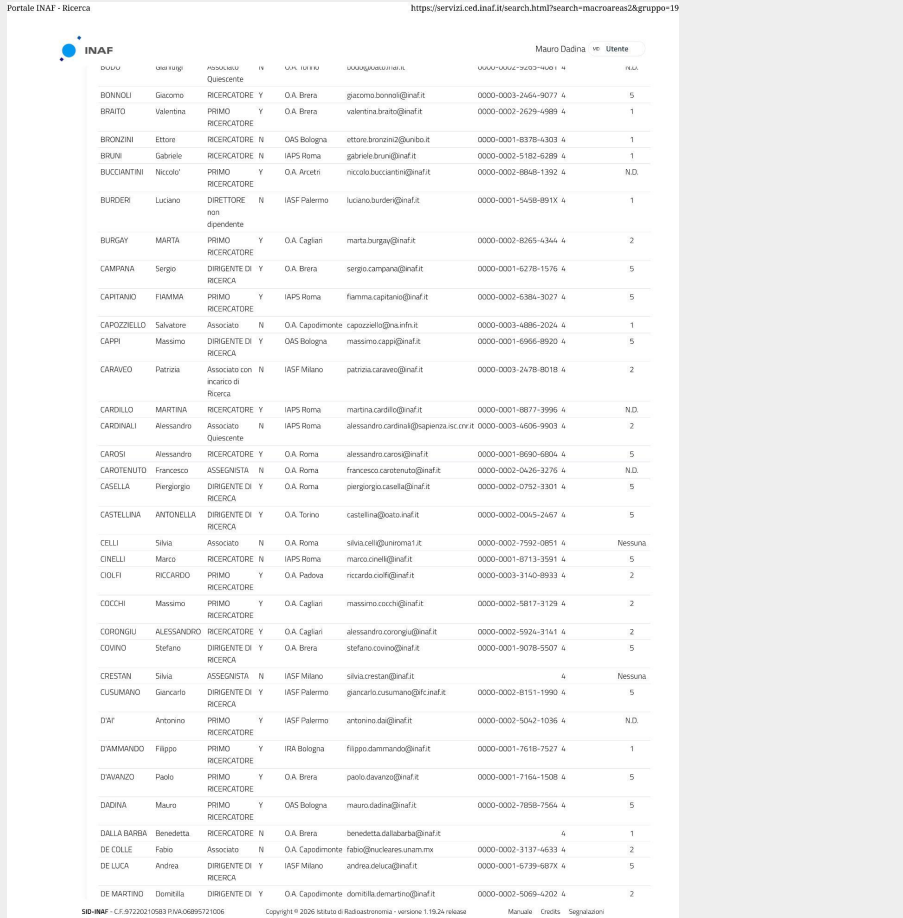
RSN4 days: SMBH (dalle Seyfert ai BLAZAR)

M. Dadina (INAF/OAS)

Few numbers to start (thanks to Gemini AI...)



Portale INAF - Ricerca https://servizi.ced.inaf.it/search.html?search=macroareas2&gruppo=19

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1. From “Anagrafica INAF”: 197 researchers in RSN4 (no quiescent researchers included)

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2. 39 mainly working on “AGN”

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3. 10 Mi (9 OAB + 1 IASF), 9 IRA, 7 IAPS Roma, 7 OAS, 2 IASF-Palermo, 4 in other Institutes...

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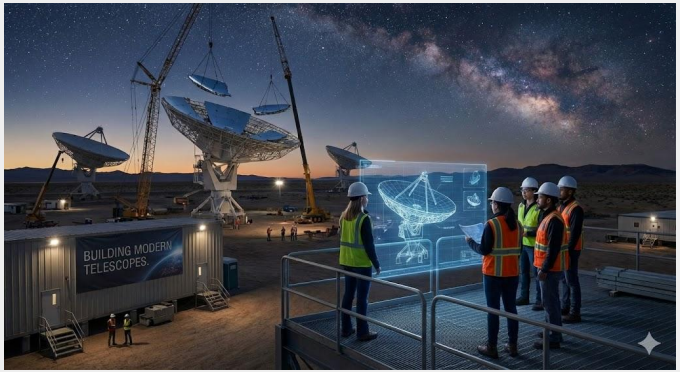
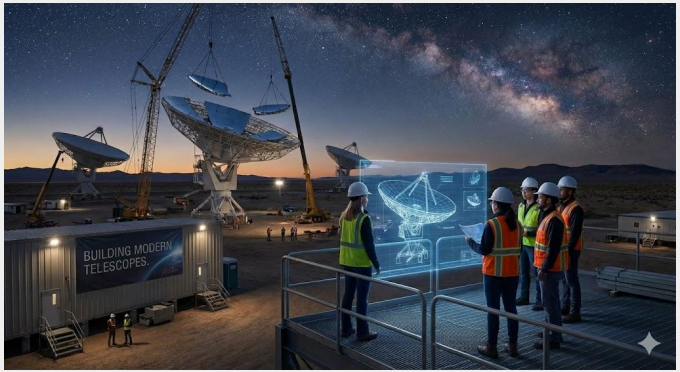
4. which 2nd RSN?: 21 RSN1, 14 RSN5, 1 RSN2 (assegnista), 3 N.D.



Few starting numbers (thanks to Gemini AI...)

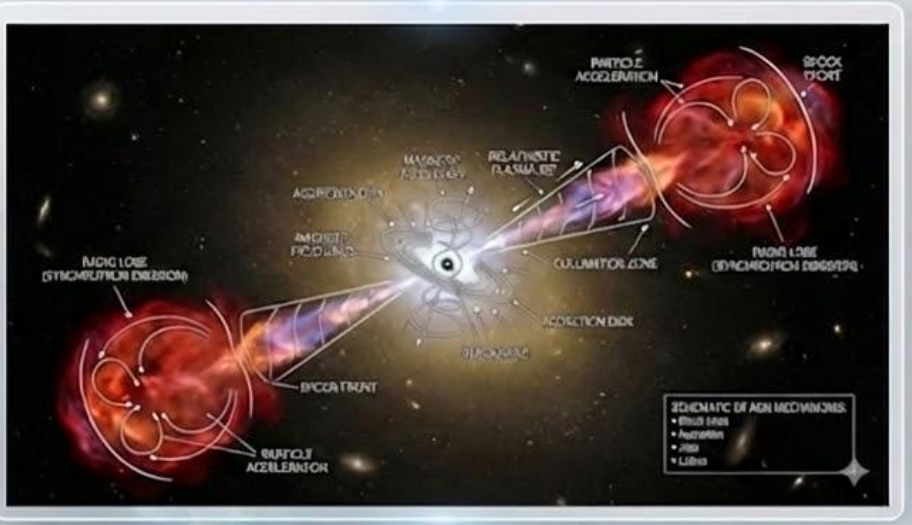
1. From “Anagrafica INAF”: 197 researchers in RSN4 (no quiescent researchers included - 139 reserachers from other RSNs “are RSN4” as second option …. 57 of whom belong to RSN1 and 54 RSN5

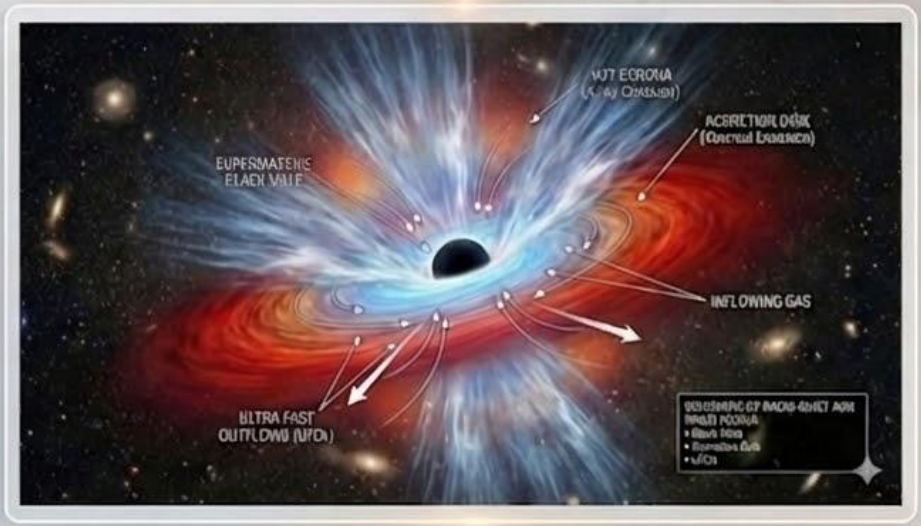


...going-on with Gemini AI...

RL-AGN → 22 researchers

RQ-AGN → 17 researchers





How to collect INFO on what's going on SMBH among RSN4 researchers?

“Carissime colleghe e carissimi colleghi,

Mi e' stato chiesto di fare una breve review (20 minuti) nel corso delle giornate RSN4 che si terranno a Napoli dal 28 al 30 gennaio 2026. Io, in particolare, dovro' concentrarmi su

Supermassive black-holes (dalle Seyferts ai Blazars)

Considerando che l'intento dell'incontro e' di avere una panoramica sulle "**... attivita' relative a questo tema**," su " **in quali istituti/osservatori vengono fatte e di quali aspetti si occupano**" mi e' stato chiesto di individuare/sottolineare "**..qualche highlights, domande aperte, come possiamo affrontarle in futuro, di cosa c'è ancora bisogno, sinergie con altri gruppi, grandi progetti in cui sono coinvolti...**"

Sono con questa a chiedervi quindi idee, contibuti, commenti sui punti sopra menzionati e, se possibile, di inviarmeli il prima possibile.”

