

GUAIX / Science

IPARCOS Scientific Advisory Board: Bi-Annual Review 2026



IPARCOS



UNIVERSIDAD
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GUAIX Overview

- **GUAIX – UCM Group of Extragalactic Astrophysics and Astronomical Instrumentation**
PI: Prof. Jesús Gallego

36

members

165

refereed papers
since Jan 2024

4.7 M€

active funding

3+4

full + associate
professors

7+13+2+1

postdocs + PhD
students + PM + Tech.

- **Current Size:** 36 members:
 - 3 Full Professors (catedráticos)
 - 4 Professors (prof. Titulares)
 - 1 PPL Professor
 - 1 Assistant Professor
 - 2 Senior Researchers (Ramón y Cajal / Talent Attraction Program)
 - 7 Postdoctoral Researchers
 - 13 PhD Students
 - 1 Researcher
 - 1 Lab Technician
 - 1 Honorary Professor
 - 2 Project Managers
- **Key Personnel Changes:** Dr. Fumihiro Naokawa, a JSPS Research Fellow from the Tohoku University, will conduct a two-year research stay within our group.

NOTE: (Last two years only, ~from 2024 on)



Key Performance Indicators

High-Impact Publications: 165 peer-reviewed papers. 165 in Q1 journals (SCImago SJR).

Funding Secured: The total funding across ongoing projects reaches €4.7 million.

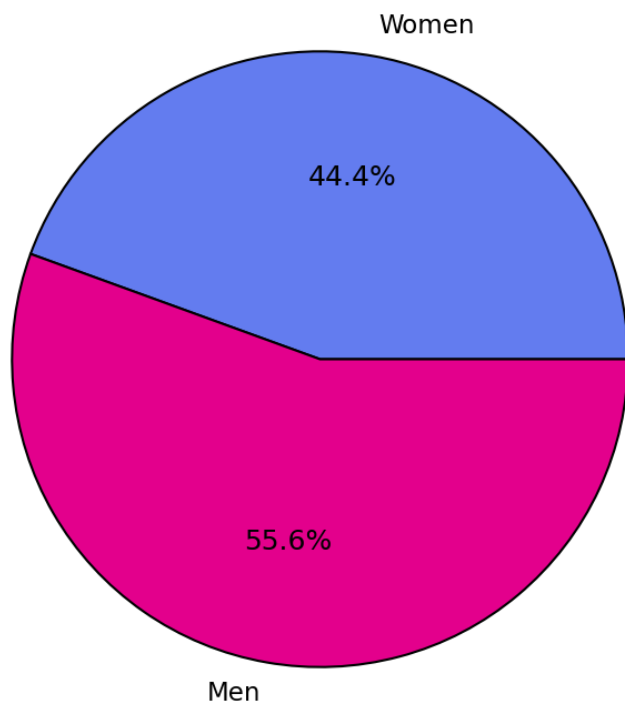
- Main sources:
 - Spanish National Plan (PID projects)
 - Horizon Europe programmes
 - Regional Government of Madrid
- Major projects include:
 - MOSAIC-ELT (€893k + €518k)
 - TARSIS (€731k)
 - ARRAKIHS (€460k)
- Horizon Europe projects (AtLAST2, PLAN-B, AC3)

Training:

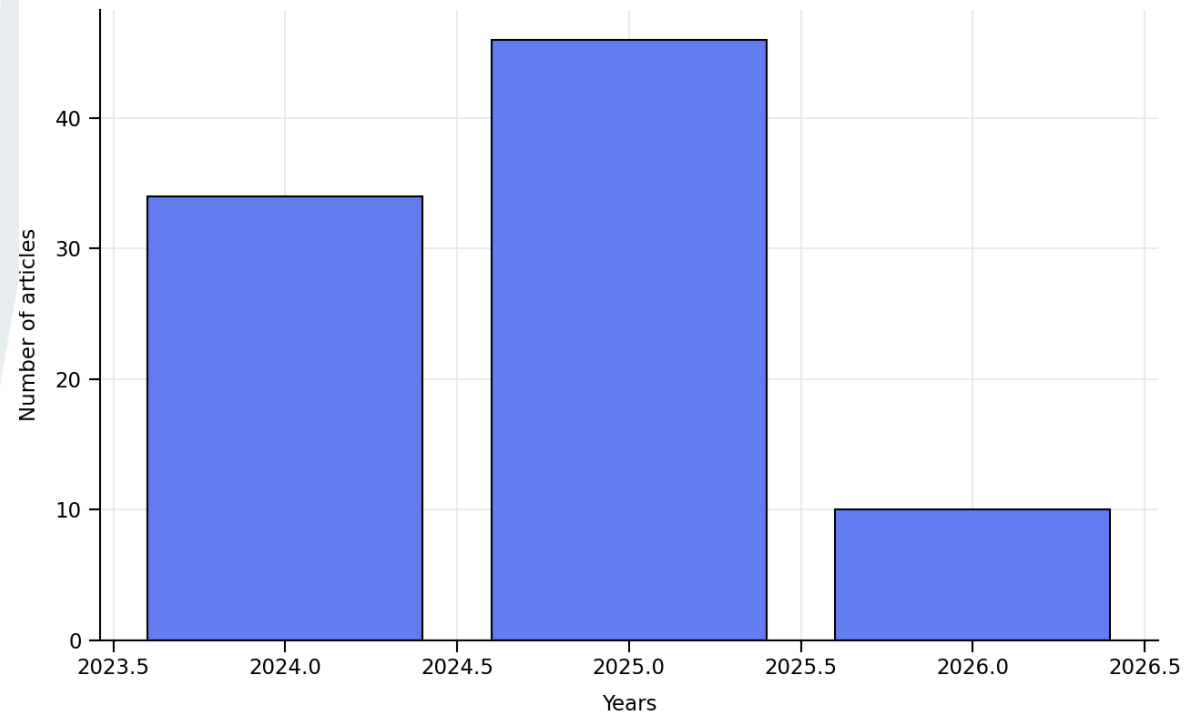
- **24 PhD theses defended** (total). 4 PhD theses defended in 2023–2024.
- 13 PhD theses currently in progress (2 to be defended within the next two months).



