Chile: Astronomy Capital of the World

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Universidad de Chile

Centro de Astrofísica y Tecnologías Afines

National Astronomical Observatories

Beijing, September 6, 2023

¿Why?

- Chile has the most arid desert in the world: The Atacama Desert.

Sky: blue and transparent
Atmosphere: dry and stable

Ideal conditions for astronomical observations.

- The Government of Chile, in particular University of Chile, give to foreign institutions all the facilities to install observatories in its territory.

By the end of this decade more than 50% of the world's astronomical observation capacity will be located and operational in Chilean territory.

International Observatories:

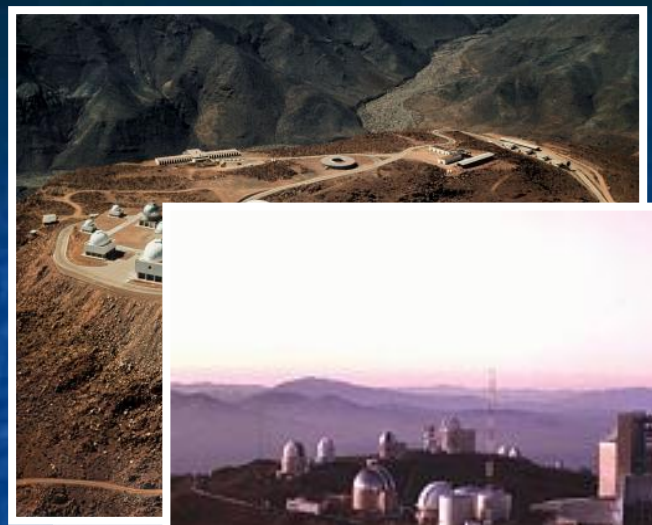
1966 Cerro Tololo Inter-american Observatory

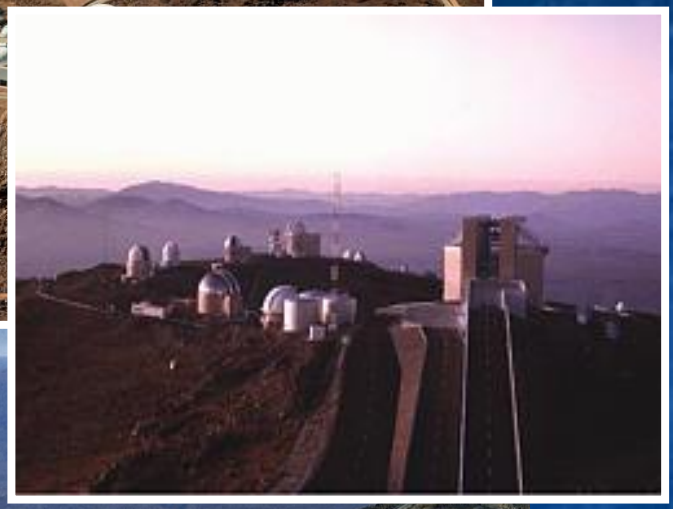
1969 La Silla Observatory (ESO)

1971 Las Campanas Observatory

1999 Paranal Observatory (ESO)

2002 Gemini Observatory





Main telescopes

ESO Very Large Telescope

4 × 8 m. telescopes in Paranal.

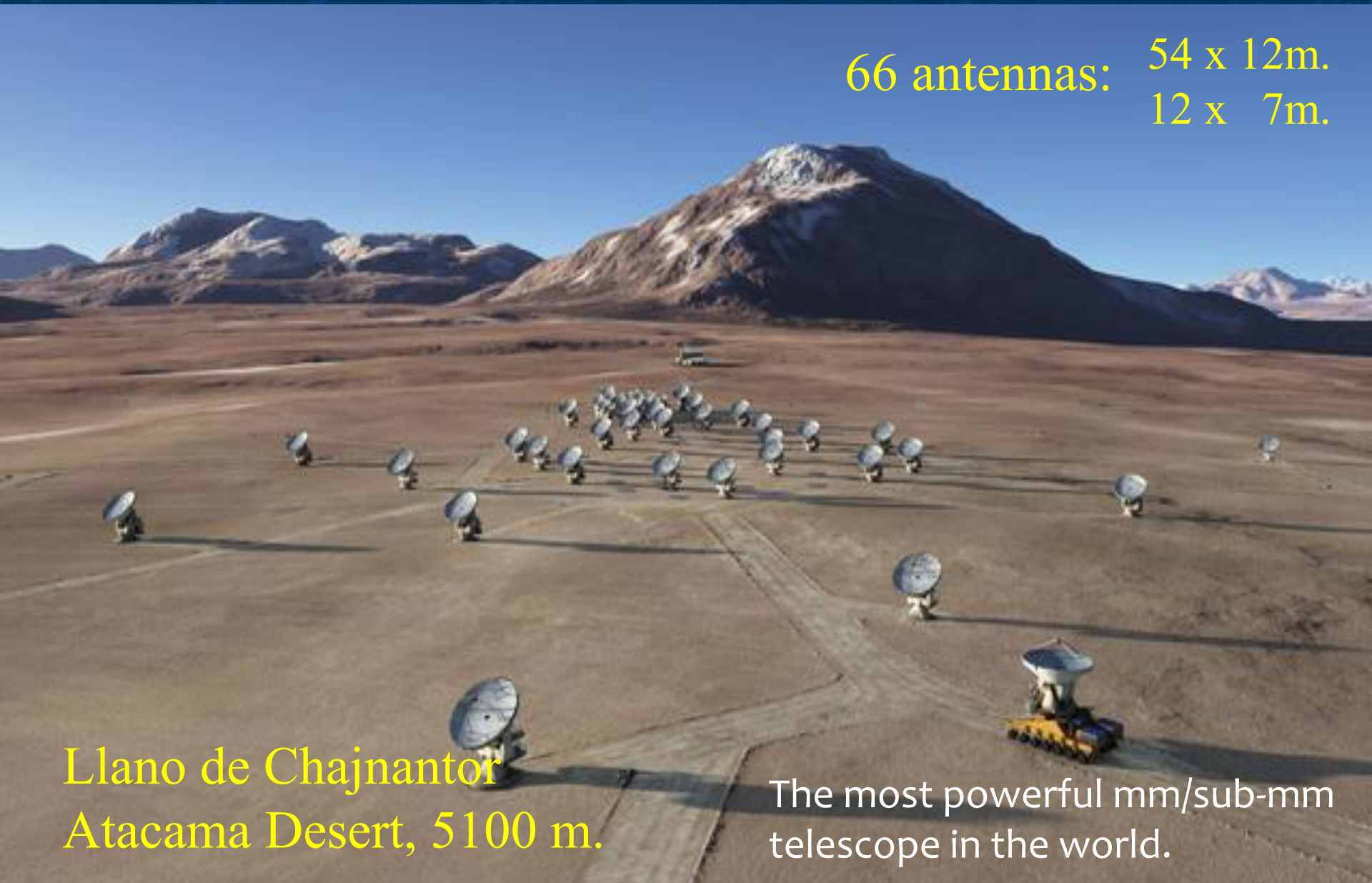
Gemini South
8 m. telescope in Pachón.