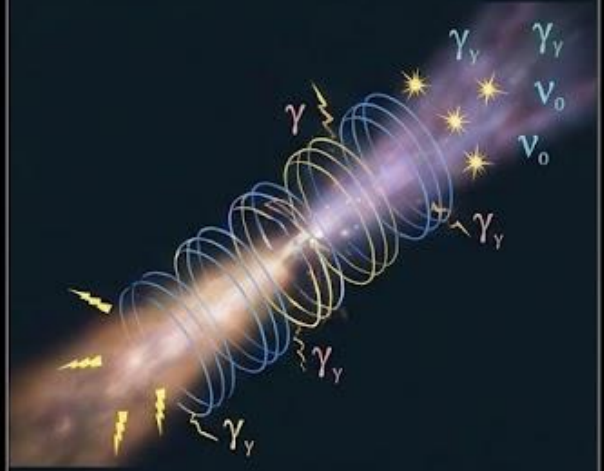
Radio-Loud AGN: Scientific Pillars and INAF Groups (RSN4)

1. Event Horizon & Jet Launch

Physical Focus: Formation, Collimation, Launch (micro-arcsec)

INAF Groups:
IAPS / IRA (mm-VLBI Team, EHT, GMVA)

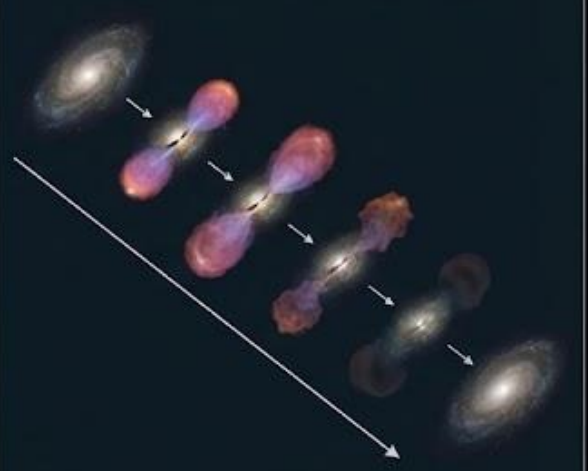
2. Acceleration and Jet Physics



Physical Focus: Shock/Reconnection, Magnetic Fields, Neutrinos, VHE observations

INAF Groups:
OAS (Hadronic models, VHE observations)
OA Brera (Theory, Accelerators, IceCube, VHE obs), **IAPS** (IXPE, AGILE)

3. Life Cycle and Duty Cycle



Physical Focus: Temporal evolution, Restarted sources, Galactic feedback

INAF Groups:
IRA (HE-VLBI)
OA Padova (Optical monitoring)
OA Torino (WEBT, LSST)

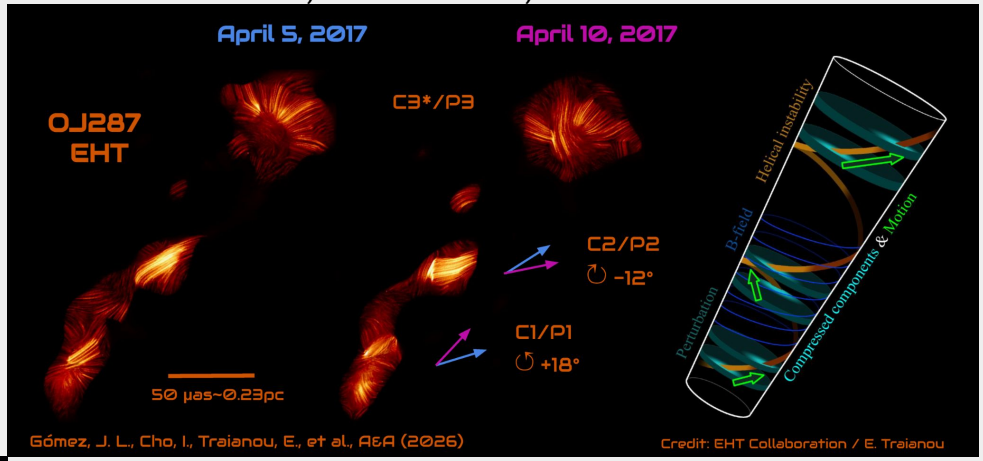
SMBHs e mm-VLBI

(Rocco Lico, Marcello Giroletti, Monica Orienti, Filippo D'Ammando, Nicola Marchili, Elisabetta Liuzzo)

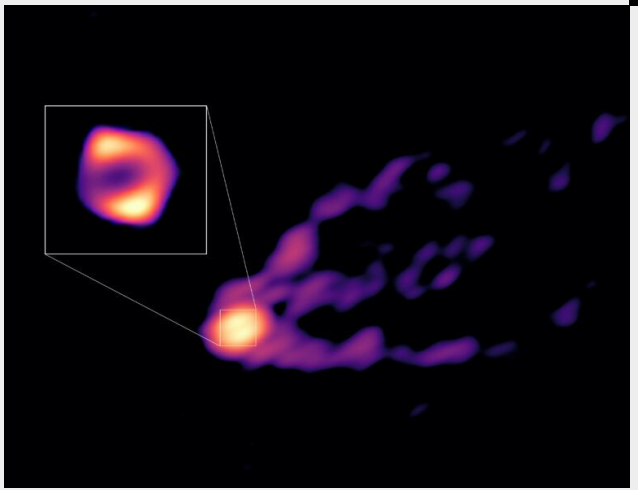
Observation mainly based on two arrays:

1) 3 mm con Global mm VLBI array (GMVA)
2) 1mm con Event Horizon Telescope (EHT)
   microarcsec resolution

Study of the jet structures: formation, collimation, acceleration, evolution



EH scale...



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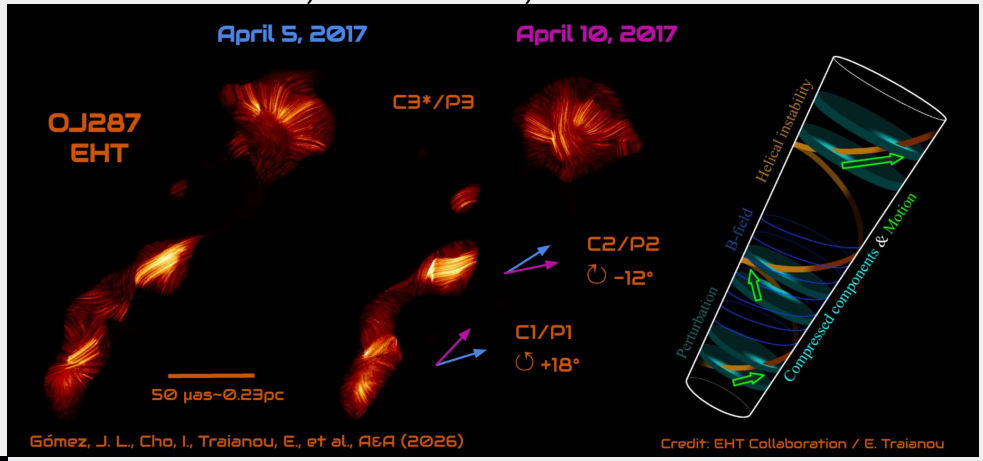

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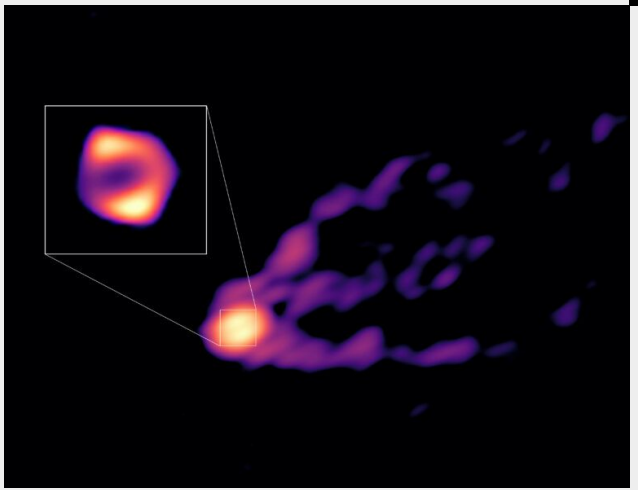

EH:

1. magnetic fields well organized
2. polarization (15%)
3. MAD?
4. -> long term observations: dynamic environment: variable polarization close to EH

future: increasing number of telescope, frequencies, space-VLBI

SMBHs e mm-VLBI

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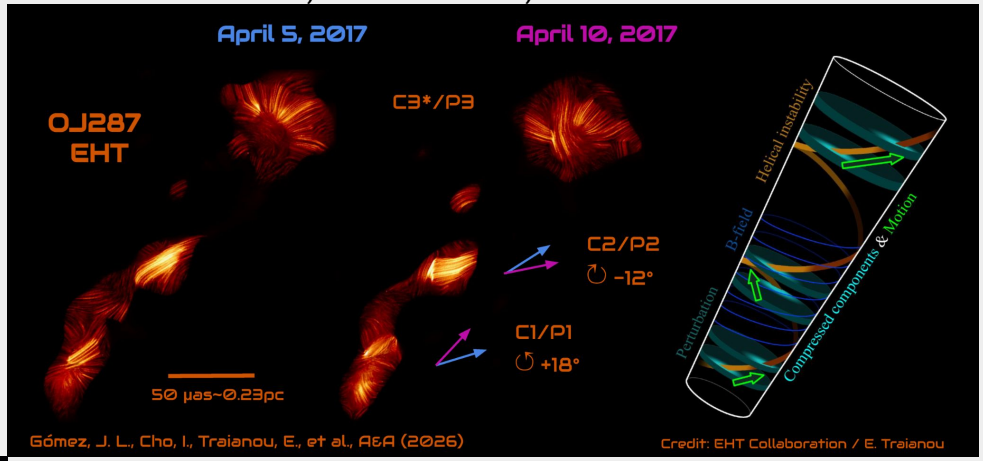

