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LIneA Science Platform

Tools for scientific exploration of LSST data and other astronomical archives

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Abstract. The rapid advancement of large astronomical surveys has introduced unprecedented challenges for accessing, processing, and analyzing data at scale. The LIneA Science Platform (LSP) emerges as a response to these demands, providing the Brazilian scientific community with an integrated, free, web-based environment for exploring astronomical data. The platform offers curated data collections aligned with international collaboration agreements and integrates tools for querying, visualization, and reproducible analysis, including interactive notebooks, crossmatch services, scientific catalog generation, and high-performance computing. The LSP will be the primary interface for scientists using IDAC-Brazil, an initiative that ensures national access to Rubin Observatory LSST data, public or proprietary, depending on project affiliation and embargo periods. In this way, it prepares researchers and students for the cutting-edge science that will be enabled by the survey. The oral presentation associated with this manuscript showcased the main features of the LSP, example use cases, and ways in which any researcher can leverage this infrastructure to enhance their astronomical research.

Resumo. O avanço dos grandes levantamentos astronômicos trouxe desafios inéditos para o acesso, processamento e análise de dados em larga escala. O LIneA Science Platform (LSP) surge como uma resposta a essas demandas, oferecendo à comunidade científica brasileira um ambiente integrado, gratuito e baseado na web para a exploração de dados astronômicos. A plataforma disponibiliza acervos de dados em sinergia com acordos de colaboração internacional e integra ferramentas para consulta, visualização e análise reprodutível, incluindo notebooks interativos, serviços de crossmatch, geração de catálogos científicos e processamento de alta performance. O LSP será a principal interface para os cientistas usuários do IDAC-Brasil, iniciativa que garante o acesso nacional aos dados do Rubin Observatory LSST, sejam eles públicos ou proprietários, a depender da afiliação ao projeto e do período de embargo. Dessa forma, prepara pesquisadores e estudantes para a ciência de ponta que será viabilizada por esse levantamento. A apresentação oral à qual este manuscrito se refere apresentou os principais recursos do LSP, exemplos de uso e formas de como qualquer pesquisador pode se beneficiar dessa infraestrutura para potencializar suas pesquisas em astronomia.

Keywords. Methods: data analysis – Methods: laboratory

1. Introduction

Modern astronomy is undergoing a profound transformation driven by the growing capability to observe, store, and process data. Surveys such as the Dark Energy Survey (DES), the Sloan Digital Sky Survey (SDSS), and, on an even larger scale, the Legacy Survey of Space and Time (LSST), led by the Vera C. Rubin Observatory, demand new computational approaches. The data volumes involved, the complexity of the pipelines, and the need for reproducible analyses require integrated e-Science environments capable of supporting a broad and diverse scientific community.

In this context, the Laboratório Interinstitucional de e-Astronomia (LIneA) has established itself as a national institution dedicated to the development and operation of technological solutions for astronomy based on large-scale data. The institution acts as a bridge between the user community and major international projects, offering infrastructure, specialized human support, and advanced tools for scientific analysis.

2. Institutional Context and History of LIneA

Founded as a private, non-profit Science and Technology Institution (ICT), LIneA operates under the provisions of the Brazilian Innovation Law (Law 10.973/2004), which regulates ICT activities in the country. Throughout its trajectory, LIneA has formed strategic partnerships with national and international funding agencies. Historical funding from CNPq and FAPERJ, especially through the INCT e-Universo, has provided essential support for the development of large-scale projects. Additionally, grants from FINEP and international contributions—such as those from the Heising-Simons Foundation and the LSST Corporation (now LSST Discovery Alliance)—have helped expand the institution's capacity to operate in scientific training and education.

LIneA is part of a Brazilian ecosystem of private ICTs that includes institutions such as the National Research and Education Network (RNP) and the Institute for Pure and Applied Mathematics (IMPA), which complement the public network of research centers and units linked to MCTI. Interaction with public and private organizations through various partnerships and agreements strengthens the national research environment and supports initiatives requiring expertise in scientific computing, data science, and large-scale data analysis.