New Technology Telescope
2.2 m. telescope in La Silla.

Magellan Telescope

2 × 6.5 m. telescopes in Las Campanas.

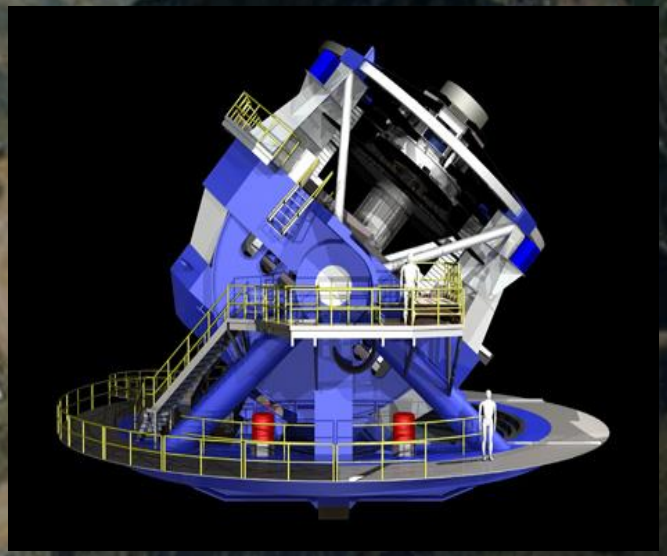
Atacama Large Millimeter Array



Future telescopes

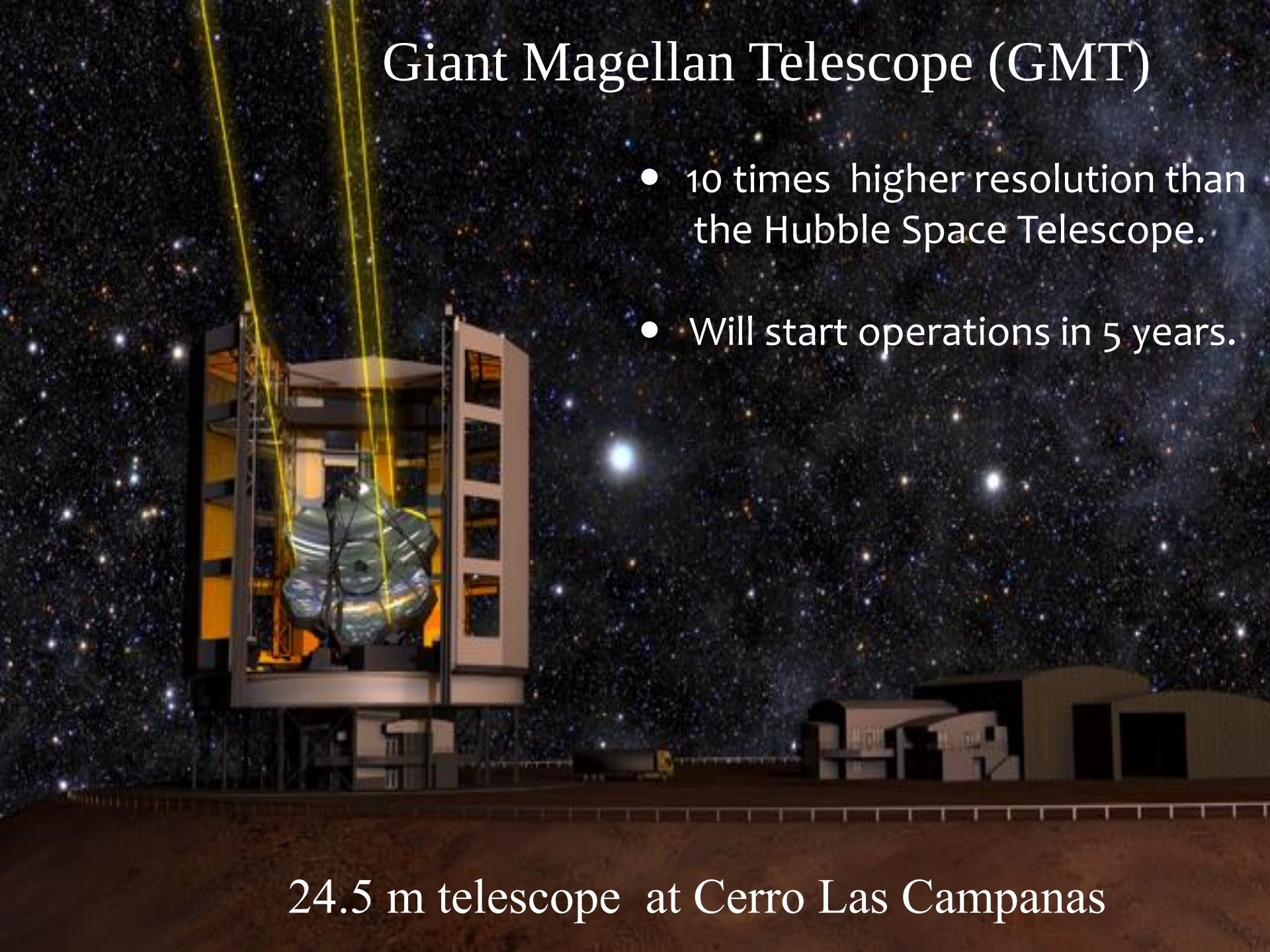
Large Sinoptic Survey Telescope (LSST)

- The largest digital camera in the world (3.2 Giga pixels)
- Will observe the whole southern sky every three days.
- Operations will start in 2024



8.4 m telescope at Cerro Pachón

Giant Magellan Telescope (GMT)



- 10 times higher resolution than the Hubble Space Telescope.
- Will start operations in 5 years.