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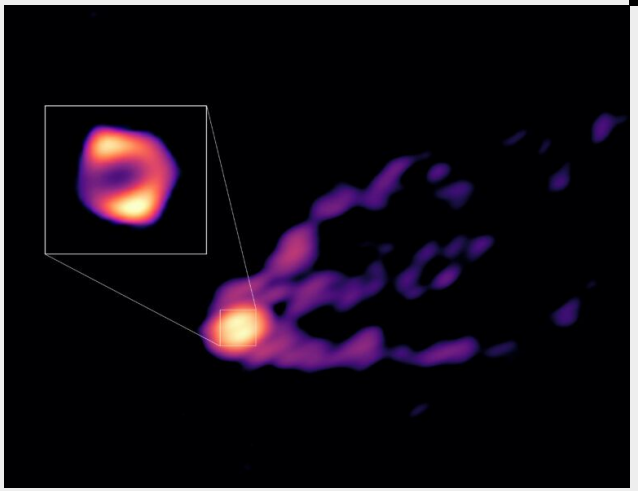
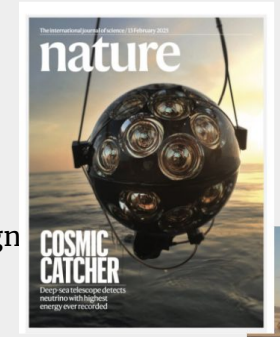
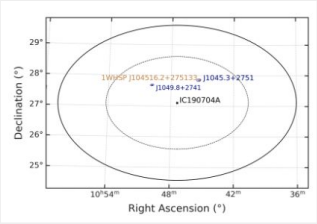


1. **Ultra-High Resolution:** mm-VLBI achieves microarcsecond precision, allowing direct observation of the jet's formation and acceleration zones.
2. **Energy Transition:** At ~10^5 Schwarzschild radii, the "mm-VLBI core" marks where magnetic energy converts into mechanical power, making the jet kinematically dominated.
3. **EHT Insights (e.g., OJ287):** Recent data reveals complex internal structures, including **non-ballistic shocks** and **Kelvin-Helmholtz instabilities** within helical magnetic fields.
4. **Frequency Synergy:** While 1mm (EHT) provides maximum detail, **22-43 GHz** observations offer higher temporal cadence to track the jet's evolution over time.
5. **Italian Contribution:** INAF is finishing the installation of **triple-band receivers on its antennae**, placing Italy at the forefront of global relativistic jet research.

Jetted AGN: radio to high-energy studies (INAF-IRA)





Research topics

- jet formation, accretion & ejection processes;
- jet structure, particle acceleration & radiative processes;
- gamma-ray & multi-messenger astrophysics;
- evolution of the extragalactic radio sources, feeding & feedback.

Methods:

- Multi-frequency radio observations & VLBI, neutrino-candidate follow-up campaign
- High-energy (X-to-gamma-ray) analysis;
- Population studies & multi-wavelength emission modeling;
- MHD simulations

National & International collaborations:

- Ongoing, active collaborations with several INAF institutes (Torino, Milano, Padova & Rome);
- European/international collaborations: large collaboration for neutrino follow up campaigns, long-term collaboration with Asia radioastronomy institutes (Japan/Korea/China), collaborations with US colleagues (CfA) & UK

Involvement in collaborations, current instrumentation & future projects:

- Italian VLBI network, EVN, Eating VLBI (East-Asia Italy Nearly Global VLBI) & Korea/Japan radioastronomy projects & collaboration;
- X-ray & gamma-ray missions (XMM, Swift, Chandra, NuSTAR, Fermi);
- CTA, SKA, LSST, Athena.

Fundings (most recent):

- Fermi/ASI: 1 co-funded TD (but no clear further funding);
- 2024 INAF grant call: n.2 AGN-related GO (PI: Orienti, Migliori) resulting in 1 PhD fellowship……+ n.2 minigrants (PI:Spingola, Lico);

Critical points:

- Need to consolidate the young scientist staff;
- Lack of students (Master & PhD level)
- Timeline for the awarded INAF grants
- Radio data handling: need for technological improvement to face the increasingly large datasets;

Jetted AGN: radio to high-energy studies (INAF-IRA)

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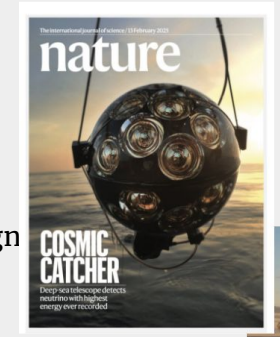
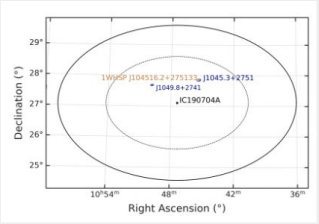




SMBH as particle accelerators

RL AGNs are the large majority of HE and VHE emitters in the extragalactic sky

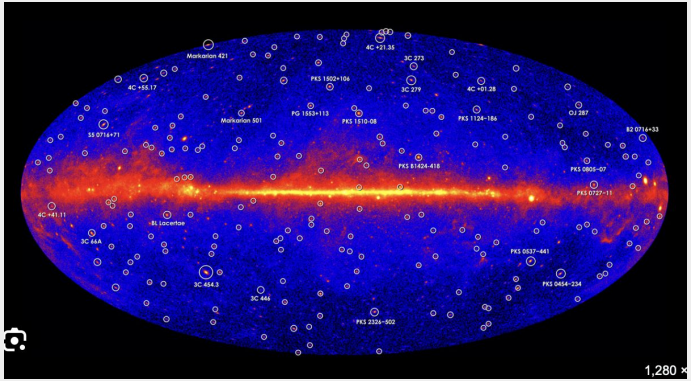
Acceleration mechanisms of the relativistic particles? Fast variability at VHE points to magnetic reconnection/turbulence (but modeling of the emission suggest small/moderate magnetization). IXPE results support shocks (?)
Jet structure and dynamics? Role of instabilities? Magnetic field structure?

IceCube results point to AGNs (both RL and RQ) as the dominant high-energy (E>100 TeV) neutrino emitters.

Where and how high-energy protons are accelerated? What are the targets (pp vs $p\gamma$)? Is the emitting region opaque or transparent to gamma-rays? Is there any connection with UHECR sources?

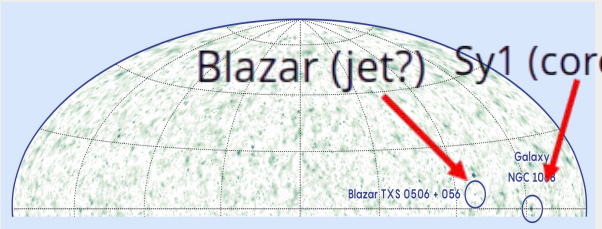
SMBH as particle accelerators

1. **Particle Acceleration:** A major international focus is understanding how electrons and nuclei reach ultra-high energies, bridging plasma physics simulations with **multi-messenger** data (neutrinos and UHECRs).
2. **Emission Sites:** Evidence suggests neutrinos may originate from both **Seyfert galaxies (coronae)** and **blazars (jets)**, highlighting different acceleration environments.
3. **Instrumental Synergy:** Future progress depends on linking high-energy observatories (**CTA, ASTRI, IXPE, COSI**) with neutrino detectors like **Km3Net**.
4. **The Role of Theory:** Advanced simulations (**MHD and PIC codes**) are essential to keep pace with international standards and interpret complex data.
5. **Crisis in Research:** There is a critical need to train young theorists, yet the field faces significant hurdles due to the **elimination of dedicated "Theory" funding** channels and a shrinking workforce caused by retirements.



