



Teaching and Research @ IAG

Laerte Sodré Jr.

IAG – USP

INFIERI 2016

4th Summer School on INtelligent signal processing for FrontIER Research and Industry

January 23rd to February 3rd, 2017



IAG: Instituto de Astronomia, Geofísica e Ciências Atmosféricas

Departments:

- **Astronomy**
- **Geophysics**
- **Atmospheric Sciences**

- Faculty: 69 (+7)
- UNDERGRADUATES: 345
- GRADUATES: 236
- POSTDOCS: 66
- Good CAPES grades!

ASTRONOMY

- FACULTY: 31 (+4)
- UNDERGRADUATES: 67
- GRADUATES: 71+29
- POSTDOCS: 40
- CAPES GRADE: 7

GEOPHYSICS

- FACULTY: 20 (+2)
- UNDERGRADUATES: 171
- GRADUATES: 50
- POSTDOCS: 12
- CAPES GRADE: 6

ATMOSPHERIC SCIENCES

- FACULTY: 18 (+1)
- UNDERGRADUATES: 107
- GRADUATES: 86
- POSTDOCS: 14
- CAPES GRADE: 7

Administrative/technical staff: 129



IAG: Instituto de Astronomia, Geofísica e Ciências Atmosféricas

Undergraduate courses:

- **Astronomy (2009) – 20/yr**
- **Geophysics (1984) – 30/yr**
- **Meteorology (1977) – 30/yr**



Graduate courses:

- **Astronomy (1973)**
- **MSc in Teaching of Astronomy (2013)**
- **Geophysics (1974)**
- **Meteorology (1975)**

>1000 PhD and MSc!





Astronomy @ IAG

Solar System

Exoplanets, Astrochemistry & Astrobiology

Stellar Structure and Evolution

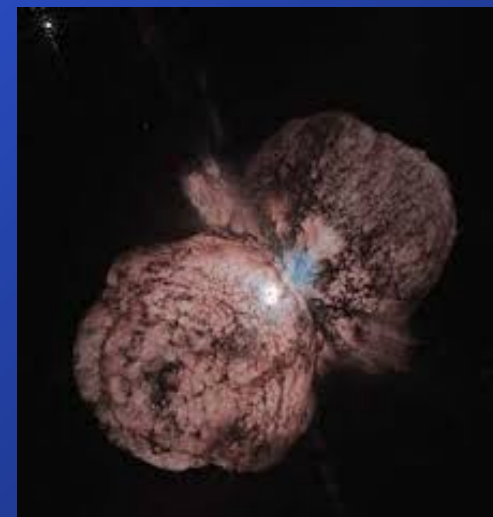
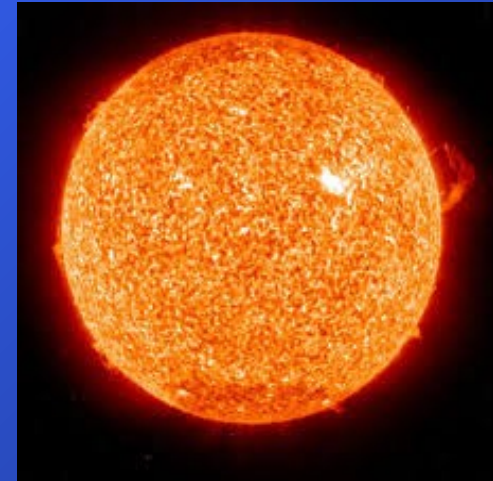
Stellar Populations

