Illustration of the rogue planet Cha 1107-7626.
https://www.eso.org/public/images/eso2516a/
Credit: ESO/L. Calçada/M. Kornmesser

# Methodological Frameworks for Assessing Data Management Practices in Astronomical Observatories

Javier Enciso
CEO - Enciso Systems
October 4, 2025

Sun Emits a Solstice CME
https://science.nasa.gov/image-detail/amf-gsfc_20171208_archive_e001434/
Credit: NASA/Goddard/SDO

# Agenda

Introduction & Context

Why Study Data Management in Observatories?

Methodological Frameworks Overview

Key Approaches in Practice

Conclusions & Future Directions

Circumpolar Laser Tests at Gemini North
https://noirlab.edu/public/images/iotw2008a/
Credit: International Gemini Observatory/NOIRLab/NSF/AURA/J. Chu/J. Pollard

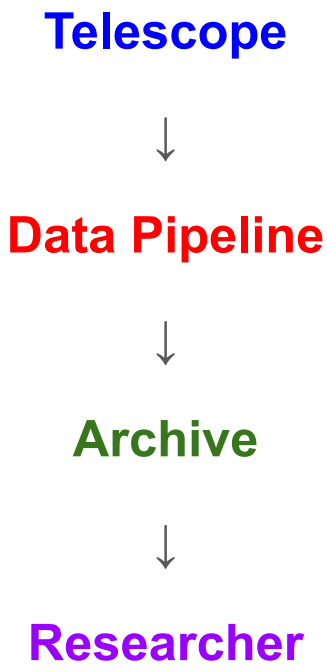
# Introduction & Context

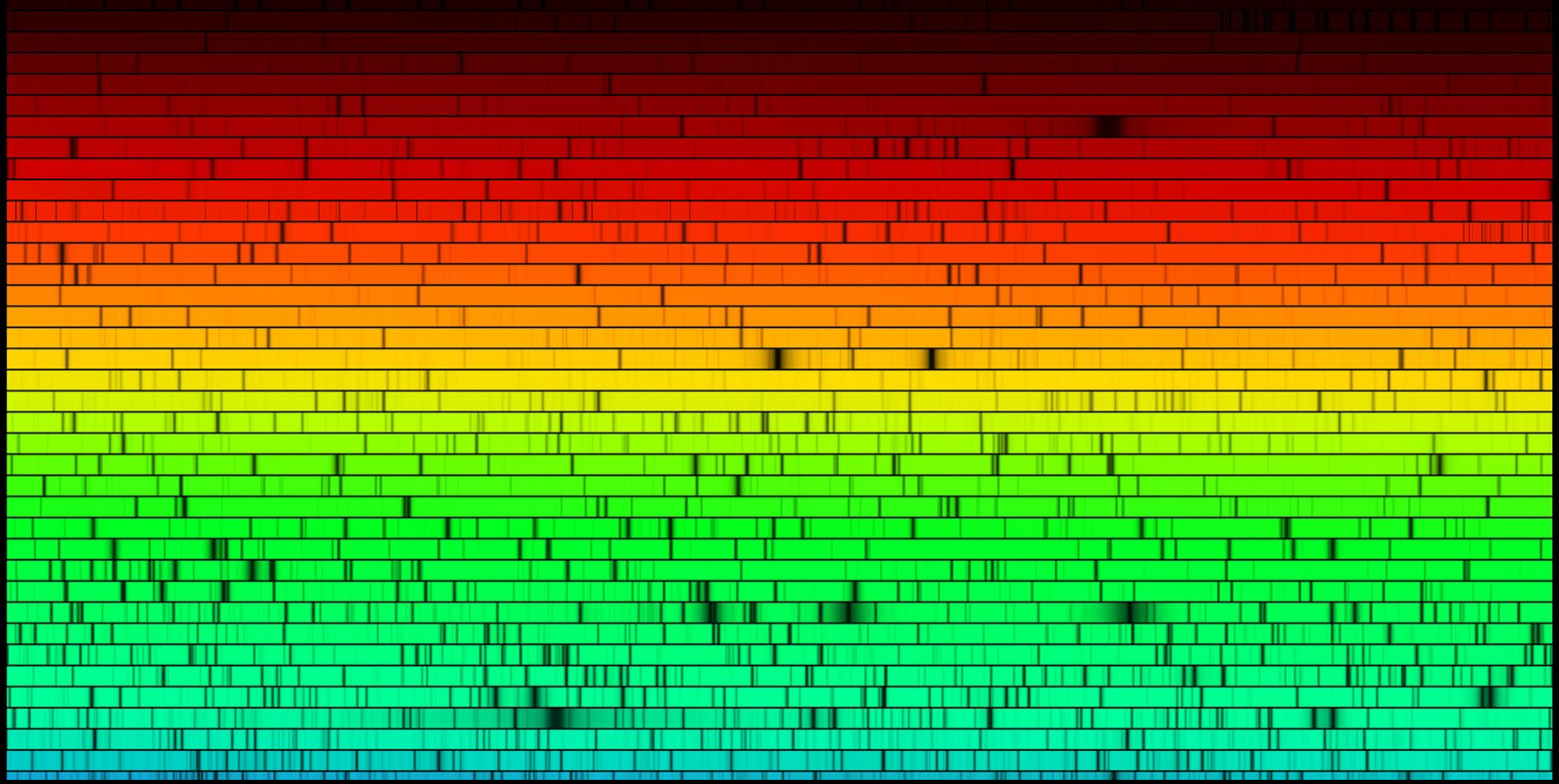
**Astronomical observatories** → massive, complex data pipelines