24.5 m telescope at Cerro Las Campanas

European Extremely Large Telescope (E-ELT)

- The largest telescope in the world
- Will start operations in ~6 years

39 m telescope at Cerro Armazones

Cherenkov Telescope Array (CTA)

Gamma ray observatory at Cerro Paranal 99 telescopes

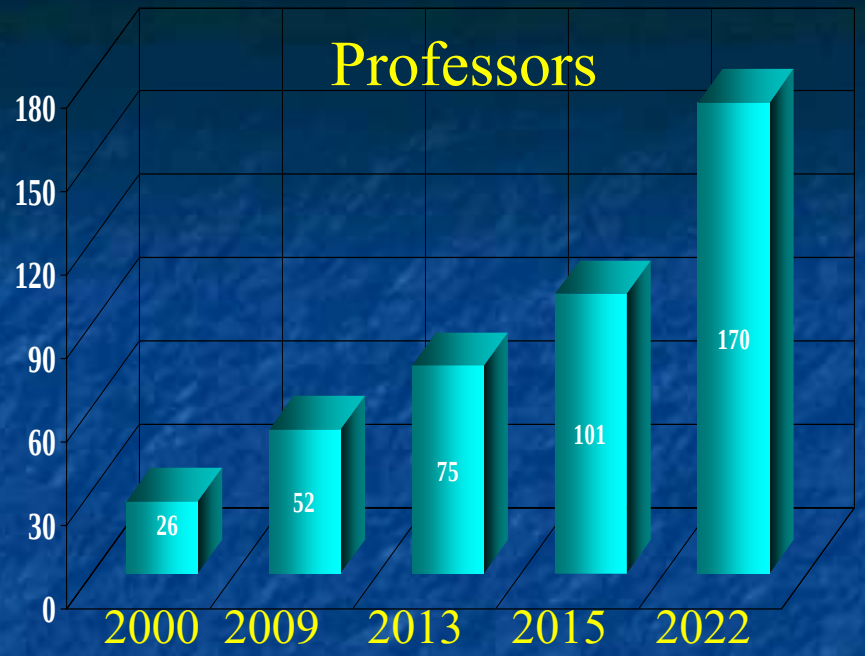
Chilean astronomy

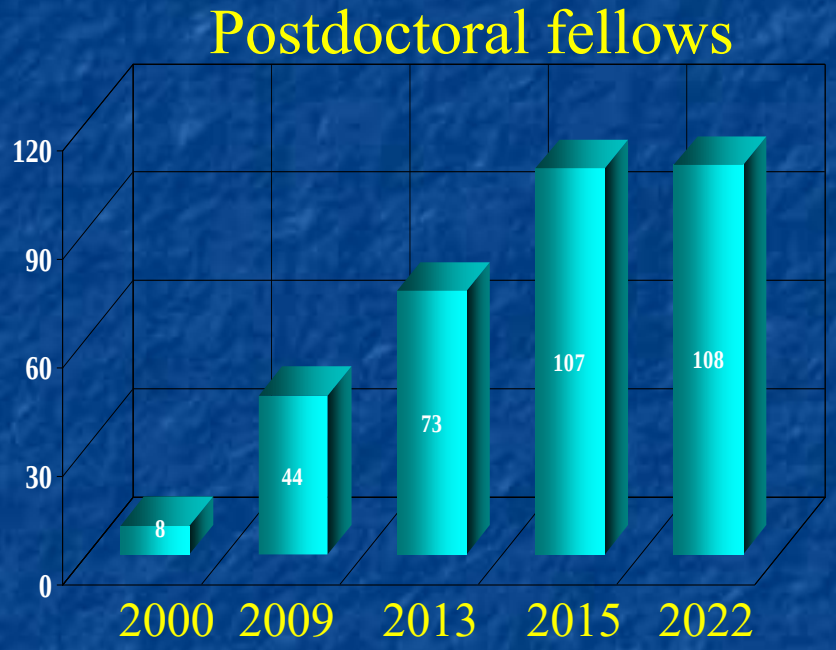
In return for allowing institutions from foreign countries to install observatories in Chilean land, free of taxes, our Government requests the International Observatories to allocate 10% of the observing time, in all of their telescopes, for the use of astronomers in Chilean institutions.

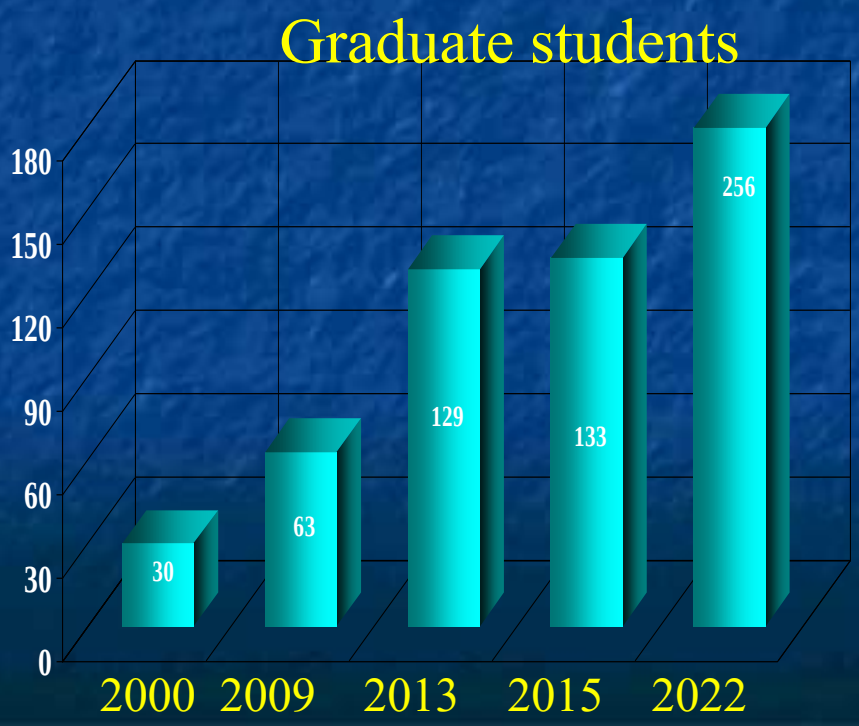
This has led to a rapid grow in astronomy during the last 30 years.

2000
2 Astronomy Departments

2023
23 Institutions with Astronomy groups


Professors
180
150
120
90
60
30
0
26
52
75
101
170
2000
2009
2013
2015
2022


Postdoctoral fellows
120
90
60
30
0
8
44
73
107
108
2000
2009
2013
2015
2022


Graduate students
180
150
120
90
60
30
0
30
63
129
133
256
2000
2009
2013
2015
2022

The main Chilean consortium for research and development of astronomy:

CENTER FOR ASTROPHYSICS and ASSOCIATED TECHNOLOGIES

CATA
CENTRO DE ASTROFÍSICA Y TECNOLOGÍAS AFINES

A Center of Excellence supported by the Chilean National Agency for Research and Development (ANID).