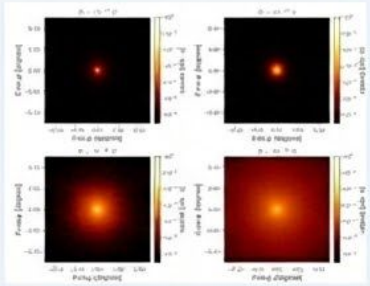
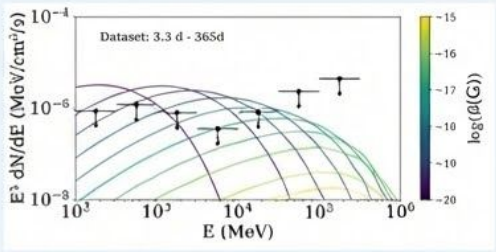
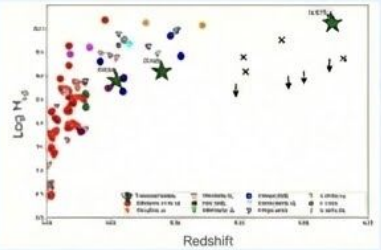
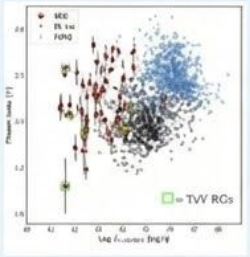
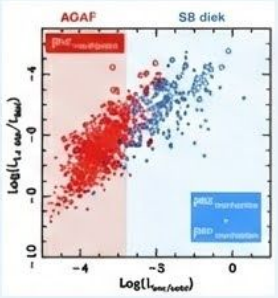
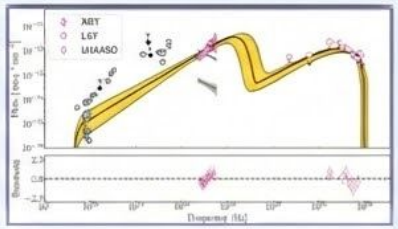
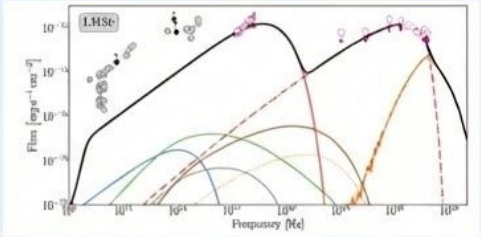
IceCube “hot spots”

	Source Name	Class
1	NGC 1068	SBG
2	PKS 1424 + 240	BLL
3	PMN J1650-5044	BLL
4	GB6 J1542 + 6129	BLL
5	TXS 0506 + 056	BLL
6	G343.1-2.3	PWN
7	PMN J1603-4904	BLL
8	MGRO J2019 + 37	GAL
9	4C + 55.17	FSRQ
10	M 31	SBG
11	Galactic Center	BCU
12	TXS 1714-336	BLL
13	PKS 1717 + 177	BLL
14	PKS 1830-211	FSRQ
15	PMN J1802-3940	FSRQ
16	B2 1520 + 31	FSRQ
17	QJ 014	BLL
18	GRS 1285.0	UNIDB
19	MGRO J1908 + 06	GAL
20	PKS 0048-09	BLL



OABrera (F. Tavecchio e coll.)

High- and very-high energy group @ OAS Bologna

Blazars and GRBs	VHE gamma-rays are absorbed by background radiation and reprocessed to GeV energies; in the presence of an **Inter Galactic Magnetic Field**, this leads to observable signatures such as blazar halos and GRB echo -> IGMF constraints	 
Radio galaxies	**Radio, sub-mm, X-ray, and gamma-ray observations** from the ground and from space, based on **large samples** of sources Exploitation of **high-energy archives** and **deep radio–IR–optical surveys**	  
	Modeling of spectral energy distributions using **leptonic** and **hadronic** models Estimate of the **contribution** of radio galaxies to the **cosmic neutrino emission**	 

OAS

Paola Grandi, Eleonora Torresi, Paolo Da Vela (TD), Ettore Bronzini (TD)

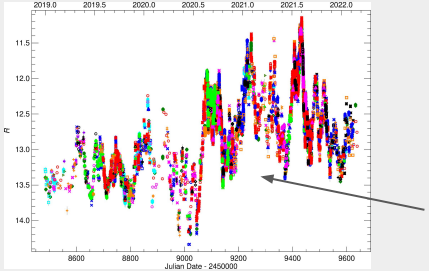
Importance of MW and long term monitoring:

Many programs based on the exploitation of MW data to study these “particle accelerators”.

Simona Paiano, INAF-IASF Palermo ZBLLAC

Claudia M. Raiteri, INAF-OATo

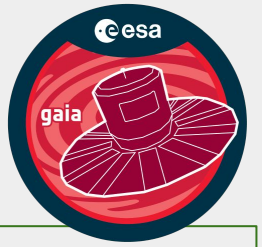
AGN (mainly blazar) multiwavelength variability



From Raiteri et al. 2024, A&A,692,A48
A wiggling filamentary jet at the origin of the blazar multi-wavelength behaviour
BL Lacertae in 2019-2022

Executive Officer (since 2000) of the Whole Earth Blazar Telescope (WEBT), an international consortium that synchronizes tens of global ground-based telescopes to achieve continuous, multi-wavelength monitoring of the very variable emission of relativistic jets.
Campaign Manager of most of its projects.

Scientific responsible (since 2019) of the AGN work package within Coordination Unit 7 (variability) of the Gaia Consortium (DPAC), with significant current involvement in achieving the publication of DR4 by the end of 2026. Selection and characterisation of variable AGN.



VERA C. RUBIN OBSERVATORY

Program Manager (since 2021) of the Italian participation in Rubin-LSST through an in-kind contribution Program led by INAF to provide data rights for the national scientific community (see Rubin-LSST@Italy website https://sites.google.com/inaf.it/rubin-lsst-italy)
Member of the "AGN" and "Transients and Variable Stars" Science Collaborations.
Co-chair of the Blazar follow-up task force.

Domenico Impiombato -OAPd

Monitoraggio ottico di blazar TeV con il telescopio Schmidt 67/91 cm di Asiago (2024–2026)

Campagna Osservativa

-Telescopio Schmidt 67/91 – Osservatorio di Asiago
- Monitoraggio fotometrico in banda R e I su 3 blazar TeV: PG 1553+113, 1ES 1959+650, 1ES 1426+428
- Oltre 15.000 osservazioni (2024–2025), ridotte con calibrazioni complete (bias, flat, patching)
- Aperture ottimizzate per minimizzare la contaminazione della galassia ospite

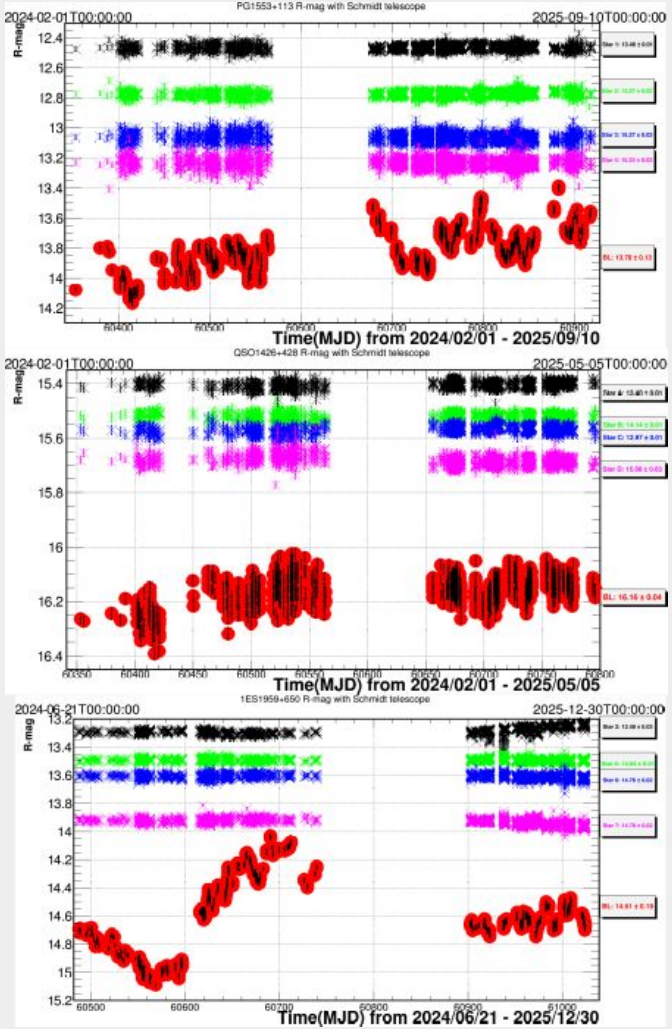
Risultati principali in corso di pubblicazione

- 1ES 1426+428: IDV significativa in 7 notti (>3σ), ampiezze 9-12%
- PG 1553+113 e 1ES 1959+650: solo possibile IDV (2.6–3.3σ), non confermata

Sinergie e sviluppi futuri

Il programma si colloca in **sinergia con MAGIC** per il follow-up ottico simultaneo a eventi gamma. Stiamo valutando di proporre, per la prossima **Call Schmidt 2026 (scadenza 12 gennaio)**, un'estensione a nuovi target come **FSRQ** di interesse per la comunità ad alte energie

sorgente	filtro	notti	Tot.ore
PG1553+113	R	167	93
PG1553+113	I	157	86
QSO1426+428	R	113	36
QSO1426+428	I	108	33
1ES 1959+650	R	157	78
1ES 1959+650	I	150	70



The X-ray duty-cycle of gamma-ray narrow-line Seyfert 1s: a multi-year, multi-objects approach

Stefano Vercellone & Patrizia Romano

These sources have been observed by Swift mainly as follow-up of flares at other wavelengths

This introduces a bias in the understanding of their X-ray variability behavior and duty-cycle because they favor high states

We started our project with a sample of 4 well-known g-NLS1s:

