

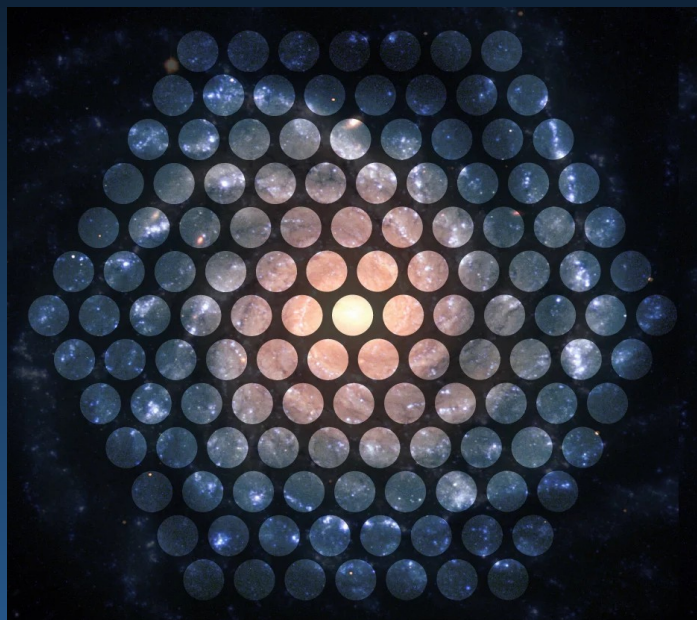
Exploring the Relationship Between Stellar Population and Nuclear Activity in Hydrodynamical Simulations: An Analysis of the iMaNGA Sample in the Illustris TNG Simulation

Felipe Albanez, Sandro Rembold

Universidade Federal de Santa Maria

Context

MaNGA survey



Study the stellar populations and ionized gas properties of a robust sample of AGN hosts

MNRAS **472**, 4382–4403 (2017)

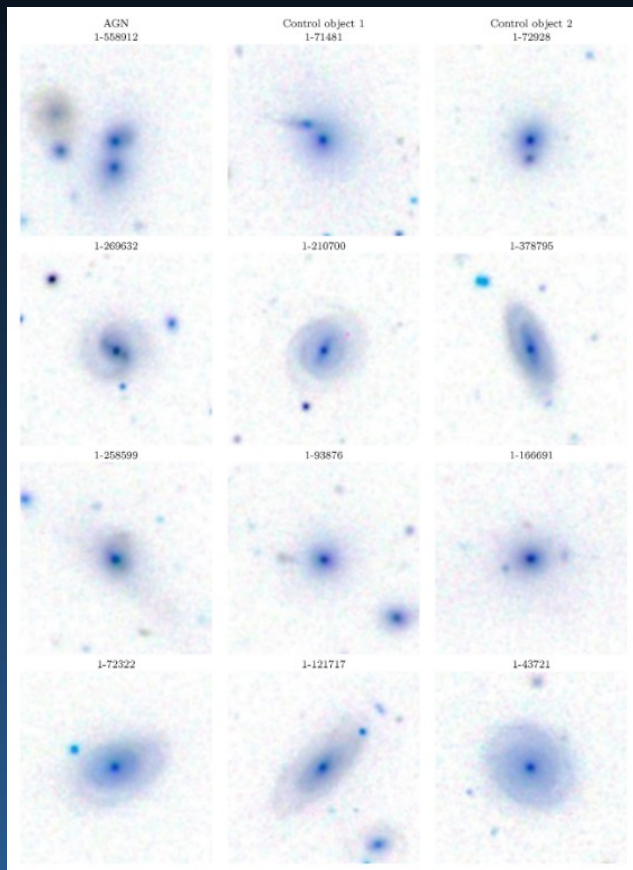
Advance Access publication 2017 September 4