Creation date: March, 2008

Five Associated Institutions

Universidad de Chile

Universidad Católica

Universidad de Concepción

Universidad Andres Bello

Universidad Diego Portales

Mission

1. *Research.* *Tackle fundamental problems in astrophysics making the best use of the available resources.*
2. *Education.* *Educate and train the new generations of chileans astrophysicists and engineers specializing in astronomical instrumentation.*
3. *Technology.* *Boost the development of high technology in Chile supporting initiatives of astronomical instrumentation between astronomers and engineers.*
4. *Collaboration.* *Encourage joint projects between astronomers from the different associated institutions. Create links with International Centers of Excellence.*
5. *Outreach.* *Carry out education and outreach activities for the whole Chilean society.*

Human resources

15 Principal Researchers

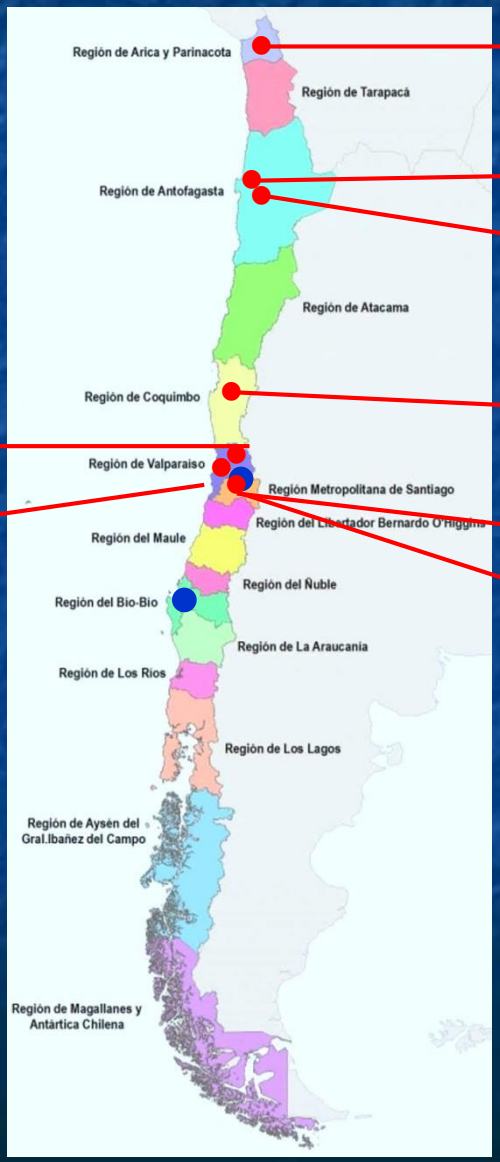
40 Associated Researchers

42 Postdoctoral fellows

132 Graduate students

- 68 Ph.D.
- 64 Magister

Several associated researchers from newly born astronomy groups in the country:



U. de Tarapacá.

U. de Antofagasta.

U. Católica del Norte.

U. de La Serena.

P.U.C. de Valparaíso.

UTFSM Valparaíso.

UMCE.

U. Adolfo Ibañez.

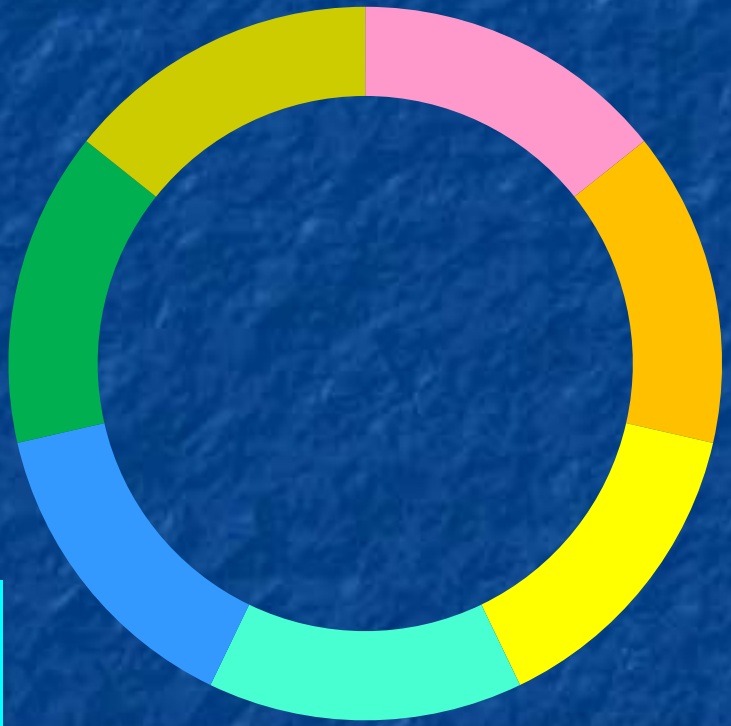
CATA's influence extends widely across the country.

