EAST : EMIR ASSOCIATED SCIENCE TEAM

L. CAIRÓS, EAST manager

EAST: EMIR ASSOCIATED SCIENCE TEA

What is EAST ?

EAST (EMIR Associated Science Team) is a scientific group in charge of developing an observing program complementary to that of GOYA, to be carried out taking advantage of the *EMIR Guaranteed Time* (EGT).

EMIR

WIDE-FIELD, NEAR-IR MULTIOBJECT SPECTROGRAPH FOR THE GTC (NASMYTH FOCUS)

Top priority: MOS in K band

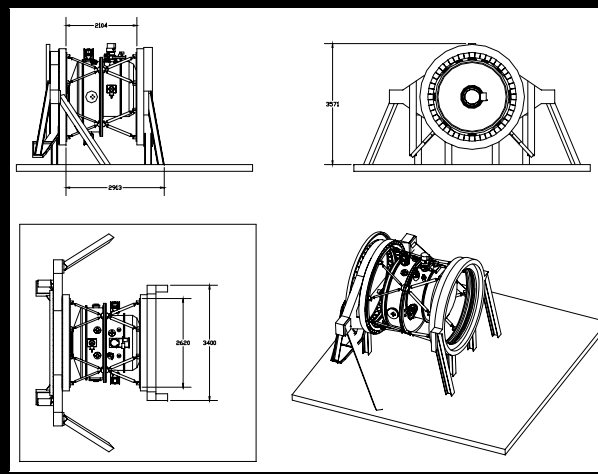
Wavelength range : 0.9-2.5 μm [1.1-2.5 μm]

Detector : Rockwell HgCdTe 2048 x 2048

Scale : 0.2 arcsec/pix

Observing modes:

- Wide Field imaging (WFIM)
- Long-Slit spectroscopy (LSSM)
- Multi-Slit spectroscopy (MOSM)



Observing modes: IMAGING

Highly powerful wide field IR imager , FOV 6 x6

S/N ~5	Z ~28.2
Tint ~ 4 hours	J~26.6
	H~25.8
	K~24.7

EMIR	6 x 6	GTC
NIRC	38”	KECK
NIRI	2 x 2	GEMINI
FLAMINGOS	2.5 x 2.5	GEMINI
ISAAC	2.5 x 2.5	VLT

BROAD-BAND FILTERS: Z, J, H, K, K’

NARROW-BAND FILTERS: TBD

HeI (1.08 μm; 2.07 μm) , **Paγ** (1.094 μm) , **Paβ** (1.28 μm), **CH4** (1.58 μm) **[FeII]** (1.644 μm), **H2** (S1: 2.12, 2.24 μm), **Brγ** (2.17 μm), **CO** (2.28, 2.32 μm), **Jcont, Hcont, Kcont**

Observing modes: Spectroscopy

Spectral range 0.9-2.5 μm [1.1-2.5 **μm]**

Spectral resolution: R_J = 5000

R_H = 4250

R_K = 4000

Slit width = 0.6 arcsec

FOV: 6 x 4 arcmin

MOS spectroscopy

~ 50 slitlets

Long-slit spectroscopy

S/N ~5

Tint ~ 4 hours

J~23.4
H~22.5
K~21.6

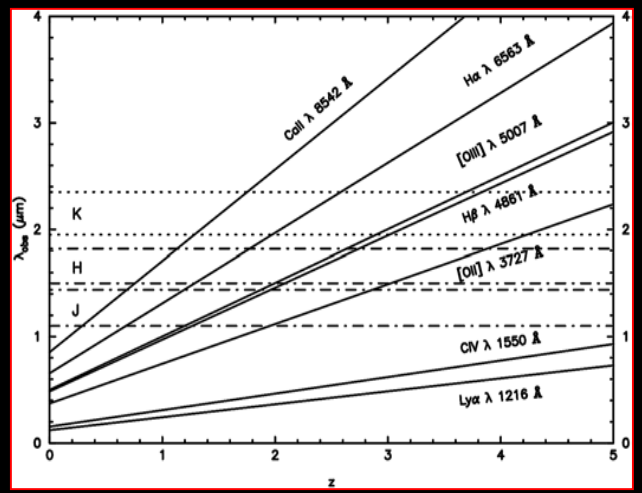
GTC Second Light instrument

Commissioning at telescope starts	August 2006	October 2006
EMIR First Light	November 2006	January 2007

EMIR Scientific Drivers

The GOYA (COSMOS) project is a *comprehensive study of the properties of the galaxian population, at 1.5 < z < 3*, which is an *epoch of maximum star-formation* in the history of the Universe.

Most of the strong and well studied spectral features seen in the rest-frame optical spectrum shift into the NIR (1-2.5 μm range) Probe the early Universe with the same parameters space as in the local Universe



GOYA: Probing the Universe at z > 1

Measuring the physical parameters of the galaxies at z > 1 using the same parameter space as for galaxies in the local Universe

3500 – 8000 μm, if z=1.5 0.9 – 2 μm

if z=2 1.05 – 2.4 μm

EMIR, MOS IN THE NIR: 0.9-2.4 μm, R_k=4000

- Star-forming rate: Hα , [OII]
- Chemical abundances in the ISM (O/H, N/O, etc) and physical properties of the gas
- Velocity dispersion: [OIII], [OII], Balmer lines; estimation of the mass, M/L
- Dynamical masses from rotation velocities

EMIR Scientific Exploitation

GOYA

CENTRAL PROGRAMME PROPERTIES OF THE GALAXIES AT 1.5 < z < 3

50% EGT

EAST

OPEN TO ALL OTHER PROJECTS
50% EGT

EAST: The Emir Associated Science Team

All astrophysical domains, NO GOYA : from solar system to extragalactic

Open group: http://www.iac.es/proyect/emir/emir.html

EAST main objectives are:

- Identify the scientific areas of interest
- Start designing and preparing the scientific proposals
- Prepare preliminary observing plans
- Present and discuss projects/first results in EAST meetings
- Make known the EMIR capabilities

SCIENCE WITH EMIR/ EAST:

INVITATION TO EAST
April 2004

RESPONSES FROM THE USER COMMUNITY
May –June 2004

→ **INITIAL LIST OF ASSOCIATES**

FIRST ASSOCIATES METING (IAC)
April 2004

→ **INFORMATION ABOUT EAST**
SCIENTIFIC TOPICS
CALENDAR FOR PROPOSALS

SECOND ASSOCIATES MEETING (IAC)
July 2004

↷ **FIRST PROPOSAL SUBMISSION**
DEADLINE SEP. 30TH

↷ **PRESENTATION OF THE PROPOSALS**

Ricardo Amorín	IAC
Alfonso Aragón Salamanca	University of Nottingham
Santiago Arribas	ESA / IAC / CSIC
Eduardo Battaner	Univ Granada
John Beckman	IAC
Narciso Benítez Lozano	JHU
José Antonio Caballero	IAC
Antonio Cabrera	IAC
Luz Marina Cairós	IAC
Nicola Caon	IAC
Ruth Carballo Fidalgo	U.Cantabria
Nicolás Cardiel	UCM/ CAHA
Conrado Carretero	IAC
Héctor Castañeda	IAC
José María Castro Cerón	STScI
Matilde Fernández	IAA
María Luisa García	GTC
Begoña García-Lorenzo	IAC
Francisco Garzón	IAC
Franco Giovanelli	Istituto di Astrofisica Spaziale
Denise Gonçalves	IAC
José Nicolás González	IAC
Cecile Gryl	VILSPA
Javier Gorgas	UCM
Ana Guijarro Román	Univ. Granada

Peter Hammersley	GTC
Artemio Herrero	IAC
Jorge Iglesias	LAM
Arturo Manchado	IAC
Esther Mármol	UCM
Isabel Márquez	IAA
Miguel Mas-Hesse	LAEFF
Eduardo Martín	IAC
Bruno Millard	LAM
Verónica Melo	IAC
Mariano Moles	IAA
Casiana Muñoz	IAC
Francisco Najarro	CSIC
Ismael Pérez	IAC
Ana Pérez García	IAC
Rafael Rebolo	IAC
José Ricardo Rizzo	Univ. Europea de Madrid
José Miguel Rodríguez	IAC
Patricia Sánchez	UCM
Marcos Santos	UCM / CAHA
Tariq Shahbaz	IAC
Guillermo Tenorio	INAOE
David Vals	LAT, OMP, Toulouse
Alexander Vazdekis	IAC
José M. Vílchez	IAA
Cristina Zurita	IAC

SCIENCE WITH EMIR/ EAST:

INVITATION TO EAST
April 2004

RESPONSES FROM THE USER COMMUNITY
May –June 2004

→ **INITIAL LIST OF ASSOCIATES**

FIRST ASSOCIATES METING (IAC)
July 2004

→ **INFORMATION ABOUT EAST**
SCIENTIFIC TOPICS
CALENDAR FOR PROPOSALS

SECOND ASSOCIATES MEETING (IAC)
November 2004

→ **FIRST PROPOSAL SUBMISSION**
DEADLINE SEP. 30TH

→ **PRESENTATION OF THE PROPOSALS**

EAST First meeting (held on 2th July, IAC)

1. Information about EAST
2. Discussion of the first scientific projects/ideas

12 talks covering very different astrophysical areas:

- Spectroscopic NIR follow-up of far-IR and Submm extragalactic sources (I. Pérez-Fournon)
- ALHAMBRA (M. Moles)
- Starbursts galaxies (C. Muñoz-Tuñón, L.M. Cairós, J.M. Vílchez)
- Stellar populations in early type galaxies (J.Gorgas, C. Carretero)
- Massive stars (P. Najarro , R. Rizzo)
- Inner Galaxy Sources (P. Hammersley)
- Post-AGB stars (A. Manchado)
- NIR spectroscopy of jovians planets (J.A. Caballero)

30 Sep. FIRST PROPOSAL SUBMISSION

FIRST EAST COMMENTS

DISCUSSION . EAST SECOND MEETING

EAST Second meeting : 11-12 November IAC

Presentation and discussion of the EMIR-EAST guaranteed time proposals.

OBSERVING TIME PROPOSAL EMIR-EAST GUARANTEED TIME: EMIR SCIENTIFIC GOALS

15 Proposals have been submitted

- Spectroscopic follow-up of wide-field multi-wavelength Sky Surveys
- Star-Formation:
  - Highly obscured regions of star-formation
  - Young Stellar Objects
- Structure of the Milky Way central regions
- AGB stars
- Stellar populations in nearby elliptical galaxies
- Starbursts
- The search for brown dwarfs/low mass stars and extrasolar planets

SUMMARY, COMMENTS …

Scientific Topics

- A total of 15 proposals have been submitted, covering a wide variety of scientific topics
  7 extragalactic proposals + 5 galactic / stellar physic projects

EAST split naturally in at least two scientific groups

- missing topics: solar system
  AGNs

- 2 proposals/projects are “Estallidos”

Starbursts and EAST

So far, lack of general projects focused on starbursts and AGNs, although The NIR is the optimal spectral regime to study starburst.

- Reduced extinction ($\Delta K \sim 0.11\ \Delta v$)

The IR regime contains a number of diagnostic features for probing the astrophysical of starburst galaxies:

- The Lyman continuum flux can be probed using hydrogen recombination lines (Paschen and Brackett series)
- The temperature of the ionizing field can be probed using suitable ratios of helium and hydrogen recombination lines
- Supernova rate can be obtained from [FeII] lines

Starbursts and EAST

- The age of the stellar population (e.g. Brγ)
- Warm molecular gas can be probed by H2
- Extinction can be derived from ratios of hydrogen recombination lines, ratios H2 or [Fe]
- A possible hidden AGN can be revealed by [SiV]1.96
- The kinematics can be study using absorption lines (CO)
- Dynamical mass can be derived

Starburst could/should be one of the main projects of EAST !!!!

TITLE: NEAR INFRARED MAPPING OF BLUE COMPACT DWARF GALAXIES: DISENTANGLING THE STARBURST AND THE OLD STARS

IP: Luz Marina Cairós Barreto

CoIs: N. Caon, R. Amorín, C. Muñoz-Tuñón, P. Papaderos, B. García-Lorenzo, A. Pérez, J.A. L. Aguerri

TITLE: SUPER GALACTIC WINDS IN THE LOCAL UNIVERSE

IP: Casiana Muñoz Tuñón

CoIs: V. Melo,J.M. Rodríguez-Espinosa, G. Tenorio-Tagle, S. Silich, I. Martínez-Delgado, L.M. Cairós

NIR MAPPING OF BLUE COMPACT DWARF GALAXIES: AN OBSERVING PROPOSAL FOR EMIR

L.M. Cairós, N. Caon, R. Amorín (PhD Thesis),

C. Muñoz-Tuñón, B.García-Lorenzo, A. Pérez-García,

J. A. L. Aguerri, P. Papaderos, K. Noeske

NEAR INFRARED MAPPING OF BLUE COMPACT DWARF GALAXIES: DISENTANGLING THE STARBURST AND THE OLD STARS

We aim to:

Take advantage of the unique capabilities of EMIR to perform the first comprehensive multi-wavelength analysis of a large sample of BCDs.

Obtain deep broad-band (JHKs) and narrow band imaging (Brγ), and high signal-to-noise spectroscopy of about 20 galaxies.

Combine these NIR spectrophotometric data with our previously collected and analyzed optical data in order to effectively disentangle and characterize the stellar populations in the sample galaxies.

We propose to use EMIR/GTC to perform a deep NIR spectrophotometric analysis of about 20 BCDs already observed in the optical.