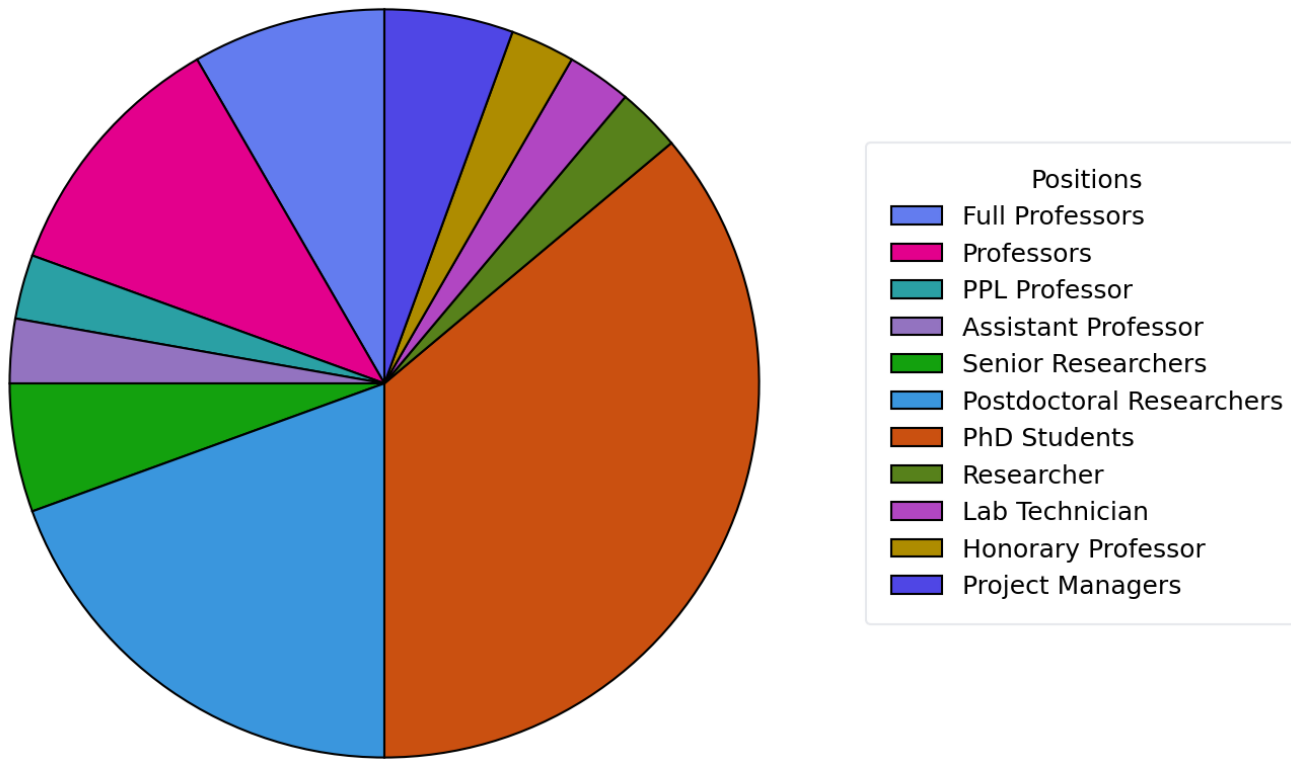
Group Composition (36 total)



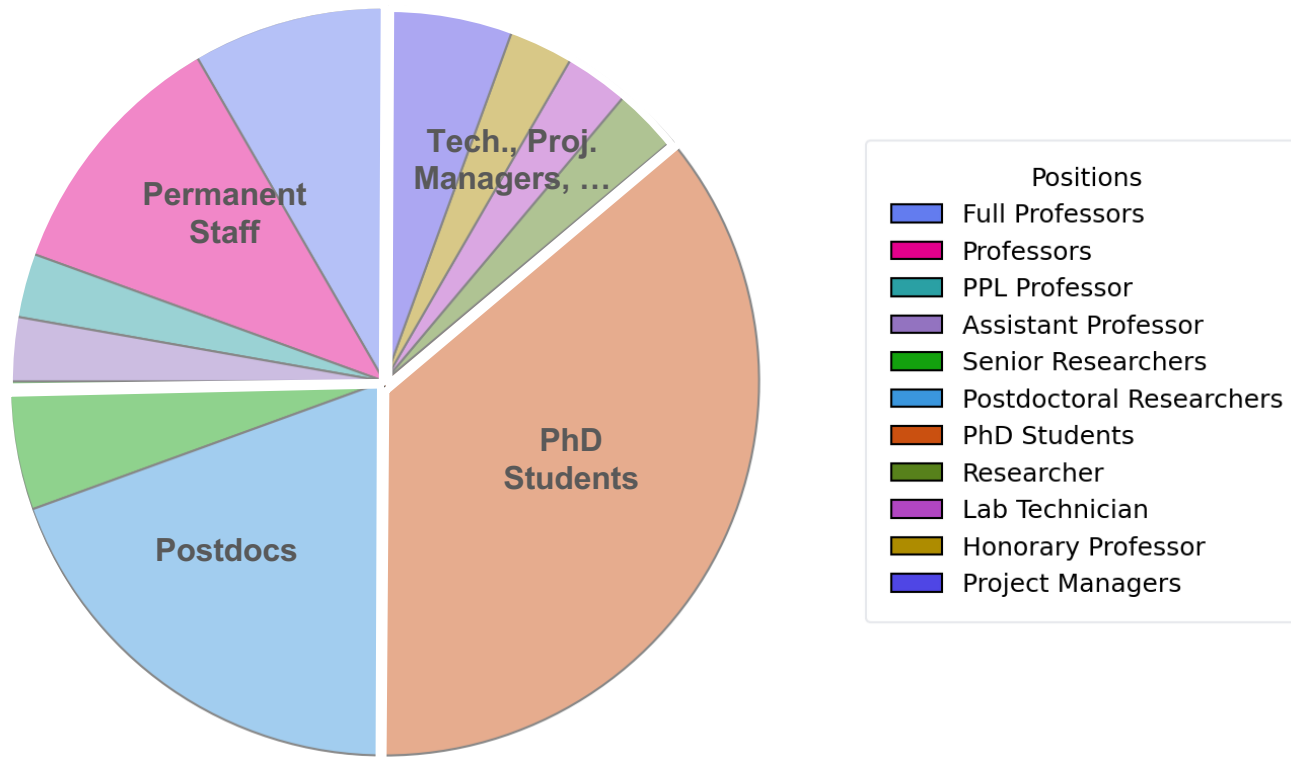
GUAIX scientific production (Refereed articles)