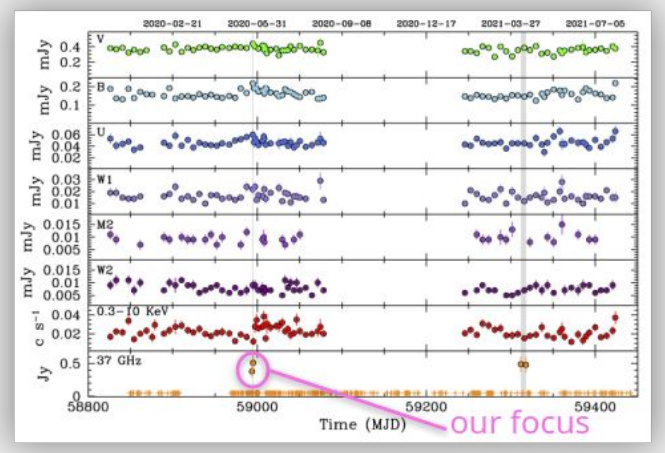
SBS 0846+513

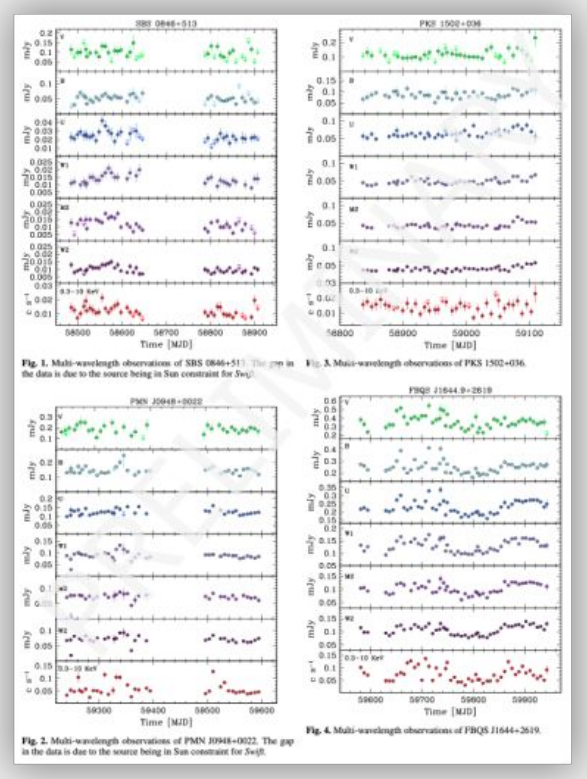
PMN J0948+0022

PKS 1502+036

FBQS J1644.9+2619

Good VHE candidates !
[see Romano et al., 2020, MNRAS, 494, 411]





Swift Observatory
1 observation/week
3 ks each observation
1 year baseline
Optical + UV + X-ray

Blazars in Gamma-rays @iaps

Statistical study of **gamma-ray flares from FSRQs**:

Waiting times between flares ……..**done**, **Pacciani 2022**

Flare Luminosity and duration distribution ……..**work in progress**

Triggering ToO observations for Cherenkov telescopes when a gamma-ray flare is detected with FERMI-LAT with significant emission above 10 GeV.
Several blazars detected after this trigger with Cherenkov telescope! ……**active and working**

Luigi Pacciani, Valerio Vittorini, Antonio Stamerra (OAR), Fabrizio Tavecchio (OAB)

X-ray polarimetric signatures of Blazars with IXPE@IAPS and connection with acceleration mechanism

- X-Ray EVPA traces the magnetic field direction in blazar jet.
- For High Synchrotron peaked blazars, X-rays and TeV Gamma-ray
- Are tought to come from the same electron population.
- X-ray polarimetry reveals the magnetic field direction in the emitting region
- For the majority of IXPE observation of HSP blazars, the X-ray EVPA is parallel to the jet (but see, Pacciani 2025).
- Acceleration by shock needs magnetic field parallel to the shock front;
- Jet direction, and X-ray polarization exceeds optical polarization.
  - Energy stratified shock model (**Liodakis 2022**) seem to be favored for Mkn 501 (but see, e.g., **Bolis 2026**)
- **MWL campaigns up to TeV** allow to model acceleration processes.
  - IXPE ToO on flaring HSP already performed; simultaneous to MWL campaign on the source (**MAGIC** & **VERITAS**);
  - IXPE observation of 1ES 1959+650 obtained for IXPE CYCLE 3, and MWL campaign up to **TeV** organized.

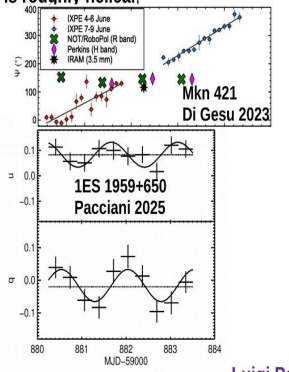
Luigi Pacciani, Dawoon Kim, Paolo Soffitta, Fabio Muleri

X-ray polarimetric signatures of Blazars with IXPE@IAPS and connection with jet magnetic field structure

Mkn 421:

Discovery of EVPA Rotation in X-ray (twice on 5 observations, **Di Gesu 2023**, **Kim 2024**);
Plasma follows magnetic field lines;
EVPA is orthogonal to the projected magnetic field for Synchrotron emission;

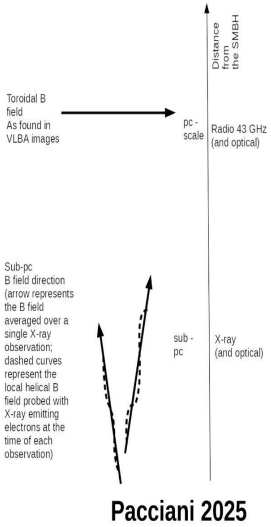
- **Magnetic field structure within the jet is roughly helical**;



1ES 1959+650:

Discovery of EVPA Rotation in X-ray (twice on 6 observations; average EVPA perpendicular to the Jet axis when rotation is detected (**Pacciani 2025**), contrary to finding for Mkn 501 (**Maksim 2025**).

- Acceleration through shock is disfaveored;
- To observe the whole helical pattern, the helical magnetic field should be stretched along the jet axis (in contrast to findings from VLBA).
- Are we observing the base of the jet in X-ray during flaring activity ?!!! (Jet is opaque in radio on sub pc scale, VLBA observes the magnetic field at pc distance from the SMBH).

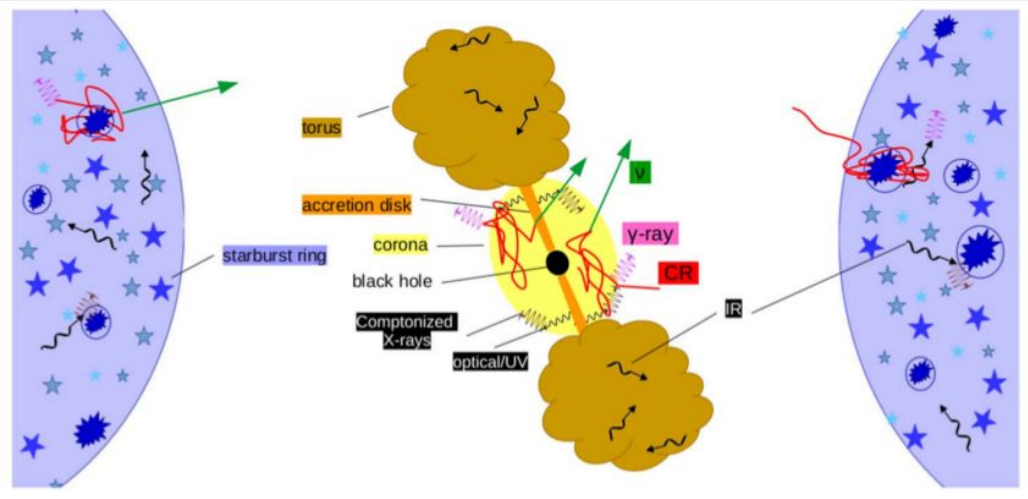


Luigi Pacciani, Dawoon Kim, Paolo Soffitta, Fabio Muleri

Neutrinos from AGN coronae

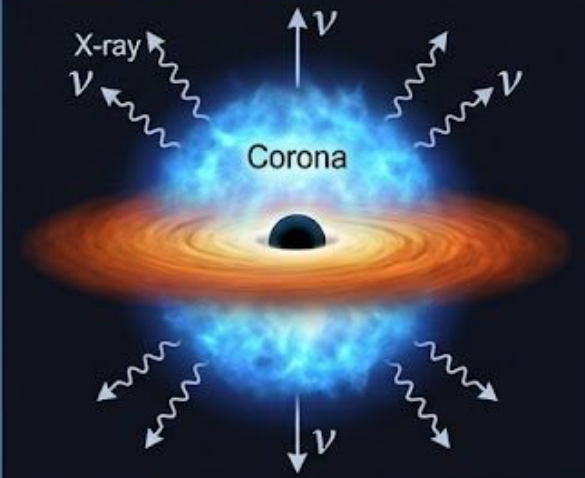
James Rodi, Gabriele Bruni (IAPS)

- Recent results suggest neutrinos may also be produced in Seyferts (I+II)
- Neutrinos possibly produced in AGN core/coronae
  - Process(es) for proton acceleration in cores remains debated
  - Hard X-rays provide a probe for particle processes in coronae
- Studied the Seyfert II AGN 3C 403 and NGC 1068



Radio-Quiet AGN: Scientific Pillars and INAF Groups (RSN4)

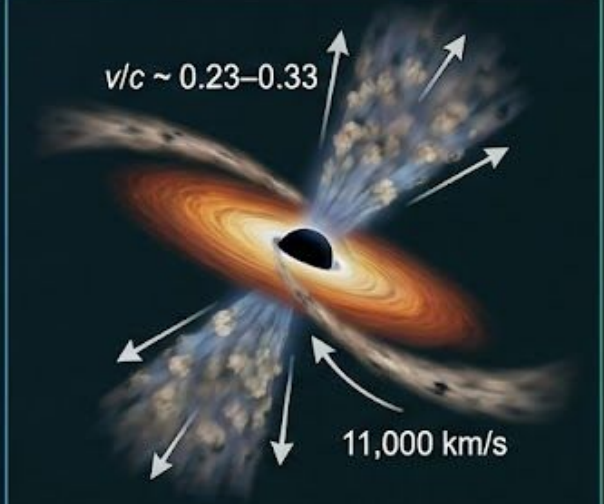
1. Coronae & Neutrino Sources



Physical Focus: X-ray spectro-polarimetry (geometry), Proton acceleration in core/coronae, Neutrino sources, Origin of Radio Emission in RQ AGN.