Data volume & variety **growing exponentially** (petabytes per year)

Effective data management = scientific **productivity** + long-term **preservation**

Need structured methods to **assess** current practices





High resolution solar spectrum
https://noirlab.edu/public/images/noao-sun/
Credit: N.A. Sharp/KPNO/NOIRLab/NSO/NSF/AURA

# Why Study Data Management in Observatories?

**Scale:** New observatories (e.g., Rubin, SKAO, JWST) → unprecedented data volumes

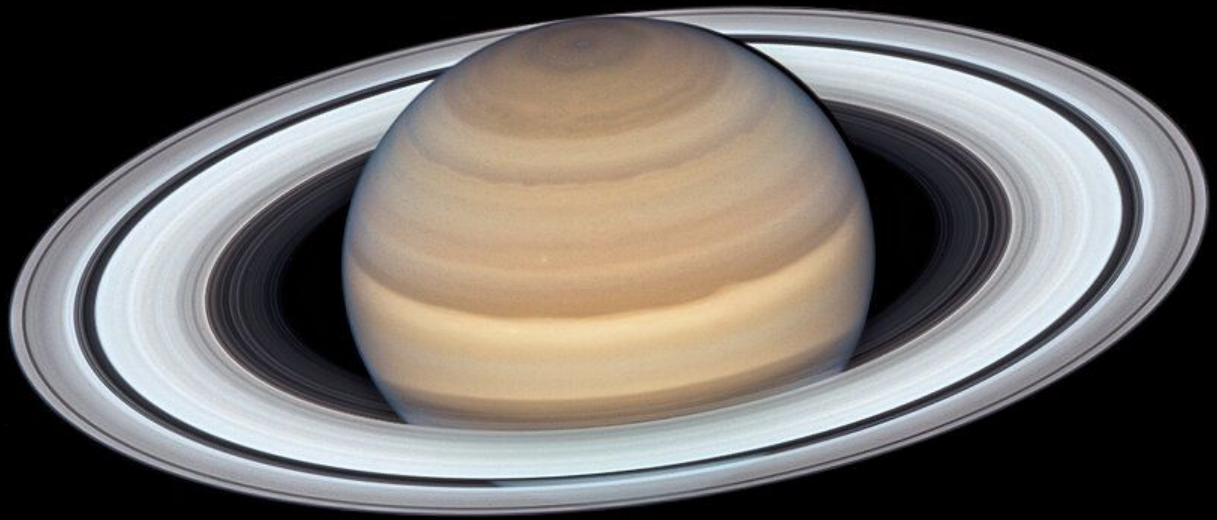
**Complexity:** Heterogeneous data formats, instruments, and workflows

**Collaboration:** Global teams need interoperability and shared standards

**Sustainability:** Long-term curation, reproducibility, and FAIR (findable, accessible, interoperable, reusable) data principles