Research

Scientific Areas

Cosmology and Galaxy formation

SMBHs and Energetic Phenomena



Theoretical Astrophysics

Galaxies

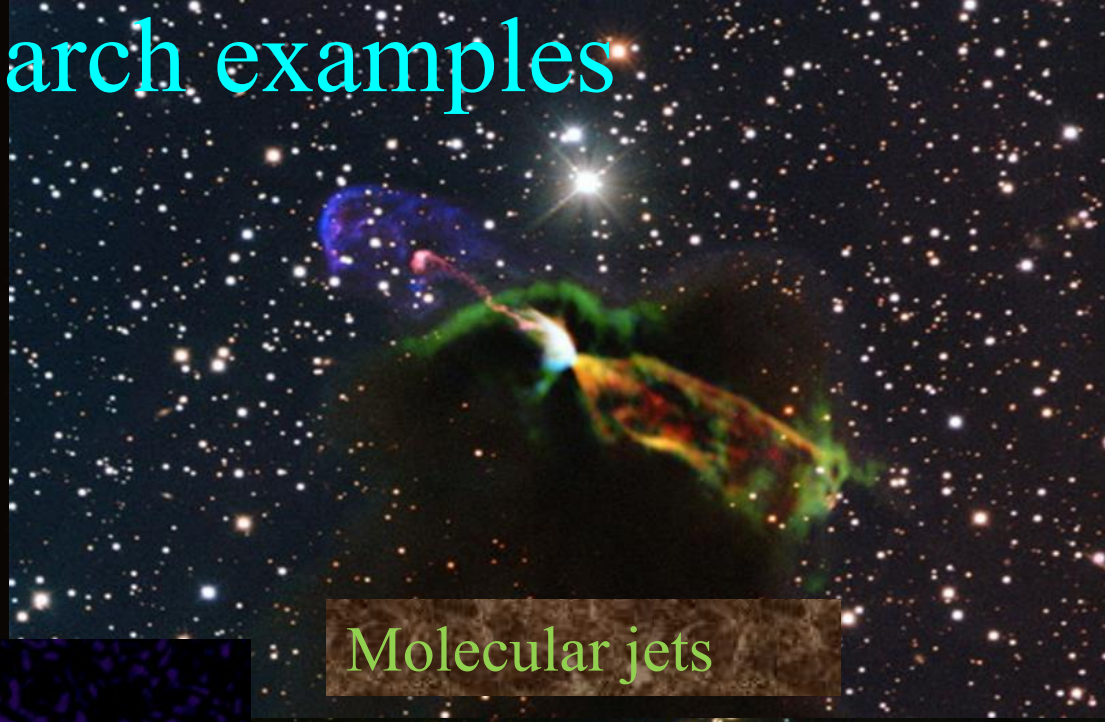
Exoplanets and Astrobiology

Local Universe

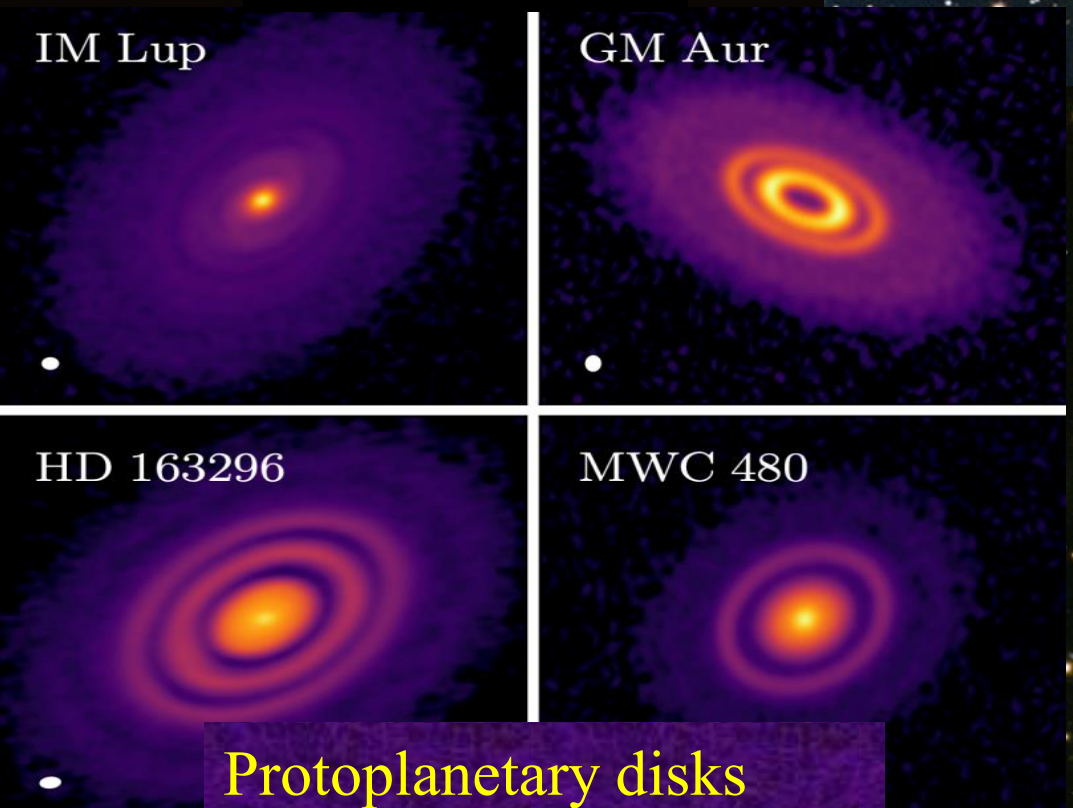
Stars and Planets formation

✦ Research examples

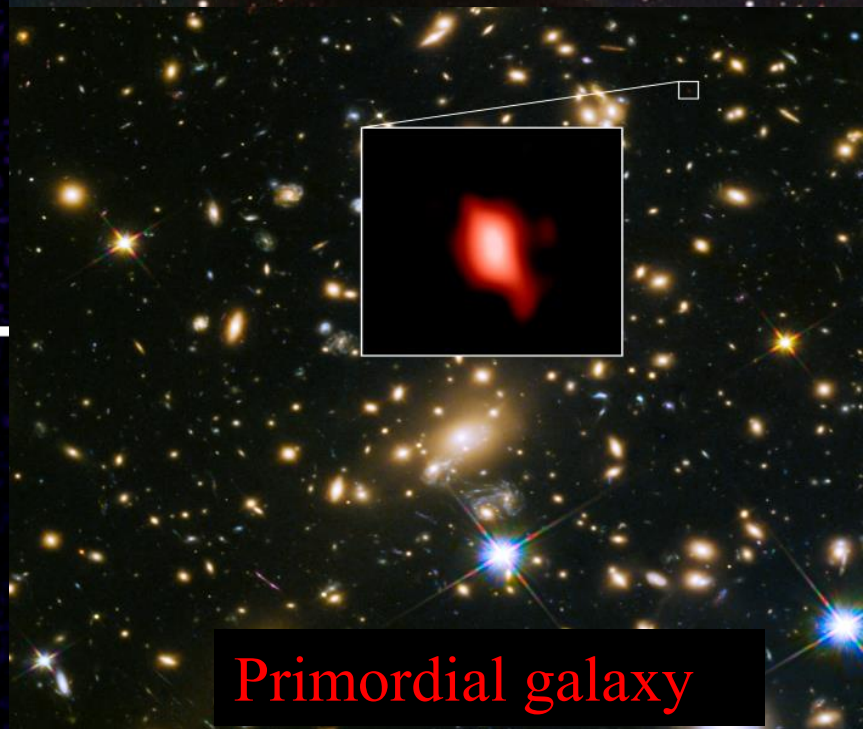
Black holes



Molecular jets



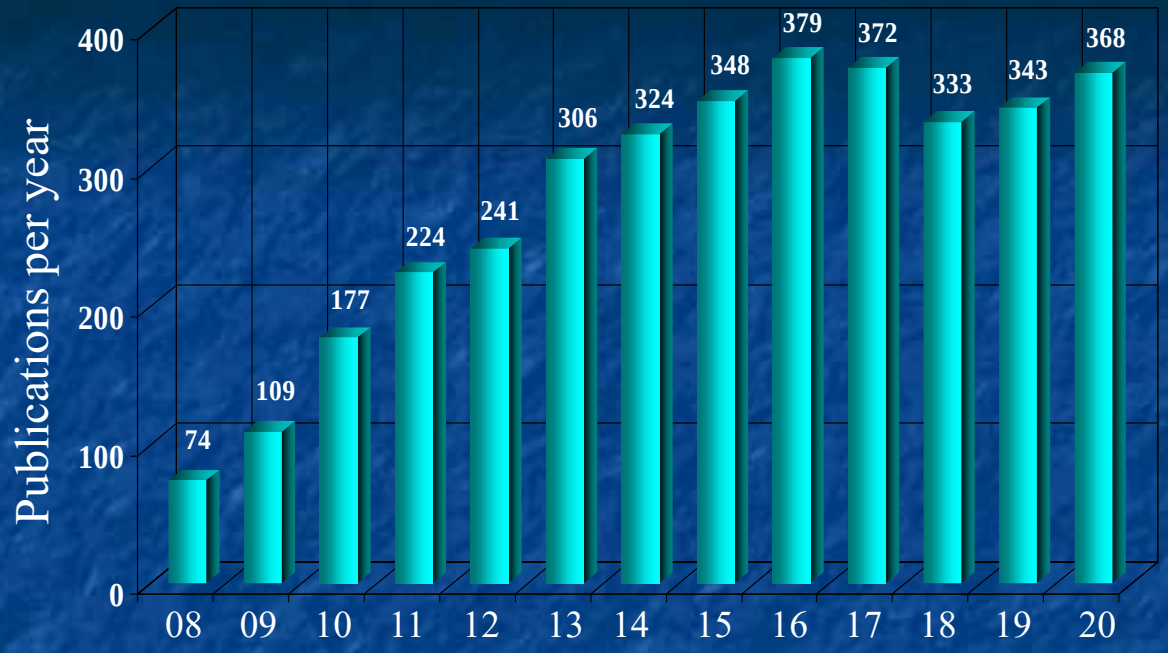
Protoplanetary disks



Primordial galaxy

✦ Achievements

3.591
refereed
publications



148.700
citations

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Astronomical instrumentation