We will obtain:

1. Deep broadband imaging: J, H, Ks

$\mu_{J,LIM}$ ~ 25 mag arcsec^{-2}

$\mu_{K,LIM}$ ~ 24 mag arcsec^{-2}

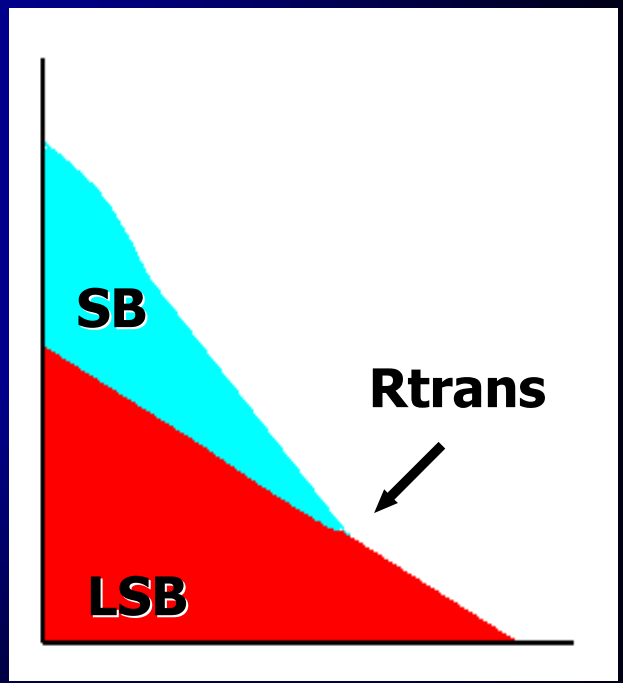
2. Deep narrowband imaging: Brγ

3. High signal to noise NIR spectroscopy: JG, HG, KG

1. DEEP BROAD-BAND IMAGING IN JHK$_s$

Unveil the properties of the galaxy host

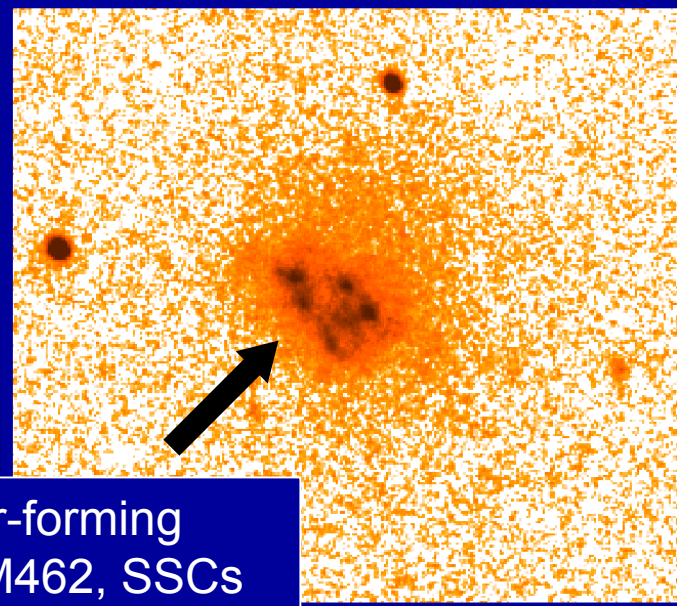
- Derive the light and color distribution of the galaxies outskirts
- Determine the structural parameters (n, Re, μe) of the underlying host, fitting a Sersic model
- Compare the distribution of the parameters in the Re--μe and Re-M diagrams with that of other dwarf galaxies
- Investigate structural and evolutionary links among different dwarf types



1. DEEP BROAD-BAND IMAGING IN JHK$_s$

Investigate the starburst properties

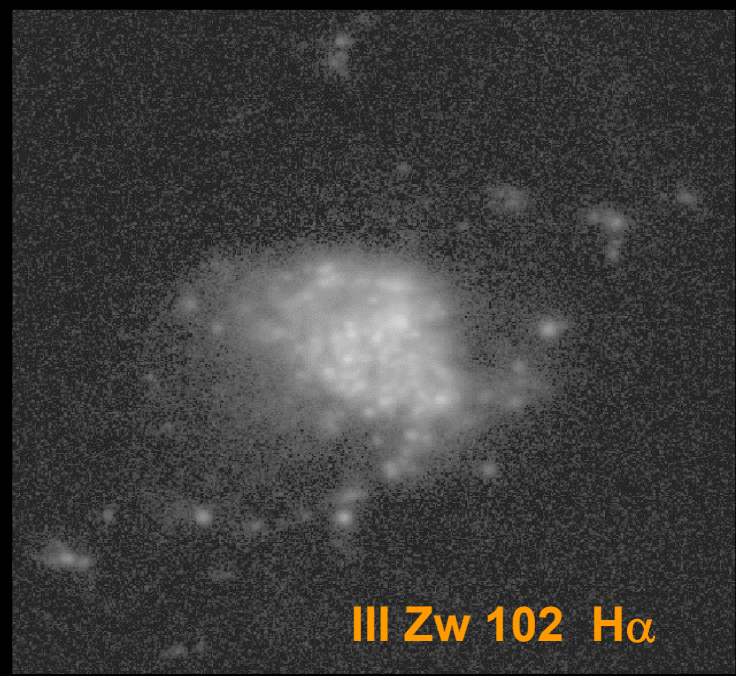
- Morphology, Super Stellar Clusters
- Map the dust distribution
- Map stellar populations: red super giants



Ring of star-forming knots in UM462, SSCs (Cairós et al. 2003)

2. DEEP NARROW BAND IMAGING (Brγ)

- Map the ionized gas morphology
- Delimit the starburst emission
- Measure the star-forming rate
- Estimate the age
- Perform 2-D subtraction of gas emission from the broadband frames



3. HIGH SIGNAL TO NOISE SPECTROSCOPY

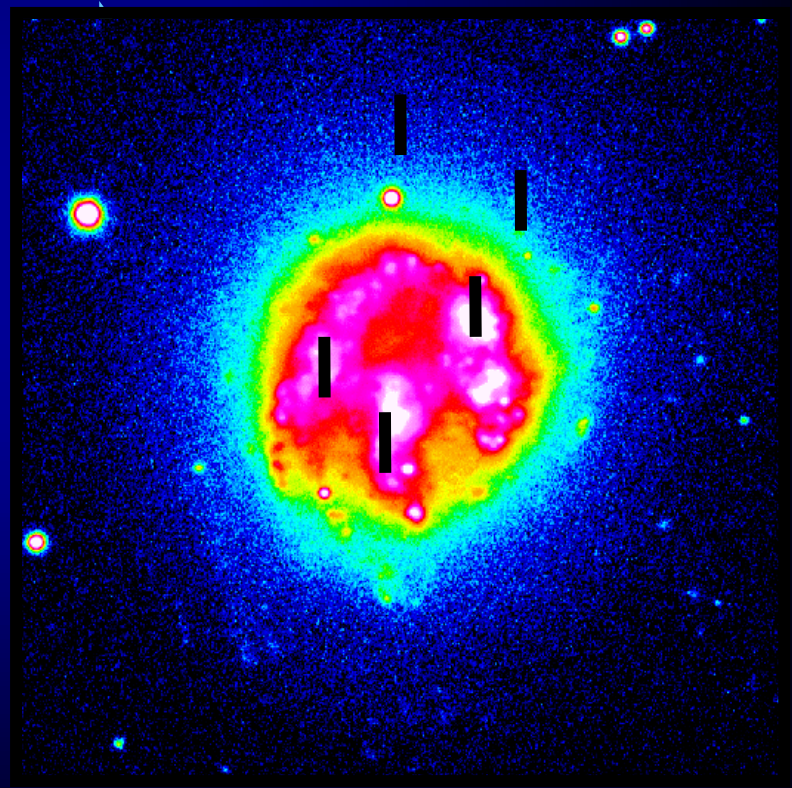
- We can estimate the extinction: **Pa**γ, **Pa**β ,**Br**γ
- Estimate the nebular contribution to the emission in order to decontaminate broad-band colors
- Search for absorption features such as the CO

  Constraint the stellar populations

  Study the kinematics of the stars
- Measure indicators of excitation mechanisms, such as [FeII]

3. HIGH SIGNAL TO NOISE SPECTROSCOPY

MOS allows to take simultaneously the spectra of several star forming knots, together with the spectra of selected regions of the galaxy free from the starburst emission (i.e. the host)



5. OBSERVATIONAL STRATEGY

We require the three EMIR observing modes:

Wide Field Imaging:

- JHKs imaging reaching comparable radius as in the optical

J ~ 24.5-25 mag arcsec^{-2}, K ~ 23.5-24 mag arcsec^{-2}

Texp, J ~ 8 minutes, Texp, H ~ 12 minutes, Texp, K ~ 20 minutes

- Narrow-band imaging

Exp. Time ~ 25 min + 25 min

Spectroscopy: long slit and MOS

Exp. Time ~ 60 min – 90 min

TOTAL :

Texp ~ 5 h compact galaxies

Texp ~7 h large galaxies

6 galaxies ~ 3 nights

20 galaxies ~ 10 nights

Super vientos galácticos.
Modelado y estudio en el universo local

PROPUESTA OBSERVACIONAL PARA **EMIR**

IP: C. Muñoz-Tuñón

V. Melo , J. M. Rodríguez-Espinosa, I. Delgado, S. Silich, G. Tenorio-Tagle, L.M. Cairós

Super vientos galácticos. Modelado y estudio en el universo local

PROPUESTA OBSERVACIONAL PARA **EMIR**

IP: C. Muñoz-Tuñón

V. Melo , J. M. Rodríguez-Espinosa, I. Delgado, L.M. Cairós, S. Silich, G. Tenorio-Tagle

Objetivos del proyecto

Determinar la estructura interna de las galaxias con starburst nuclear, para entender la hidrodinámica dentro de su volumen central así como los eventos que definen la física en el núcleo y los supervientos galácticos.

Obtener imágenes en banda estrecha (Brγ, H2, FeII) y espectroscopía de una muestra de galaxias starburst.

Justificación científica

Galaxias starburst:

- Son brotes violentos de formación estelar
- Son muy luminosas sobre todo en el infrarrojo (L_{FIR}=2 x 10^{10} – 2 x 10^{13} L_o, *Kennicutt 1998*)
- Ricas en polvo (en NGC 253 M_{dust}=8.2 x 10^7 M_o, Melo et al. 2002)
- Provocan muchos procesos físicos de interacción: fotoionización del gas por estrellas calientes, vientos estelares, formación de super-burbujas y vientos galácticos...

Evolución de un estallido estelar

Cúmulo de estrellas jóvenes y masivas

↓

Liberan material a altas velocidades
→ se forman arcos y filamentos

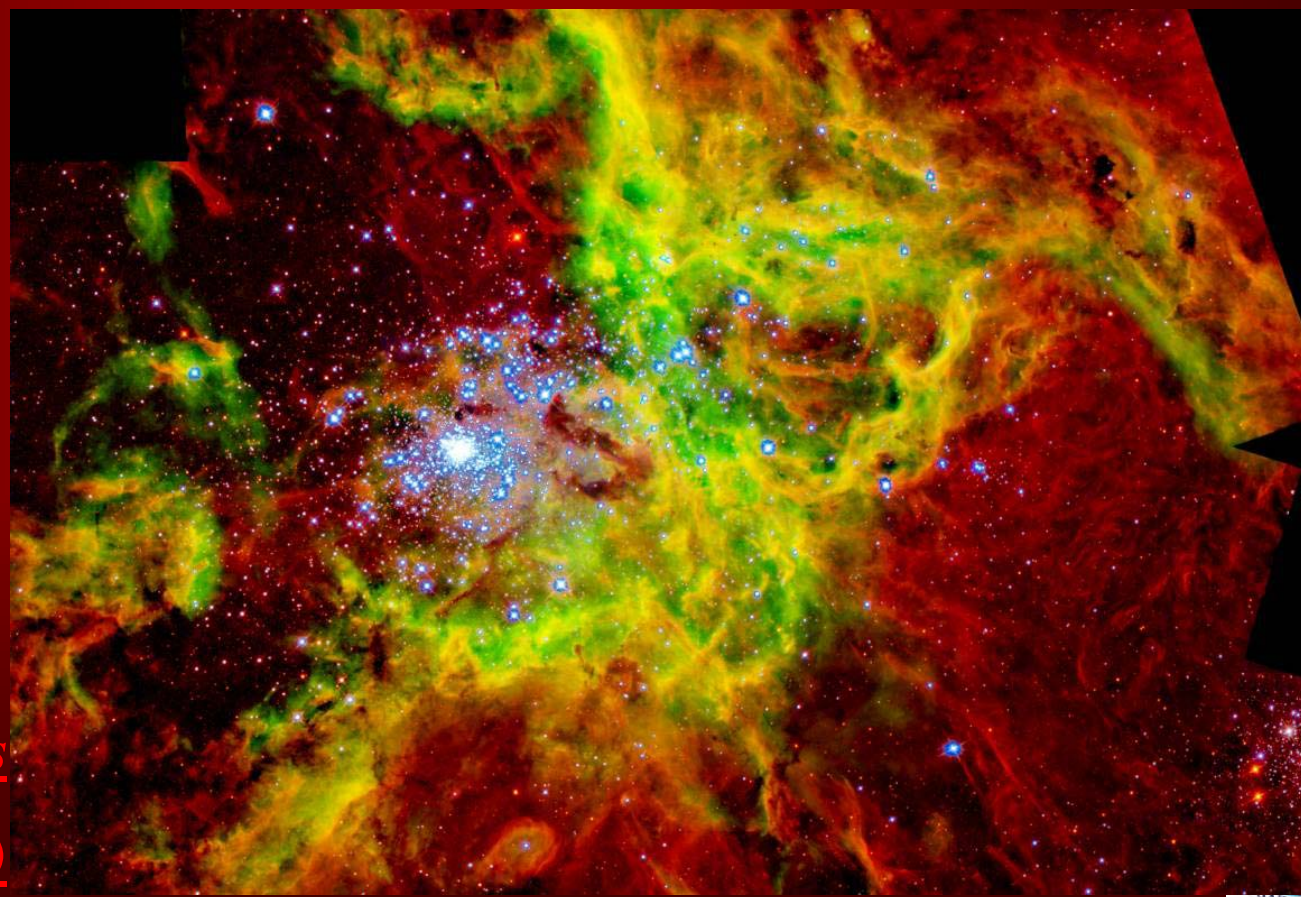
Flujo de fotones ionizantes
→ emisión en el ultravioleta

Principales fuentes de energía:

-Vientos estelares

-Explosiones de supernovas

-Radiación ionizante

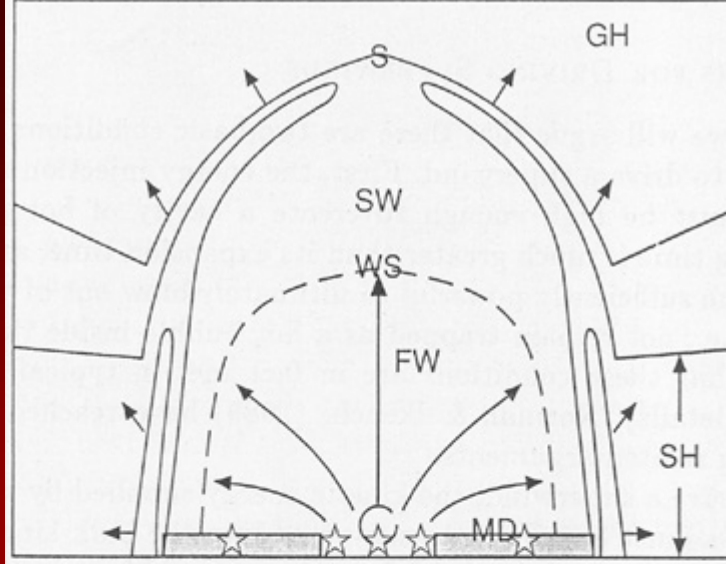


30 Dorados

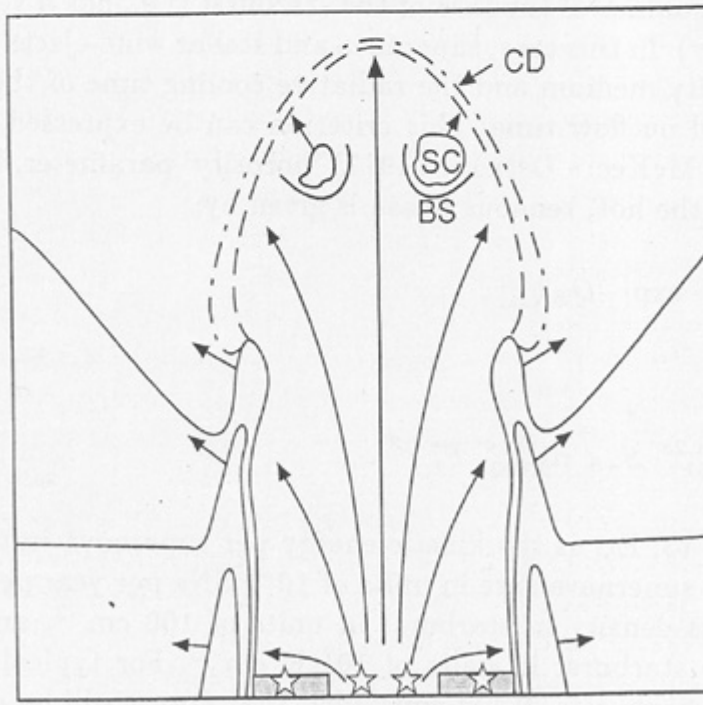
(J. Maíz-Apellániz)

Rotura de la burbuja

- **Vientos estelares** expulsan material violentamente al medio (FW)
- Empieza a **barrer el medio** se forma **onda de choque externa**
- El material se frena dentro de la burbuja y se comienza a **termalizar** a partir de una **onda de choque interna**
- Tenemos dos **medios**, el **termalizado** (a altas temperaturas $T>10^7$-10^8 K, SW) y el **barrido** separados por discontinuidad de contacto ➔ el medio interestelar se va enriqueciendo

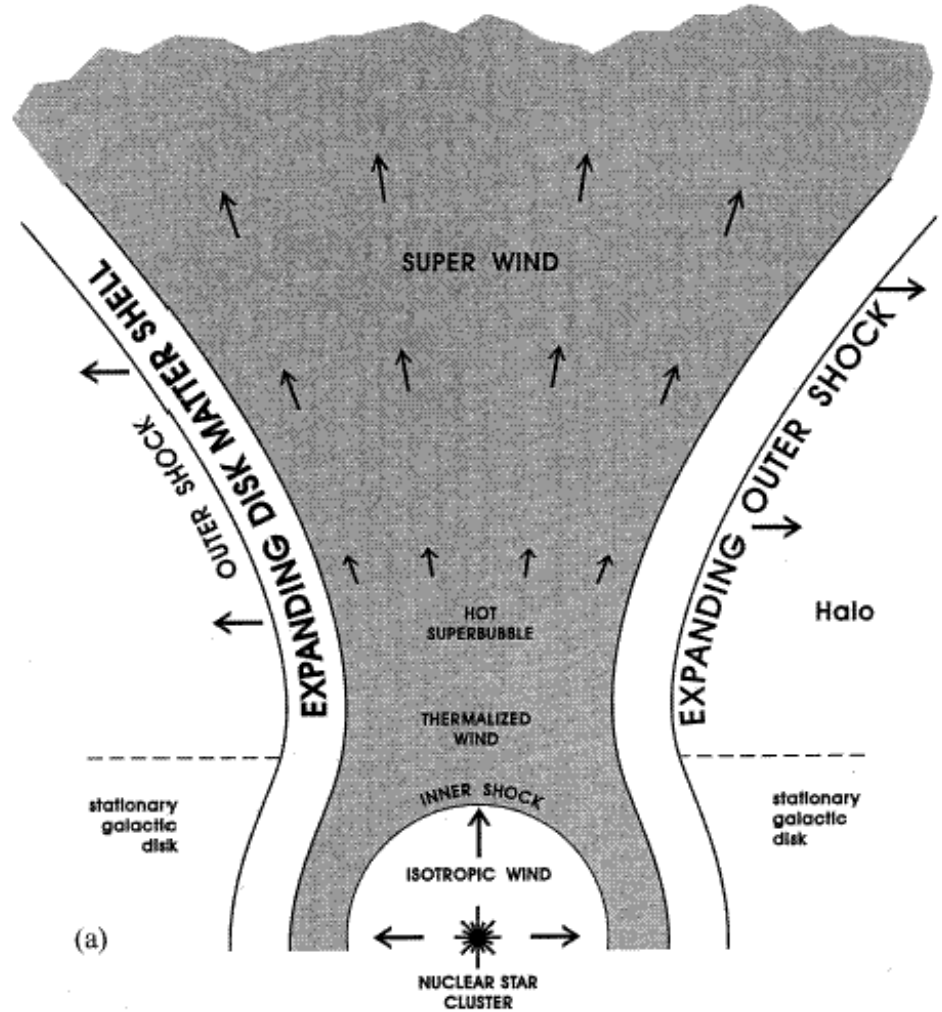


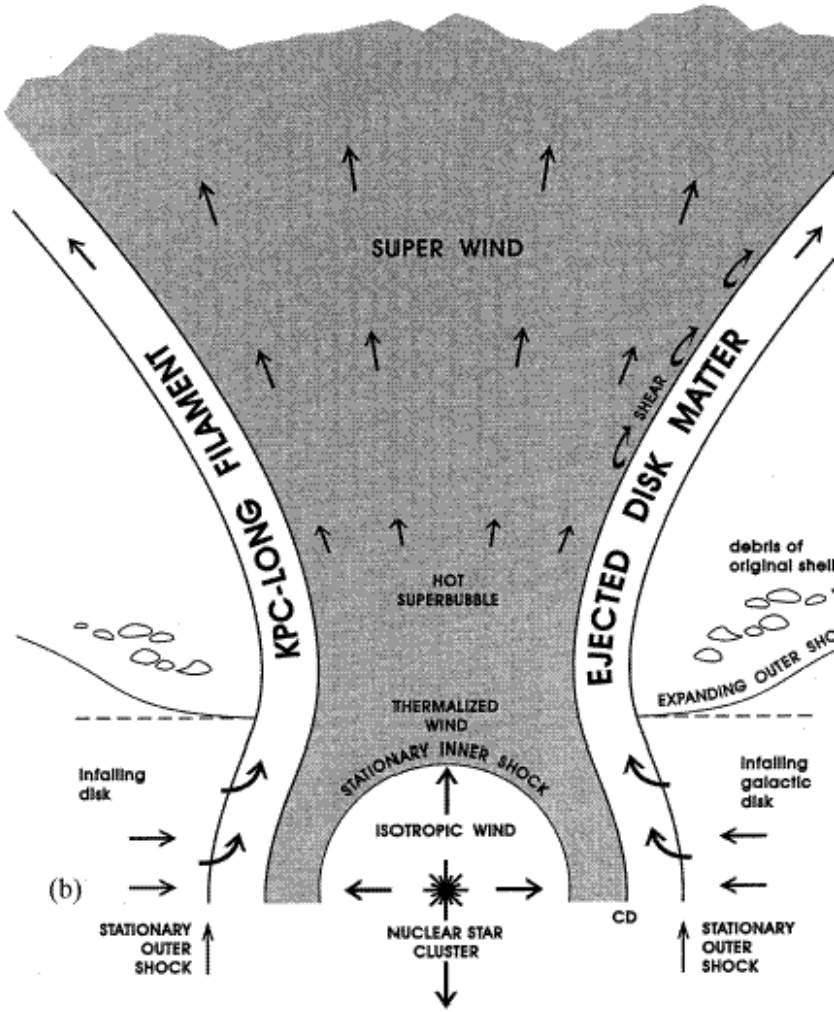
Heckman y Lehnert (1993)



- Gradiente negativo de densidad ➔ rompe la burbuja ("blow-out")
- El cascarón sufre la inestabilidad de Rayleigh-Taylor y se fragmenta
- Si alcanza el halo de la galaxia se forman los supervientos galácticos, si no un segundo "blow-out"

Modelos de Super Vientos Galácticos I





Tenorio-Tagle y Muñoz-Tuñón (1997, 1998)

Super Cúmulos Estelares

- Los SSC son cúmulos de estrellas muy compactos, jóvenes y con altas luminosidades *(Ho 1997)*
- HST los muestra como las unidades de los starbursts

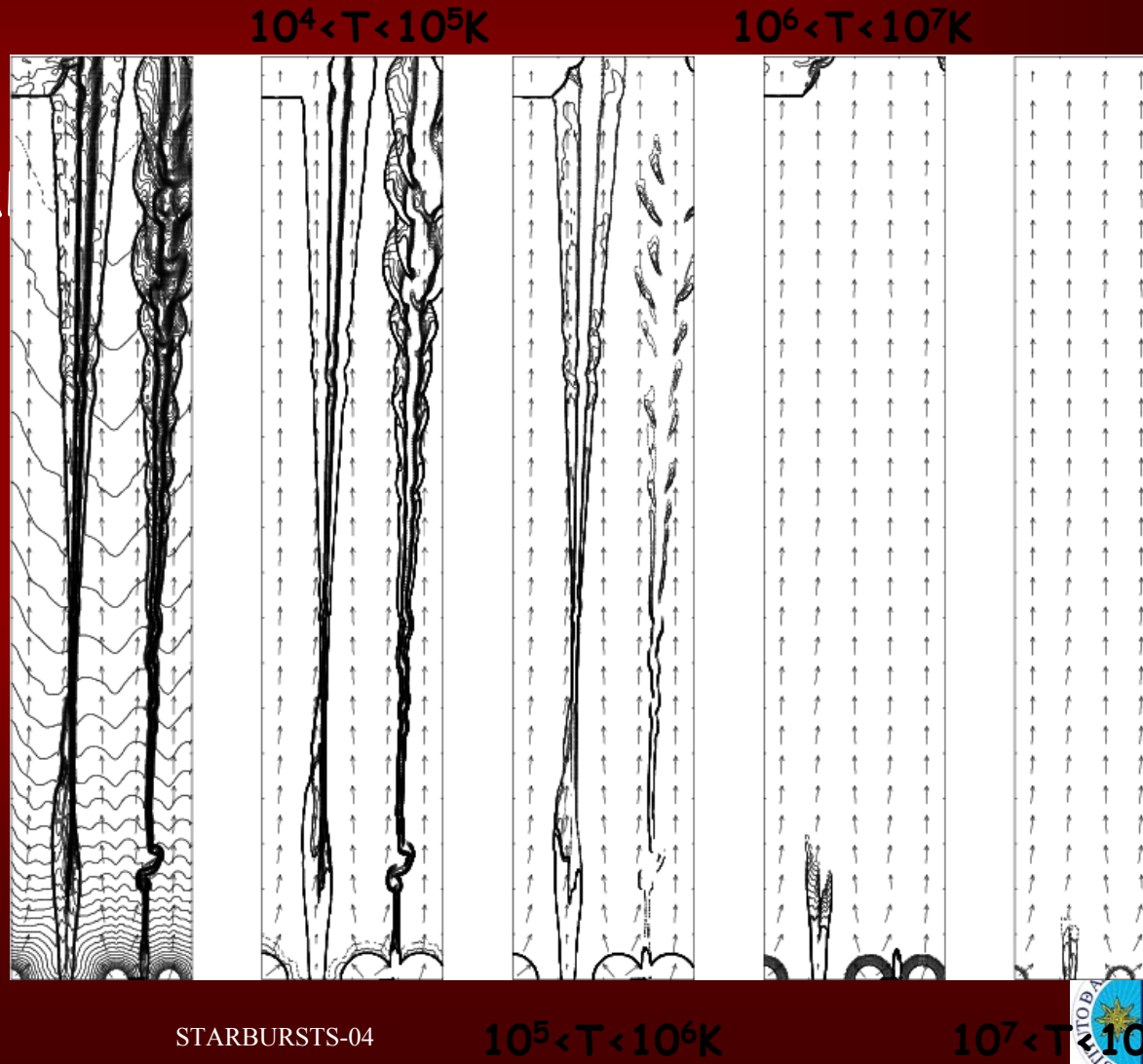
- Principales rasgos:
  1. Masivos: > 10^4 M_o (Strickland y Stevens, 1999)
  2. Pequeños: R ~ 1-6 pc (van den Bergh, 1995)
  3. Muy jóvenes: 1-10 Ma
  4. Muy luminosos. Con luminosidades bolométricas de hasta 10^{40}-$10^{42.5}$ (Strickland y Stevens, 1999).

