Building a time machine

How supercomputing is giving astronomy a new window into the past

Dr Sarah Pearce, SKA-Low Telescope Director

International Workshop on OpenMP and Euro MPI
25 September 2024

We recognise and acknowledge the Traditional Owners of the lands on which our facilities are located, and pay our respects to their Elders past and present.

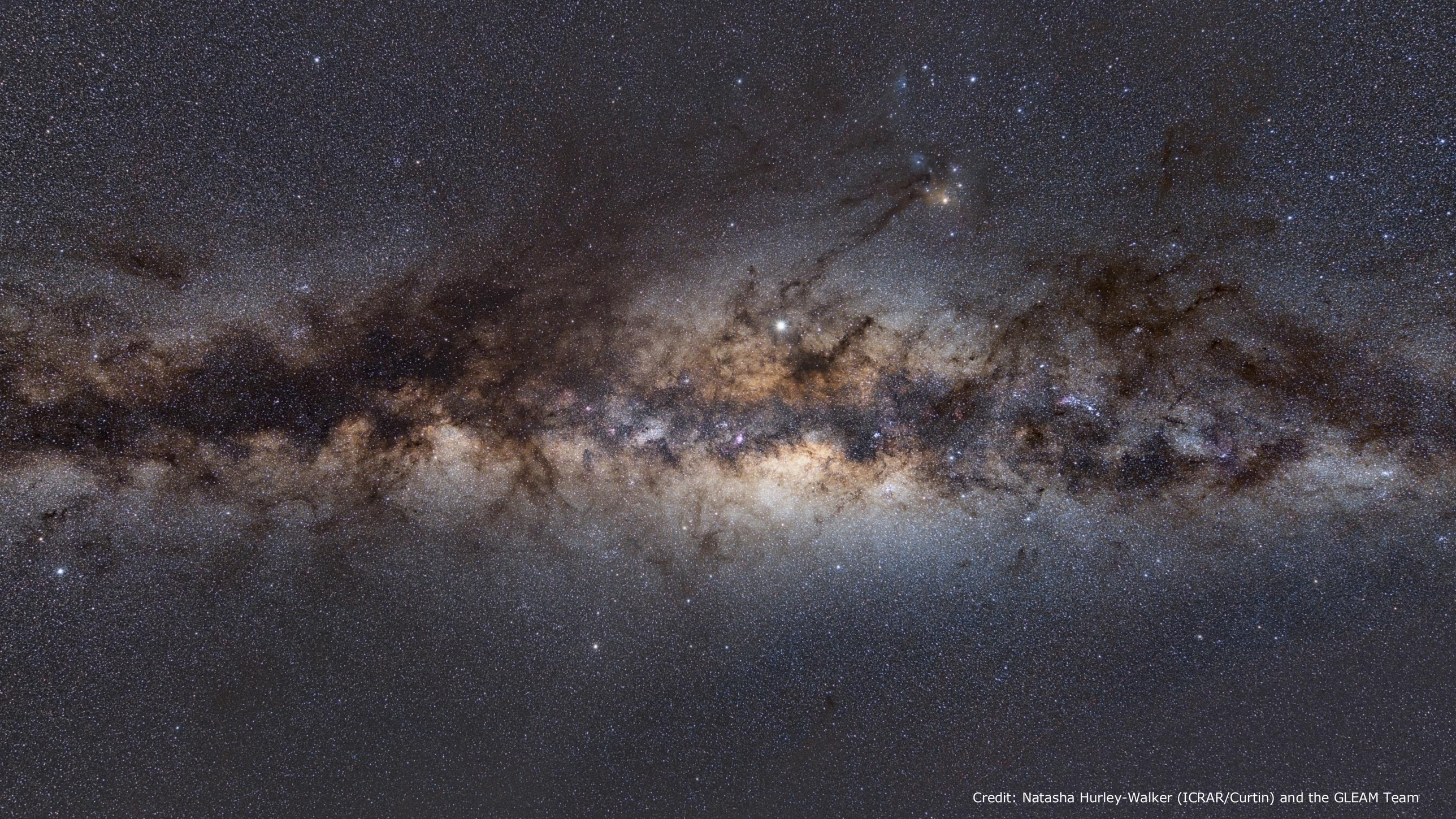
Australia's Indigenous people are the first scientists and have long standing knowledge of the Universe that we continue to build on today.

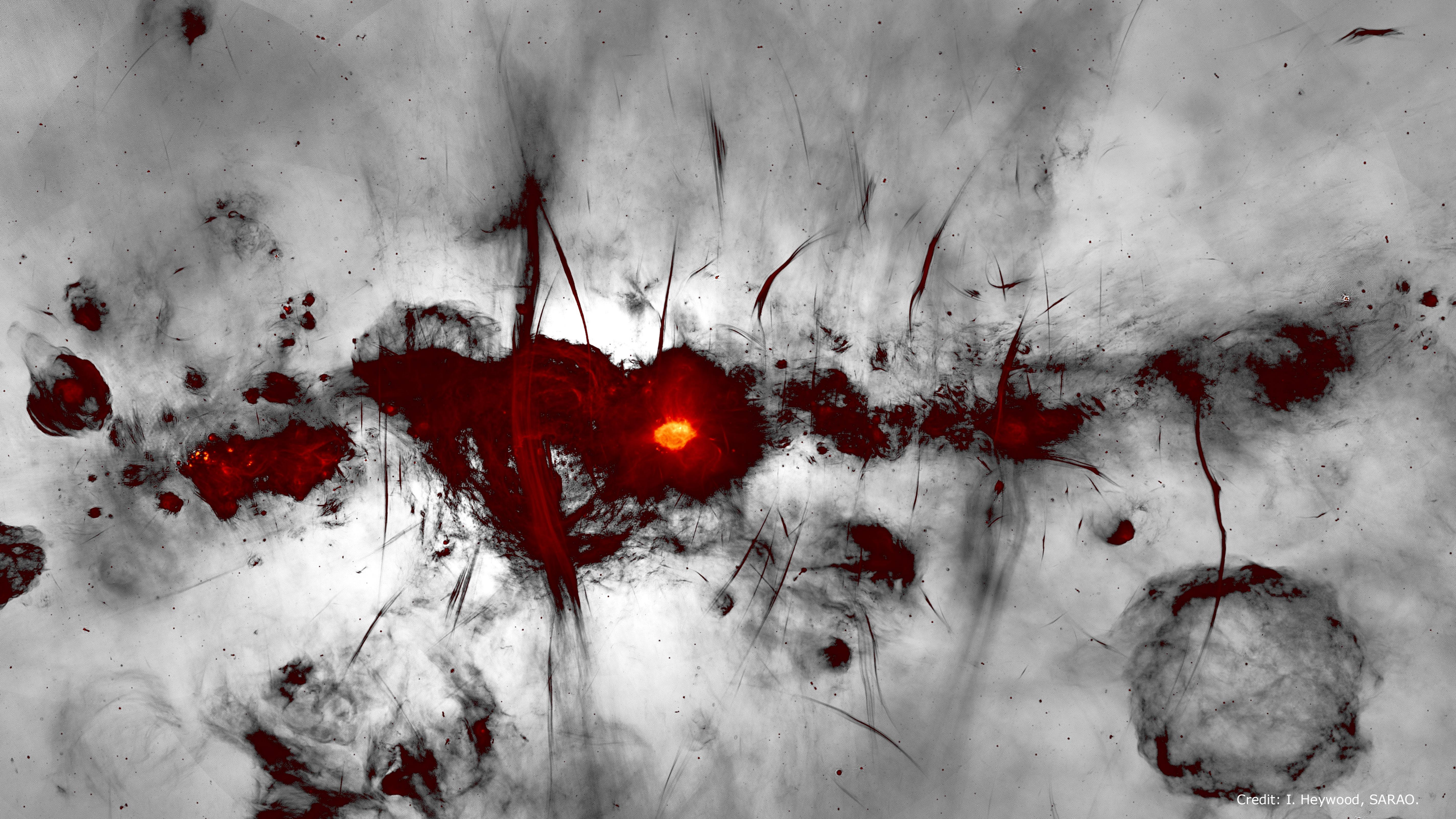
We acknowledge the Wajarri Yamaji as the Traditional Owners and native title holders of Inyarrimanha Ilgari Bundara, the CSIRO Murchison Radio-astronomy Observatory, where we are building the SKA-Low telescope in Australia.