Three laboratories:

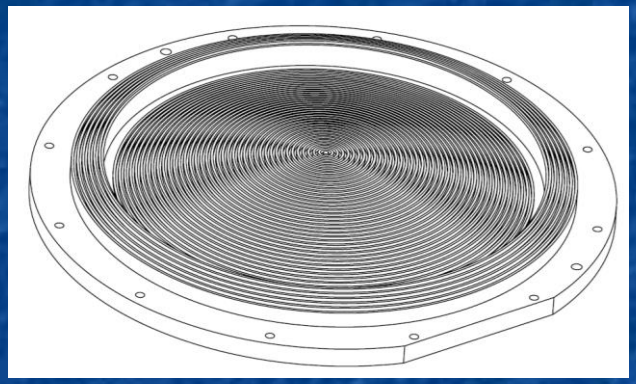
Millimeter Wave Laboratory
Universidad de Chile

Center for Astro-Engineering
Universidad Catolica

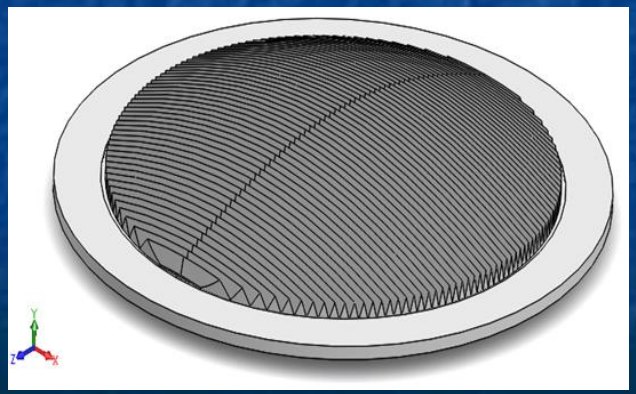
Center for Astronomical Instrumentation
U. de Concepción

Developments

Design and construction of microwave lens for ALMA Receivers (Bands 1 & 2+3)



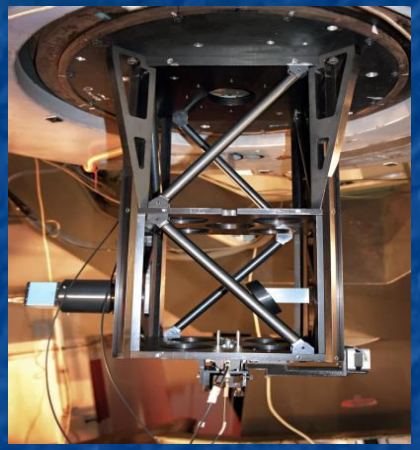
ALMA Band 1 (35-50 GHz)



ALMA Band 2+3 (67-116 GHz)

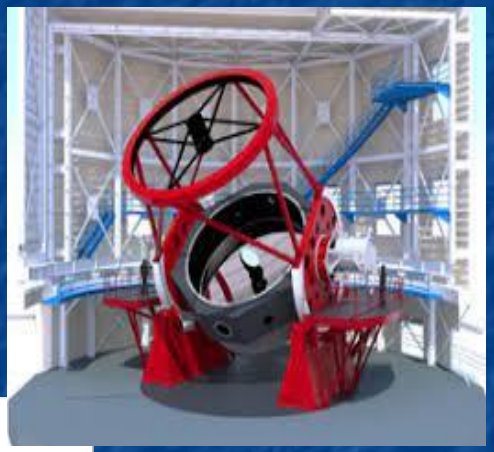
Full Receiver construction for the LLAMA Radio Telescope

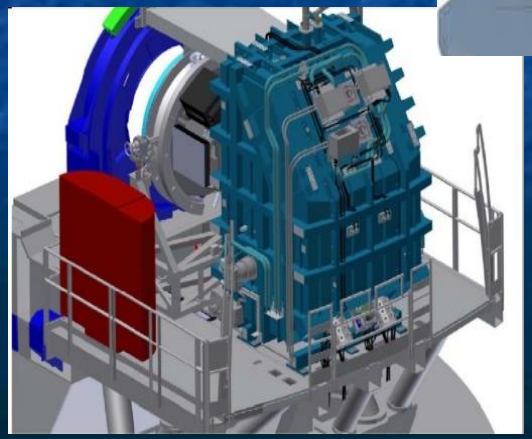
High resolution spectrographs (optical and IR bands)



PUCHEROS+
ESO 1.5 m

TARDYS
TAO

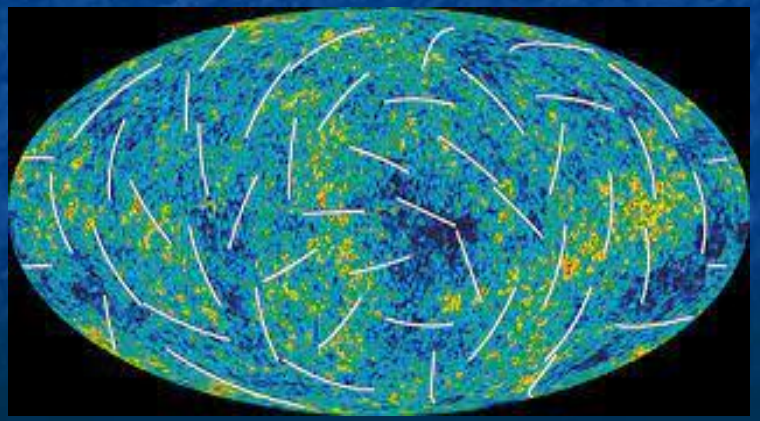




MOONS
ESO VLT

Drone-based polarization calibration source of millimeter waves.

Atacama Cosmology Telescope
Cerro Toco, 5600 m Atacama Desert



Accurate polarized reference for CMB telescopes

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Technology transfer and link with industry

Objective: put special efforts to develop technologies that can be transfered to areas outside astronomy, having impact on society and feasible of commercialization in Chile.