doi:10.1093/mnras/stx226

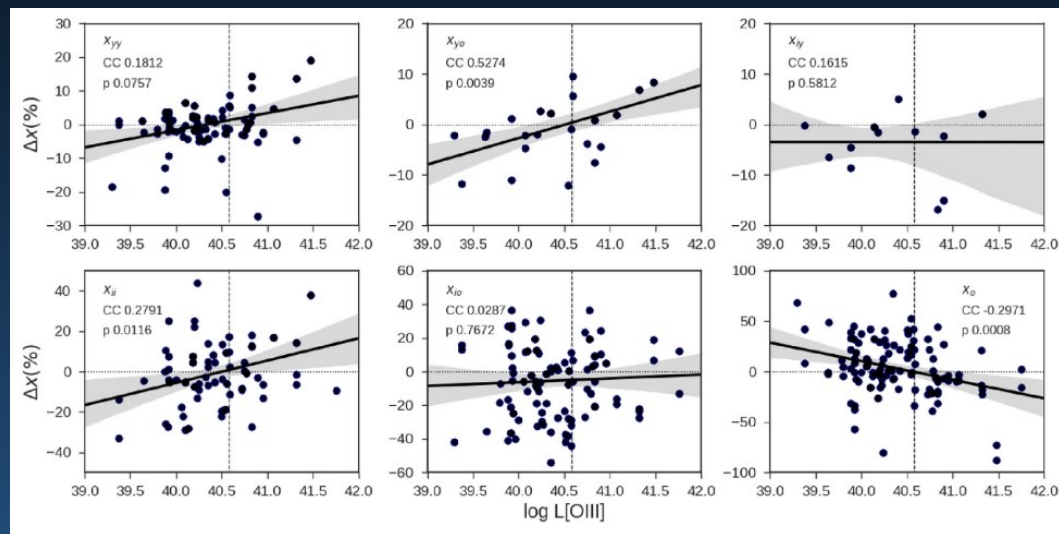
The first 62 AGNs observed with SDSS-IV MaNGA – I. Their characterization and definition of a control sample

Sandro B. Rembold,^{1,2★} Jáderson S. Shimoia,^{2,3★} Thaisa Storchi-Bergmann,^{2,3★} Rogério Riffel,^{2,3} Rogemar A. Riffel,^{1,2} Nicolás D. Mallmann,^{2,3} Janaína C. do Nascimento,^{2,3} Thales N. Moreira,^{1,2} Gabriele S. Ilha,^{1,2} Alice D. Machado,^{1,2} Rafael Cirolini,^{1,2} Luiz N. da Costa,^{2,4} Marcio A. G. Maia,^{2,4} Basílio X. Santiago,^{2,3} Donald P. Schneider,^{5,6} Dominika Wylezalek,⁷ Dmitry Bizyaev,^{8,9} Kaike Pan⁸ and Francisco Müller-Sánchez¹⁰

Context



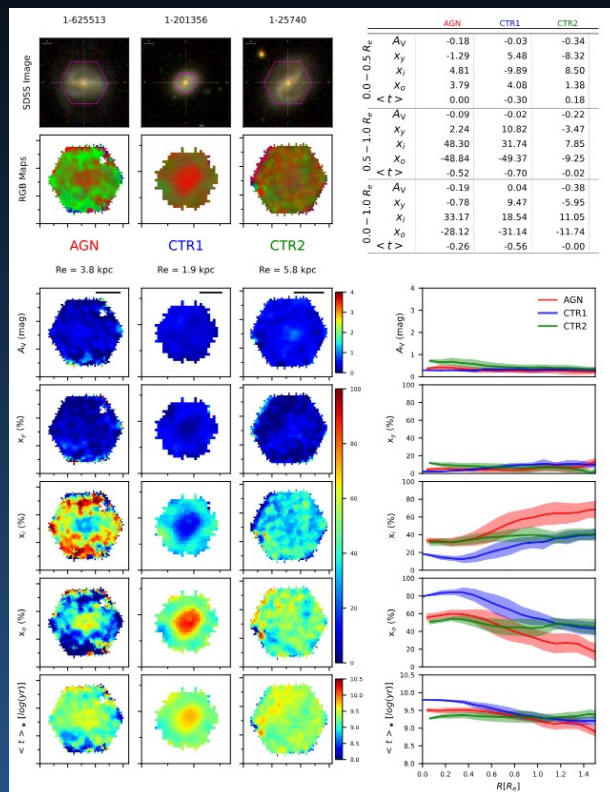
Optically selected AGN hosts + control sample of inactive galaxies



SDSS-III spectroscopy: excess of young & intermediate stellar populations in (luminous) AGN hosts wrt controls

Context

Final sample
& Urutau (Riffel+23)
"MEGACUBES"