We acknowledge the Whadjuk Noongar as the traditional owners of the land where our Science Operations Centre is situated in Perth, and the Southern Yamatji as the traditional owners of the land where our Engineering Operations Centre is situated in Geraldton.

I also pay my respects to all First Nations people in attendance.

A collaborative painting from Aboriginal Yamaji artists from WA for the SKAO *Shared Sky* exhibition. Credit: Yamaji Arts Centre.


Credit: Natasha Hurley-Walker (ICRAR/Curtin) and the GLEAM Team


Credit: I. Heywood, SARAO.

SKAO Science Working Groups

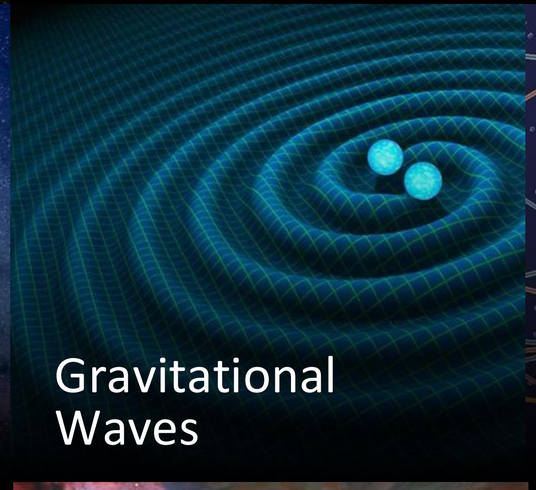

Cosmology

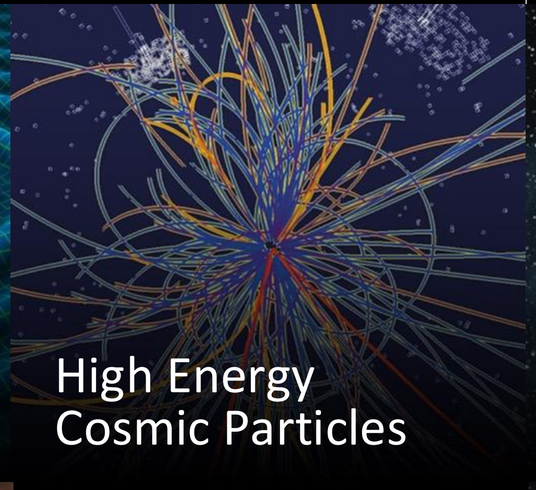

Cradle of Life


Epoch of Reionization

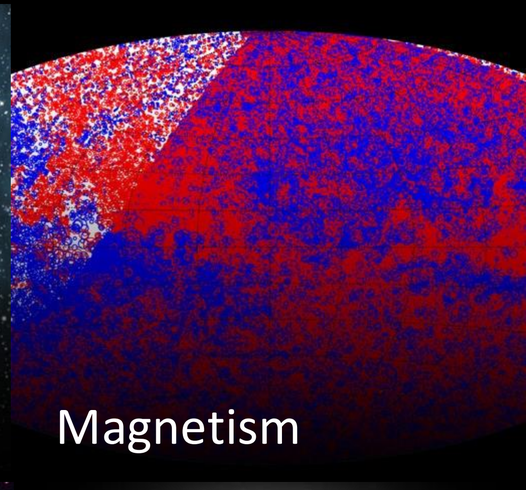

Extragalactic Continuum


Extragalactic Spectral Line


Gravitational Waves

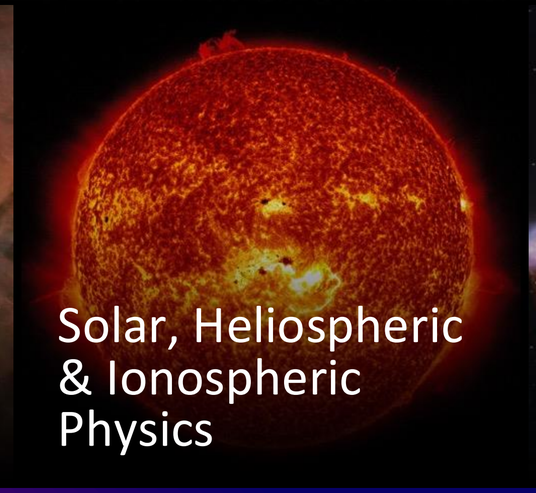

High Energy Cosmic Particles

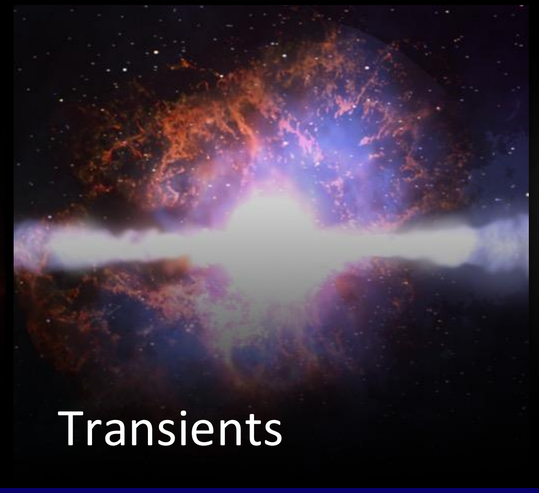

HI Galaxy Science