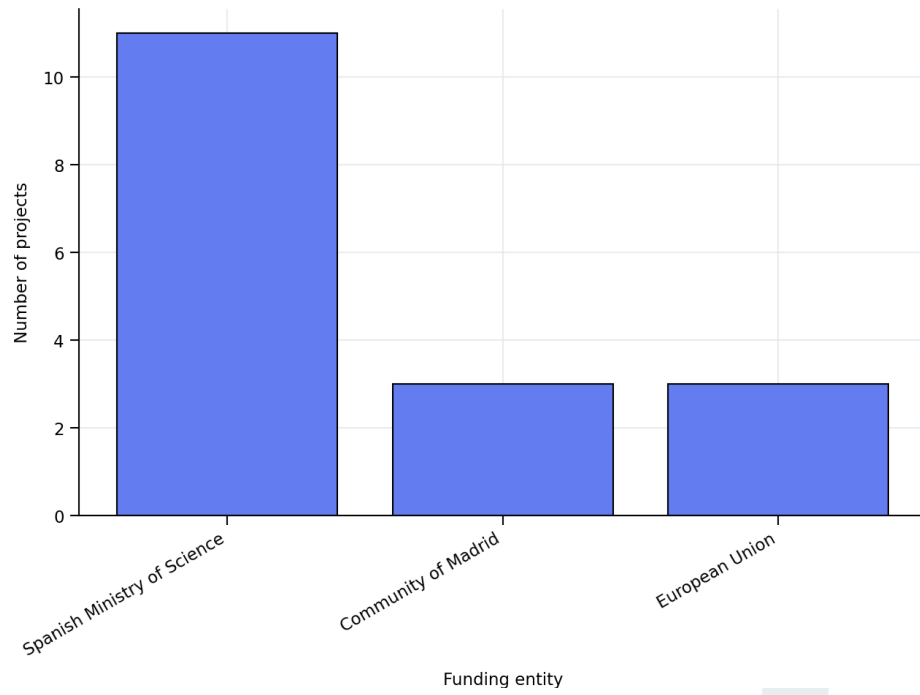
GUAIX Group Composition



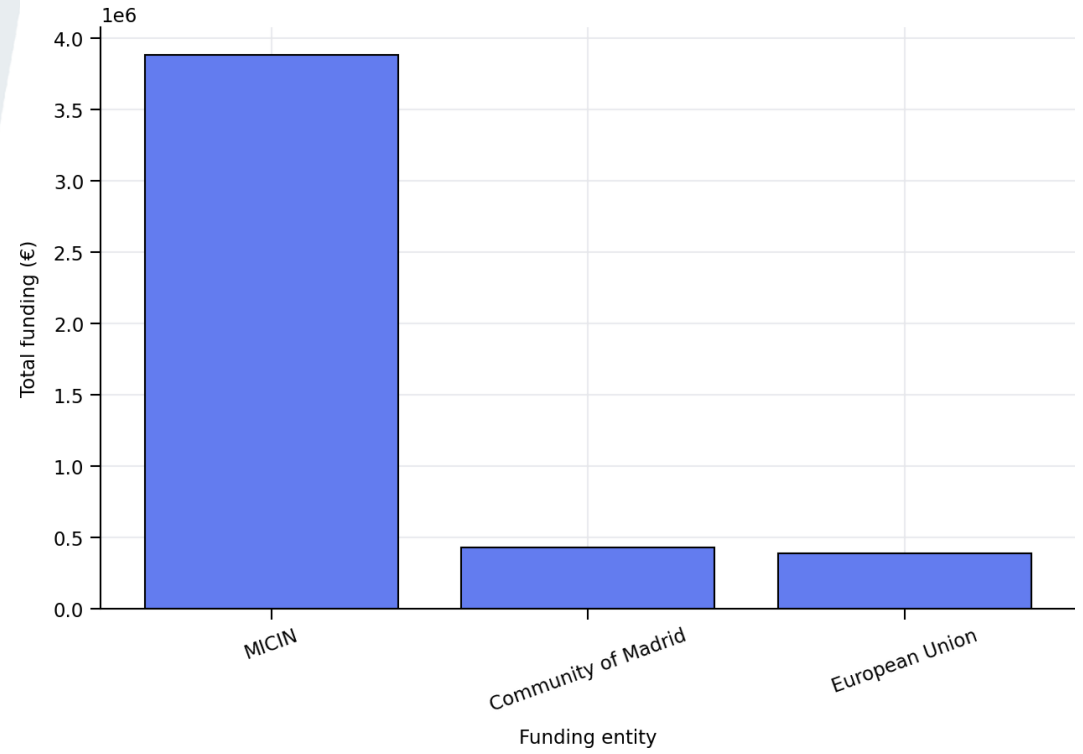
GUAIX Group Composition



Funding Sources Distribution



Funding Distribution by Budget



Science map and current drivers

A broad extragalactic programme with instrumentation as an enabling layer

Nearby galaxies + stellar populations + AGN feedback + high-energy/magnetism

connected through IFU spectroscopy, surveys, simulations and multi-wavelength facilities

Main active projects and collaborations

- MOSAIC / ELT: Spanish contribution to PDR + LLI-FDR
- TARSIS: Calar Alto 3.5m instrument + science prep.
- ARRAKIHS: ESA F-class mission phase at UCM
- AtLAST2 + Mad4Space + SKA-prep / cosmic magnetism
- PLAN-B / light and noise pollution impacts
- AC3: cloud-edge continuum management
- Dwarfs4MOSAIC: IFU observations (MEGARA & WEAVE) of nearby dwarfs as local analogs of early star-forming galaxies