MaNGA data: excess of young & intermediate stellar populations confirmed and quantified

Mapping the stellar population and gas excitation of MaNGA galaxies with MEGACUBES. Results for AGN versus control sample

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Rogemar A. Riffel^{2,4} Thaisa Storch-Bergmann^{1,2} Daniel Ruschel-Dutra⁶ Alexandre Vazdekis^{3,7}
Ignacio Martín-Navarro^{3,7} Jaderson S. Schimoia^{4,2} Cristina Ramos Almeida^{3,7} Luiz N. da Costa²
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LineA MaNGA Portal

IFU Viewer

Click the figure above to enter the portal.

We present spaxel-by-spaxel stellar population fits for the more than 10 thousand SDSS MaNGA datacubes. All data distributed here follows the SDSS acknowledgment rules. We provide multiple extension .fits files, referred to as MEGACUBES, with maps of several properties and emission-line profiles provided for each spaxel and a table with the mean properties over different galaxy radii. For more details and description of the figures presented here see [Riffel et al 2023](#).

To enter the portal click on the figure above.

Goals

Are those trends also observed in hydrodynamical simulations?

MNRAS **515**, 320–338 (2022)

Advance Access publication 2022 June 7

<https://doi.org/10.1093/mnras/stac1531>

iMaNGA: mock MaNGA galaxies based on IllustrisTNG and MaStar SSPs – I. Construction and analysis of the mock data cubes

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David R. Law,³ Lewis Hill^{①,1} Annalisa Pillepich^{①,4} Renbin Yan^{①,5} Yanping Chen⁶ and Dan Lazarz⁷

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⁵*Department of Physics, The Chinese University of Hong Kong, Shatin, N.T., SAR 999077, Hong Kong SAR, China*

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- Define AGN & control samples in mock MaNGA datacubes
- Apply Urtau & compare the stellar population properties

Methods

iMaNGA

iMaNGA focuses on generating a catalog of simulated galaxies to improve the understanding of galaxy formation and evolution (Nanni et al. 2022).

- The project aims to strengthen the connection between theoretical simulations and observational data, specifically targeting the testing of galaxy formation theories.
- Advanced cosmological simulations (IllustrisTNG) are used to create simulated observations that resemble real data from the MaNGA survey.

The IllustrisTNG project is a set of state-of-the-art cosmological galaxy formation simulations. Each simulation in IllustrisTNG spans a large portion of a simulated Universe, from shortly after the Big Bang to the present day, while accounting for a wide range of physical processes that drive galaxy formation. The simulations can be used to study a broad range of topics on how the Universe — and the galaxies within it — have evolved over time.

[TNG](#) [PROJECT DESCRIPTION](#) [PEOPLE + CONTACT](#) [RESULTS](#) [IMAGES + VIDEOS](#) [DATA ACCESS](#) [EXPLORE](#) [TNG-CLUSTER](#)

TNG

The IllustrisTNG project is a suite of state-of-the-art cosmological galaxy formation simulations. Each simulation in IllustrisTNG evolves a large swath of a mock Universe from soon after the Big-Bang until the present day while taking into account a wide range of physical processes that drive galaxy formation. The simulations can be used to study a broad range of topics surrounding how the Universe — and the galaxies within it — evolved over time.

Motivation and Big Ideas

The standard model of cosmology posits that the mass-energy density of the Universe is dominated by unknown forms of dark matter and dark energy. Testing this extraordinary scenario requires precise predictions for the formation of structure in the visible matter, which is directly observable as stars, diffuse gas, and accreting black holes. These components of the visible matter are organized in a 'Cosmic Web' of sheets, filaments, and voids, inside which the basic units of cosmic structure — galaxies — are embedded. To test our current ideas on the formation and evolution of galaxies, we strive to create simulated galaxies as detailed and realistic as possible, and compare them to galaxies observed in the real universe. By probing our successes and failures, we can further enhance our understanding of the process of galaxy formation, and thereby perhaps realize something fundamental about the world in which we live.