SKAO



Latest Saturn Portrait
https://esahubble.org/images/heic1917a/
Credit: NASA, ESA, A. Simon (Goddard Space Flight Center), and M.H. Wong (University of California, Berkeley)

# Methodological Frameworks Overview

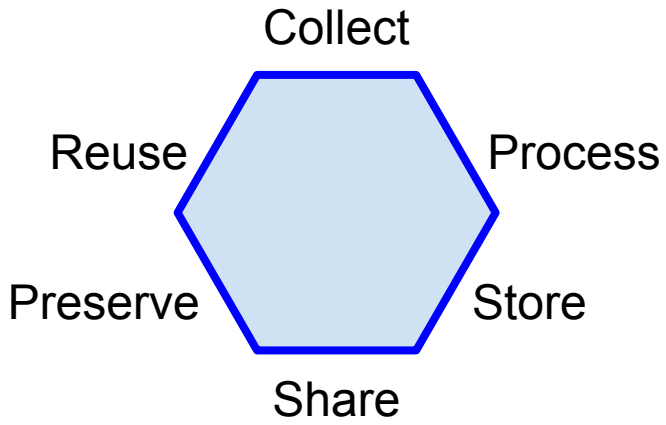
**Data Lifecycle Analysis:** from acquisition to archiving and reuse

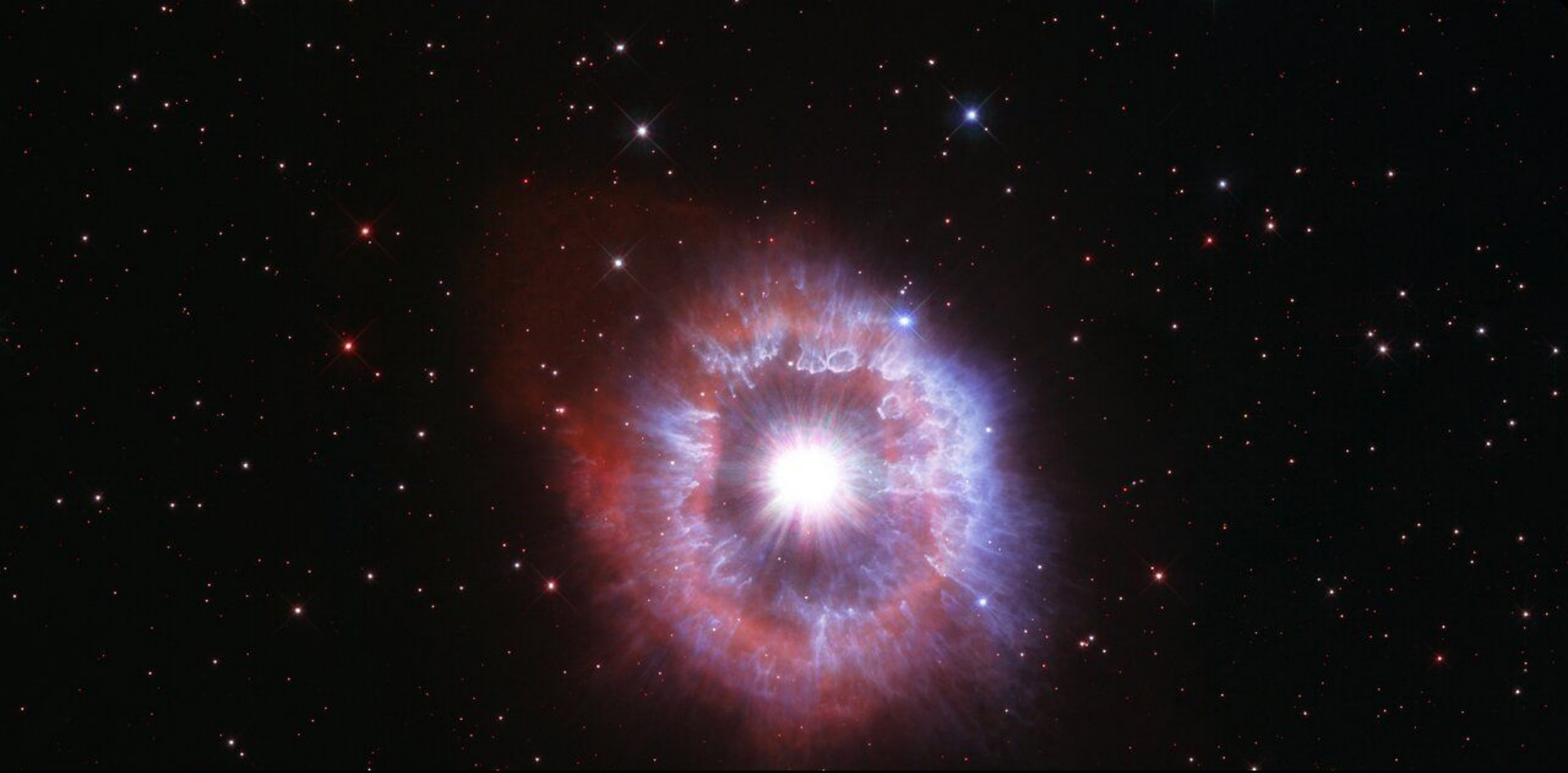
**Stakeholder-Centered Evaluation:** scientists, engineers, IT, archivists