Some Developments

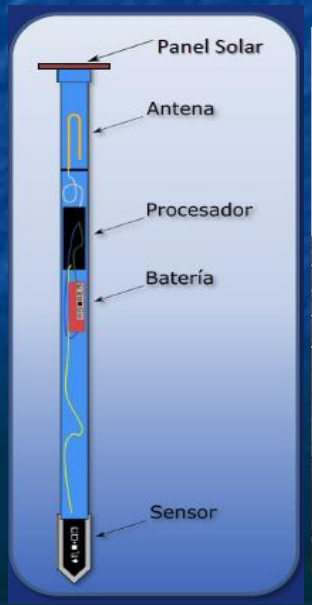
1. RadioVision

RIDAR
RADIO IMAGING DETECTION AND RASTERIZATION

A radio-frequency camera which maps the emission from cells and superimpose it over a video.

Applications:
- Location of portable devices for cell-phone control.
- Search and rescue operations.

2.Telemetry of lixiviation piles and tailings

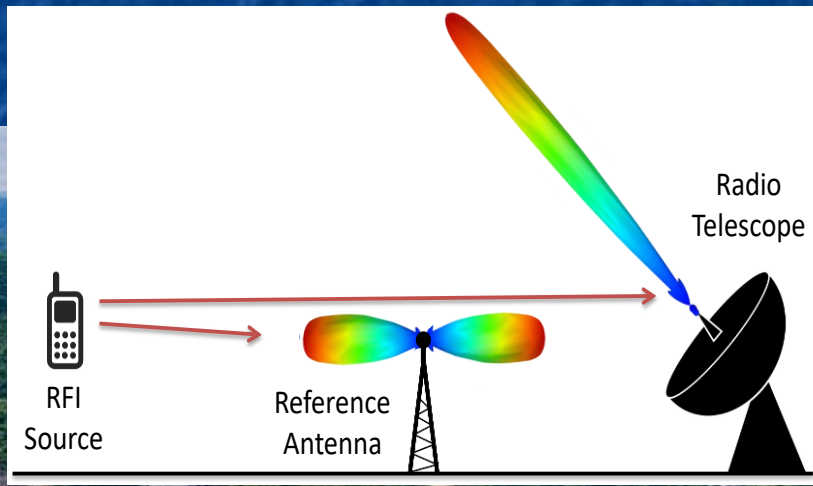


In situ monitoring of variables.

Applications:
- Mining (lixiviation and tailings)
- Geology (displacement of massifs)
- Agriculture (crop sensing)

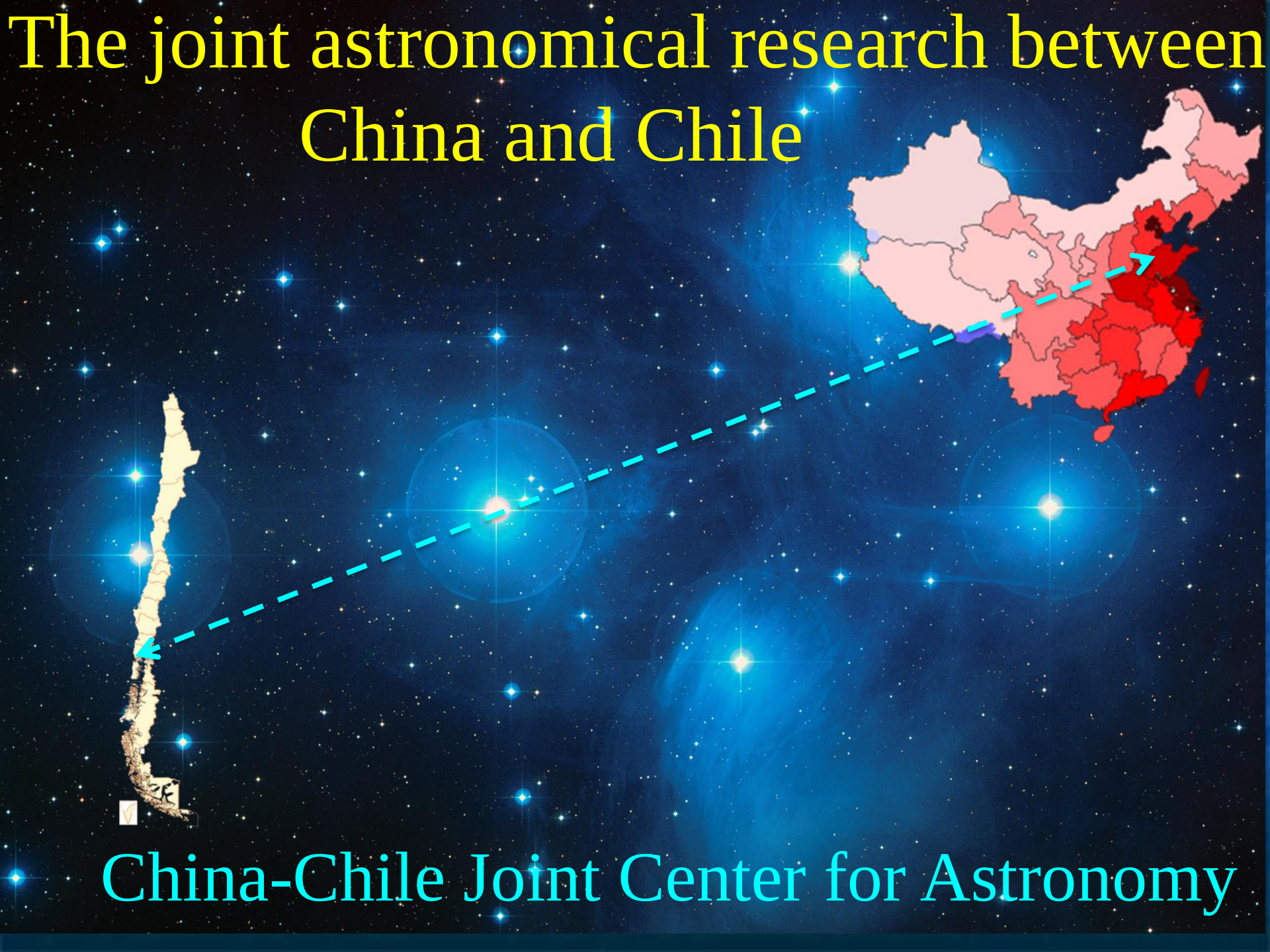
3. RFI-Adapt

A digital adaptive filter for the mitigation of radio frequency interference (RFI). Possible applications in telecommunications and defense.