Milky Way

Formation and Evolution of Galaxies

Physics of Black Holes and compact objects

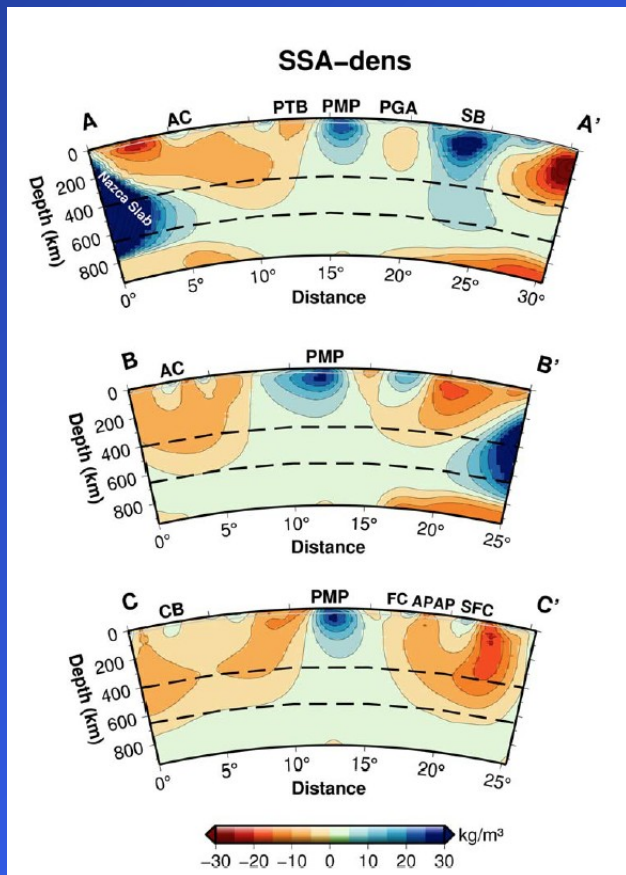
Cosmology



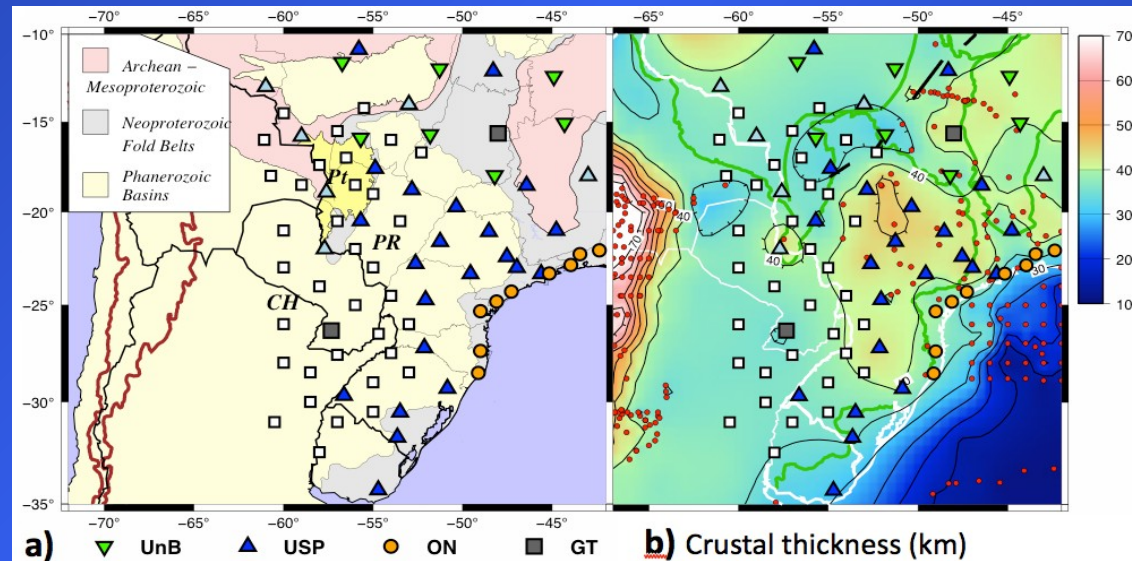
Geophysics @ IAG



Structure and Dynamics of the Earth: relation between deep and surface processes

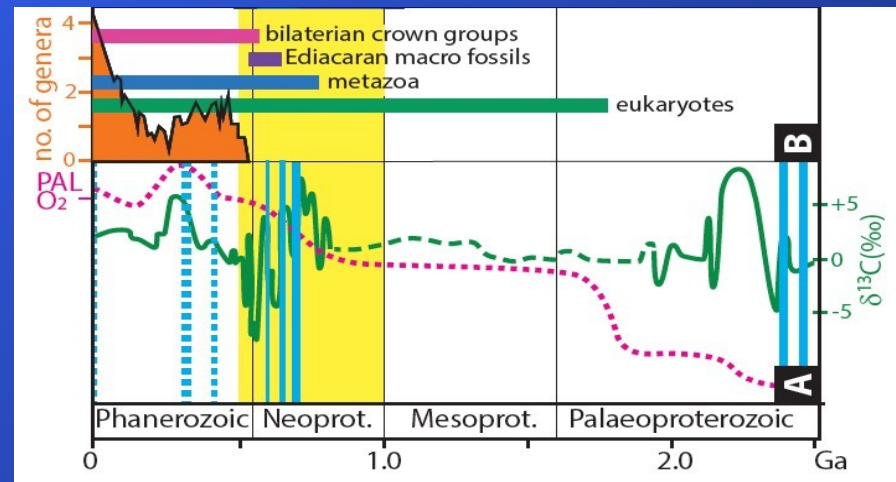