**Workflow Mapping:** identifying bottlenecks and redundancies

**Standards & Compliance Checks:** IVOA (International Virtual Observatory Alliance), FAIR, metadata practices

**Comparative Benchmarking:** across facilities and disciplines

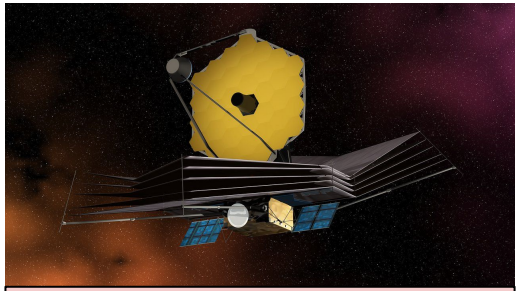




Hubble Celebrates its 31st anniversary with a magnificent view of AG Carinae
https://esahubble.org/images/heic2105a/
Credit: NASA, ESA and STScI

# Key Approaches in Practice

**Lifecycle Analysis**
Mapping Rubin Observatory's nightly data flow → identifies storage & processing peaks



**Workflow Mapping**
Tracing JWST calibration pipeline → reveals bottlenecks in metadata enrichment

**Standards Compliance**
Checking NOIRLab archives against FAIR principles → highlights interoperability gaps

Webb Inspects the Heart of the Phantom Galaxy
https://esawebb.org/images/potm2208a/
Credit: ESA/Webb, NASA & CSA, J. Lee and the PHANGS-JWST Team. Acknowledgement: J. Schmidt

# Conclusions & Future Directions

Structured **frameworks** enable **systematic evaluation** of observatory data practices