INAF Groups: IAPS (IXPE team, AGILE team: 3C 403, NGC 1068), IAPS (Radio emission origin).

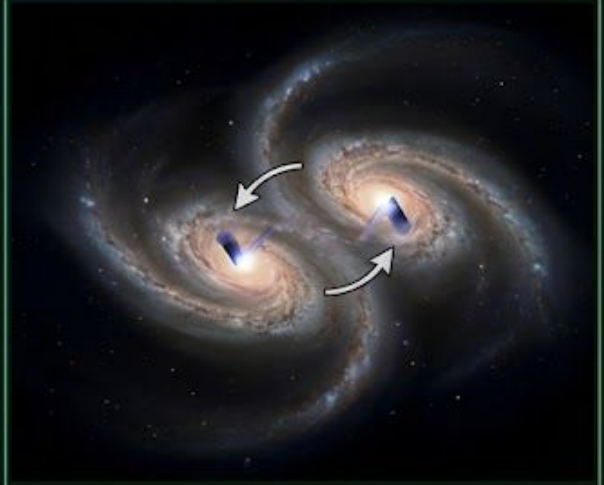
2. Relativistic Winds & Inflows



Physical Focus: Ultra-Fast Outflows (UFOs), Clumpy wind structures, High-velocity inflows.

INAF Groups: OA Brera / OAS (XRISM Campaigns: PDS 456, PG 1211, Mrk 509).

3. Dual AGN & Evolution



Physical Focus: SMBH growth through mergers, Observing early-to-late merging stages, Coalescence signatures.

INAF Groups: IAPS / OA Brera / OAS ('Cosmic Duets', Dual AGN).

Gamma Radio Astronomy Laboratory GRAL Group

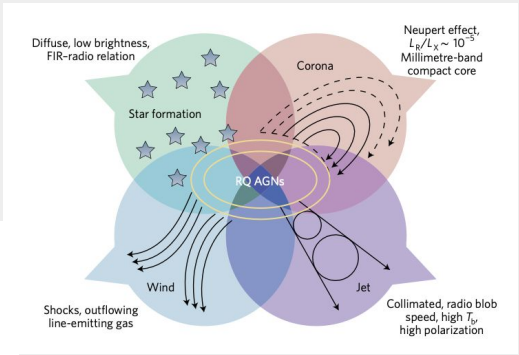
Accretion & Ejection physics

People: F. Panessa (Primo Ricercatore), G. Bruni (TD), Matteo Fanelli (Ph.D.), Maya Garbaccio Gili (Ph.D.)

Projects: **Multi-frequency observations of accretion and ejection phenomena in radio-quiet and radio loud AGN**

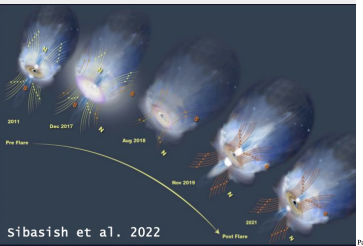
- Origin of radio emission in radio-quiet AGN
- Jets and particle acceleration
- AGN Radio feedback on the host galaxy
- Black holes across the mass scale and time-domain studies
- Study of the AGN jet duty cycle.

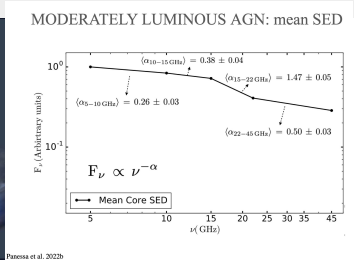
IAPS



Panessa et al. 2019, Nature Astronomy Review

Highlights & Collaborations





A Discovery of Young Radio Sources in the Cores of Giant Radio Galaxies Selected at Hard X-Rays

G. Bruni[1], F. Panessa[1], L. Bassani[2], E. Chiaraluce[1,3], A. Kraus[4], D. Dallacasa[5,6], A. Bazzano[1], L. Hernández-García[7], A. Malizia[2], P. Ubertini[1]
+Show full author list

Published 2019 April 19 •
The Astrophysical Journal, Volume 875, Number 2

IAPS

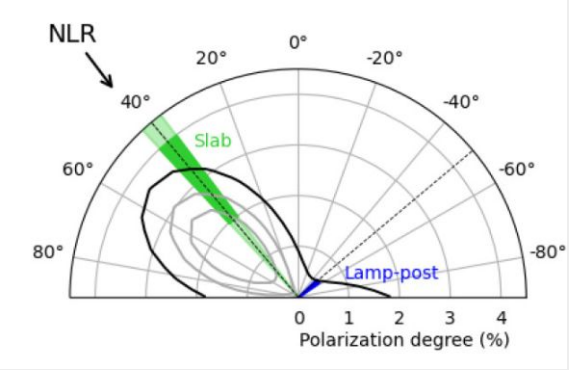
Radio Quiet AGNs

Physical parameters of the AGN's corona are degenerate with respect to geometry. Polarimetry can help to break this degeneration.

MCG-5-23-16 (Sefert-1)

Tagliacozzo, D. et al., MNRAS, 2023

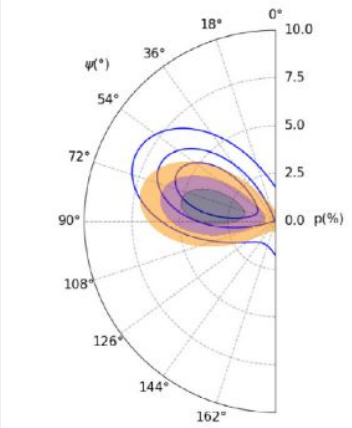
PD < 3.2 % (99 % C.L.)



IC4329A (Sefert-1)

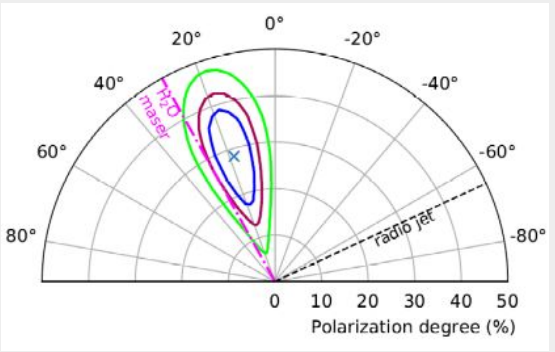
Ingram, A. et al., MNRAS, 2023

PD=3.3+/-1.1 %



Circinus galaxy (Compton thick Sy2)

Ursini et al., MNRAS 2023



For The cold reflector (torus) IXPE measured a 2-6 keV polarization of:
P = 28 %+/- 7% and Theta = 18o +/-5o

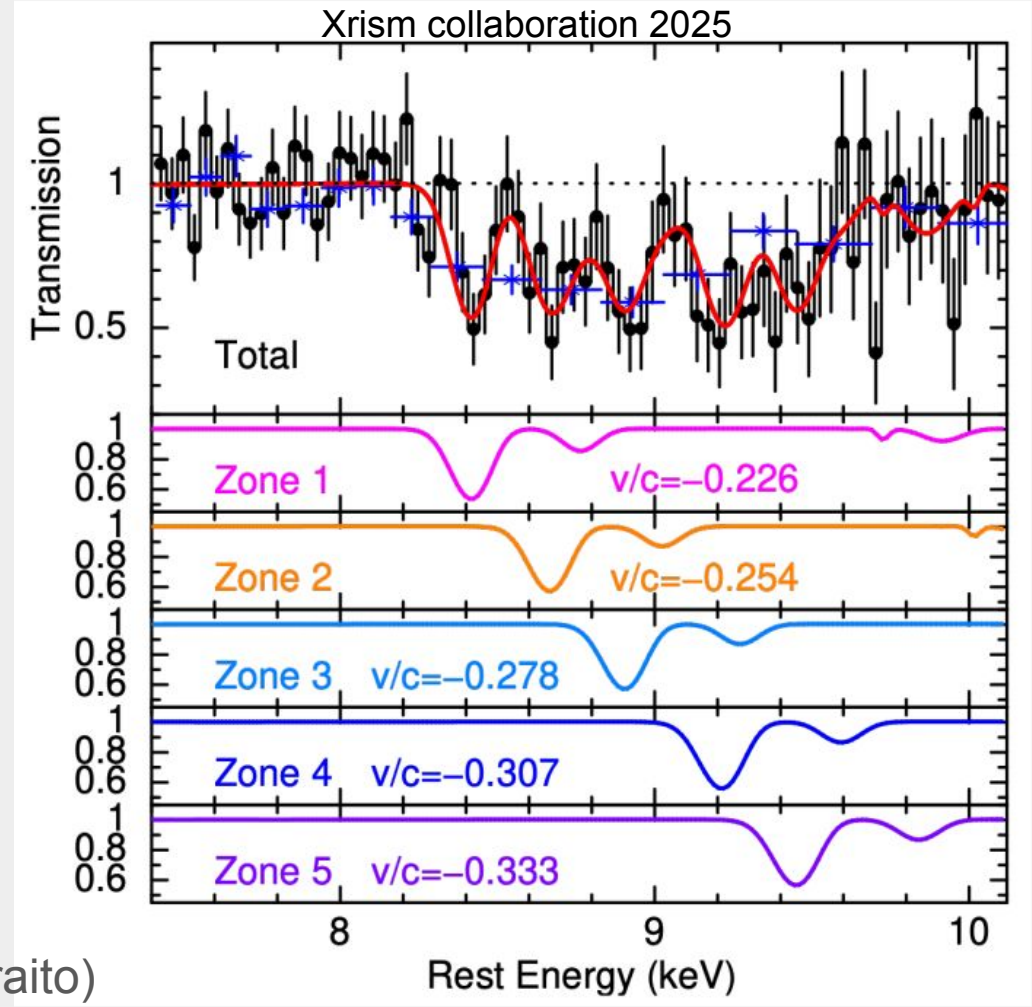
Sey1: Polarimetry of NGC 4151 the corona is parallel to the disk. MCG-5-23-16 and IC4329A suggest with low significance the same geometry

Sey2: X-ray spectro-polarimetry in Circinus galaxy and NGC-1068 showed at low significance that the torus axis and the radio jet are aligned. The torus aperture is similar in both.