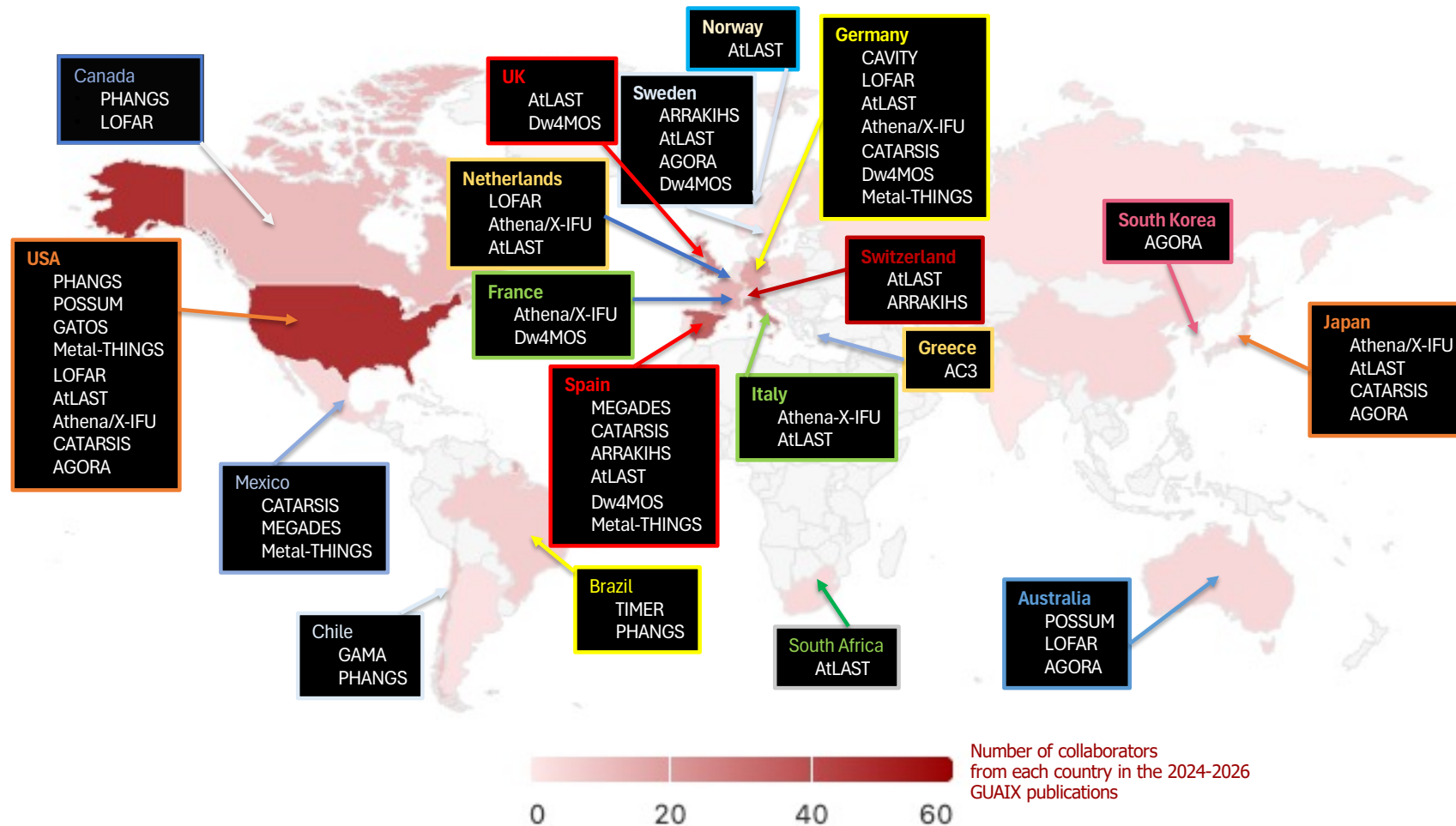
What the group delivers

- MEGARA science exploitation
- Survey science: MEGADES, PHANGS, TIMER, CAVITY, GATOS, POSSUM
- Galaxy evolution across environments and cosmic time
- New constraints on feedback and outflows
- Metallicity determinations in nearby galaxies: Metal-THINGS
- Training pipeline for instrumentation + data-intensive astronomy



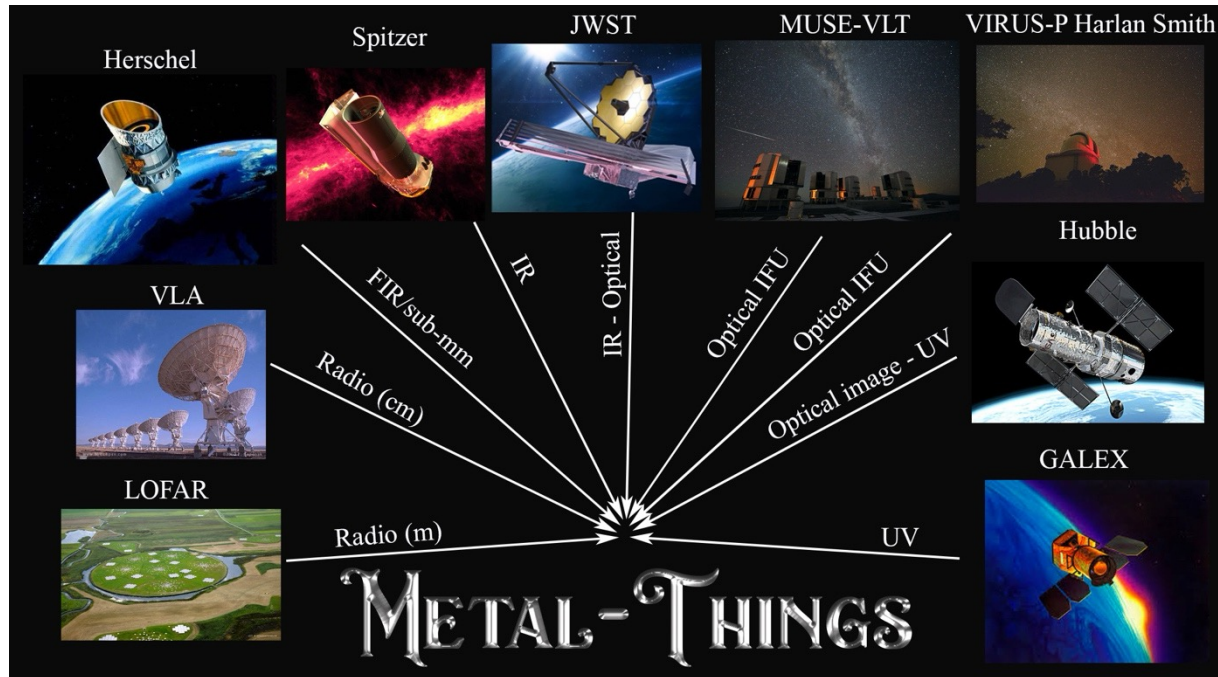
GUAIX scientific internationalization

Fostering international collaboration between GUAIX and other research groups worldwide



Nearby galaxies, ISM and star formation

Resolved gas, H II regions, metallicity gradients and local galaxy laboratories



Glimpse of the programme

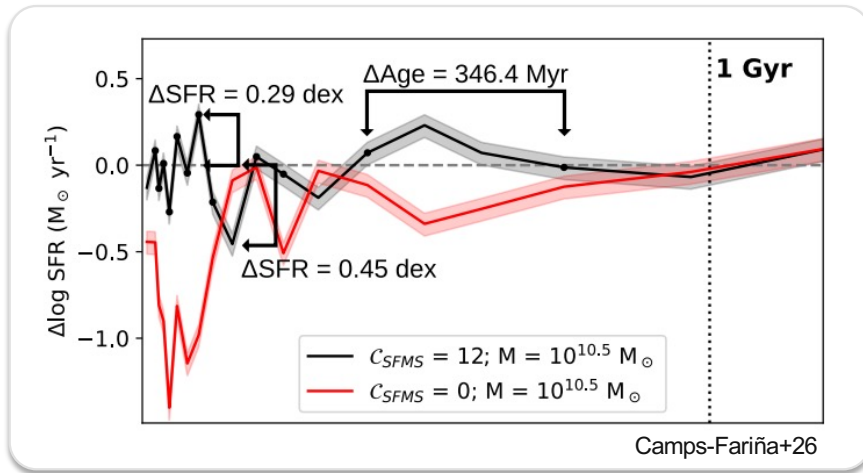
- IFU mapping of ionized gas and stellar populations
- Gas flows, metallicity gradients and H II-region physics
- Strong GTC/MEGARA exploitation (incl. MEGADES), linked to PHANGS, Metal-THINGS and other IFU-based science
- OTELO/GAMA science

