.72
U1350_07766563(aowfs)	10:24:35.837	47:09:10.08	17.5 mag	separation 5.72
Observing conditions:		resources:		
IRAS F10214+4724	10:24:34.56	47:09:9.59	N~	
GSC0343500222(wfs)	10:24:00.991	47:08:43.19	13.34 mag	separation 5.72
U1350_07766563(aowfs)	10:24:35.837	47:09:10.08	17.5 mag	separation 5.72
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Observing conditions:		resources:		

Observing Conditions

Name	Image Quality	Sky Background	Water Vapor	Cloud Cover
Band 3 Observing Conditions	Any	Any	Any	Any
Global Default	Any	Any	Any	Any

Resources

- Gemini North
  - NIRI
    - Camera
      - f/6 (0.12 arcsec)
      - f/32 (0.02 arcsec)
    - Filter
      - Broad-Band
        - L' (3.78 um)
    - Adaptive Optics
      - Altair
      - Field lens
      - Laser guide star
  - NIFS
    - Disperser
      - Z-grating
      - J-grating
      - H-grating

- K-grating
- Filter
  - ZJ
  - JH
  - HK
- Adaptive Optics
  - Altair
  - Field lens
  - Laser guide star

Michelle

- Filter
  - N' 11.2um (semi-broad)
- Disperser
  - Mirror

Scheduling Information

Scheduling constraints and non-usable dates

- (impossible):
- (optimal):
- (synchronous):

Additional Information

Keyword Category: extraGalactic