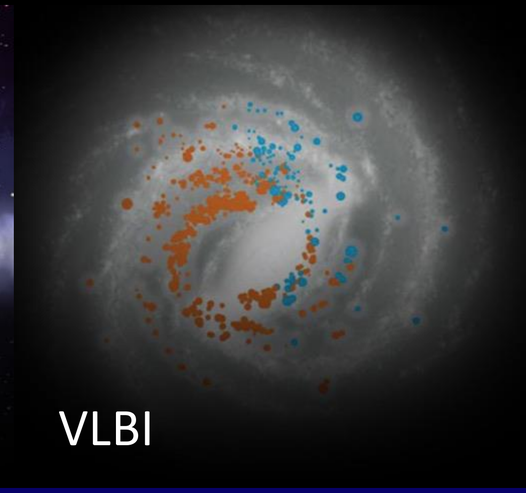

Magnetism

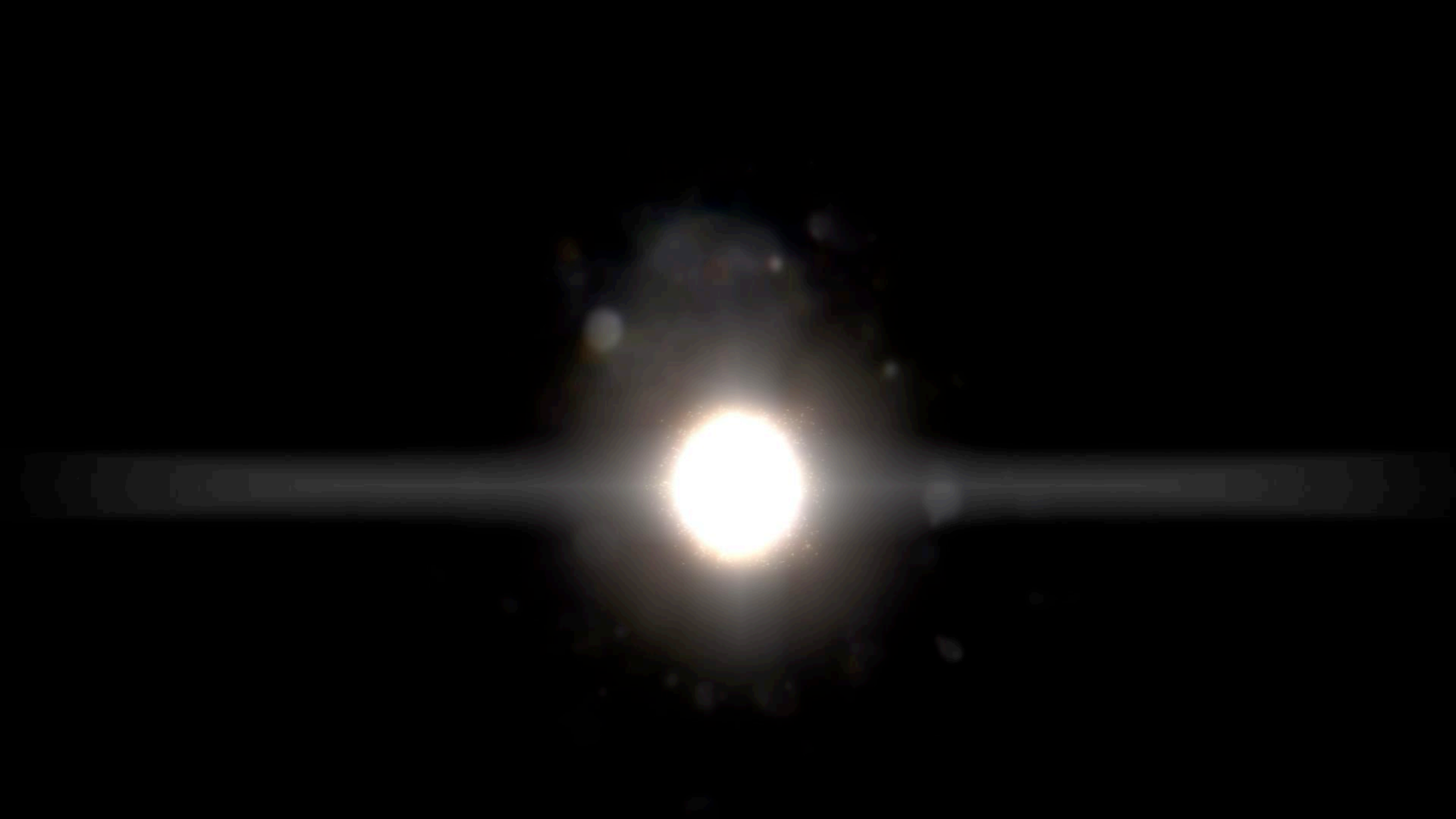

Our Galaxy


Pulsars

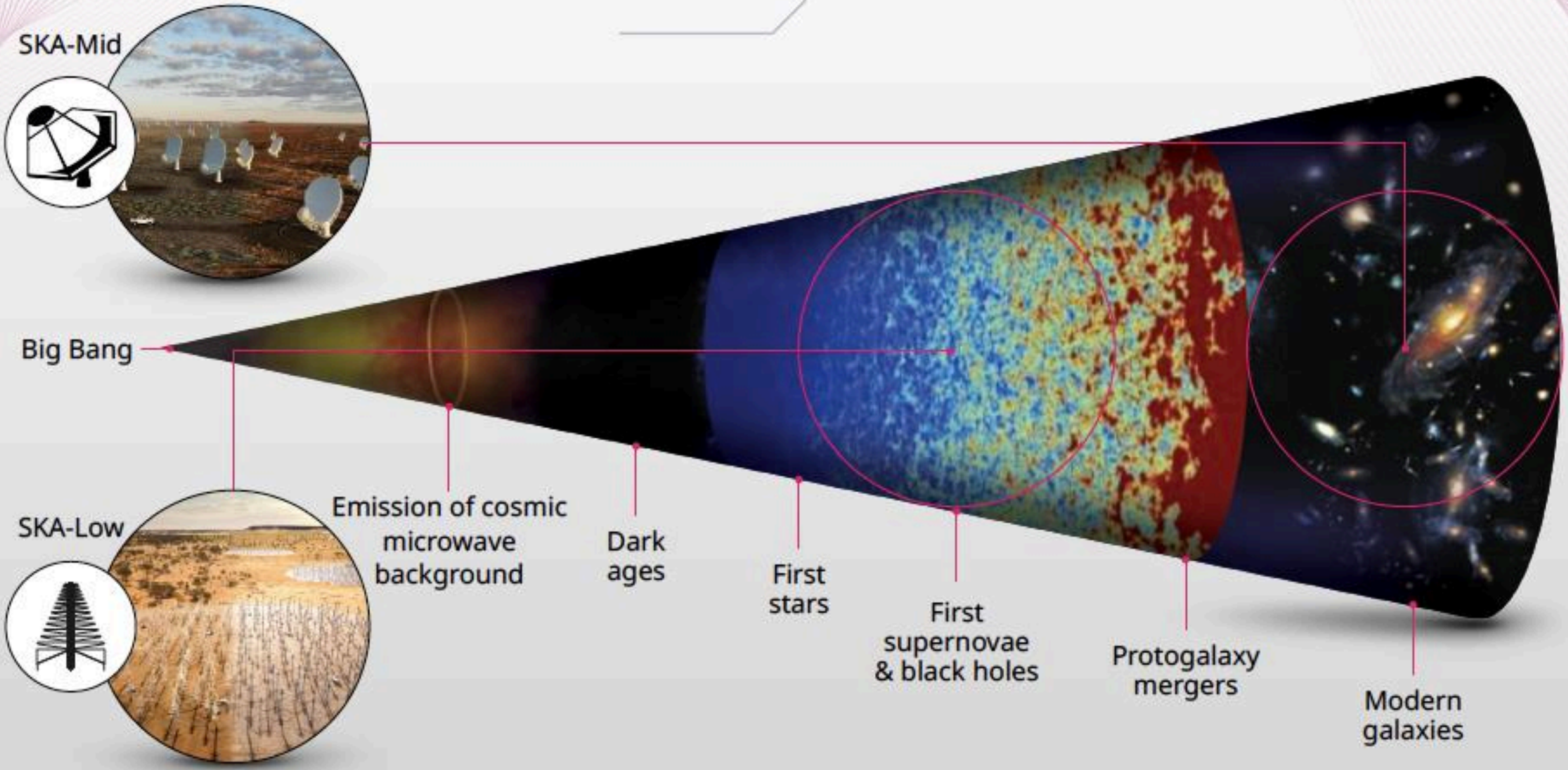

Solar, Heliospheric & Ionospheric Physics

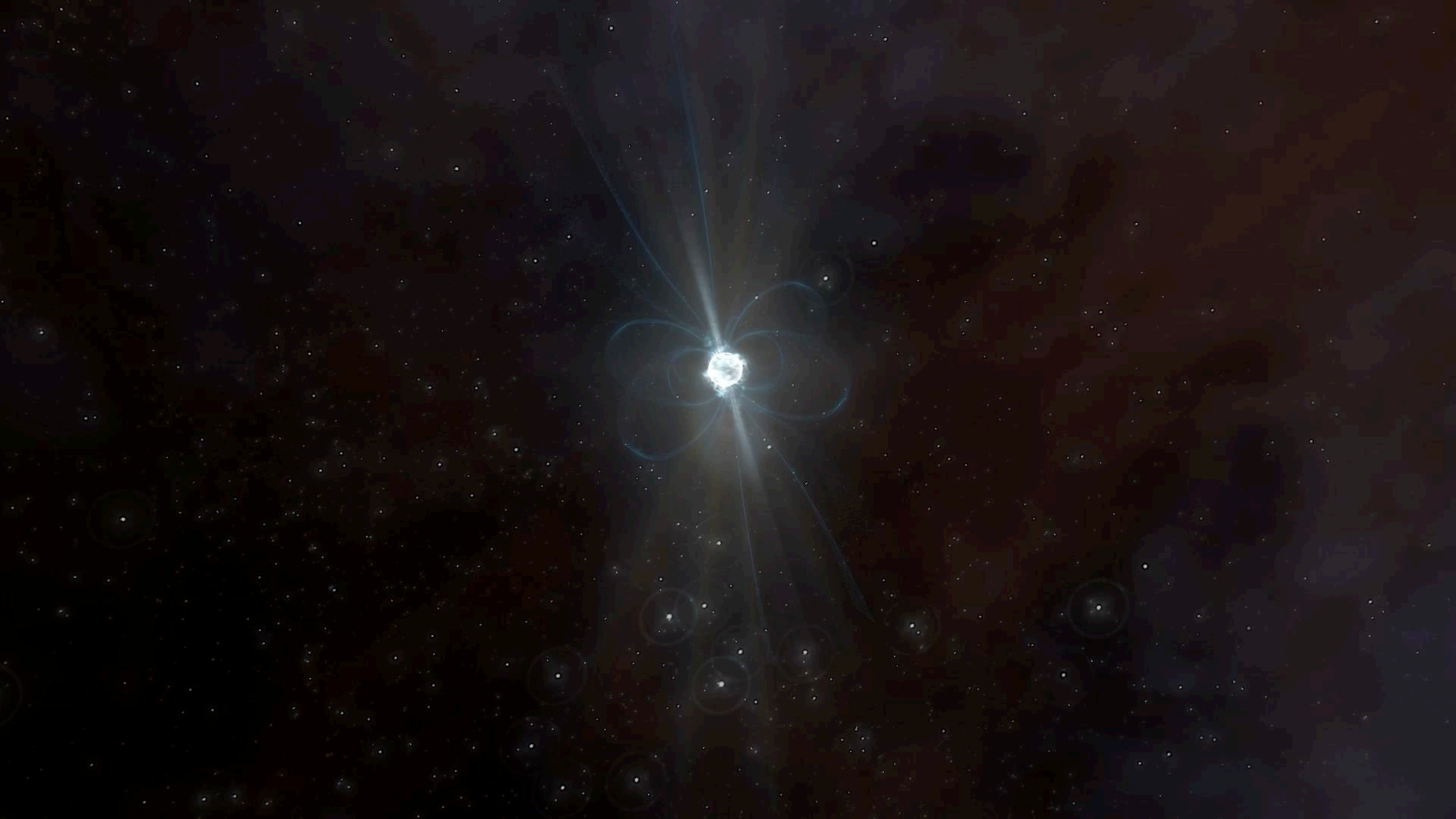

Transients

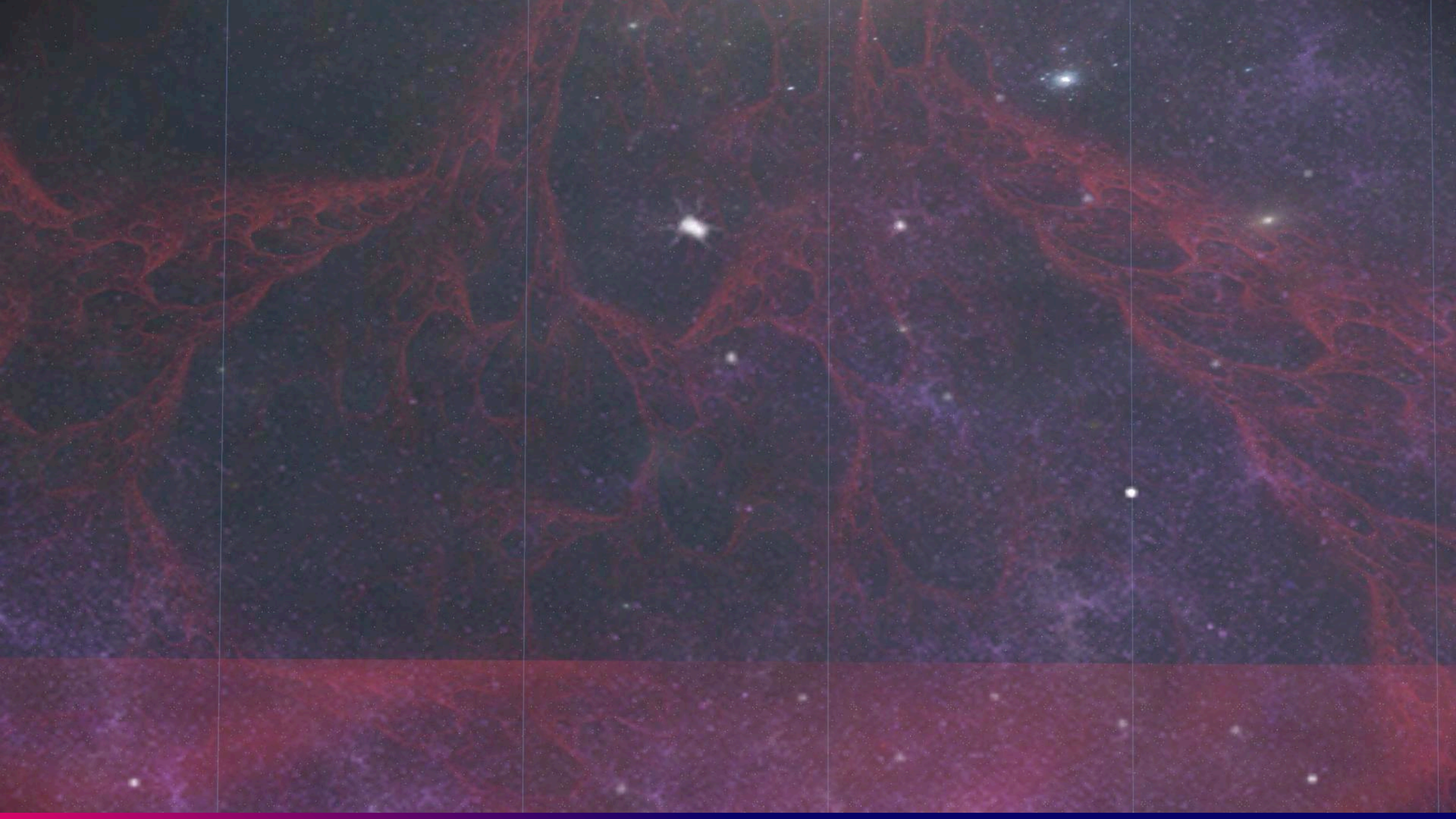

VLBI

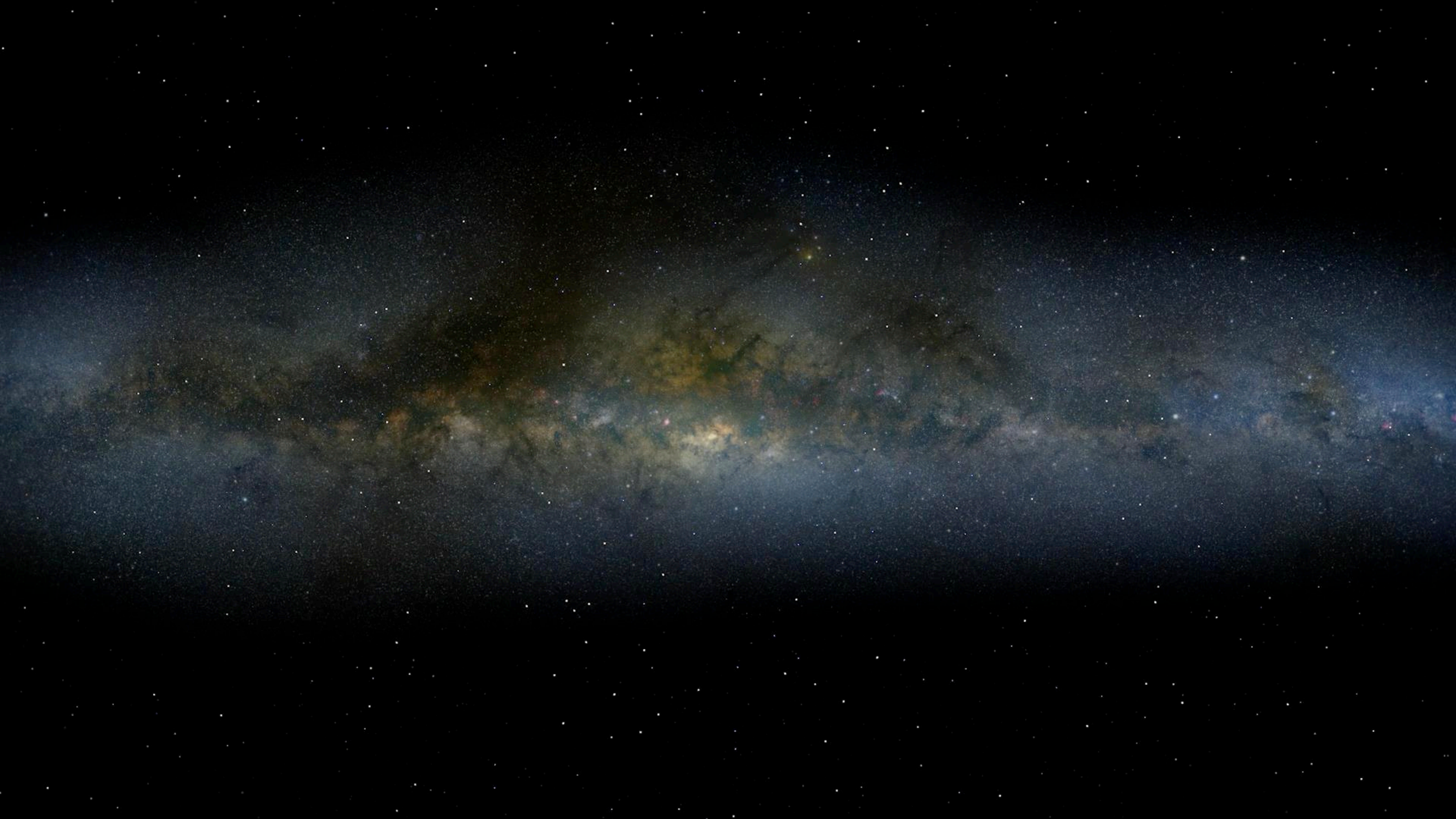


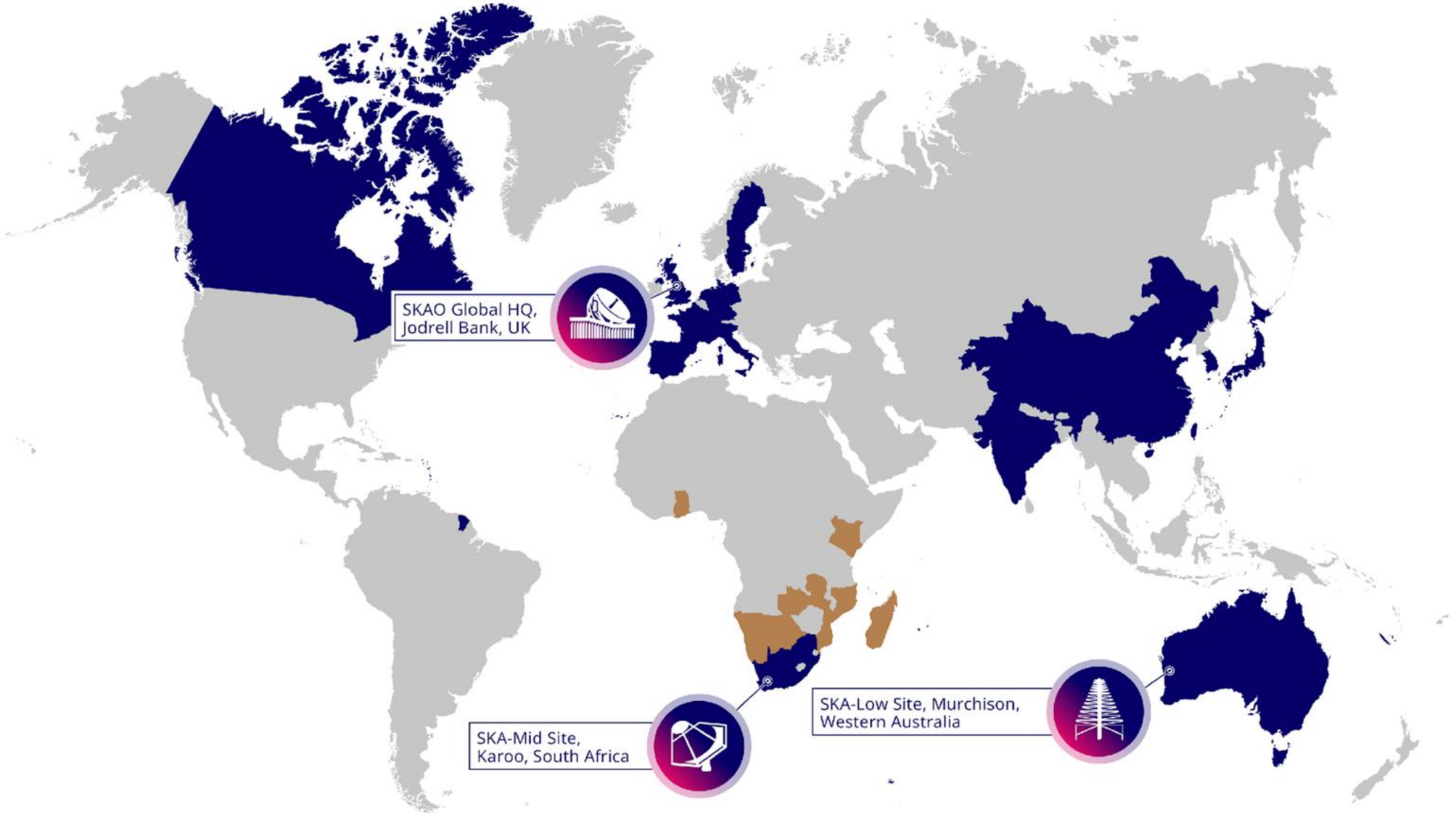
Evolution of the Universe










SKAO Global HQ,
Jodrell Bank, UK
SKA-Mid Site,
Karoo, South Africa