Methods

Our project consists of analyzing the properties of the stellar population in simulated galaxies, reproducing our previous investigations of real galaxies in the MaNGA survey. It can be divided into 4 steps:

1. Download the 1,511 data cubes that constitute the iMaNGA catalog.

The size of the data cubes varies between 2 and 10 GB, totaling approximately 20 TB. With our limited network, it would take days just to download the data.

```
-rw-r--r-- 1 felipe.albarez public 10299971520 Jan 8 22:48 98 741861_ready.fits
-rw-r--r-- 1 felipe.albarez public 96261120 Jan 8 22:47 98 743380_ready.fits
-rw-r--r-- 1 felipe.albarez public 6757822080 Jan 8 22:48 98 743562_ready.fits
-rw-r--r-- 1 felipe.albarez public 7677031680 Jan 8 22:48 98 743873_ready.fits
-rw-r--r-- 1 felipe.albarez public 252823680 Jan 8 22:47 98 744686_ready.fits
-rw-r--r-- 1 felipe.albarez public 10299971520 Jan 8 22:48 98 745190_ready.fits
-rw-r--r-- 1 felipe.albarez public 2540784960 Jan 8 22:47 98 745266_ready.fits
-rw-r--r-- 1 felipe.albarez public 7325464320 Jan 8 22:47 98 747447_ready.fits
-rw-r--r-- 1 felipe.albarez public 678556800 Jan 8 22:47 98 747660_ready.fits
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-rw-r--r-- 1 felipe.albarez public 10299971520 Jan 8 22:53 98 749198_ready.fits
-rw-r--r-- 1 felipe.albarez public 6537170880 Jan 8 22:53 98 749234_ready.fits
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-rw-r--r-- 1 felipe.albarez public 124646400 Jan 8 22:54 98 759471_ready.fits
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-rw-r--r-- 1 felipe.albarez public 10299971520 Jan 8 23:01 98 791321_ready.fits
-rw-r--r-- 1 felipe.albarez public 8281296000 Jan 8 23:01 98 79_ready.fits
-rw-r--r-- 1 felipe.albarez public 2820948480 Jan 8 23:00 98 805518_ready.fits
-rw-r--r-- 1 felipe.albarez public 10299971520 Jan 8 23:01 98 808174_ready.fits
```

Methods

2. Model the files to ensure compatibility with Urutau's requirements, adopting a structure similar to that used by MaNGA files. ✓

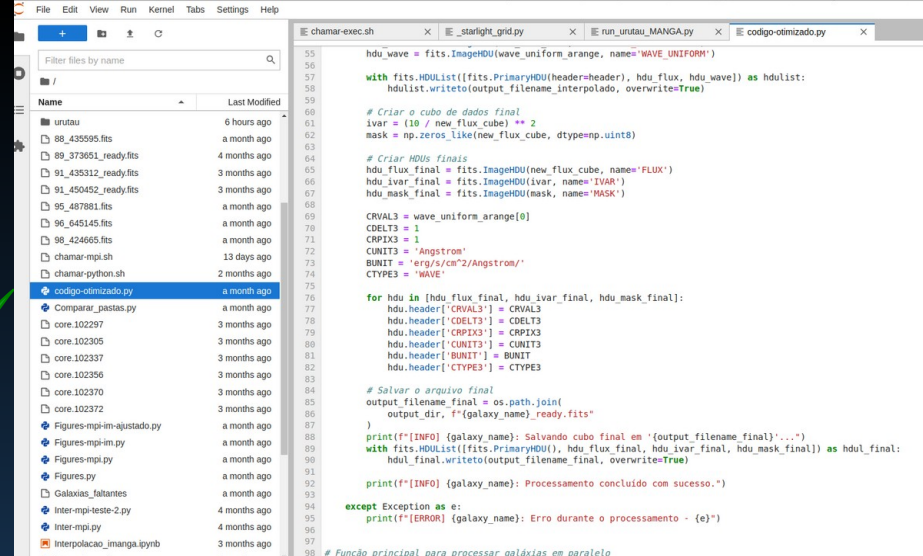
Load parameters (iMaNGA).

Define a uniform grid between 3621 and 10353 Å.