Representative papers (2024–2026)

- Chamorro-Cazorla+26 — MEGADES: ionised-gas diagnosis
- Valé+25 — Metal-THINGS gas metallicity gradients
- Pilyugin+25 — Metal-THINGS: NGC 3521
- Arroyo-Polonio+25 — IZw18 with GTC/MEGARA + JWST/MIRI
- García-Vargas+24 — low-metallicity dwarf SDSSJ0859+3923 with MEGARA
- Querejeta+24 — PHANGS: spiral arms and star-formation efficiency
- Pathak+25 — 18,000 H II regions: masses, SFE and evolution
- Koda+24 — compact high-excitation molecular clumps in M83
- Cedrés+25 — OTELO downsizing at $0.38 < z < 1.43$
- Molina-Calzada+25 — GAMA: environment, metallicity and SFR

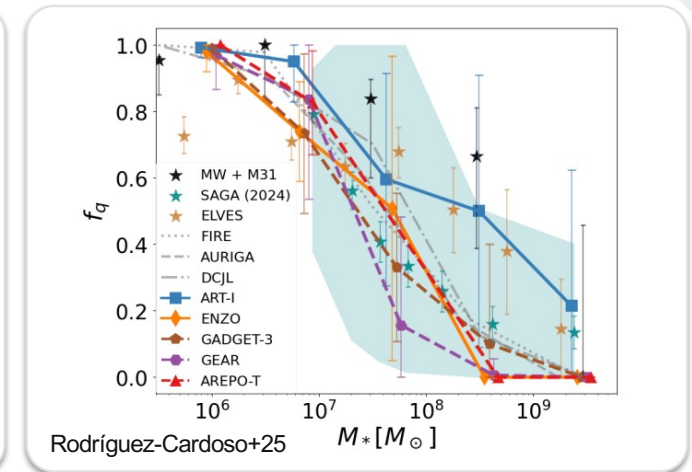
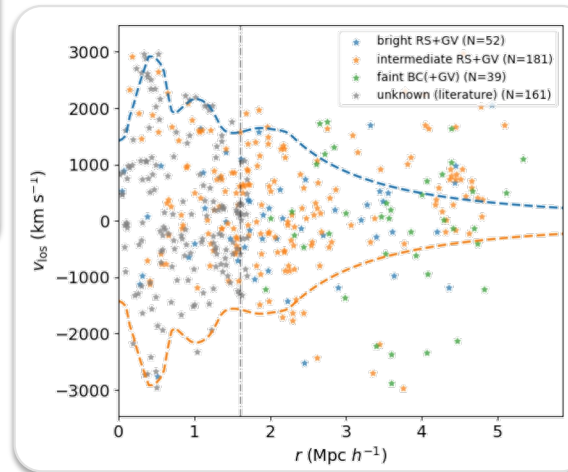
Stellar populations, dynamics and galaxy assembly

From local streams and discs to survey-driven stellar population constraints



Glimpse of the programme

- Stellar populations and dynamics as fossil records of assembly
- Environmental effects: voids, cosmic web, bars and streams
- IFU + simulations + deep imaging as complementary tools



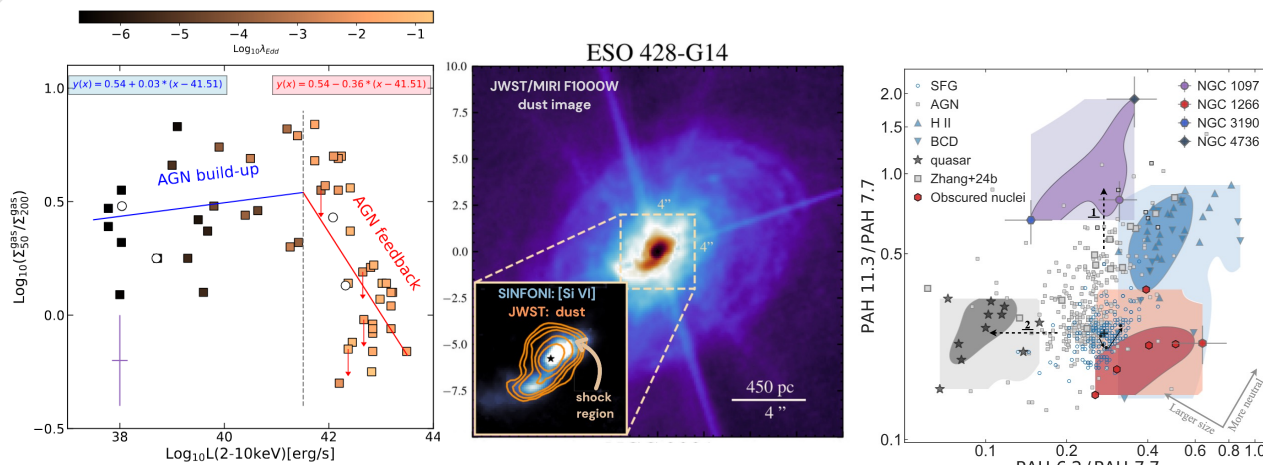
Representative papers (2024–2026)

- Camps-Fariña+26 — sub-Gyr variability around the star-formation main sequence
- Camps-Fariña+24 — mass/morphology effects on mass assembly
- Conrado+24 — CAVITY: spatially resolved stellar populations in voids
- García-Benito+24 — CAVITY first public data release
- Pérez+25 — galaxy mass-size segregation in the cosmic web
- de Sá-Freitas+25 — bar ages in nearby galaxies (TIMER)

- Sánchez-Menguiano+26 — bars and H II regions in TIMER
- Ikhsanova+25 — mock TNG50 galaxies for WEAVE-StePS
- Martínez-Delgado+24 — NGC 7241 blue stellar stream with MEGARA
- Miró-Carretero+25 — tidal streams: observations meet simulations
- Rodríguez-Cardoso+25 — AGORA simulations: satellite quenching
- Marrero-de la Rosa+26 — BEARD: drivers of mass-size relation

AGN feedback and outflows

Ionized, molecular and mid-IR diagnostics of how AGN couple to their host galaxies



The AGN feedback reshapes the structure of the molecular gas in the nucleus, reducing its clumpiness (and likely its ability to form stars)

(Fast) shocks may be a key driver of the extended dust emission in the central few hundred parsecs of AGN, potentially dominating over direct AGN radiative heating

LLAGN show higher 11.3/7.7 ratios \rightarrow dominance of large PAHs, consistent with destruction of small PAHs by AGN feedback