SKA-Low Site, Murchison,
Western Australia
SKAO Partnership - includes SKAO Member States* and SKAO Observers (as of June 2024)
African Partner Countries

The SKA project in numbers

€1.3 BILLION
CONSTRUCTION COST (2021 €)

131,072 ANTENNAS
IN WESTERN AUSTRALIA

710 PETABYTES PER YEAR
OF SCIENCE DATA DELIVERED TO SCIENCE USERS

€0.7 BILLION
FIRST 10 YEARS OF OPERATIONS COST (2021 €)

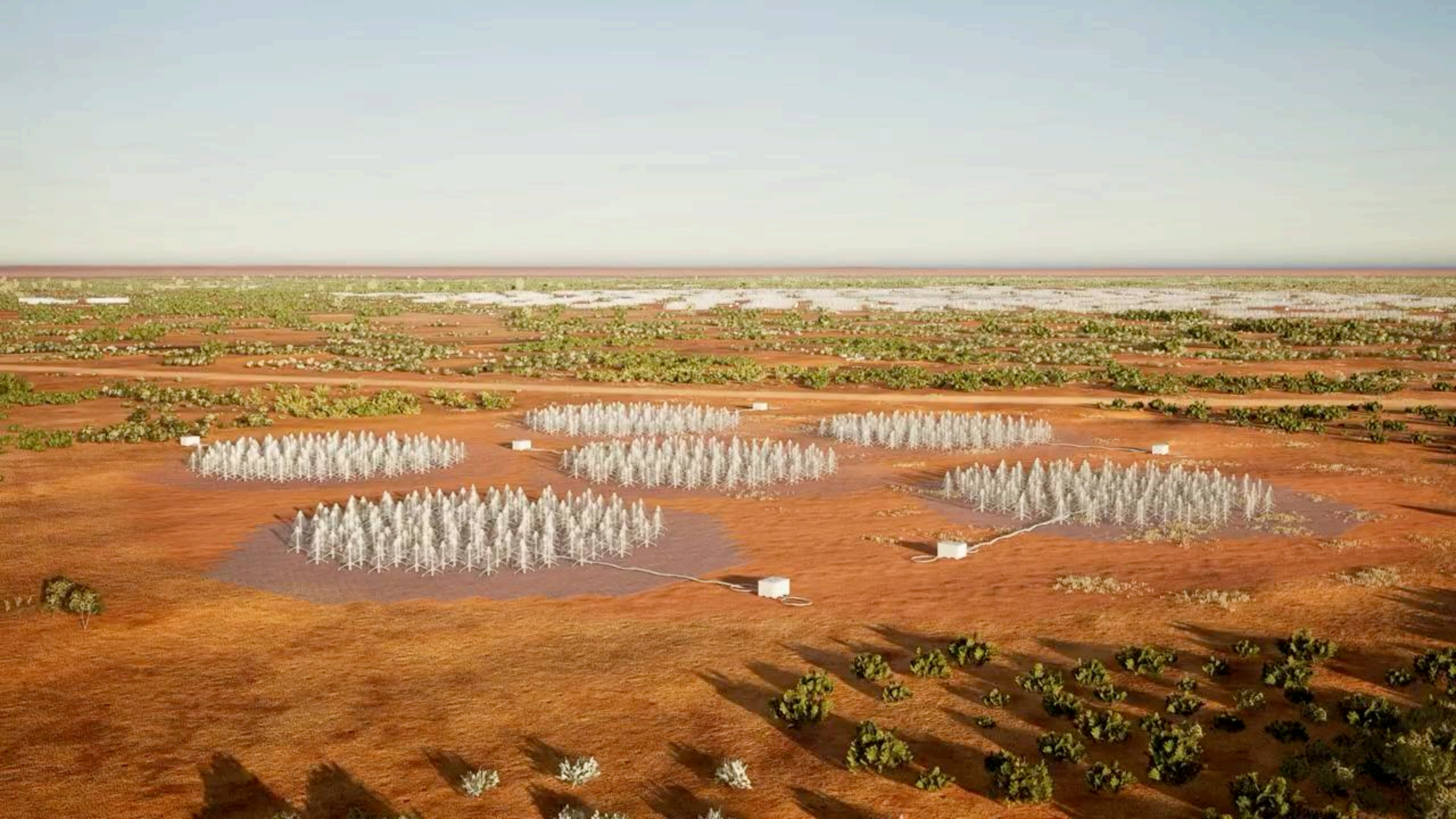
197 DISHES
IN SOUTH AFRICA (INCLUDING 64 MEERKAT DISHES)