Area needed!!!!

The clumpy wind of PDS456

- 5 distinct high-velocity components with v/c~0.226-0.333
- Opacity arises from He-like 1s-2p lines.
  Approx constant ionization ($\log\xi = 5$ for PDS SED) but wide velocity range.
- Not smooth or constant velocity wind. UFO is highly inhomogeneous, with up to 106 clumps.
- From the Fe-K emission profile we inferred a wide angle of 2π
  &
- $\dot{M}$out=60-300MSun/yr
- LKIN~1047 erg/s ~LEdd



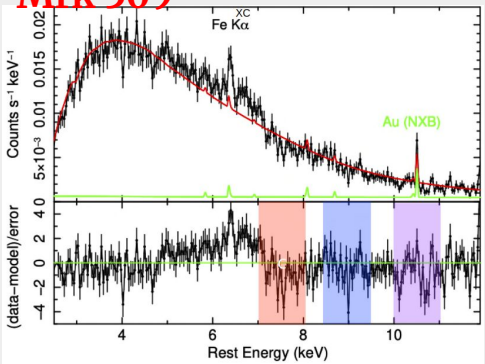
PG1211+143: 2024 XRISM campaign + Mrk 509

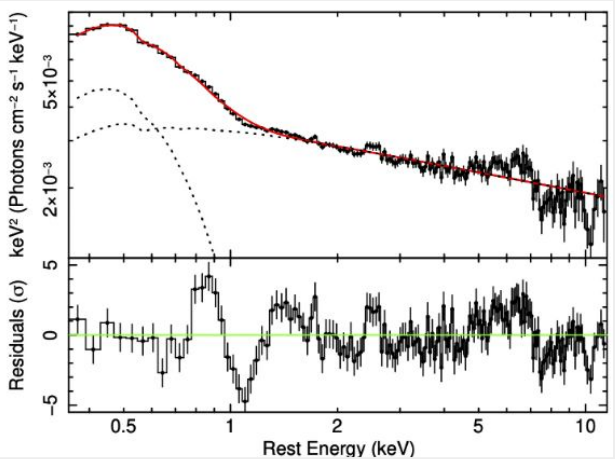
230 ksec XRISM on 29 Nov 2024
NuSTAR (80ks), XMM (120 ks) DDT
Swift (35x1.5 ks)

XMM: a relatively unobscured state, evident structures both in the soft and Fe-K

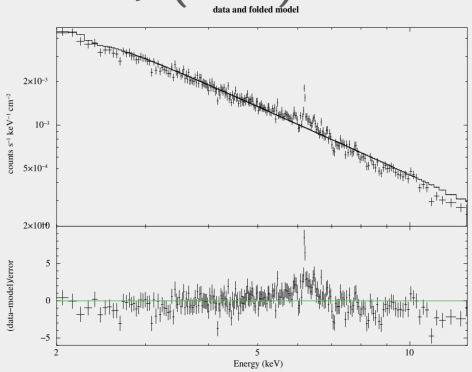
XMM-NuSTAR-Xtend: all reveal the presence of broad absorption features between 7-8 keV (Rest frame z=0.0809) and possibly higher velocity components btw 9-11 keV.

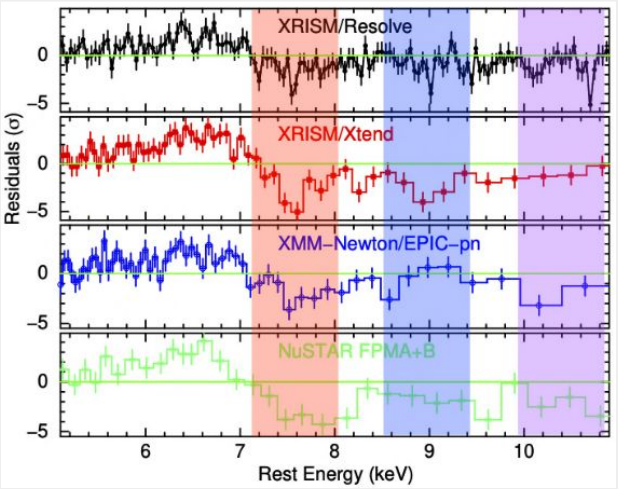
Like in PDS456, Fe K absorption is resolved into multiple lines by XRISM/Resolve!



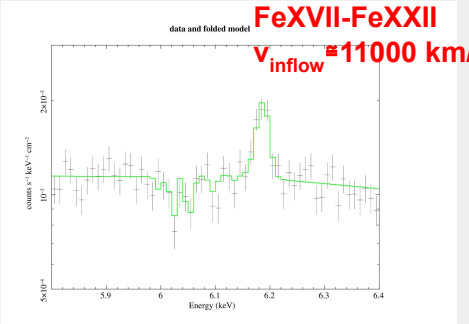


Mrk 509 (OAS)





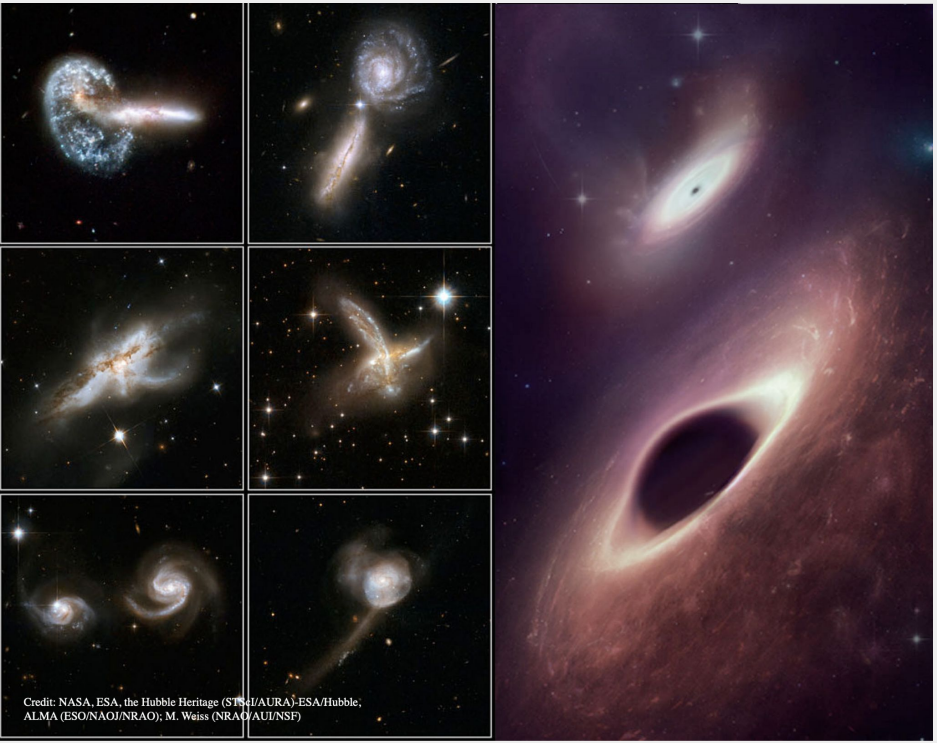
Absorption from FeXVII-FeXXII
V_{inflow}≅11000 km/s



IASF Palermo group is also working on this...

Dual AGN

Galaxy mergers may be a way through which SMBHs form
Major mergers may trigger the most luminous AGN



core questions related to merger–AGN connection:

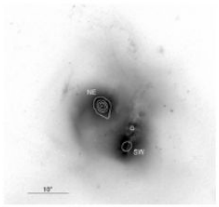
- Are mergers the primary trigger of AGN?
- Rate of dual AGN at different separations in merging galaxies dual AGN characterization (Ledd, NH, type, BH mass ratio..) at different stage of separation
- Do all galaxy mergers produce AGN?
- Incidence of AGN in mergers vs isolated galaxies

IAPS-OABrera… (OAS…)

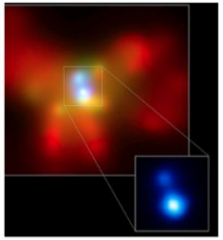
Begelman et al., 2006; Mayer et al., 2010; Mayer and Bonoli, 2019, Treister et al. 2012; Fan et al. 2016; Goulding et al. 2018, ..