García-Burillo+21,24, Esposito+26

Haidar+24,26

Zhang+24,26,
García-Bernete+24

Glimpse of the programme

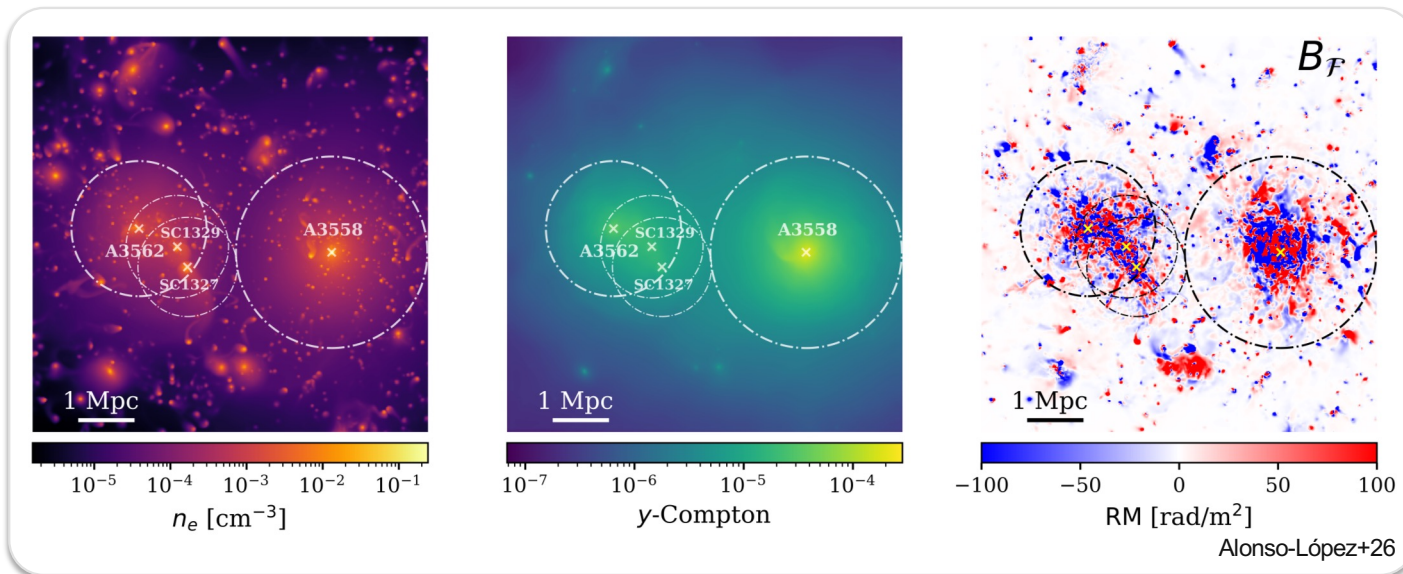
- MEGARA and JWST/MIRI data expose outflow geometry and energetics
- GATOS and related collaborations connect dust, molecular gas and nuclear activity
- The group contributes to both survey-scale and target-specific feedback constraints

Other representative papers (2024–2026)

- Bellocchi+26 — multi-phase AGN-driven outflow in IRAS 17020+4544
- Hermosa Muñoz+24 — MEGARA view of outflows in LINERs
- Esposito+26 — GATOS X: molecular gas clumpiness under AGN influence
- Zhang+26 — feedback effects in low-luminosity AGN with JWST
- Haidar+26 — GATOS XI: excess dust heating in NLRs
- Lopez-Rodriguez+25 — GATOS VIII: extended mid-IR emission in AGN
- Fuller+25 — GATOS VII: SOFIA 20–214 μm imaging atlas
- González-Martín+25 — JWST diversity of nuclear obscuring dust
- Campbell+25 — GATOS IX: emission-line contamination in JWST/MIRI
- Delaney+25 — molecular hydrogen excitation in Seyferts

High-energy, magnetism and multiwavelength transients

Gamma rays, radio polarization and transient hosts as complementary windows on feedback and environments



Glimpse of the programme

- Optical spectroscopy connects AGN/outflow energetics to γ -ray limits
- POSSUM/LOFAR work probes magnetized cosmic structures
- FRB and blazar host follow-up extends the group into fast multiwavelength science

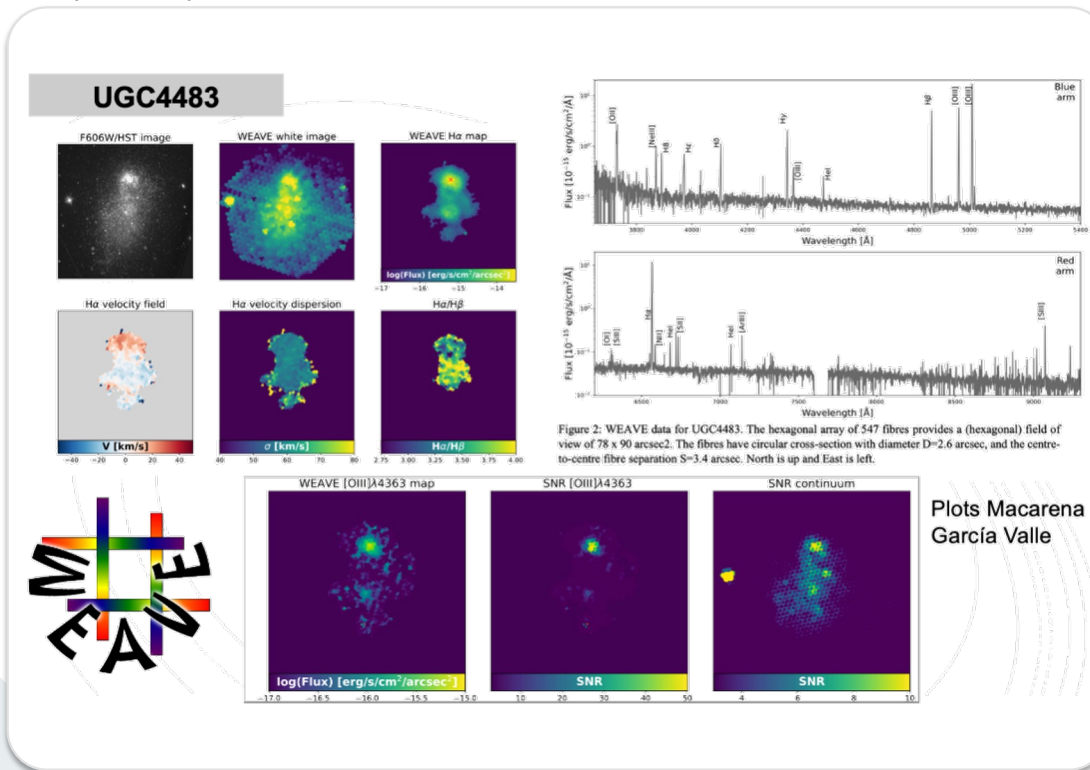
Representative papers (2024–2026)