1 GLOBAL NETWORK
OF DATA CENTRES TO DELIVER SCIENCE-READY DATA PRODUCTS TO END-USERS

8 YEARS
TO CONSTRUCT

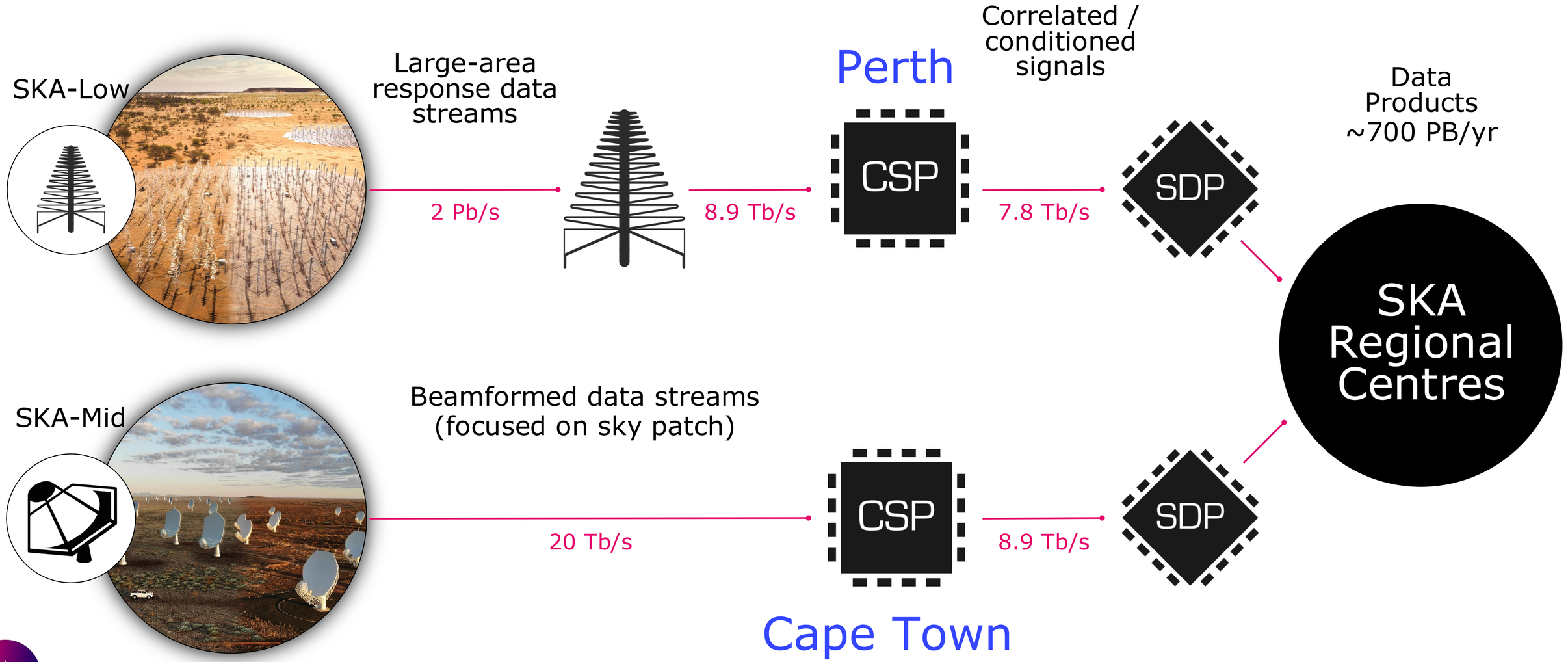
16 COUNTRIES
PARTICIPATING IN 2023

50+ YEARS
OF TRANSFORMATIONAL SCIENCE



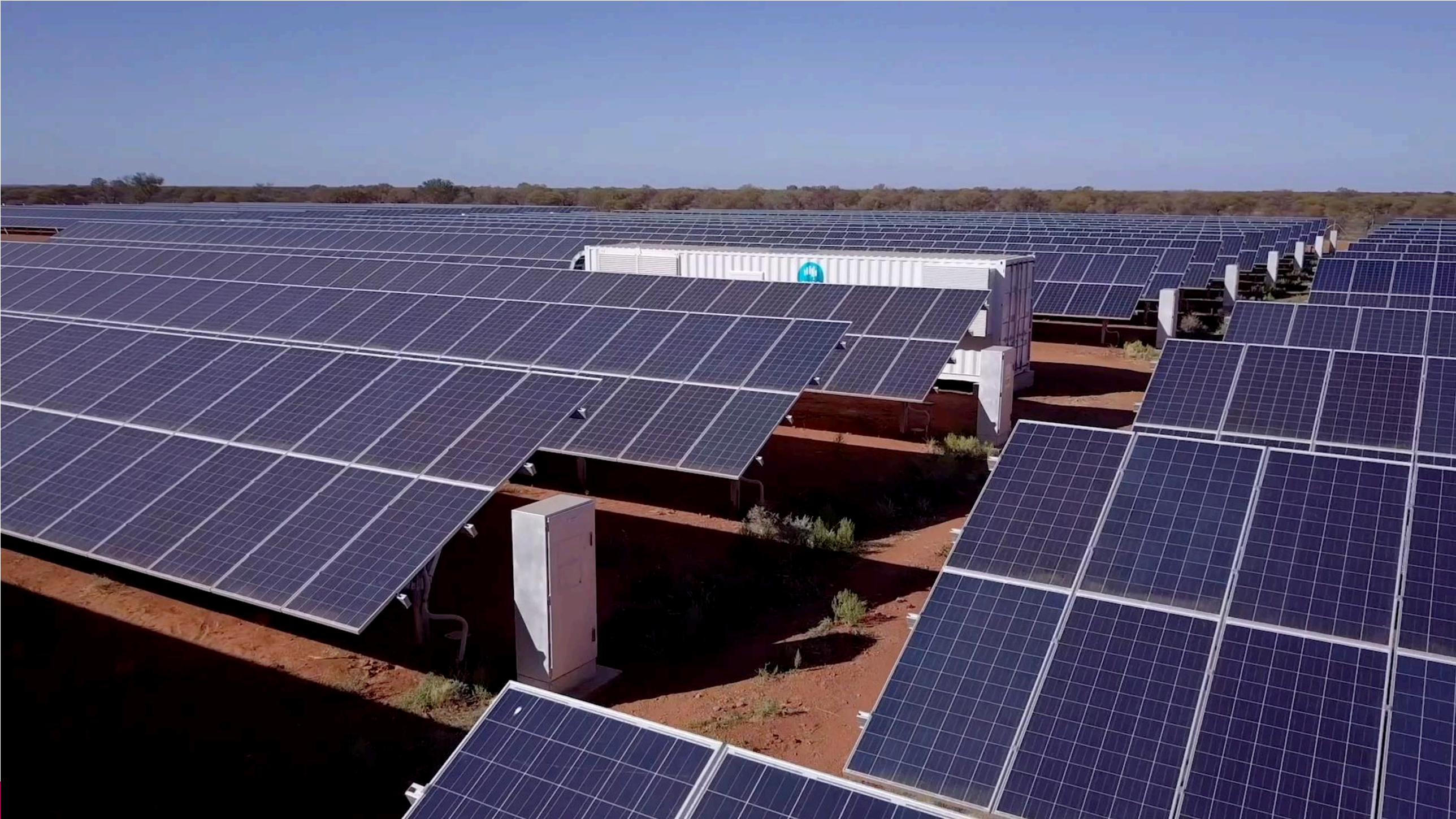
A SOFTWARE TELESCOPE

SKAO data processing stages



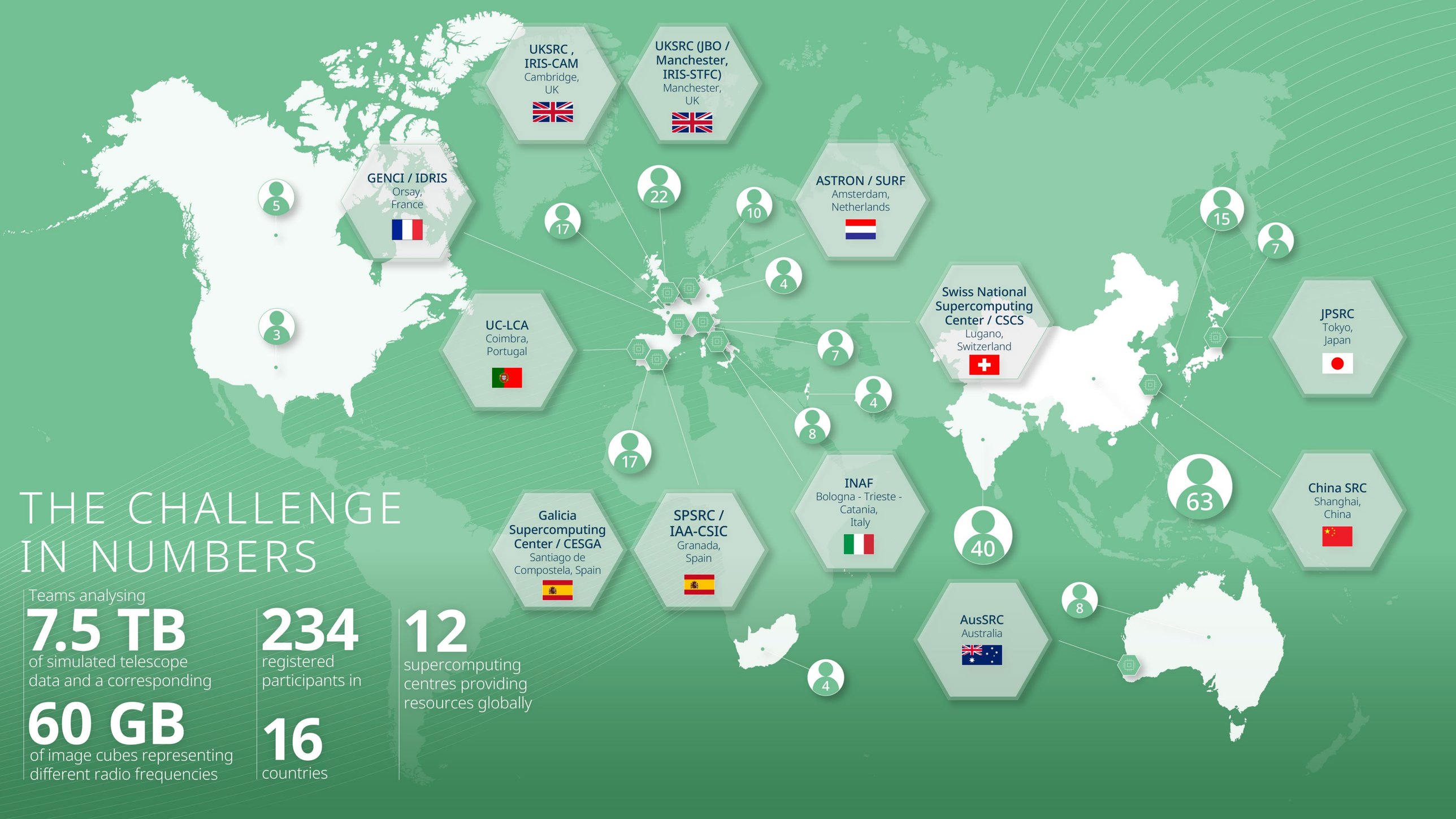

SKAO
04

SUSTAINABLE SUPERCOMPUTING




Pawsey Building
(supercomputer)

DATA CHALLENGES



THE CHALLENGE IN NUMBERS

Teams analysing

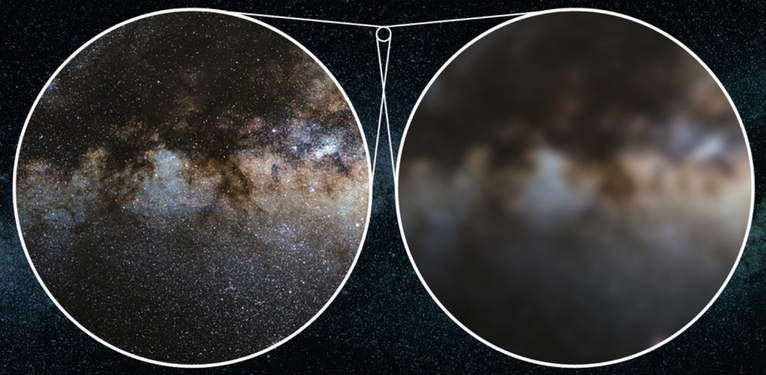
7.5 TB
of simulated telescope data and a corresponding

60 GB