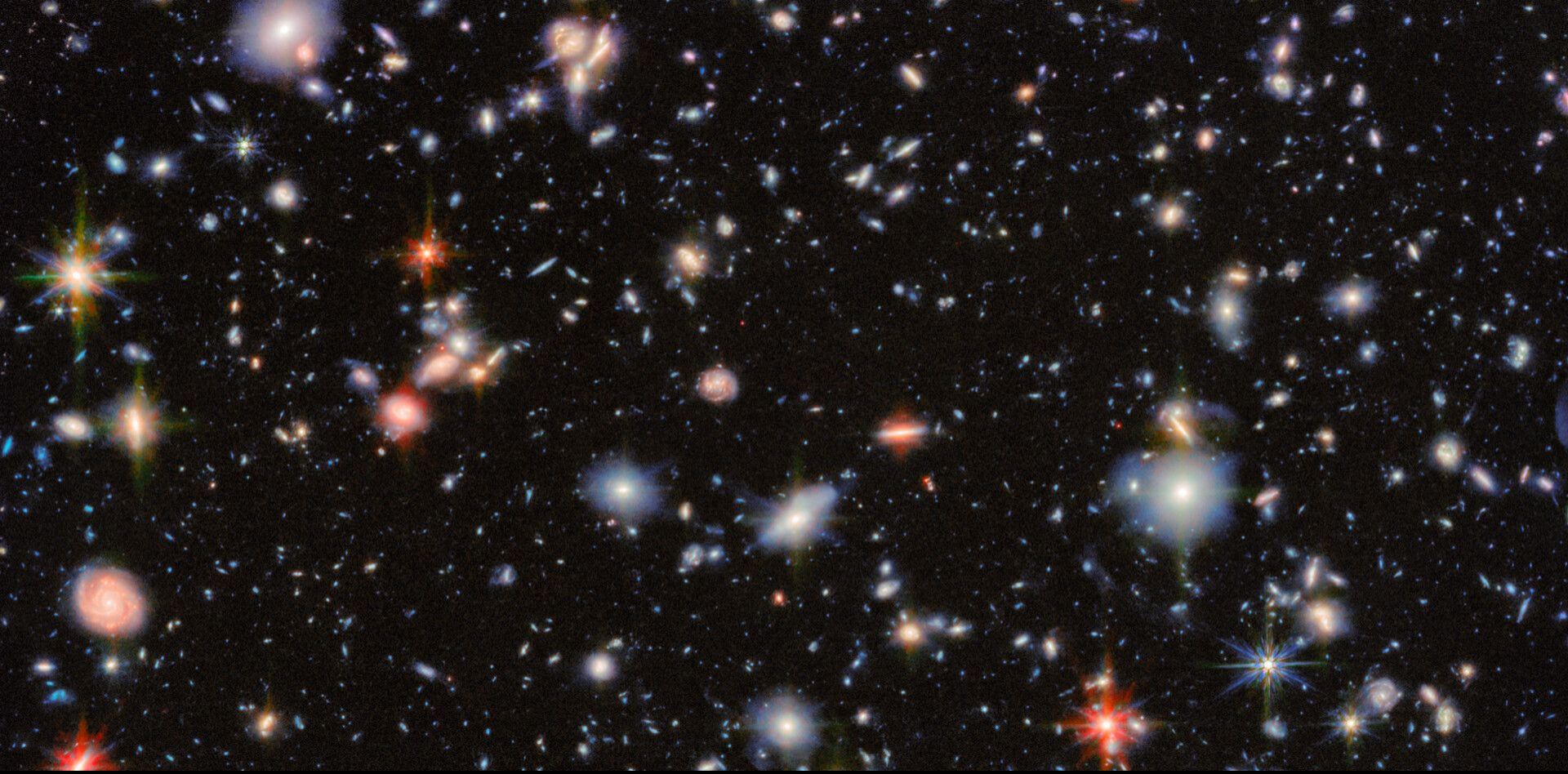
**Methods** reveal **bottlenecks, gaps, and best practices** across facilities

**Key lesson:** metadata and standards compliance are central to long-term reuse

**Future:** integration of AI/ML for workflow optimization

**Future:** greater focus on interoperability and cross-observatory collaboration

**Future:** alignment with open science and FAIR data principles



A fresh look at a classic deep field
https://esawebb.org/images/potm2507a/
Credit: ESA/Webb, NASA & CSA, G. Östlin, P. G. Perez-Gonzalez, J. Melinder, the JADES Collaboration, the MIDIS collaboration, M. Zamani (ESA/Webb)

# Bonus: Project Ideas for Space Apps Challenge

1. **Smart Data Lifecycle Tracker** – tool to visualize telescope → archive → reuse stages
2. **Metadata Quality Checker** – automated FAIR/IVOA compliance audit tool
3. **Workflow Bottleneck Detector** – ML-based analyzer of data pipelines
4. **Interoperability Dashboard** – cross-archive data integration prototype
5. **Data Preservation Assistant** – AI for long-term archiving recommendations
6. **User-Centric Access Portal** – improve researcher experience with tailored search & visualization
7. **Collaboration Toolkit** – platform for multi-observatory, multi-disciplinary teams to share data practices

A glimpse of the distant past
https://esawebb.org/images/potm2505a/
Credit: ESA/Webb, NASA & CSA, H. Atek, M. Zamani (ESA/Webb). Acknowledgement: R. Endsley

# Thank You

Questions & Discussion

Advancing astronomical discovery through better data management!

**Javier Enciso**

CEO - Enciso Systems

📧 jenciso@encisosystems.com

🌐 encisosystems.com / linkedin.com/in/encisoj/