- León+26 — LINER outflows with Fermi-LAT and MEGARA
- Álvarez-Crespo+25 — Fermi blazar candidates; changing-look blazar
- Hazra+24 — most distant γ -ray BL Lac object
- Bhardwaj+25 — hyperactive FRB in an SMC-like satellite host
- Hewitt+24 — repeating FRB source in a low-luminosity dwarf galaxy

- Alonso-López+26 — magnetic fields in the Shapley Supercluster core
- Pignataro+25 — detection of magnetic fields in superclusters
- Gaensler+25 — POSSUM science goals and survey description
- Carretti+25 — LOFAR RMs and magnetic fields in cosmic filaments
- Piras+25 — LOFAR Deep Fields polarized extragalactic sources

Dwarfs4MOSAIC: La Palma ITP project

A 2D study of low-mass star-forming galaxies as low-redshift analogs to reionization-epoch primeval galaxies. A pilot study for MOSAIC at ELT



Glimpse of the observational programme

- From June 2024 to December 2026
- 80h GTC/MEGARA
- 82h WHT/WEAVE
- 3n LT/IO
- 7n INT/WFC

Scientific cases

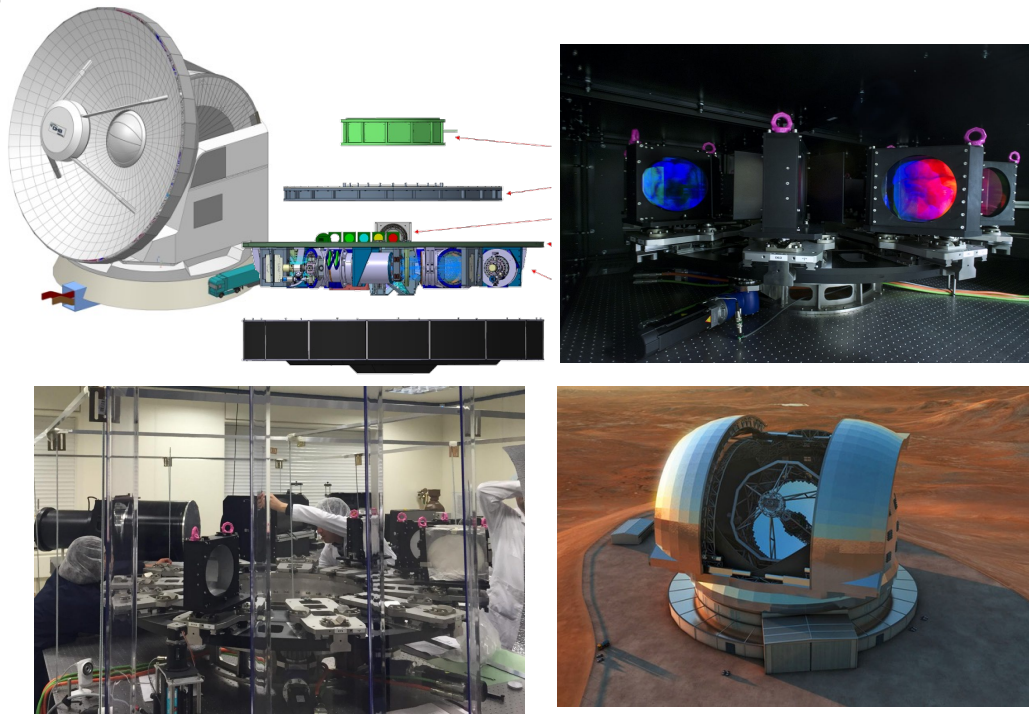
- Local counterparts and Lyman continuum leakers
- Probing mass assembly in low-mass galaxies through gas metallicity gradients
- Census of central black holes in low-mass galaxies
- Highly ionized gas in high-z dwarf Galaxy analogs
- Stellar kinematics of low-mass star-forming galaxies
- PopII galaxies in nearby Galaxy clusters
- Reconciling the cosmological dust attenuation with the one per stellar mass bin
- Tidal streams or any sign of past interaction in low-mass galaxies
- Synergies with present and future facilities

Representative papers (2024–2026)

- Gallego et al 2025, Presentation of the Data Release 1 to the MOSAIC consortium
- Gallego et al 2026, Public release of the Dwarfs4MOSAIC Data Release 1
- Chillarón-Víctor et al 2026, Presentation of the Project to the Spanish Astronomical Society

Instrumentation as a science accelerator

(details covered in the dedicated GUAIX instrumentation presentation by J. Gallego)



Science-enabling role

- MEGARA: mature science exploitation and community impact
- TARSIS: science preparation + construction (PDR completed) (after Calar Alto EC ruling, the team is looking for alternatives: ESO, PO, ING)
- MOSAIC / ELT: Spanish contribution through design milestones
- ARRAKIHS, Athena/X-IFU and AtLAST: broader instrumental footprint

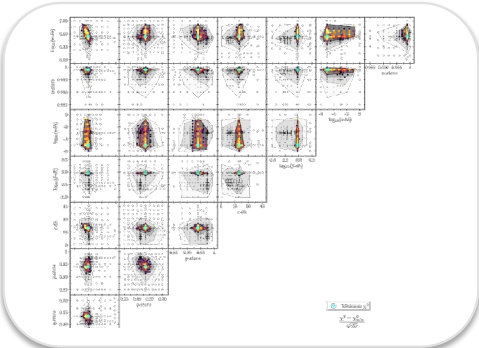
Representative papers (2024–2026)

- Mroczkowski+25 — AtLAST conceptual design
- van Kampen+24 — AtLAST science: surveying the distant Universe
- Ceballos+24 — optimizing Athena/X-IFU-like TES detectors
- Peille+25 — X-ray Integral Field Unit after Athena reformulation
- Chamorro-Cazorla+26 — MEGADES science enabled by MEGARA
- Martínez-Delgado+24 — MEGARA follow-up of stellar streams
- García-Vargas+24 — MEGARA IFU on a low-metallicity dwarf
- Hermosa Muñoz+24 — MEGARA outflows in LINERs

Latest results — off the press

Submitted GUAIX-participated publications

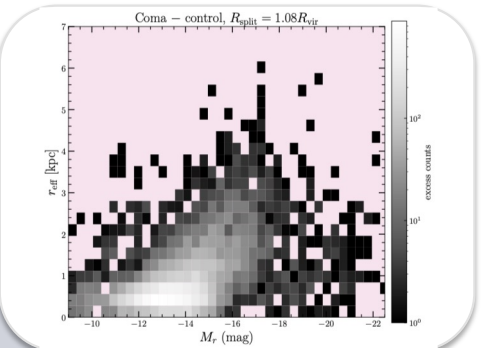
M32 dynamics



Beamuz-Mingote, Gil de Paz & Chamorro-Cazorla
Ready for submission

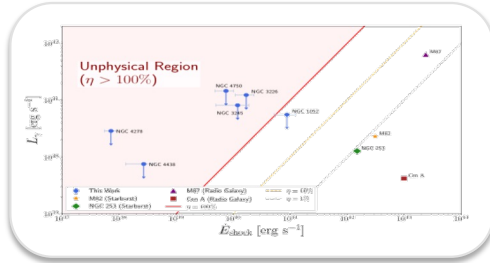
- Schwarzschild modeling with MEGARA
- SMBH mass: $3.6 \times 10^6 M_\odot$
- Nuclear disk-like dynamical component

Coma Cluster UDGs



Macías, Koda, Gil de Paz, Catalán-Torrecilla, in prep.
• Smooth transition between normal galaxies and UDGs (no dichotomy).