of image cubes representing different radio frequencies

234
registered participants in

16
countries

12
supercomputing centres providing resources globally

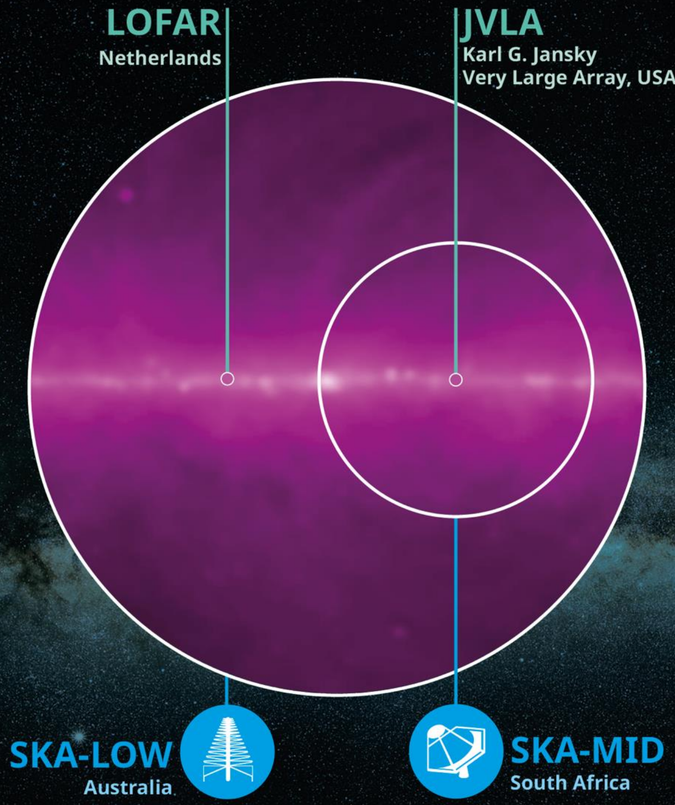


SKA-LOW x1.2 LOFAR NL

SKA-MID x4 JVLA

RESOLUTION

Thanks to their size, the SKA telescopes will see smaller details, making radio images less blurry, like reading glasses help distinguish smaller letters.



SKA-LOW x135 LOFAR NL

SKA-MID x60 JVLA

SURVEY SPEED

Thanks to their sensitivity and ability to see a larger area of the sky at once, the SKA telescopes will be able to observe more of the sky in a given time and so map the sky faster.