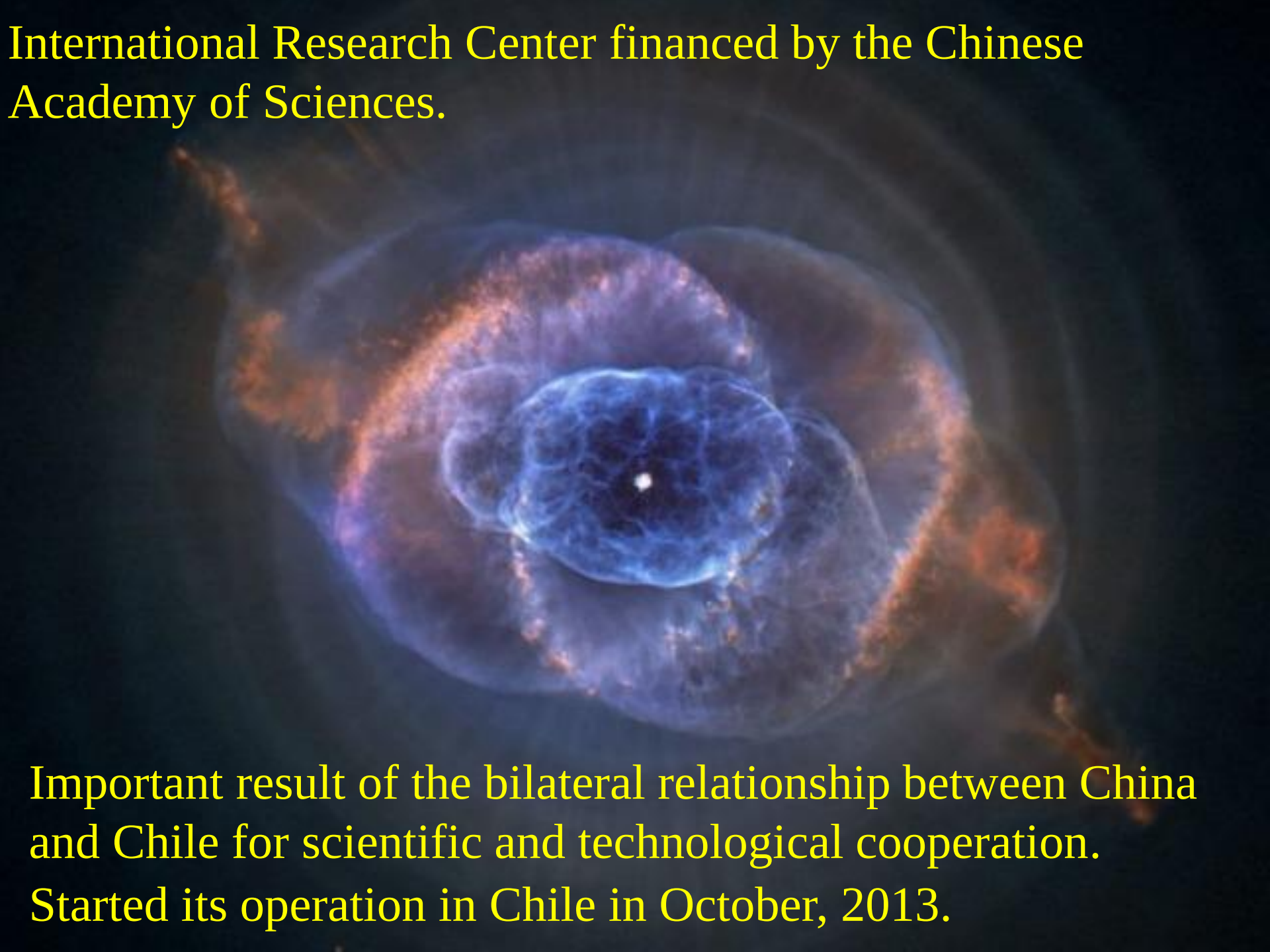
FAST 500m telescope

The joint astronomical research between China and Chile



China-Chile Joint Center for Astronomy

International Research Center financed by the Chinese Academy of Sciences.



Important result of the bilateral relationship between China and Chile for scientific and technological cooperation.

Started its operation in Chile in October, 2013.

MISSION

- Promote scientific research and collaboration in astronomy between Chinese and Chilean astronomers.
  - ♦ Both comunities are undergoing a rapid development and their strenghts are complementary.
  - ♦ Tackle together fundamental problems in astrophysics making use of the extraordinary infraestructure available in Chile.
- Attract the young generations to astronomy providing them the opportunity of performing frontier research.

Main actions

① China-Chile Joint Research Projects

Joint Research Fund created under an agreement between the NAOC and ANID-Chile.

Objective: support programs of collaborative research between China and Chile in astronomy and astrophysics.

② China-ANID postdoctoral fellowships

Objective: strenghten the cooperation between China and Chile in astronomy through the inclusion of young researchers.

The research is carried out in chilean institutions, with the possibility of continuing it in China.

③ China-Chile Scientific Meetings

Objectives: Get together researchers from both countries allowing them to establish ties based in common scientific interests as well as to boost the interchange of people.


Opening the horizons of CATA to
the rest of the world

We are seeking for formal collaborations (agreements) with other Centers of Excelence and Universities across the world.

Goal: Engage in activities for the development of astronomy and astronomical instrumentation for the mutual benefit of both partners.

- Thesis student exchange program.
  Opportunity for Chinese students to engage in observational thesis using the astronomical facilities available in Chile.

  Opportunity for Chileans students to be involved in theoretical work and simulations using frontier computer facilities.

- Fellowships for graduate students.
  CATA funds a significant number of fellowships for students entering the graduate programs of the 5 associated Universities.

- Joint research projects.
  Undertake frontier research in collaborative form, making use of the best astronomical facilities in the world.

- Joint Instrumentation developments.
  Build astronomical instrumentation for the largest telescopes in Chile and abroad.

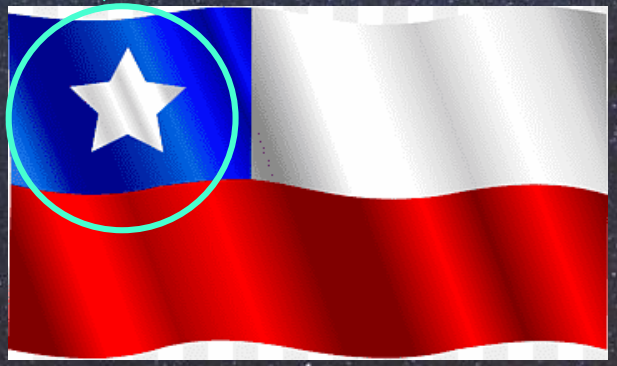
Current partners for technology transfer in instrumentation in China:

- The Chinese Academy of Sciences South America Center for Astronomy.
- Five-hundred-meter Aperture Spherical Radio Telescope (FAST-CAS).

SUMMARY

Chile has the best skies for astronomical research.

CATA wants to establish strong ties between the Chinese and Chilean astronomical communities.



CHINA and CHILE united by the stars!

Contact address: administracion@cata.cl


Thanks
Chile