Density of South America up to depths of 800km



Brazil crustal thickness from seismological tomography

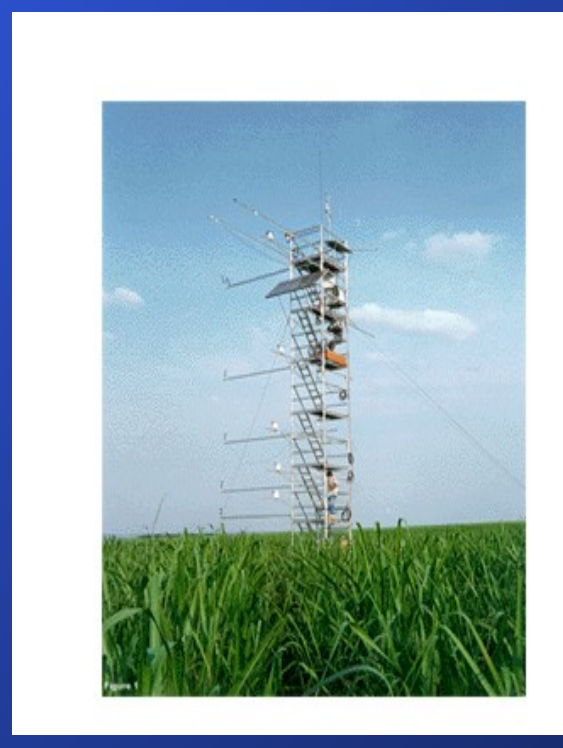
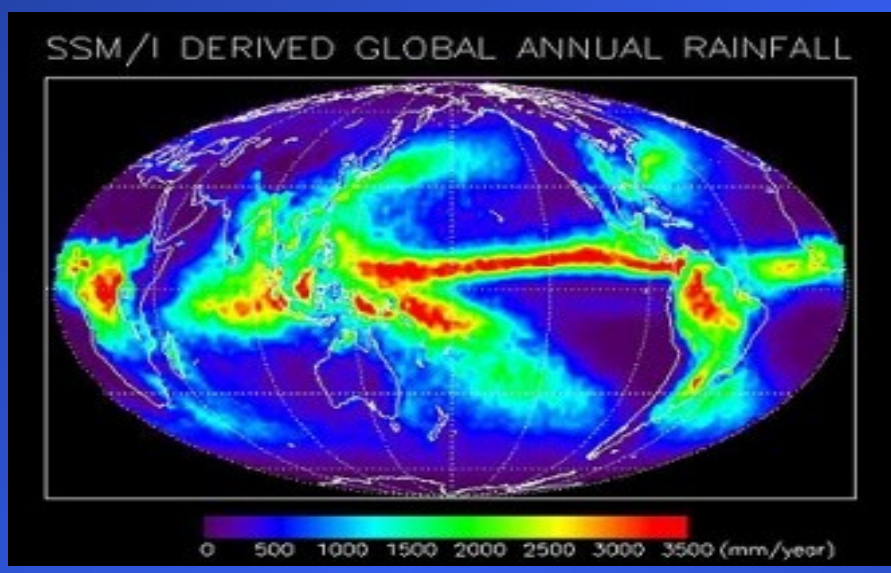
Interaction Geophysics – Biology – Atmosphere in the primitive Earth: transition from the PreCambrian to Cambrian and the origin of the Oxygen in Earth