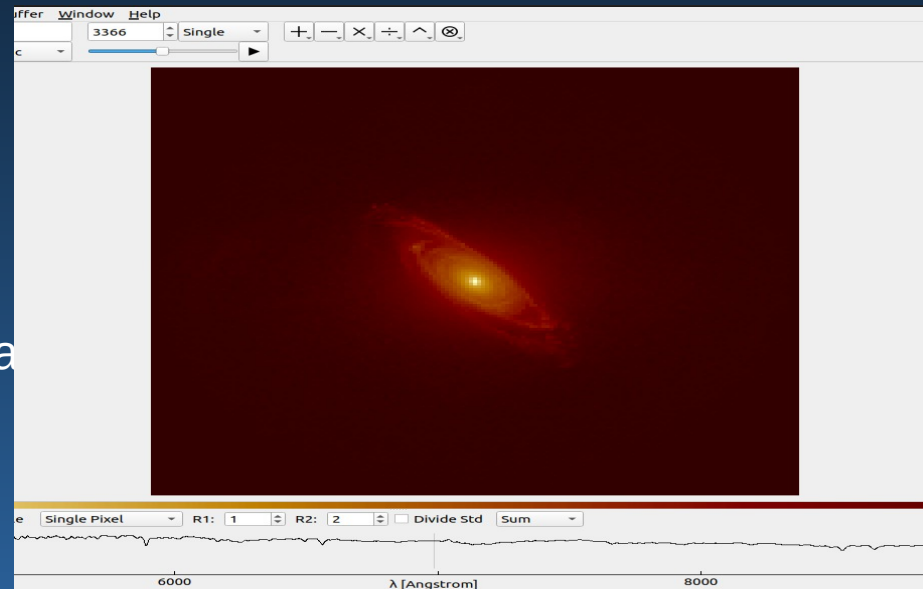
Flux density interpolation

Calculate inverse variance (IVAR) and mask (MASK) maps

Create the data cube (with final HDUs).



```
55 hdu_wave = fits.ImageHDU(wave_uniform_range, name='WAVE_UNIFORM')
56
57 with fits.HDUList([fits.PrimaryHDU(header=header), hdu_flux, hdu_wave]) as hdu_list:
58     hdu_list.writeto(output_filename_interpolado, overwrite=True)
59
60 # Criar o cubo de dados final
61 ivar = (10 / new_flux_cube) ** 2
62 mask = np.zeros_like(new_flux_cube, dtype=np.uint8)
63
64 # Criar HDUs finais
65 hdu_flux_final = fits.ImageHDU(new_flux_cube, name='FLUX')
66 hdu_ivar_final = fits.ImageHDU(ivar, name='IVAR')
67 hdu_mask_final = fits.ImageHDU(mask, name='MASK')
68
69 CRVAL3 = wave_uniform_range[0]
70 CDELT3 = 1
71 CRPIX3 = 1
72 CUNIT3 = 'Angstrom'
73 BUNIT = 'erg/s/cm^2/Angstrom/'
74 CTYP3 = 'WAVE'
75
76 for hdu in [hdu_flux_final, hdu_ivar_final, hdu_mask_final]:
77     hdu.header['CRVAL3'] = CRVAL3
78     hdu.header['CDELT3'] = CDELT3
79     hdu.header['CRPIX3'] = CRPIX3
80     hdu.header['CUNIT3'] = CUNIT3
81     hdu.header['BUNIT'] = BUNIT
82     hdu.header['CTYP3'] = CTYP3
83
84 # Salvar o arquivo final
85 output_filename_final = os.path.join(
86     output_dir, f'{galaxy_name}_ready.fits'
87 )
88 print(f'[INFO] {galaxy_name}: Salvando cubo final em '{output_filename_final}'...')
89 with fits.HDUList([fits.PrimaryHDU(), hdu_flux_final, hdu_ivar_final, hdu_mask_final]) as hdu_list:
90     hdu_list.writeto(output_filename_final, overwrite=True)
91
92 print(f'[INFO] {galaxy_name}: Processamento concluído com sucesso.')
93
94 except Exception as e:
95     print(f'[ERROR] {galaxy_name}: Erro durante o processamento - {e}')
96
97
98 # Função principal para processar galáxias em paralelo
```