3. The BRA-LIN Program and Brazilian Participation in the LSST

LIneA's international engagement was consolidated with the creation of the BRA-LIN program, which formalizes Brazil's in-kind contribution to the Vera C. Rubin Observatory and its survey, the LSST. The program structures Brazil's in-kind contributions in exchange for participation slots for Brazilian researchers and access to LSST proprietary data during the embargo period. These

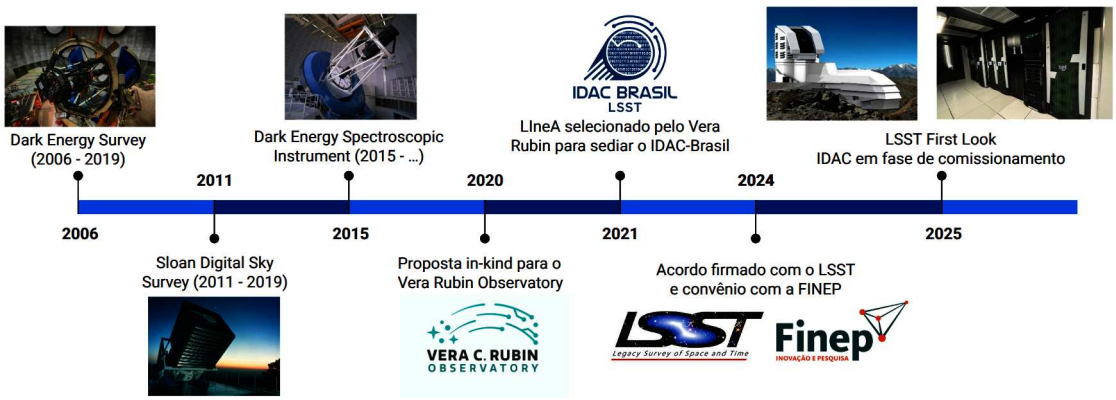

Figure 1. Timeline of major international agreements.

contributions include software development, infrastructure operations, and specialized technical support.

BRA-LIN represents a model that strengthens Brazil's scientific presence in major international collaborations while simultaneously building long-term national capacity by making services, tools, and data available to the entire Brazilian astronomical community—a "win–win" situation for the country.

4. IDAC-Brazil: Independent LSST Data Access Center

As part of BRA-LIN responsibilities, LIneA initiated the implementation of the Independent Data Access Center for LSST in Brazil (IDAC-Brazil). Integrated into a network of thirteen centers worldwide, IDAC-Brazil will provide functions complementary to the official Rubin centers located in Chile and the United States.

IDAC-Brazil is already in an advanced commissioning phase, with storage infrastructure, database services, programmatic access tools, and user-management systems aligned with LSST Data Management specifications. In addition to hosting public and proprietary data, the center will operate as a remote analysis platform, ensuring that Brazilian researchers can analyze LSST data without the need for local computational resources.

LIneA offers access to a high-performance computing (HPC) environment for members of the Brazilian Participation Group (BPG-LSST), with specialized support and without the need for justification or proposal submission, as part of the national support for LSST participation. Researchers or groups without LSST data rights may also request access by submitting a form in one of the public calls announced on LIneA's website. This initiative broadens access to HPC resources, enabling the community to prepare for the first fully public release, which will follow the two-year embargo of the first official LSST data release.

5. Multidisciplinary Team and Community Support

LIneA's activities are supported by a highly experienced multidisciplinary team composed of astronomers, data scientists, software engineers, IT professionals, and science communicators. The management committee includes three PhDs in astronomy who coordinate scientific and operational activities. The technical team brings more than a decade of experience in projects such as DES and SDSS, providing valuable expertise in large-scale processing of astronomical images and catalogs.

In addition to the permanent staff, the INCT e-Universo program has enabled the hiring of dozens of fellows who contribute to tool development, documentation, user support, and integration of new datasets. LIneA also invests in training and public outreach initiatives, expanding its role beyond the academic environment.

User support is structured at multiple levels. The helpdesk provides email-based support with specialized triage and routing. A public Slack workspace enables continuous interaction between users and the technical team. Extensive documentation—available in Portuguese, English, and Spanish—covers services, tools, and datasets. Courses, tutorials, workshops, and webinars are regularly organized, with all material freely available.

6. Data Holdings

LIneA currently hosts more than 50 TB of astronomical data, including images, catalogs, and metadata from various surveys. For IDAC-Brazil, an additional 500 TB are already provisioned. Integrated datasets include public data from DES, SDSS, Gaia, 2MASS, and other major surveys, ready to be combined to enrich LSST data by extending wavelength coverage and temporal baselines. LSST commissioning data have already been transferred to Brazil and are available according to Rubin Observatory access policies.