Atmospheric Sciences @ IAG

- Physical Processes in the Atmosphere
- Atmospheric Pollution
- Micrometeorology
- Atmosphere – Biosphere Interaction
- Climate and Global Warming

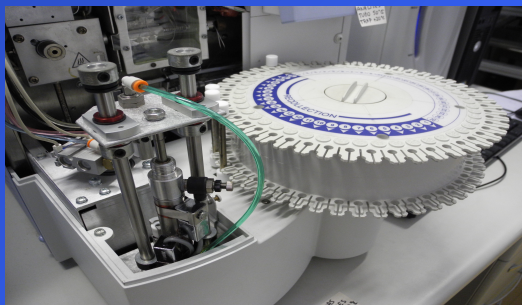




IAG infrastructure for research

HPC

- **Several clusters!**
- **Laboratório de Astroinformática:**
 - 2304 cores (192 Opteron processors)
 - +distributed processing
 - +GPUs



RESEARCH LABs:

- **Meteorological stations**
- **Seismology**
- **Paleomagnetism**
- **SOAR remote observation room**
- **Air pollution**

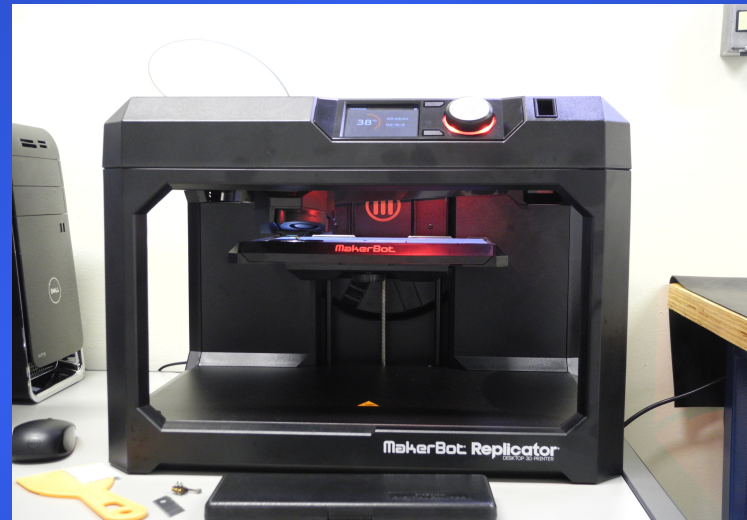
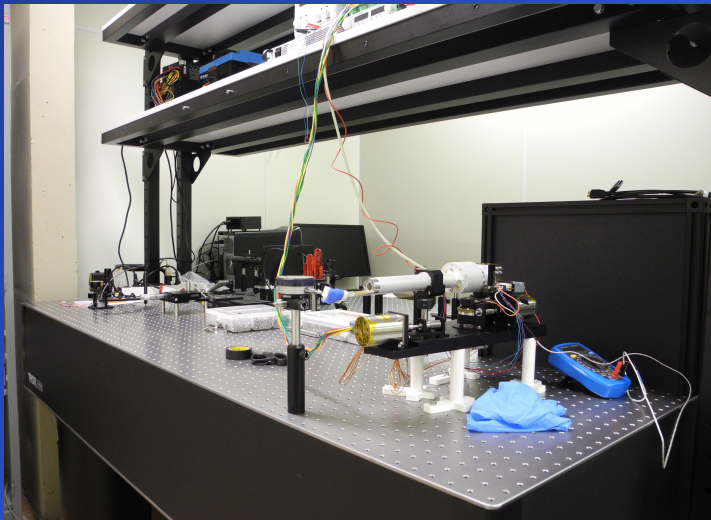




IAG infrastructure for research

Development of instruments:

- Workshops: optics, mechanics, electronics

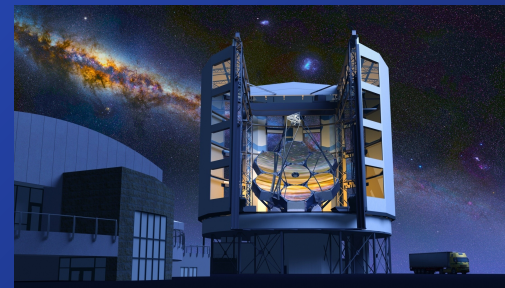


Inauguration Feb 2017

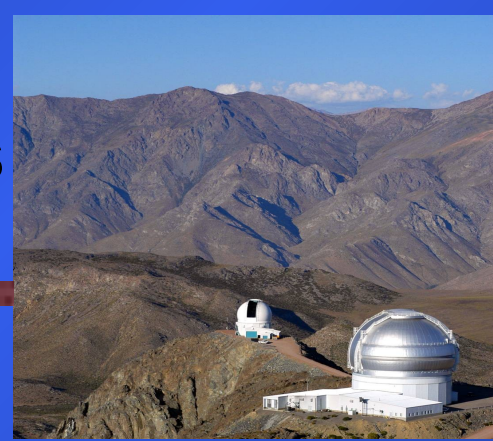


Brazilian Optical Astronomy Landscape

- Observatório do Pico dos Dias- LNA
- Gemini Observatory (6.5%)
- SOAR Telescope (34%)
- GMT (4%, SP)
- ESO? pending ratification by the Congress
- J-PAS, T80-S

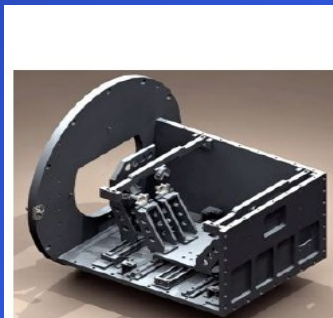


Instrumentation for optical telescopes

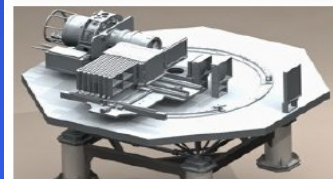


- SOAR: SIFIS, BTFI, STELES
- J-PAS (JPcam, T80Cam), South-Pol
- Subaru: PFS
- ESO: CUBES (VLT), Mosaic (ELT-MOS)
- GMT: GCLEF ...
- ...

SIFIS- SOAR Integral Field Unit Spectrograph PI: B. Barbuy, J. Lépine, C. Gneiding (LNA)



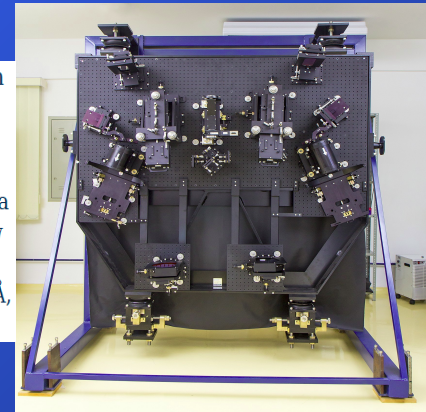
- 1300 fibers IFU
Microlens array:
26 x 50
- Two plate scales:
0.15"/pixel, field
3.9x7.5"
0.3"/pixel, field
7.8x15"
- Sky IFU
- Fiber bundle: 14m
length of "blue"
fibers (50µm core)



- Bench spectrograph
- VPH gratings
- R~1000 - 30000
- Detector:
2k x 4k Lincoln
Labs CCD

STELES- SOAR Telescope Echelle Spectrograph PI: Bruno Castilho (LNA)

- Two channel, VPH cross dispersed echelle spectrograph
- White pupil configuration
- Bench mounted
- Nasmyth focus, slit fed
- Resolving power - 50.000 (3 - 2.5 pixel resolution) with a 0.8" slit. Higher resolution can be achieved with narrow slits.
- Wavelength range - 3000 - 8900Å (blue arm 3000-5500Å, red arm 5300-8900Å)