On the way to SMBH merging: observing three stages

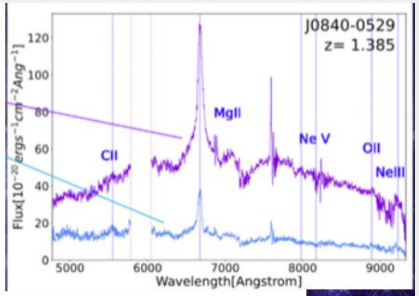
IAPS-OABrera… (OAS…)



Mrk 266 (Iwasawa+20)
z=0.027
HST WFPC2 image +
Chandra contours
Proj. sep. ~ 6 kpc (10'')

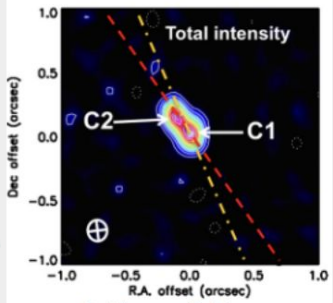


NGC6240 (Komossa+03)
z=0.024
Chandra color-image
Proj. sep. ~2 kpc (1.8'')

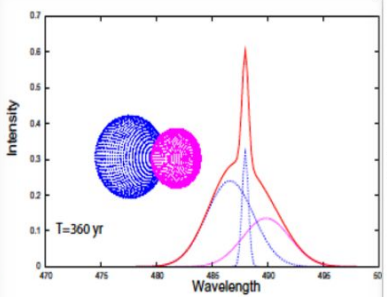


Optical GMP + MUSE
Scialpi+24, Mannucci+23,23

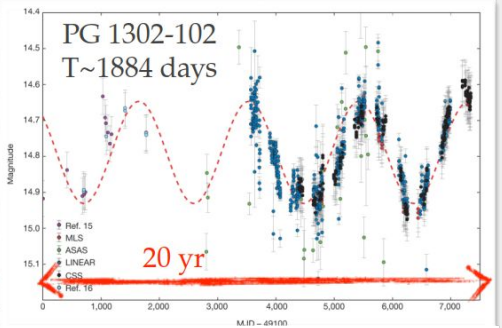
Dual AGN early late: direct imaging, X-ray/optical spectroscopy, IR photometry
Wide surveys + high spatial resolution follow-ups



z=0.17, sep=0.6 kpc
VLA images; *Müller-Sánchez+15*



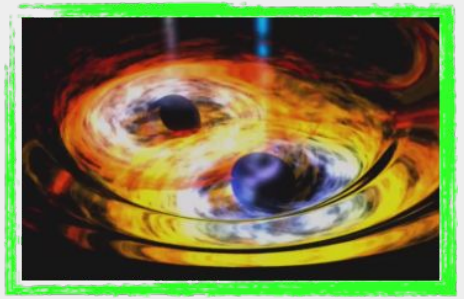
Double peaked Optical emission lines, Severgnini+21, Rigamonti+25



Photometric variability (ZTF, CRTS) Charisi+16, Graham+15,+18; Serafinelli+20, Severgnini+18

Binary AGN: indirect techniques: X-ray/optical spectroscopy and variability

Coalescence: X-ray/optical spectroscopy, variability
Multi-messenger in act!



Strutture INAF: IAPS, OA-Roma, OA-Brera, OA-Arcetri, OA-Trieste, OAS (Loiano Cassini Telescope)
Intensa trasversalità con RSN1 e RSN5 - Multi-messenger

Space-Based Observatories

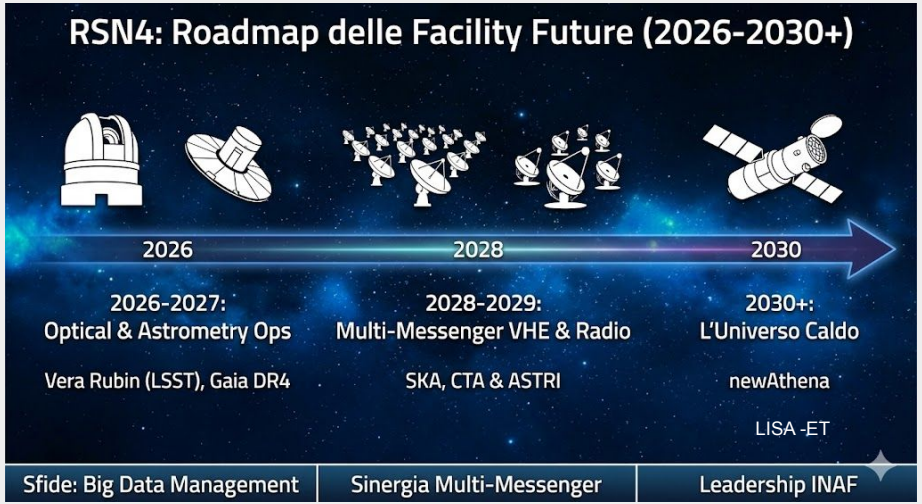
- XMM-Newton
- Swift Observatory
- Chandra
- NuSTAR
- Fermi
- IXPE
- XRISM
- AGILE
- Gaia:
- HST (Hubble Space Telescope)
- NuSTAR

Ground-Based Telescopes and Arrays

- VLBI (Very Long Baseline Interferometry):
- GMVA (Global mm VLBI array):
- EHT (Event Horizon Telescope):
- MAGIC:
- VERITAS:
- Asiago Schmidt 67/91 cm Telescope:
- WEBT (Whole Earth Blazar Telescope):
- VLA (Very Large Array):
- Loiano Cassini Telescope:
- ALMA
- IceCube
- VLT

Future facilities

- Astri
- CTA
- NewAthena
- Vera Rubin
- SKA



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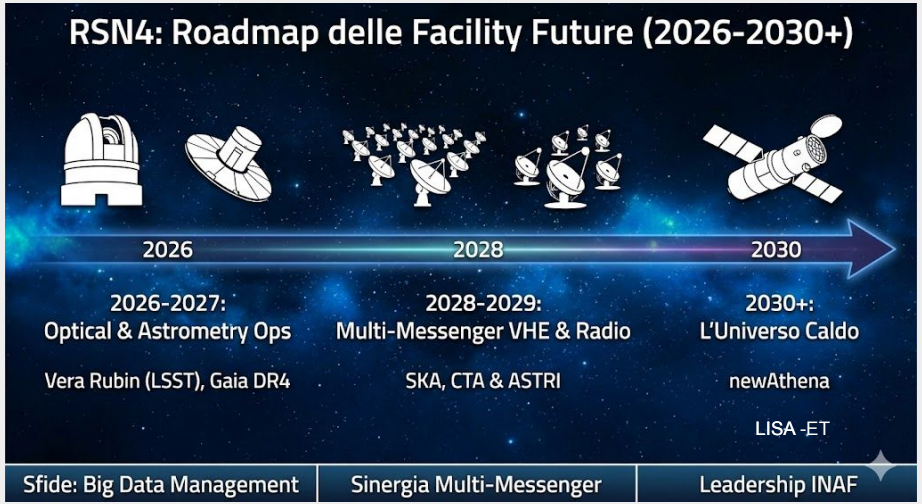
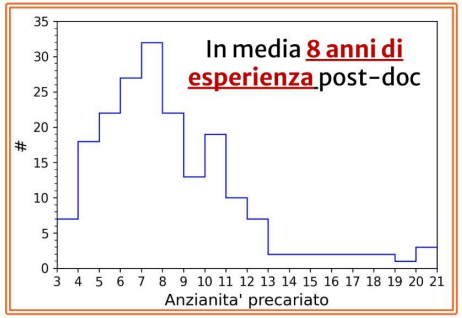
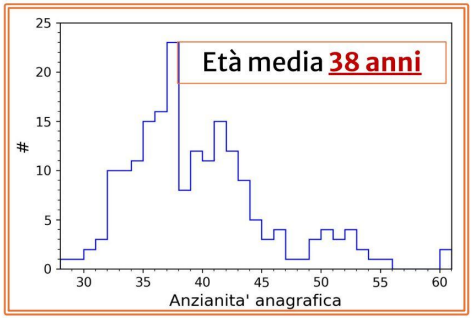
Recruiting + funding policies



La situazione del personale precario in INAF è INSOSTENIBILE!

1.200 TI Vs 650 precari: più di 1 precario ogni 2 persone di ruolo



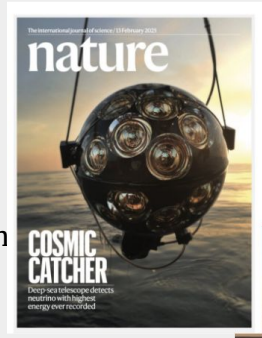


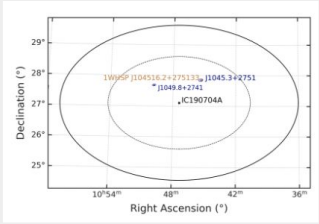
Plot di un campione rappresentativo dei precari INAF al 31/12/2024

Entro l'anno, l'attuale situazione determinerà l'esodo di > 100 lavoratori altamente qualificati

È URGENTE che INAF RIVENDICHI con fermezza, presso il MUR, finanziamenti svincolati dal turnover ed etichettati per le STABILIZZAZIONI MADIA: unica soluzione per questa emergenza

Per sostenerci, inquadra il QRcode e firma





& Rome);
mpaigns, long-term collaboration with
ues (CfA) & UK

/Japan radioastronomy projects &

llowship.....+ n.2 minigrants

- Need to consolidate the young scientist staff;
- Lack of students (Master & PhD level)
- Timeline for the awarded INAF grants
- data handling: need for technological improvement to face the increasingly large datasets;