Modelos de Super Vientos Galácticos II

Tenorio-Tagle et al., 2003, ApJ, 597, 279

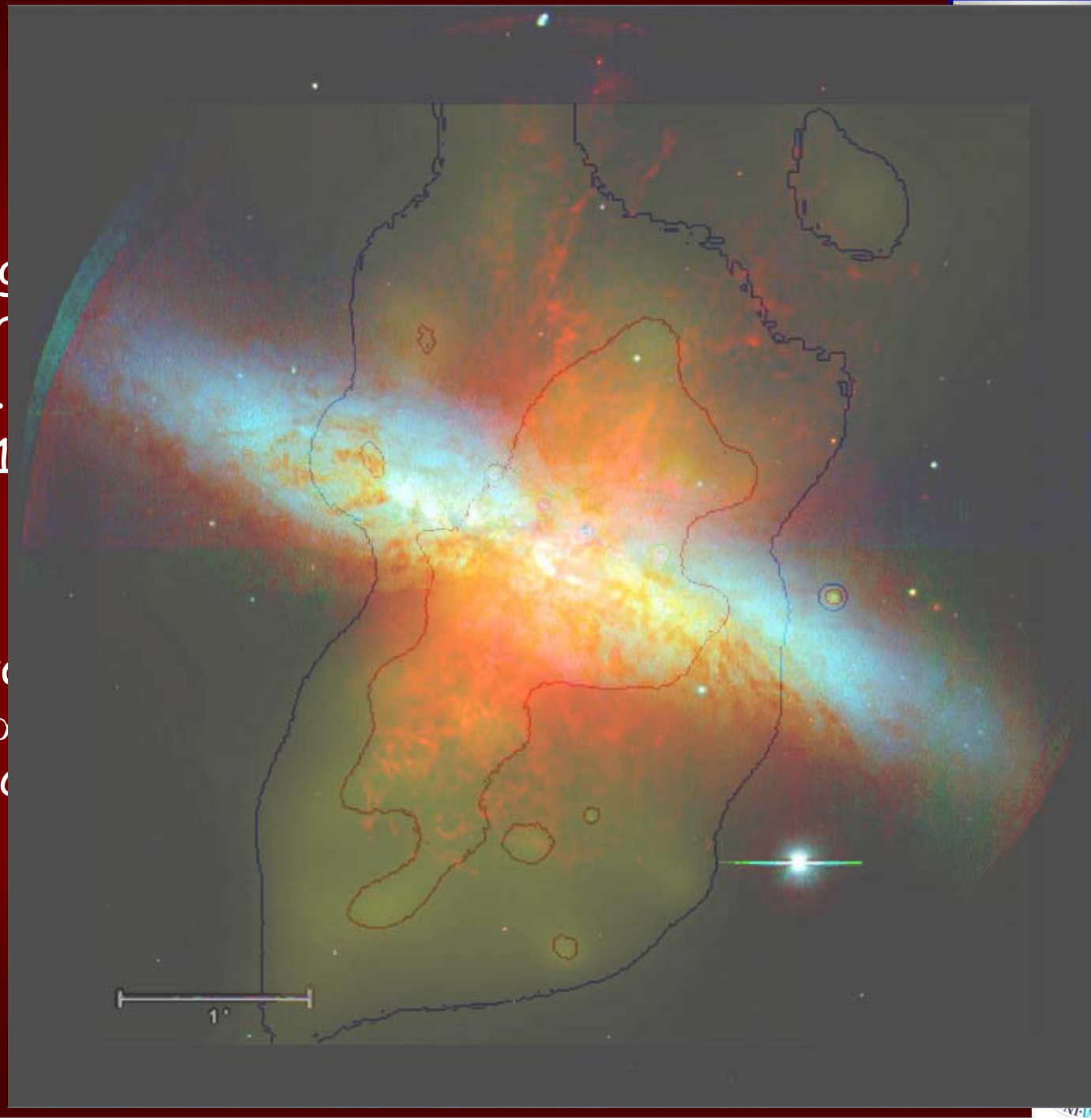
Cada SSC tiene su onda de choque interna oblicua. A través de esta se expulsa material rico en metales hasta kpc y a altas velocidades (cientos de km/s) en forma de filamentos como los de M82.

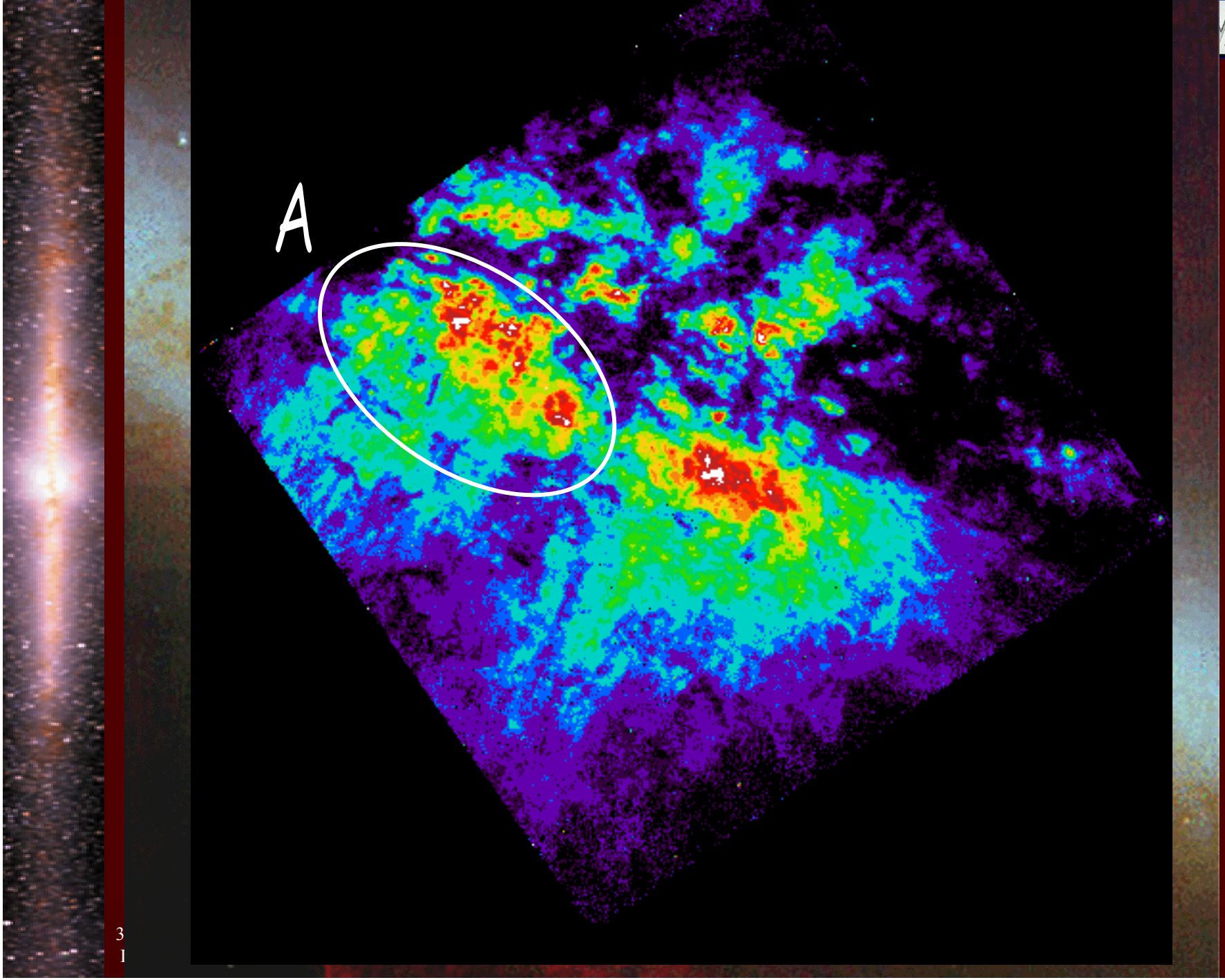
- *Va a depender de las edades y distancias entre los SSC para que se puedan acoplar.*
- *El conjunto esta autocolimado*

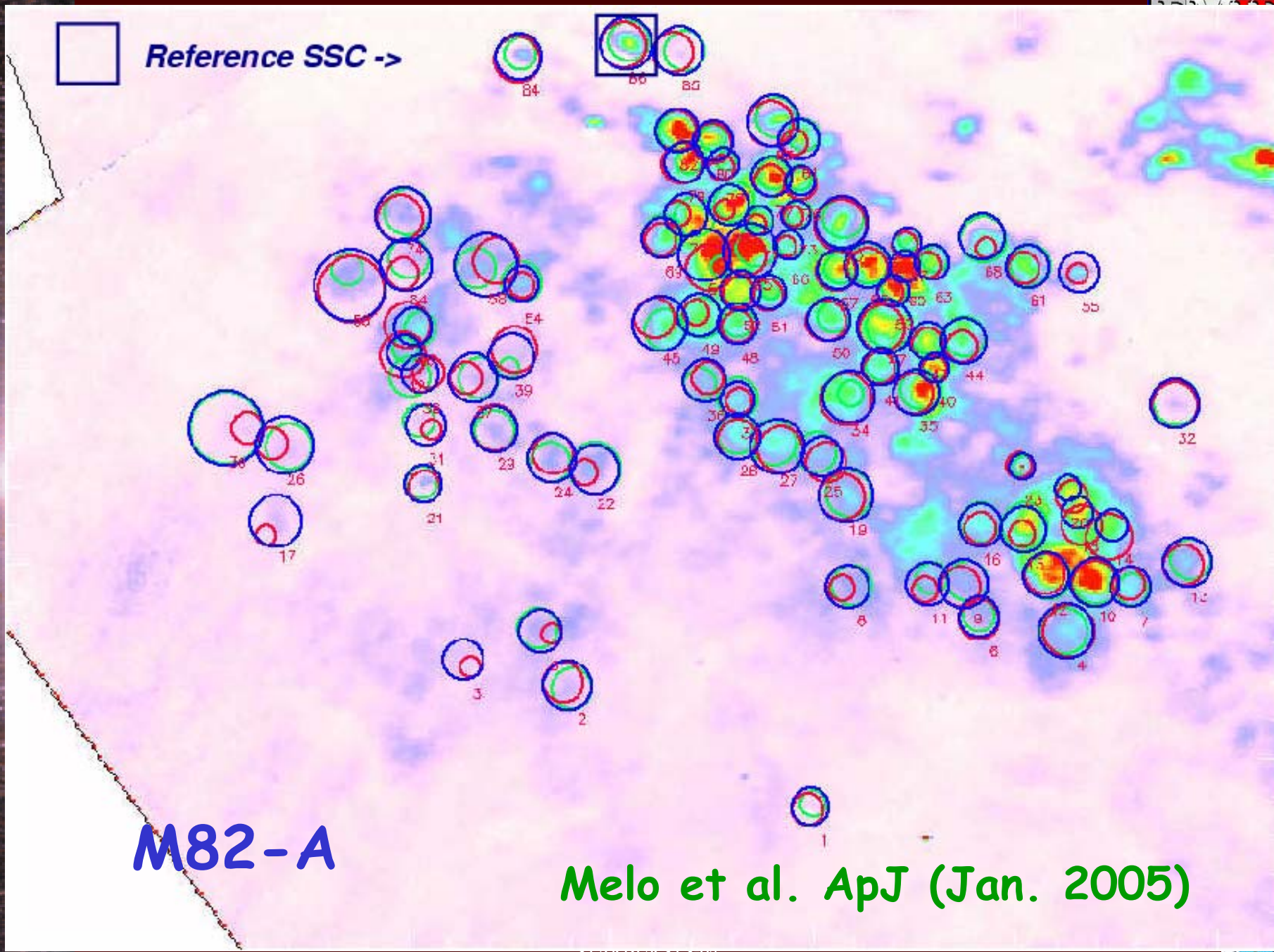


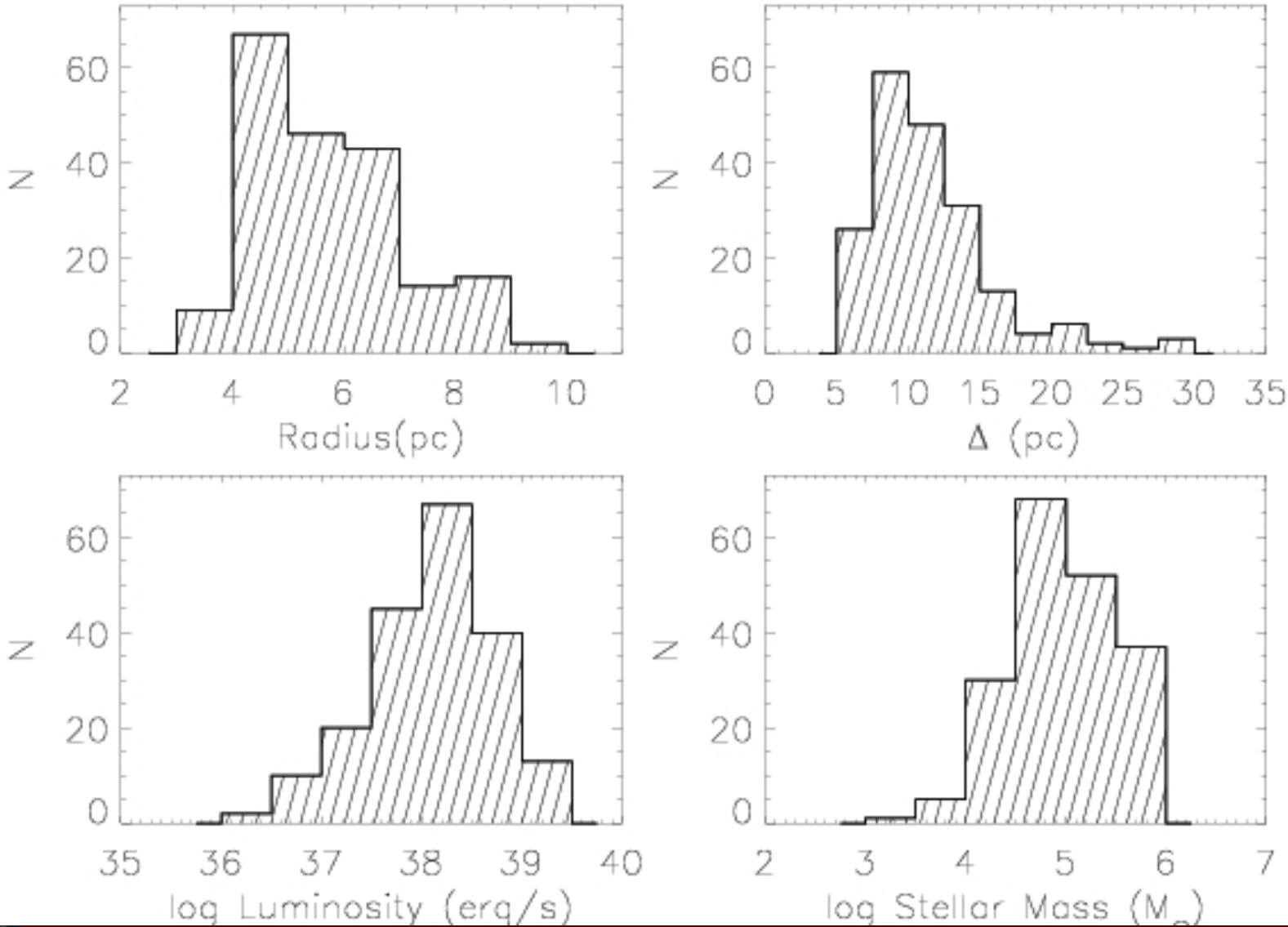
- M82 es una g
  irregular cer
- Distancia: 3.
- Escala: 1″ = 1