BTFI- Brazilian Tunable Filter Imager PI: Cláudia Mendes de Oliveira

two modes:
iBTF (tunable filter)
Low resolution mode: $5 < R < 4,000$

dual Fabry-Perot
High resolution mode: $600 < R < 35,000$



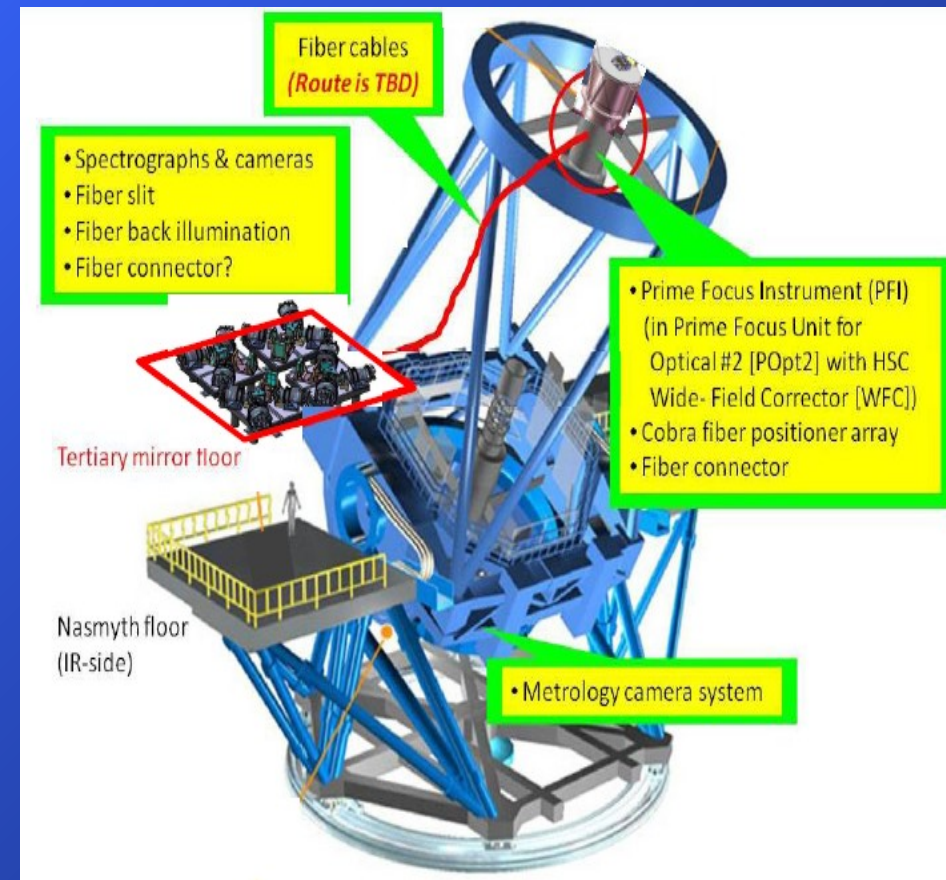
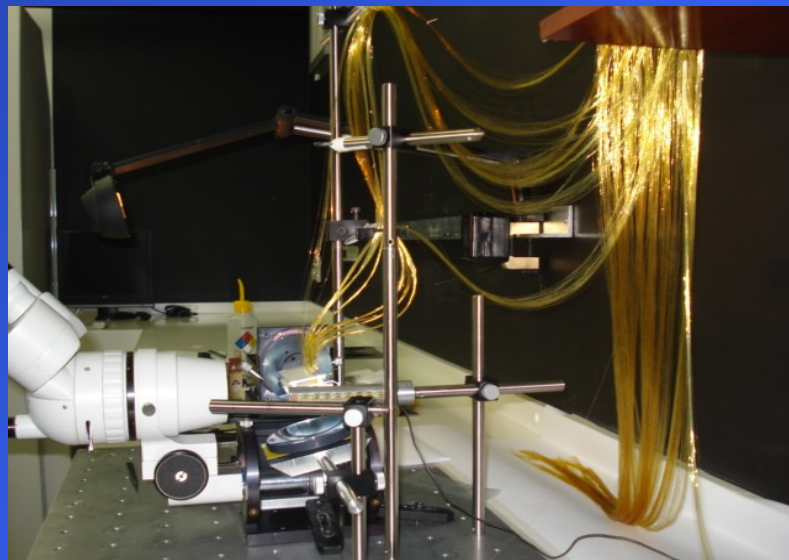
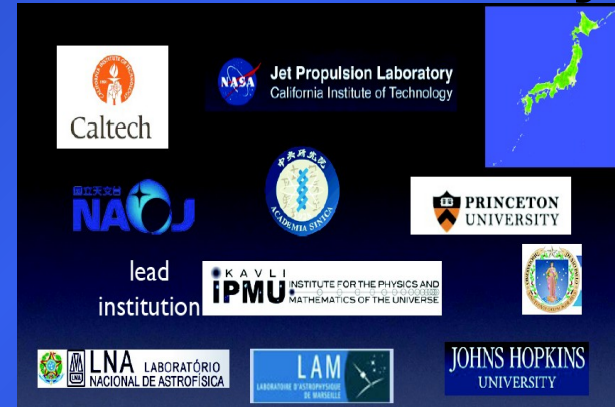