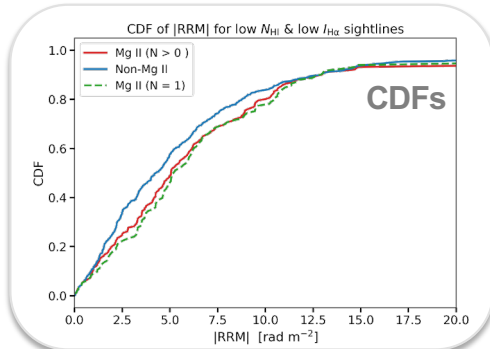
LINERs + Fermi-LAT



León, Domínguez, Dinesh & Gil de Paz
Submitted to Fermi-LAT collaboration

- First population limits on γ -ray efficiency
- Extended LINER shocks inefficient
- Efficient γ -rays require compact jets

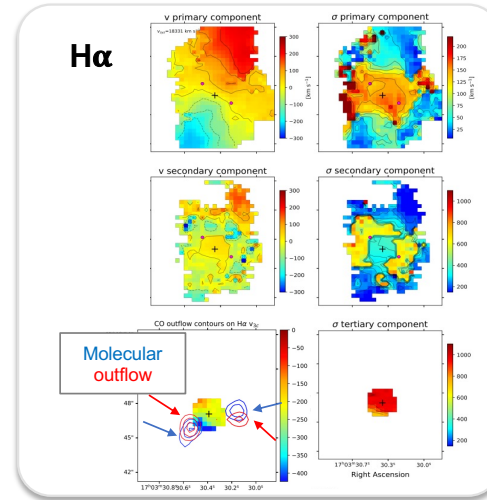
CGM magnetic fields at high-z



Malik et al., accepted for publication

- First robust detection of CGM magnetic fields at high-z

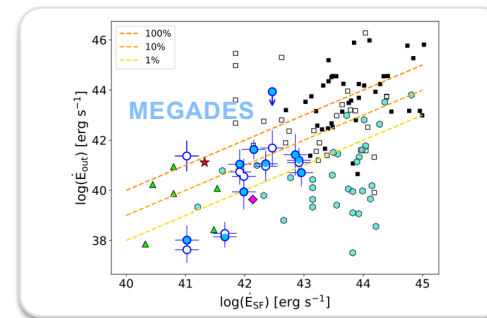
UFO in IRAS 17020+4544



Bellocchi et al., Accepted in A&A

- Fast ionized outflow in H α and [OIII]
- Multi-phase, energy-conserving feedback
- Molecular phase dominates mass budget

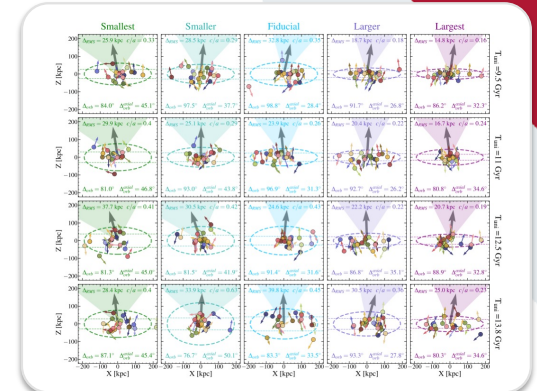
Ionized outflows in MEGADES



Bellocchi, Álvarez-Martín, Catalán-Torrecilla, Gil de Paz, Castillo-Morales, Chamorro-Cazorla, Ready for submission

- Ionized outflows (H α & [OIII]) found in Seyfert & LINERs
- Similar sizes and v_{out} to nearby LINERs and U/LIRGs
- Ionized outflows mainly powered by from SF

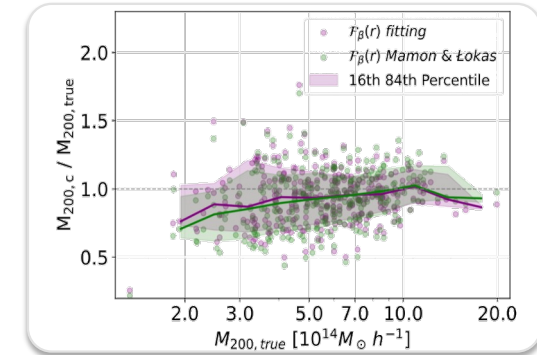
Planes of satellites (sims)



Rodríguez-Cardoso, Roca, Agertz, Gallego et al., subm. A&A

- Planarity and dynamical coherence of satellite distributions enhanced by a massive GSE-like merger
- Planes driven by anisotropies in host DM halos and LSS

Caustic masses of The300 clusters (sims)



Callejas-Córdoba, Sánchez-Blázquez, Gil de Paz et al., Accepted in A&A

- Improving the determination of Caustic masses in galaxy clusters using N-body+hydro simulations.
- Velocity anisotropy vs. mass profile degeneracies

These are not yet represented in the refereed publication statistics shown earlier.

Horizon: opportunities and challenges

Positioning GUAIX for ELT/SKA/JWST-era science while sustaining people and data capacity

Next big scientific opportunities

- MOSAIC/ELT and TARSIS: turn instrumentation leadership into flagship science
- MEGARA legacy: consolidated IFU diagnostics and public data
- SKA/POSSUM/LOFAR: cosmic magnetism and radio transients
- JWST + ALMA + NOEMA + GTC: multi-phase feedback constraints
- Simulations + surveys: connect resolved physics to population evolution
- CTA/HE & optical/nIR synergies: fostering IPARCOS collaborations

Main challenges for the group

- Funding continuity across instrumentation + exploitation cycles
- Retaining postdocs and technical expertise after project peaks
- Scaling reduction, analysis and archive tools for IFU/multiwavelength data
- Maintaining visibility in large collaborations while protecting GUAIX-led science
- Balancing dedicated instrument effort with broad astrophysics output
- Strengthening the collaboration with other IPARCOS groups

Take-home message: GUAIX is a compact but highly productive group whose distinctive value is the coupling of astronomical instrumentation, IFU expertise and multiwavelength extragalactic science