Ha sido observ
SUBARU en Ho
resultado espe
➔




A


Reference SSC ->
M82-A
Melo et al. ApJ (Jan. 2005)


N
60
40
20
0
2
4
6
8
10
Radius(pc)
N
60
40
20
0
0
5
10
15
20
25
30
35
Δ (pc)
N
60
40
20
0
35
36
37
38
39
40
log Luminosity (erg/s)
N
60
40
20
0
2
3
4
5
6
7
log Stellar Mass (M⊙)

Galaxia	No.SSC	Area(pc)	Escala	Densidad
M82	197	563.5 x 563.5	1p = 0.805pc (1″= 17.5pc)	620
NGC4631	102	5824 x 1674	1p = 3.64pc (1″= 38.4pc)	10
NGC253	48	462 x 380	1p = 1.65pc (1″= 16.5pc)	48

Galaxia	R	Δ	L	F/area	M
M82	5.7	12	3.2×10^{38}	8.5×10^{-17}	1.7×10^{5}
NGC4631	26	108	9.1×10^{37}	2.65×10^{-18}	2.3×10^{4}
NGC253	5.0	31	1.6×10^{39}	4.6×10^{-17}	3.0×10^{5}

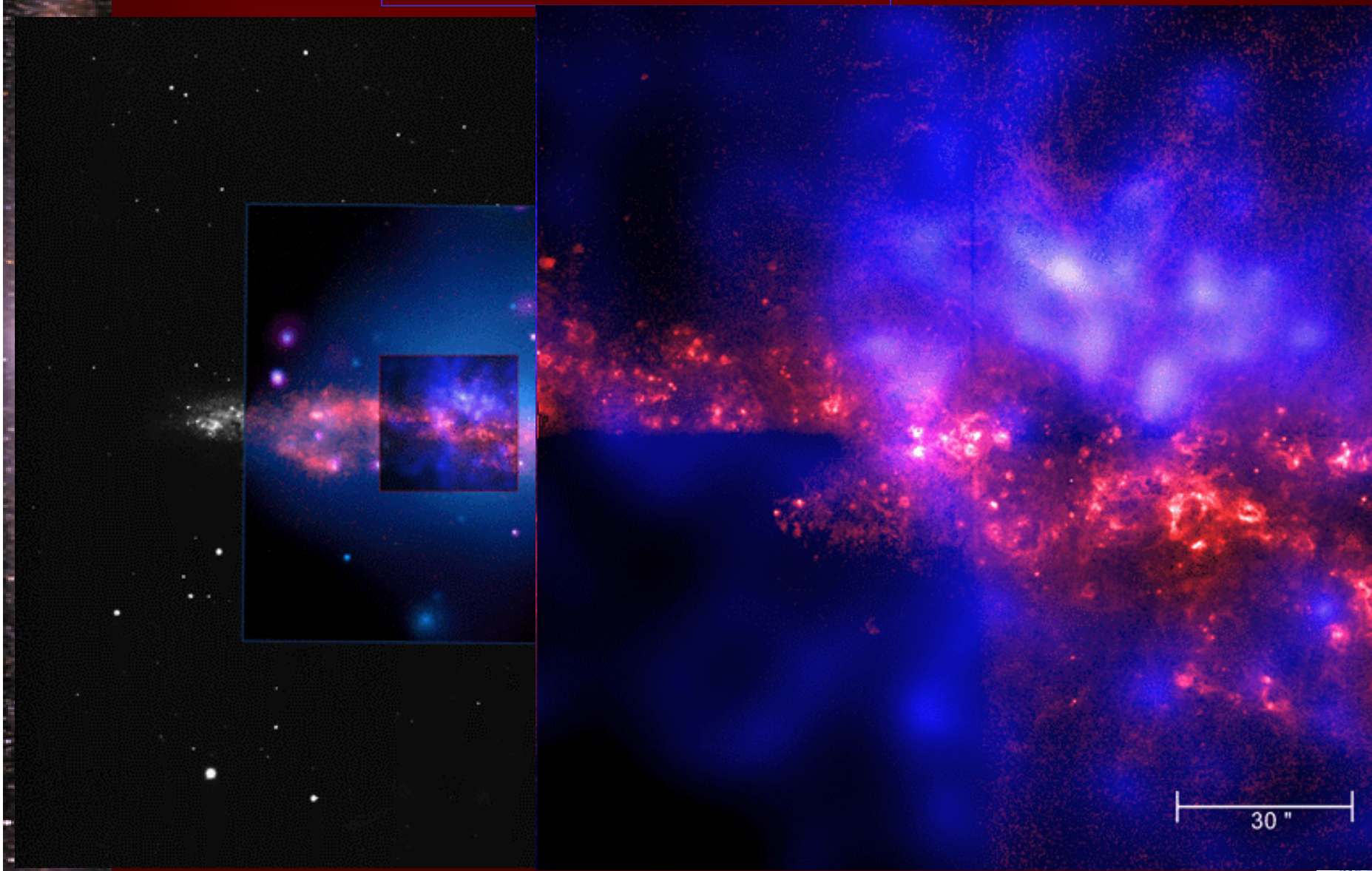
NGC 4631

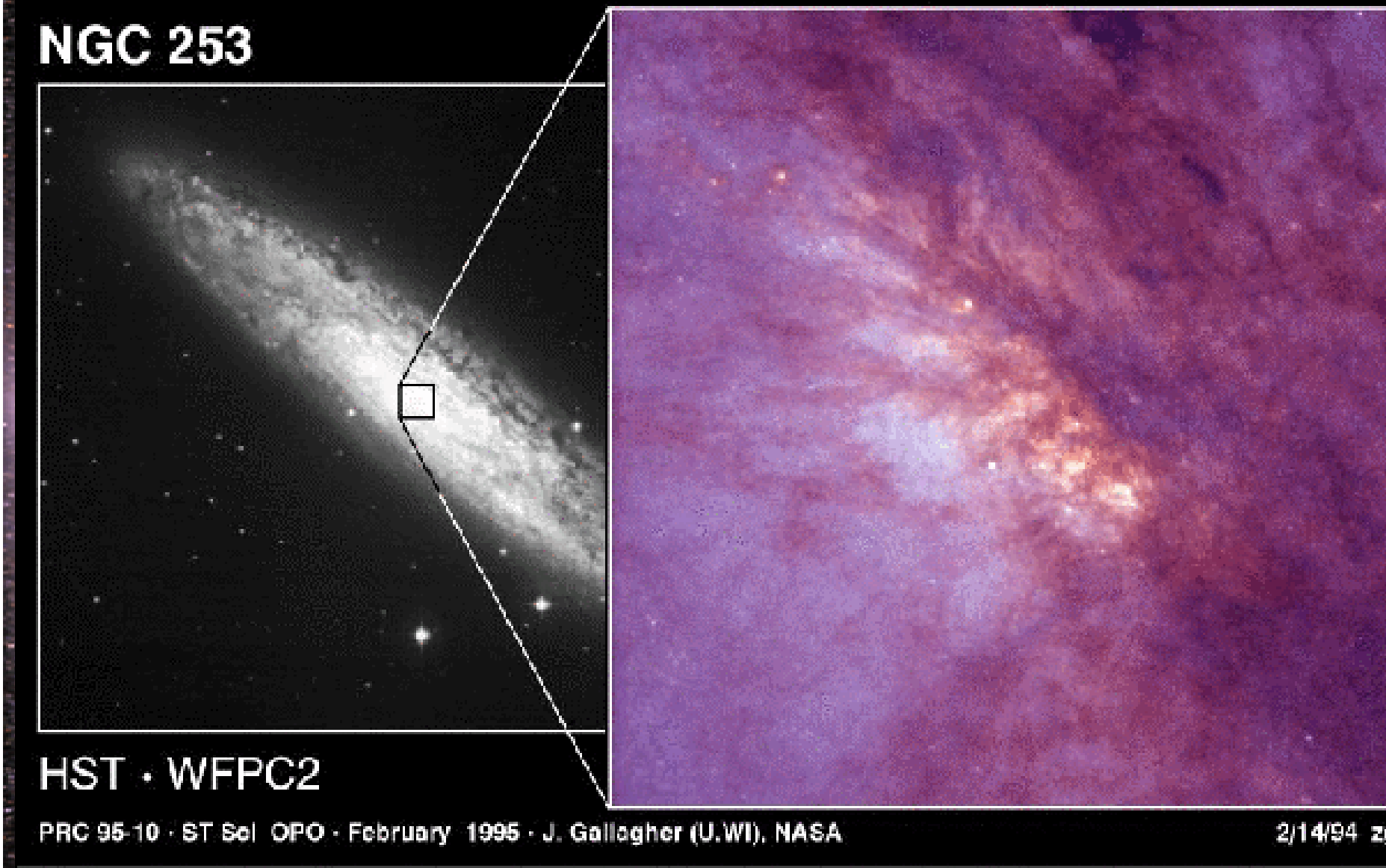
Óptica – NOAO/aura/NSF

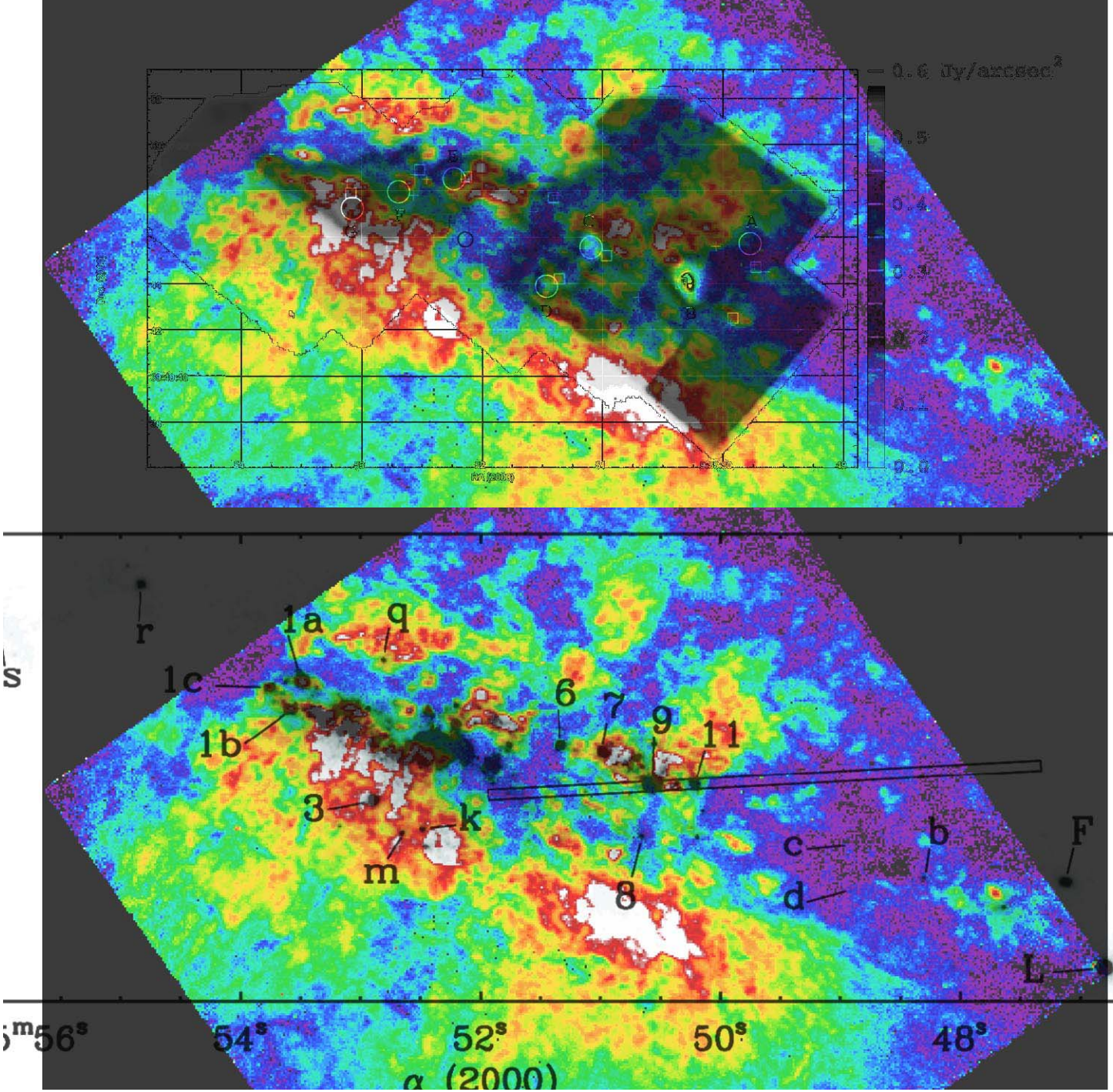
Rayos-X – NASA/Umass/D.Wang et al.