7. The LIneA Science Platform (LSP)

The LSP serves as the unified entry point for all services offered by LIneA. Developed to operate entirely through a web browser, the platform allows researchers to access tools for querying, visualization, exploratory data analysis, pipeline execution, and high-performance computing without installing local software.

The platform organizes its services into three main categories:

Basic Tools

JupyterHub, running on Kubernetes infrastructure, offers interactive environments for data exploration, analysis development, and integrated access to hosted databases. The *User Query* service provides an interface for SQL and ADQL queries, user table creation and management, and programmatic access via TAP. Visualization tools such as *Sky Viewer* and *Target Viewer* enable exploration of HiPS images, catalog access, and detailed inspection of individual objects.

Advanced Tools

The Open OnDemand service connects users to the Apollo cluster, with a capacity of up to 18 million CPU-hours per year. The

infrastructure enables notebook execution mapped to HPC resources, supporting intensive pipelines. A local instance of the Large Scale DataBase (LSDB), in collaboration with U.S. universities, provides distributed analysis capabilities for large-scale catalogs.

Thematic Platforms

LIneA maintains specialized systems for specific scientific use cases, such as the Solar System Science Platform, the Photo-z Server, and the MaNGA platform. These environments integrate visualization, querying, and ready-to-use pipelines tailored to particular research domains.

8. Final Considerations

The combination of computational infrastructure, specialized staff, integrated data holdings, and advanced scientific interfaces positions LIneA strategically to support the Brazilian community in facing the challenges imposed by next-generation surveys. IDAC-Brazil and the LSP not only expand national capacity for accessing and analyzing cutting-edge data but also democratize this access by offering modern, documented, reproducible, and easy-to-use tools.

As the LSST approaches its first official data release, LIneA's work becomes increasingly important, preparing students, researchers, and institutions to participate competitively in international science based on large-scale data.

Acknowledgements

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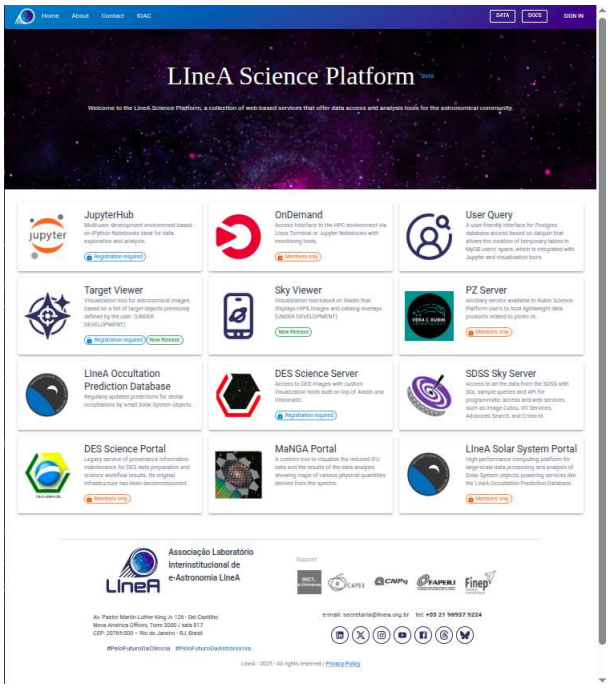

Figure 2. Home page of the LIneA Science Platform.

Survey / release	LSDB	Banco de dados	HPC
2MASS PSC	👥	👥	-
COSMO DC2	-	-	🔒
DELVE DR2	👥	-	-
DES DR2 Main	👥	👥	🔒
DES DR2 Y6 Gold	👥	🛠	🔒
DESI DR1	👥	🕒	-
Gaia DR3 Source	👥	👥	-
LSST DP0.1	-	-	🔒
LSST DP0.2	-	🔒	🔒
LSST DP1	🔒	🔒	🔒
WISE	🕒	-	-
ZTF	🕒	-	-

Legenda

👥 Público 🔒 Acesso restrito 🕒 Planejado 🛠 Em preparação

Figure 3. Main datasets hosted at LIneA and IDAC-BR. Source: LIneA data archive documentation page.

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