SKA-LOW x8 LOFAR NL

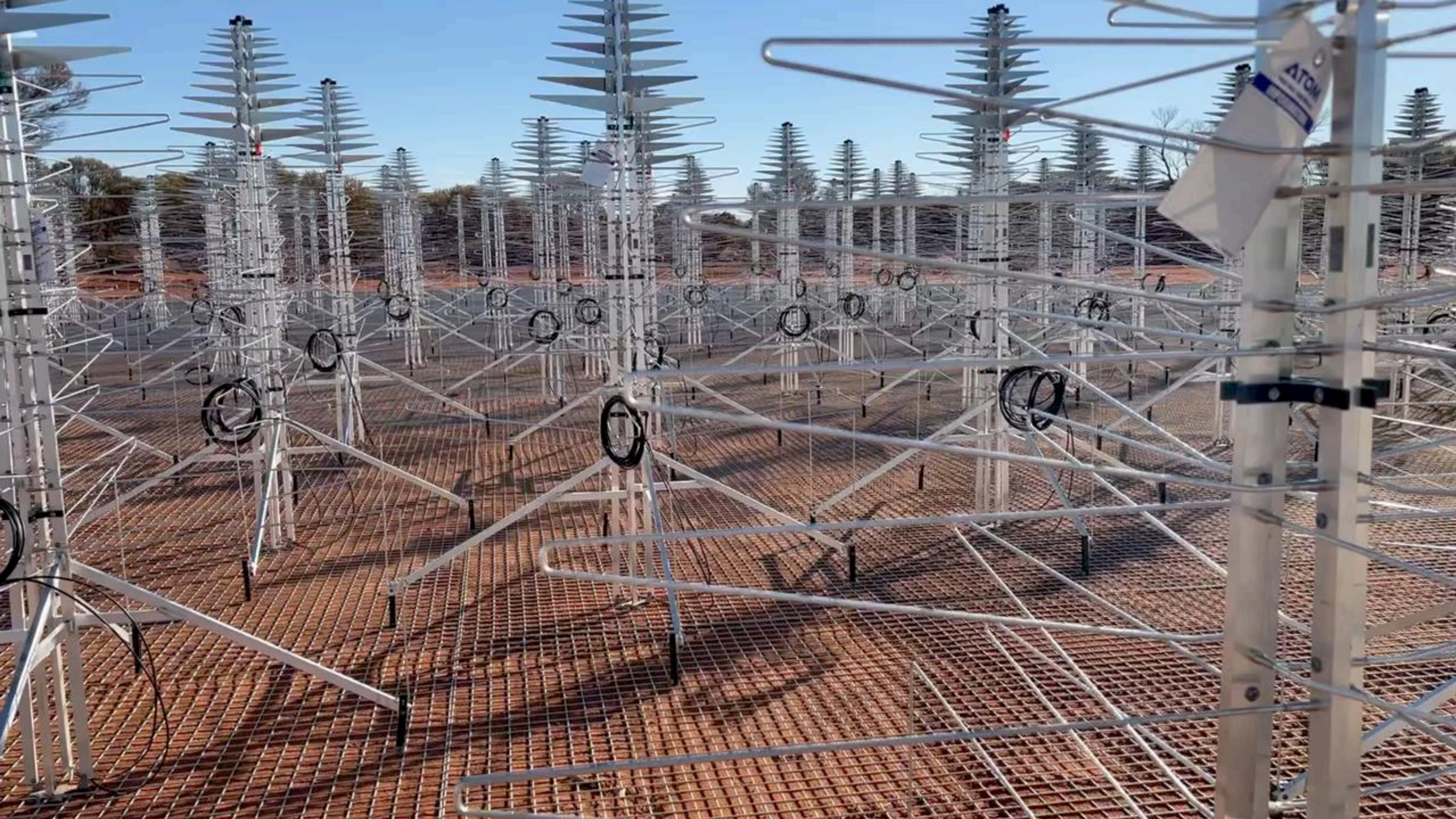
SKA-MID x5 JVLA

SENSITIVITY

Thanks to their many antennas, the SKA telescopes will see fainter details, like a long-exposure photograph at night reveals details the eye can't see.


GOVERNMENT OF WESTERN AUSTRALIA
CSIRO
Australian Government
You are now entering a Radio Quiet Zone for radio astronomy
Please
• Place all devices in flight mode
• Switch off satellite phones
• Minimise use of CB radio
• Emergency use is permitted
Your co-operation is appreciated
GERALDTON

Indigenous Land Use Agreement



SKA-Low staged construction


CETC
STC250E5

SKA-Mid telescope

July 2024: ‘Big lift’ of first SKA-Mid reflector onto its pedestal


THE ONES WHO ARE CRAZY ENOUGH
TO THINK THEY CAN CHANGE THE WORLD,
ARE THE ONES WHO DO.


SKA
SKA Organisation

Protection of the Dark and Quiet Sky

Credits: Satellites Behind Pinnacles
Image credit and copyright: Joshua Rozells

Join our SKA-Low team

Computing and software will be one of the largest SKA-Low teams in Australia. Roles ranging from IT support through to High Performance Computing specialties.

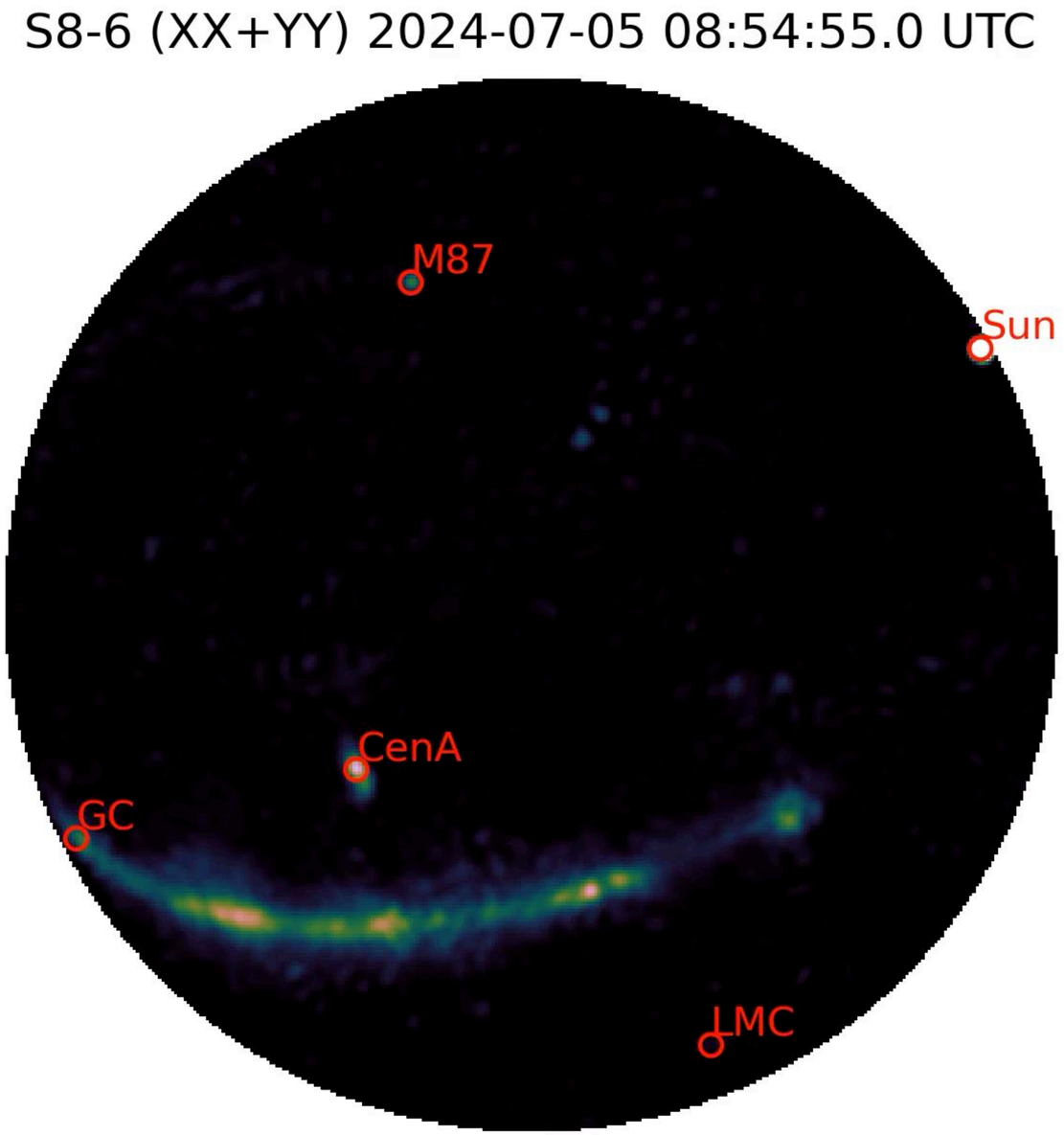
Hiring now: **FPGA Engineer**
Network and computing technician

Coming roles: Expression of Interest for upcoming roles in 2024/2025:

- **Software Engineers** in HPC, Scientific Computing Applications (Python, C++) incl. use of accelerators such as GPUs and FPGAs and workflow management systems

- **Platform and Storage System Engineers** with experience in Data Centre, HPC, large deployed clusters, OpenStack, Ceph, Lustre, etc.

Find out more: csiro.au/en/careers/career-opportunities/skao


S8-6 (XX+YY) 2024-07-05 08:54:55.0 UTC
M87
Sun
CenA
GC
LMC

SKAO

We recognise and acknowledge the Indigenous peoples and cultures that have traditionally lived on the lands on which our facilities are located.

www.skao.int