UV – NASA/GSFC/UIT

Óptica-Hα – NASA/HST/D.Wang et al.




NGC 253
HST · WFPC2
PRC 95-10 · ST ScI OPO · February 1995 · J. Gallagher (U.WI), NASA
2/14/94



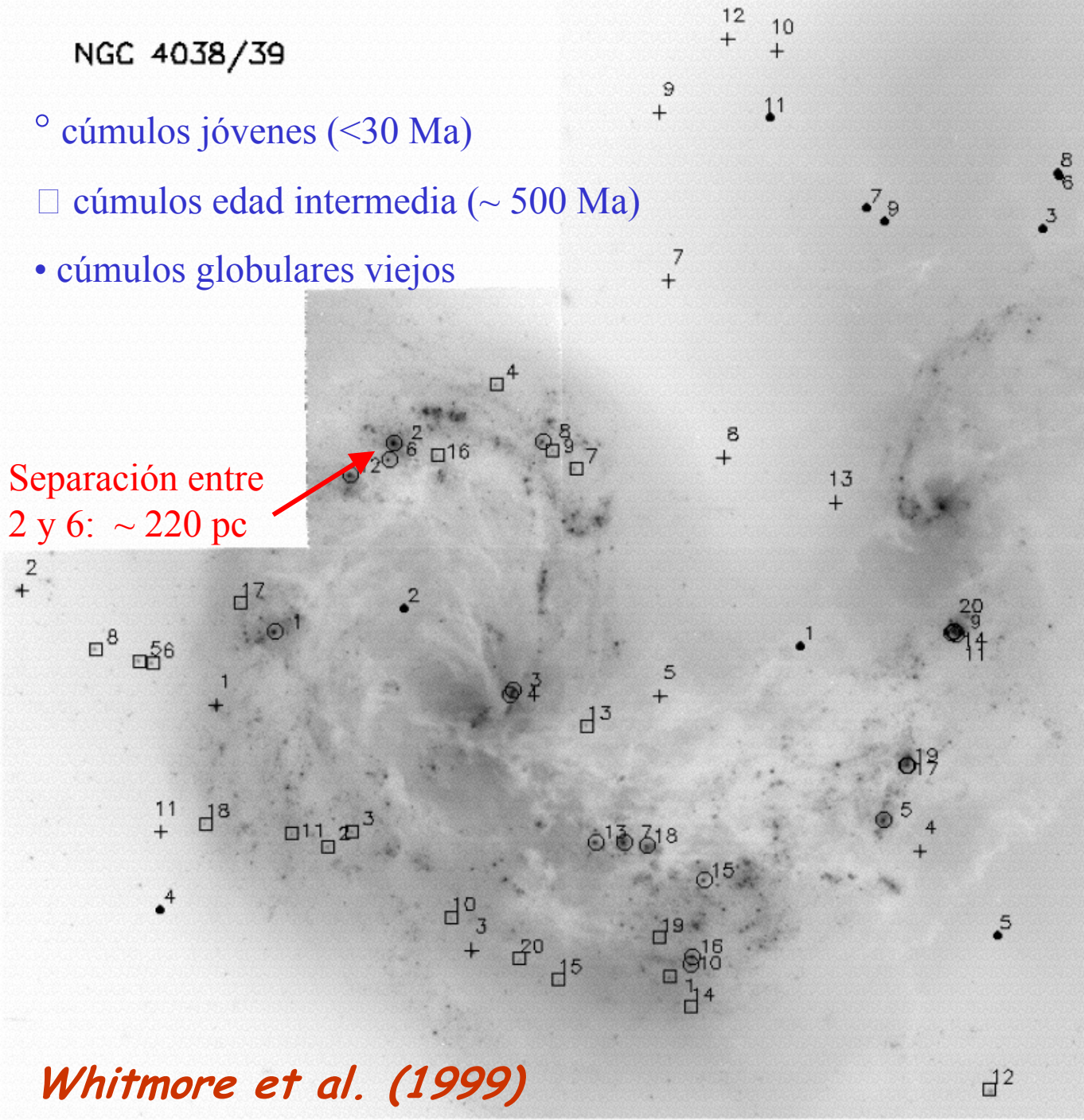
EMIR

NIR (2mm):

McCrady et a
2003

MIR (11.7mm

Lipscy et al
2004


NGC 4038/39
° cúmulos jóvenes (<30 Ma)
□ cúmulos edad intermedia (~ 500 Ma)
• cúmulos globulares viejos
Separación entre
2 y 6: ~ 220 pc
Whitmore et al. (1999)

M82-Hα+[NII] ratio to continuum (pseudo EW) - WIY

Linda Smith & Jay Gallagher, 200

Colaboration to find clusters-wind connecti

HST prop

Objetivos inmediatos:

-Tomar imágenes en banda estrecha (FeII, H2 y Brγ)

-Tomar espectros de alta S/R en J, H y K

Información que podemos extraer de los datos:

-EMIR es capaz de resolver los SSC

-Descubrir la base de los filamentos

-Medir los parámetros de excitación y gas chocado de las paredes de las burbujas individuales de los SSC que están interactuando.

Información que podemos extraer de los datos(cont.):

-detección detallada de la estructura de los filamentos en el NIR

-metalicidad del gas en las burbujas

-Variaciones espaciales de la emisión de las líneas de FeII y H2 que representan el gas chocado, de Brγ que nos informa del gas ionizado y la banda de CO que nos habla del gas molecular fuera de las burbujas de los SSC

Muestra de galaxias:

Incluiremos galaxias como M82, NGC 4631, NGC253, VIIZw403, etc. La muestra final esta por definir. Utilizaremos los archivos de datos del HST y SPITZER

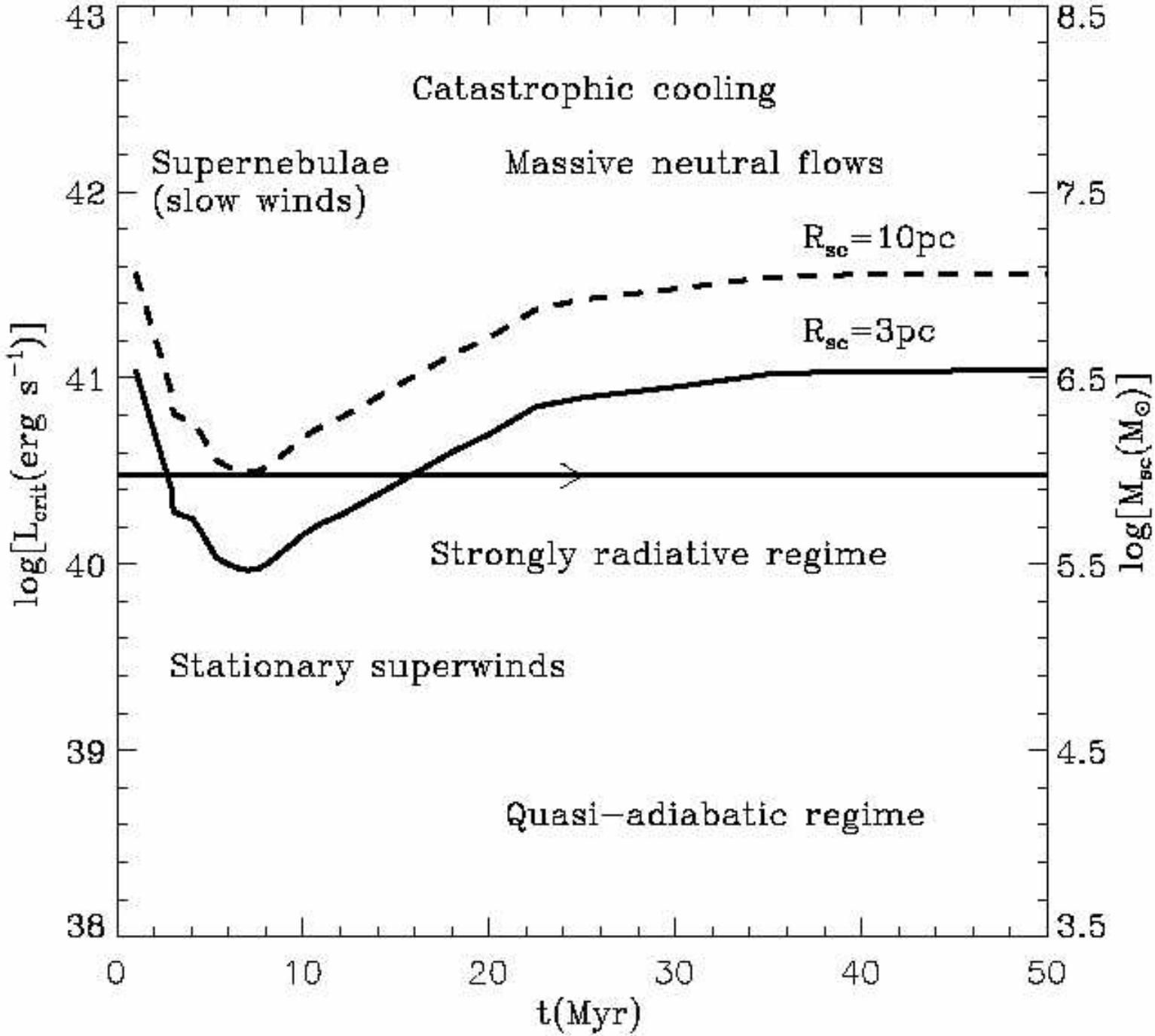
Impacto de los resultados:

-Observaciones son cruciales para determinar los mecanismos de formación de los SGWs y caracterizar la interfase entre las burbujas ionizadas y el medio interburbujas

-Porque los SSC de algunas galaxias son capaces de expulsar material fuera de la misma y otros no.

-Las observaciones en el IR son esenciales para estudiar el estado de SUPERNEBULOSA (Tenorio-Tagle et al. ApJ Feb. 2005)

-Nos permitirá distinguir los cúmulos ocultos en el óptico, si son debido a la extinción, a que son pre-SSC, están en fase de supernebulosa


Catastrophic cooling
Supernebulae
(slow winds)
Massive neutral flows
R_{sc}=10pc
R_{sc}=3pc
Strongly radiative regime
Stationary superwinds
Quasi−adiabatic regime
log[L_{crit}(erg s^{-1})]
log[M_{sc}($M_\odot$)]
t(Myr)
43
42
41
40
39
38
8.5
7.5
6.5
5.5
4.5
3.5
0
10
20
30
40
50

Otras propuestas enviadas:

-XMM: para AO-4 (Oct.04). Nos aceptaron una propuesta enviada a AO-2 (Oct.01) con prioridad C.

-FRIDA: espectroscopia de alta resolución espacial en núcleos de starburst potentes.

-OSIRIS: imágenes profundas en múltiples filtros ópticos

Por que EMIR y GTC?

-GTC/EMIR será capaz de resolver los SSC y los filamentos

-Nos va a permitir hacer espectroscopia de decenas de regiones simultáneamente

-EMIR es ideal además por su campo (6' x 6' en modo imagen) permitiéndonos observar toda la galaxia con buena resolución.

- El NIR es esencial para nuestro proyecto

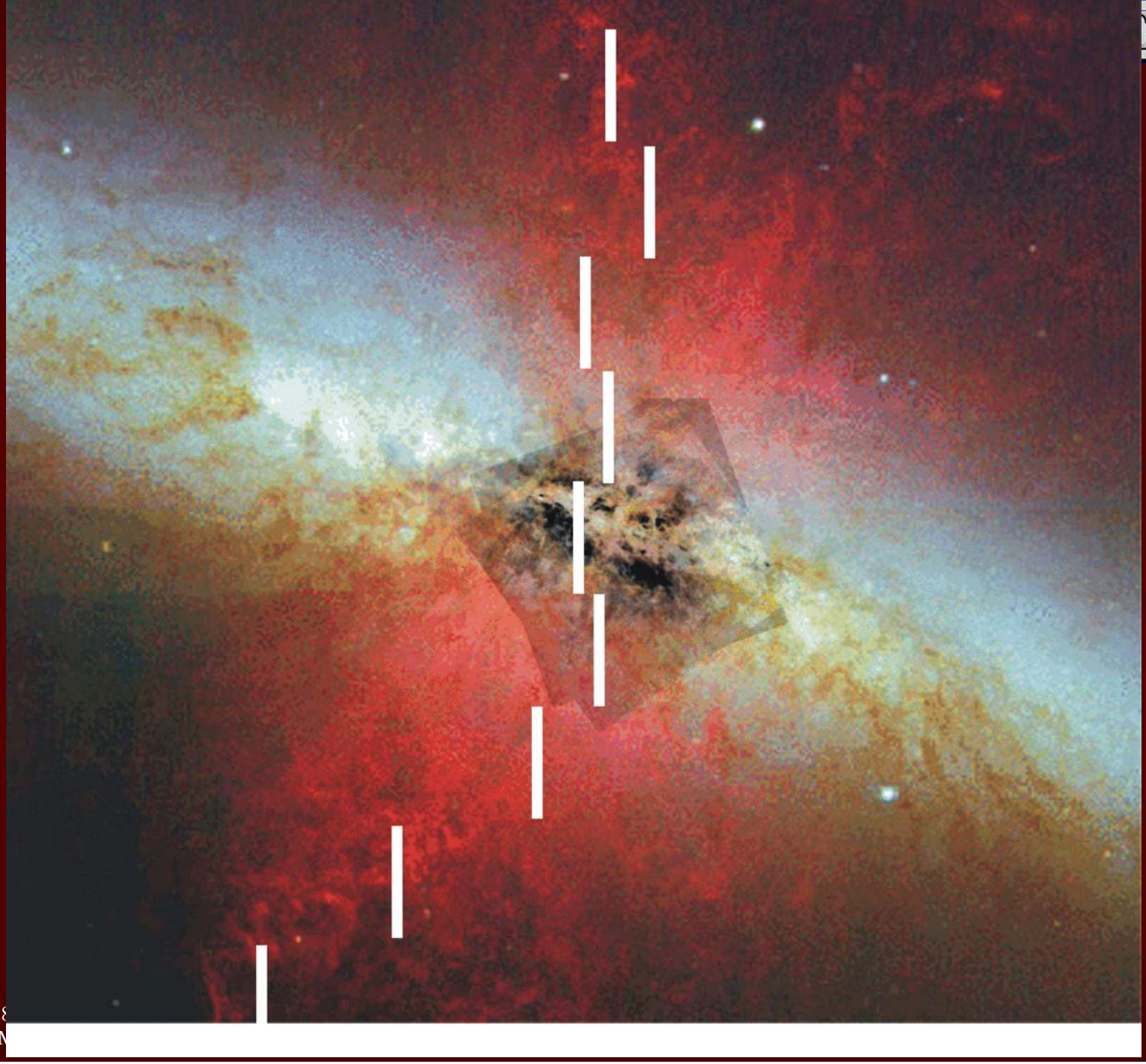
Estrategia observacional: Modos de observacion y tiempos

Imagen en banda estrecha: 10 min. en Brg, 20 min. en H2 (continuo para Brg y H2, 10 min.) y 50 min. en FeII (continuo, 40 min.).