Methods

Configuring a job in LUSTRE

```
#!/bin/sh
#SBATCH -p cpu                                # Nome da partição
#SBATCH -J Processamento_Urutau              # Nome do job
#SBATCH --nodelist=apl21_                      # Número de nós requisitados
#SBATCH --cpus-per-task=104                   # Número de tarefas por nó
#-----#

# Definir diretório de cache do Matplotlib
#export MPLCONFIGDIR=/scratch/$USER/.matplotlib

# Criar o diretório caso não exista
#mkdir -p $MPLCONFIGDIR

# Exibe os nós alocados
echo $SLURM_JOB_NODELIST
nodeset -e $SLURM_JOB_NODELIST

# Vai para o diretório de envio
cd $SLURM_SUBMIT_DIR

EXEC=/lustre/t0/scratch/users/felipe.albanez/teste-urutau/chamar-exec.sh

# Executa o script
srun $EXEC
```

Para obter uma lista completa da sintaxe, execute o comando `man sbatch`.

Sintaxe	Significado
#SBATCH -p partition	Define a partição em que o job será executado
#SBATCH -J job_name	Define o nome do Job
#SBATCH -n quantidade	Define o número total de tarefas da CPU.
#SBATCH -N quantidade	Define o número de nós de computação solicitados.

Comandos Básicos do Slurm

Para aprender sobre todas as opções disponíveis para cada comando, insira `man` enquanto estiver conectado ao ambiente do Cluster.

Comando	Definição
<code>sbatch</code>	Envia scripts de tarefas para a fila de execução
<code>scancel</code>	Cancela um job
<code>scontrol</code>	Usado para exibir o estado Slurm (várias opções disponíveis apenas para root)
<code>sinfo</code>	Exibir estado de partições e nós
<code>squeue</code>	Exibir estado dos jobs
<code>salloc</code>	Envia um job para execução ou inicia um trabalho em tempo real

  Search

Partições disponíveis

O cluster Apollo é organizado em diferentes partições (subconjunto de máquinas) para atender a diferentes necessidades, por exemplo, a garantia da prioridade máxima dos usuários do projeto LSST na utilização das máquinas dedicadas ao IDAC-Brasil.

PARTITION	TIMELIMIT	NODES	NODELIST
cpu_dev	30:00	26	apl[01-26]
cpu_small	3-00:00:00	26	apl[01-26]
cpu	5-00:00:00	26	apl[01-26]
cpu_long	31-00:00:0	26	apl[01-26]
lsst_cpu_dev	30:00	12	apl[15-26]
lsst_cpu_small	3-00:00:00	12	apl[15-26]
lsst_cpu	5-00:00:00	12	apl[15-26]
lsst_cpu_long	10-00:00:0	12	apl[15-26]

Methods

4. Processing data cubes with Urutau (ongoing)

neA OnDemand Files Jobs Clusters Interactive Apps My Interactive Sessions Help Logged in as felipe.albanez Log Out

Active Jobs

show 50 entries Filter:

ID	Name	User	Account	Time Used	Queue	Status	Cluster	Actions
>	54115	Processamento_Urutau	felipe.albanez	hpc-public	00:00:01	cpu	Completed	LineA
▼	54114	Processamento_Urutau	felipe.albanez	hpc-public	00:00:00	cpu	Completed	LineA

Showing 1 to 2 of 2 entries

Previous 1 Next


Install Urutau ✓

Testing **IN PROGRESS**

Create MEGACUBES

Summary

- Local storage solutions unavailable
- Local processing power insufficient for full scale spectra modelling
- LUSTRE & LIneA support (Help Desk and Slack) made the project feasible

**LIneA Ticket System** <ticket@linea.org.br>
para ▼

#14926: Processamento de Galáxias com o Urutau

Reporter: felipemmalbanez@... | Owner: Nubia Garcia

Type: task | Status: closed

Priority: normal | Milestone: no milestone

Component: Operation/Slurm | Severity: normal

Resolution: fixed | Keywords:

Total Hours: 0 |

Changes (by Nubia Garcia):

* status: accepted => closed

* resolution: => fixed

Comment:

Resumo do Atendimento:

"Foram realizados ajustes no código principal de processamento dos Cubos do iMaNGA, com o objetivo de corrigir erros identificados durante a execução. As correções foram implementadas, e um teste de verificação foi realizado com sucesso, confirmando o funcionamento do código. Permanece pendente a realização de um teste adicional, que inclui o aumento do número de threads utilizadas no processamento, bem como a avaliação do tempo de execução do código para uma galáxia de grande."

LIneA Service Desk
www.linea.org.br