Espectroscopia: en J, H y K, 1000s cada espectro

Tiempo total por galaxia => ~ 3 horas

Para una muestra de unas 10 galaxias => 30 horas



Objetivos del proyecto

Determinar la estructura interna de las galaxias con starburst nuclear, para entender la hidrodinámica dentro de su volumen central así como los eventos que definen la física en el núcleo y los supervientos galácticos.

Obtener imágenes en banda estrecha (Brγ, H2, FeII) y espectroscopía de una muestra de galaxias starburst.

Why observing in the NIR ?

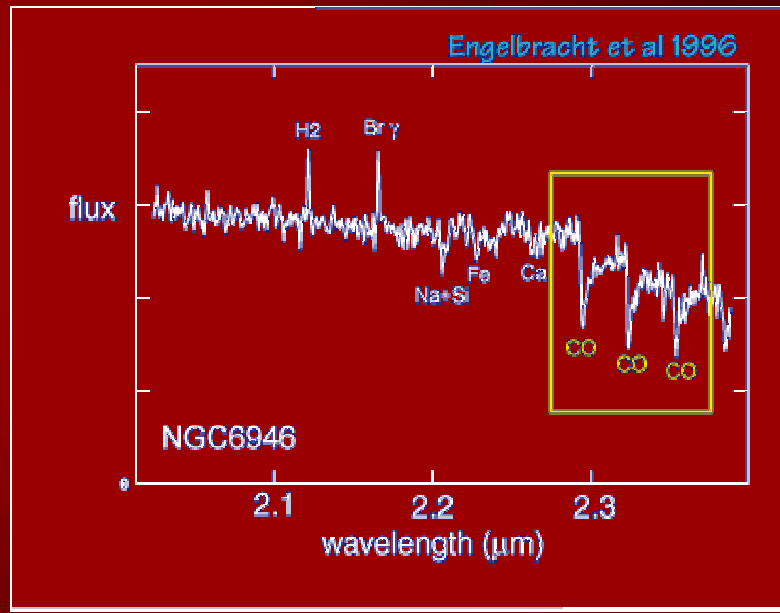
3. Better traces the smaller cooler stars

objects much too cool and/or faint : cool stars, IR galaxies, nebulae, interstellar molecules, brown dwarfs and planets.

4. Spectral features in the NIR ➡ stellar populations and kynematics

<u>Absorption features</u> as, e.g., CO λ 1.69-2.3 μm, CaT, powerful tools to determine the age of the starburst and the stellar populations properties of elliptical galaxies

<u>Emission lines</u>, e. g., [FeII] 1.64 μm : tracer of supernova remnants, H_2 Bracket lines, Paschen lines



SCIENCE WITH A K-MOS







SCIENCE WITH A K-MOS

EXPLORING THE EARLY UNIVERSE

1. DEEP MULTICOLOR SURVEYS:

studying galaxy formation and evolution

K-band: direct sensitivity to the galaxy stellar mass, rather than to the ongoing/recent star formation –allow to detect/study massive galaxies at high z .

Allow to study and derive photometric redshifts,

- High redshift massive galaxies; red-galaxies
- AGNs/ quasars
- Population III objects

2. PROBING THE UNIVERSE AT z > 1

Measuring the physical parameters of the galaxies at z > 1 using the same parameter space as for galaxies in the local Universe

3500 – 8000 μm, if z=1.5 0.9 – 2 μm

if z=2 1.05 – 2.4 μm

EMIR, MOS IN THE NIR: 0.9-2.4 μm, R_k=4000

- Star-forming rate: Hα , [OII]
- Chemical abundances in the ISM (O/H, N/O, etc) and physical properties of the gas
- Velocity dispersion: [OIII], [OII], Balmer lines; estimation of the mass, M/L
- Dynamical masses from rotation velocities

3. GALAXY DYNAMICS AND FUNDAMENTAL CORRELATIONS AT HIGHREDSHIFT

e.g. Tully-Fisher relation, fundamental plane for elliptical galaxies.

Only possible to achieve the require S/N with large telescope.

A MOS allow to observe high z-clusters at reasonable exposures times !!

Exploring the early universe: ongoing projects

GOODS (The Great Observatories Origins Deep Survey)

public multiwavelengh survey, covering ~320 arcmin^2

Hubble Deep Field-North and Chandra Deep Field-South

GOODs@ESO project: optical/NIR observations of the CDF-S

ISAAC@ANTU, JHKs images of CDF-S, 32 positions

J < 25.3 H < 24.8 Ks < 24.4

(P.I.: Cesarsky)



J H Ks composite color of the CDF-S

ISAAC/VLT 8 fields = 50arcmin^2

~ 1.4 FIELDS WITH EMIR !!

FIRES: Faint Infra-Red Extra-galactic Survey

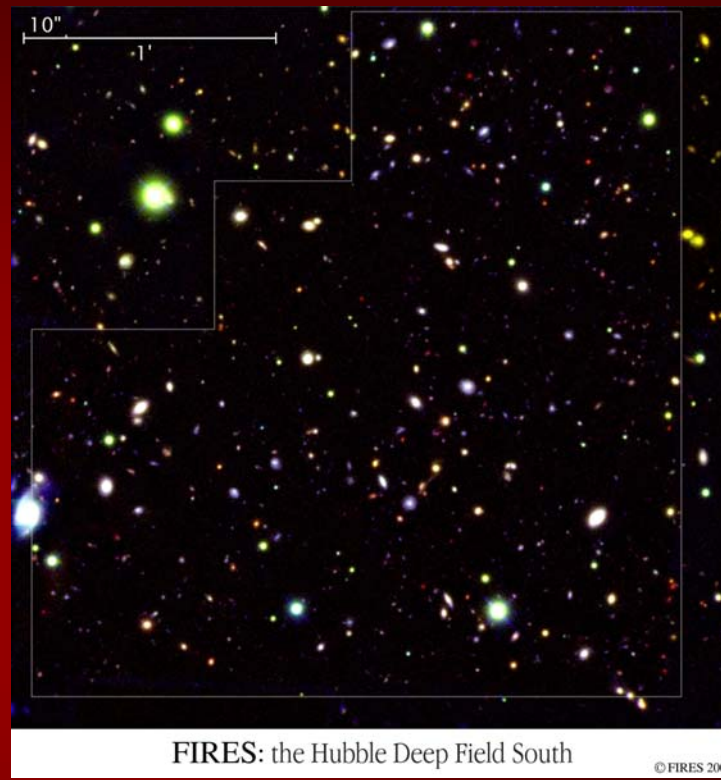
Ultradeep NIR imaging with ISAAC/VLT, JsHKs, of the HDFS (5 arcmin^2) and a field centered on the cluster MS1054 (30 arcmin^2); 32 hours in each pass-band

Js = 26.8 H= 26.1 Ks=26.25 !!

- study the statistical properties and morphologies of high z galaxies
- new population of red galaxies at z > 2

Stress the necessity of deep NIR imaging to obtain a better census of the high z Universe

P.I.: M. Franx (Leiden Observatory)



HST + ISAAC/VLT I Js Ks composite frame

Exploring the early Universe: ongoing projects

The K20 survey: probing the nature of EROs galaxies

ISAAC/VLT Daddi, E.; Cimatti, A.; Pozzetti, L. et al.

Physical properties of low-luminosity distant galaxies

ISAAC/VLT Contini et al.

Chemical evolution: metallicities, reddening and star-formation

VLT/ISAAC Lilly, Carollo et al.

Hα rotation curves of star-forming galaxies at z ~ 2

KECK/NIRSPEC Erb., D.K., Shapley, A. et al.

Exploring new territory: the detection of Population III objects.

Ultradeep survey ISAAC/VLT, spectroscopic follow-up

Pelló, R.; Schaerer, D. et al.

QUASARS/AGNs

High redshift quasars (2 < z < 6)

rest-frame UV (MgII λ 2800, CIV λ 1549, FeII ~ λ2900-3000) ➡ NIR

J,H,K NIR spectroscopy of high redshift quasars

Broad emission lines e.g. FeII/MgII: *clock* to constraint the earliest epoch of *SF*

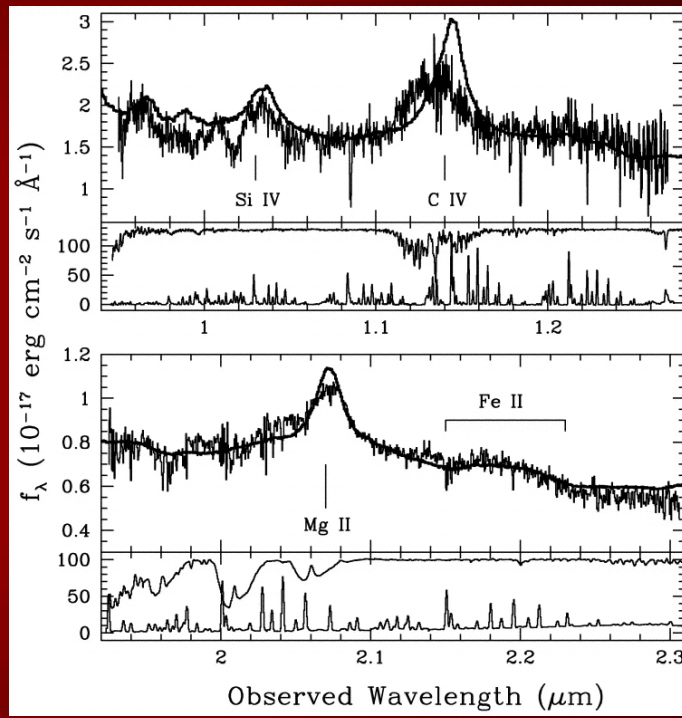
BH mass from the widths of CIV, Mg II

PC 1158+4635 NIRSPEC/KeckII z=4.733
SDSS 1204-0021 ISAAC/VLT z=5.03

Dietrich, M., Hamman, F. et al. 2003 (U. de Florida, U. de Georgia)

SDSS J114816.64+525150.3 z=6.4 J and K spectra, NIRSPEC/KeckII

Barth, A.; Martini, P., et al. 2003 (Caltech, Carnegie)



NIR spectra of SDSS J114816+525150

AGNs: nuclear interstellar dust and gas clouds strongly influence the visible NIR observations required to

- Test unified AGN theories: connection starburst-AGNs
- Obscured AGNs: NIR spectroscopy is the only viable tool to identify them. Lack of a MOS, made such programs inefficient !!
- Host galaxies

Near IR spectroscopy of (nearby) active galaxie nuclei

spectral features tracing the properties of the AGNs: [SiIV]1.96μm; Pa α; Paβ; Brγ, H_2 ; starburst stellar populations diagnostics CO, CaT

NIR spectroscopy of five Seyfert galaxies: H, imaging and spectroscopy ISAAC/VLT Boisson, C. et al.

Probing the AGN/Starburst in UGC5101:n H, -K spectroscopy NIRSPEC/Keck , Christopher, M.H., Scoville, N.Z. et al. (Caltech)

Spectroscopic NIR follow-up of wide field multi-wavelength Sky Surveys

X-rays surveys: XMM, Chandra

VISTA targets

ALMA targets

IR /sub-mm surveys:

- ELAIS (European Large Area ISO Survey)
- HERSCHEL
- SPITZER: SWIRE (The SPITZER Wide-area InfraRed Extragalactic Survey)

GLIMPSE (Galactic Legacy Infrared Mid-Plane Survey Extraordinaire)



NEARBY GALAXIES AND THE MILKY WAY

Stellar populations in galaxies

Dynamics/stellar populations from spectral features as CO absorption (2.3 μm), Si (1.59 μm) or Ca II triplet

Surveys of CO in ellipticals using 4-m class telescopes: exploring the star formation history of ellipticals (e.g. COMA; PISCES; ABELL 2634; Mobasher & James 2000; 1999; 1998)

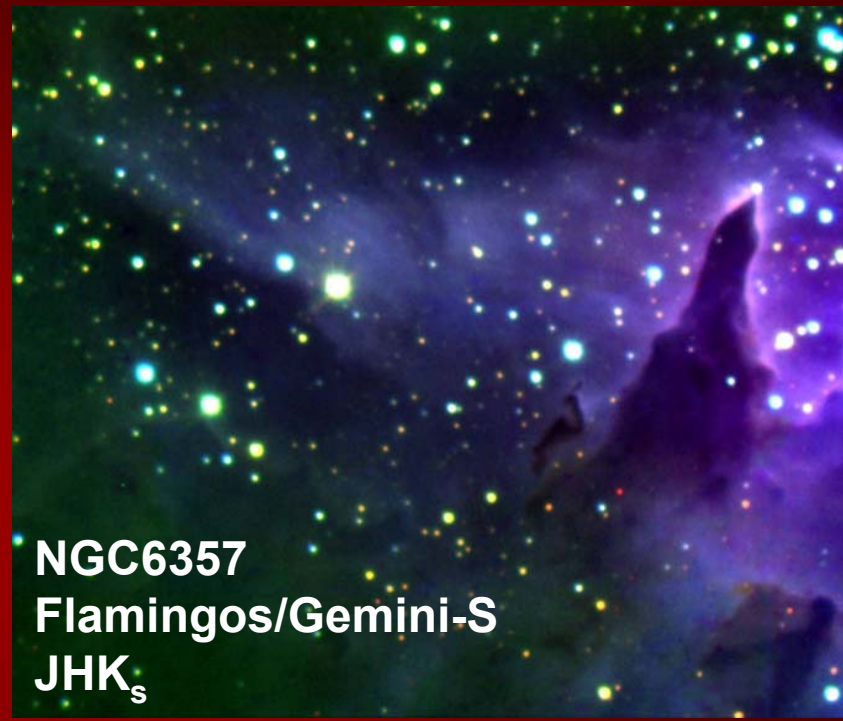
K-MOS ideal to extend CO surveys to dwarf ellipticals in nearby clusters

STAR-FORMATION

Highly obscured regions of star-formation

Investigate the nature and distribution of the young stellar content in dense molecular clouds (visual extintion of 5-20 mag !!)

NIR imaging + follow-up spectroscopy



Herbig-Haro objects ([FeII], H_2)

Circumstellar disks around YSOs

Outflows and dynamics of protostellar disks

} NIR spectroscopy

STAR-FORMATION: ongoing projects

VLT/ISAAC observations of massive star-forming regions

Ongoing investigations of southern massive star-forming regions, JHKs + Brγ, Brα, 2.122 μm H_2, probing:

- formation massive stars, embedded YSOs
- the amount and distribution of dust extinction
- search for shocks caused by winds and outflows from YSOS

Stecklum, B., Henning, T. et al. 2003/04

VLT/ISAAC H-band spectroscopy of embedded massive YSOs

probing the ionizing stars of three UC HII regions

H spectroscopy at medium resolution (R ~4000), effective tool to detect, classify and study the photospheres of the objects

Kendall, Wit, Yun 2003

FLAMINGOS Star-formation survey

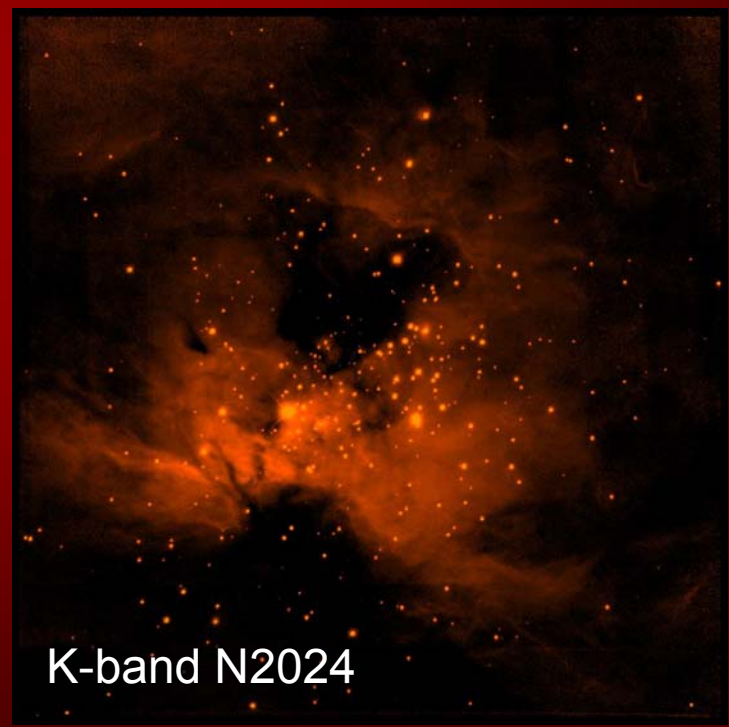
Investigate the nature and distribution of the young stellar content in Giant Molecular Clouds

Sensitive NIR imaging survey and first NIR spectral classifications for stars in GMCs

FLAMINGOS/ 2.1-m, 4-m Kitt Peak telescopes P.I. E. Lada



MOS spectra Trapezium



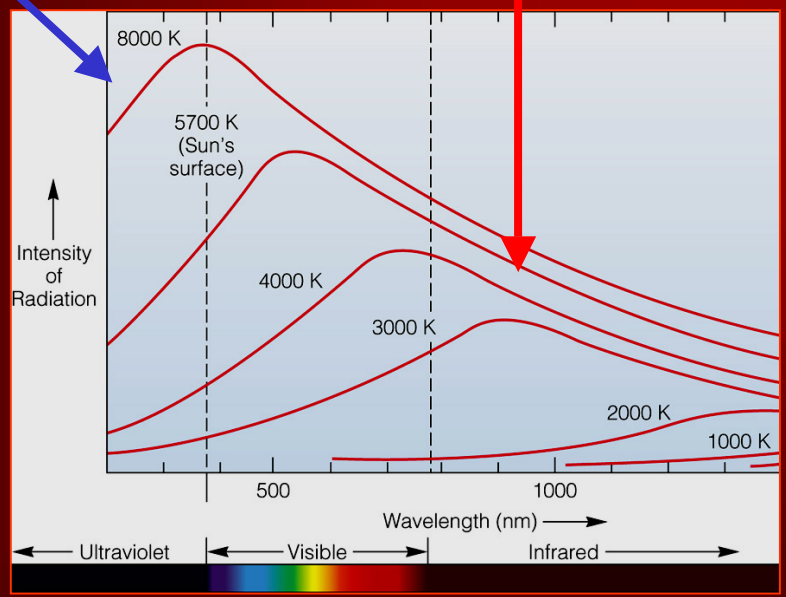
K-band N2024

BROWN DWARFS/ LOW MASS STARS/EXTRASOLAR PLANETS

LMSs are the most numerous objects in the galaxy, but difficult to detect and study due to its faintness. Most of the energy emitted emerges in the INFRARED Characterized by rich molecular and atomic absorption spectra

Hot star

Cool star



Deep NIR imaging (surveys) and Spectroscopic follow-up, with R~4000, which allow to disentangle molecular and atomic features (CH_4, H_2O)

BROWN DWARFS/ LOW MASS STARS : ongoing projects

The NIRSPEC brown dwarfs spectroscopic survey (BDSS)

NIR (0.96-2.31 μm) low resolution (R ~2000) high signal-to-noise spectra of M, L and T dwarfs

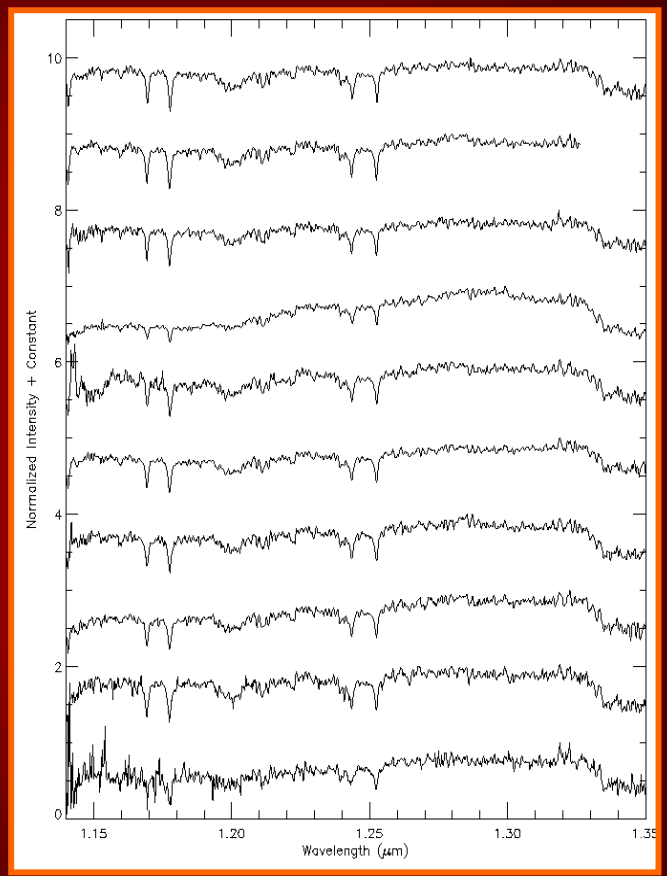
NIRSPEC/Keck II (commisioning) ; ~70 objects have been studied

A combination of four H_2O and two CH4 band strengths can be used for spectral classification in the NIR

A Spectral Atlas: atomic and molecular fingerprints

McLean et al. 2003

L dwarfs



Probing the botton end of the IMF in Orion with Gemini

very deep JHKs imaging of the Trapezium Cluster, 8 arcmin² ~2M_{Jup}

FLAMINGOS/Gemini-S; Hokupa/Gemini-N

Several PMOs have feen found

Lucas, Roche, Riddick



Ground based exoplanet NIR search by imaging and spectroscopy

Ground based IR imaging search for sub-stellar companions (brown dwarfs and giant planets) of young (100 Myrs) and nearby (<75 pc) stars.

Targets member of the TW Hya, Tucana and MBM 12 associations

iSAAC/VLT H, K bands imaging and spectroscopy

P.I.: Neuhäser, R. (MPI)

SOLAR SYSTEM

planets, satellites, comets, asteroids, trans-neptunian objects (TNOs) : Typical IR objects

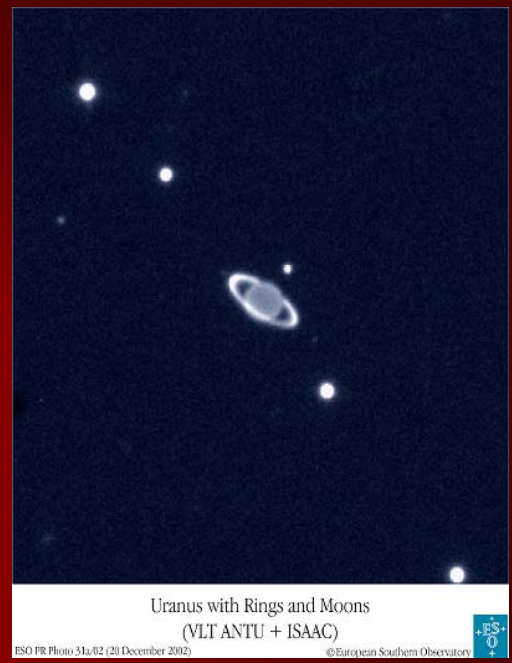
High S/N NIR spectroscopy and high spatial resolution imaging

Deep probing of the atmospheres, in particular of Uranus, Neptune, Titan:

- detection of molecules (H_2, 1.25 μm; CH_4, 1.1 μm; CO_2, 2.4 μm; H_2O, 2.4 μm)
- determination of abundance ratios
- dynamics

Spectroscopy of the asteroids to derive their composition

Detection and chemistry of faint, outer solar system bodies (TNOs)





SOLAR SYSTEM: ongoing research

Observations of Trans-Neptunian objects (TNOs) and Centaur objects

Photometric and spectroscopic data in the NIR for a large set of objects, to study the physical properties and composition of this new discovered population, which may contain the pristine material residual of the formation of our planetary system

ISAAC/VLT ; Boehnhardt et al. Barucci et al.

CISCO, Subaru

Spectroscopy of Pluto and Charon between 1.4-2.5 μm

Phoenix/GEMINI-South Cook et al.

Monitoring Titan project imaging and spectroscopy NIRC2/KeckII Gibbard et al. ongoing

First detection of Carbon Monoxide in Uranus

ISAAC/VLT Encrenaz, Th. et al. 2004

Ricardo Amorín	IAC
Alfonso Aragón Salamanca	University of Nottingham
Santiago Arribas Morocoa	HST / ESA / IAC / CSIC
Eduardo Battaner	Universidad de Granada
John Beckman	IAC
Narciso Benítez Lozano	Johns Hopkins University
José Antonio Caballero	IAC
Luz Marina Cairós	IAC
Nicola Caon	IAC
Ruth Carballo Fidalgo	U.Cantabria
Nicolás Cardiel	UCMObservatorio de Calar Alto
Conrado Carretero Herráez	IAC
Héctor Castañeda	
José María Castro Cerón	Instituto Cientifico -- HST
Matilde Fernández	IAA
María Luisa García Vargas	GTC
Begoña García-Lorenzo	
Francisco Garzón	IAC
Franco Giovanelli	Istituto di Astrofisica Spaziale e Fisica Cosmica
Denise Gonçalves	
José Nicolás González Pérez	Hamburger Sternwarte
Javier Gorgas	UCM
Ana Guijarro Román	Universidad de Granada
Artemio Herrero	IAC
Jorge Iglesias	Laboratoire d'Astrophysique de Marseille
Arturo Manchado	IAC

Esther Mármol Queraltó	UCM
Isabel Márquez	IAA
Eduardo Martín	IAC
Verónica Melo	IAC
Mariano Moles	IAA
Casiana Muñoz-Tuñón	IAC
Francisco Najarro de la Parra	Instituto de Estructura de la Materia, CSIC
Ismael Pérez Fournon	IAC
Ana Pérez García	IAC
José Ricardo Rizzo	Universidad Europea de Madrid - Depto. de Fisica
José Miguel Rodríguez Espinosa	IAC
Patricia Sánchez-Blázquez	UCM
Marcos Santos Pedraz	UCM / CAHA
Tariq Shahbaz	IAC
Guillermo Tenorio Tagle	INAOE
David Vals	LAT, OMP, Toulouse, France
Alexander Vazdekis	IAC
José M. Vílchez	IAA
Cristina Zurita	Observatorio Astronómico de Lisboa

Hitos en EAST (propuesta)

Hitos	Propuesta
1ª reunión EAST – IAC	junio/julio 04
Elaboración de propuestas por grupos/temas	hasta septiembre 04
2ª reunión. Elección de coordinadores por cada tema	octubre 04
1ª iteración sobre propuestas (¿interna?)	hasta diciembre 04
3ª reunión	enero 05
Panel externo	hasta marzo 05
4ª reunión. Selección inicial de prop.	abril 05