PFS/SuMIRe



Prime Focus Spectrograph for the Subaru Measurement of Images and Redshifts survey

- PI: Hitoshi Murayama Kavli IPMU (U. Tokyo)
- Survey epoch: 2019-2023
- Spectrograph for the Subaru Telescope: 2400 optical fibers within a FOV of 1.3 deg diameter
- Spectral coverage: 0.38 – 1.3 microns, $R \sim 3000 - 5000$
- Brazil (USP+LNA): optical fiber subsystem



PFS/SuMIRe

Prime Focus Spectrograph for the Subaru Measurement of Images and Redshifts survey

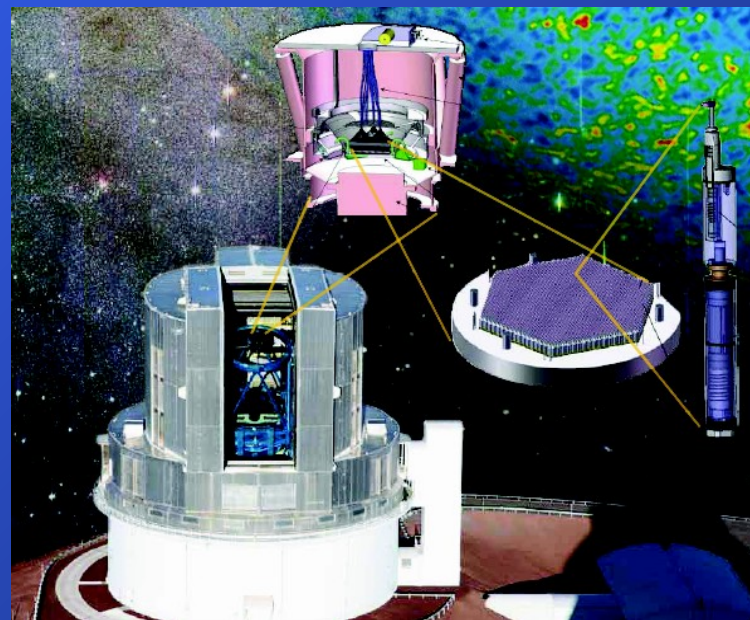
- **Science:**

- Baryon Accoustic Oscilations (BAO) @ $0.8 < z < 2.4$ ($9.3 h^{-3} \text{ Gpc}^3$)
- Cosmological distances with accuracy of 3%; structure growth with 6%
- Local Cosmology: Milky Way & Andromeda history through the observation of $\sim 10^6$ stars
- Chemo-dynamical evolution and dark matter in Local Group dwarf galaxies
- Galaxy populations and structures @ $1 < z < 2$
- “Lyman break” & “Lyman alpha” galaxies @ $3 < z < 7$: glimpses on reionization

Takada et al., 2014 arXiv:1206.0737

<http://sumire.ipmu.jp/en/2652>

<https://www.youtube.com/watch?v=5mW3v2k8Ofo>





J-PAS, J-PLUS, S-PLUS

- **J-PAS: Javalambre Physics of the Accelerating Universe Astrophysical Survey**
- **J-PLUS: Javalambre Photometric Local Universe Survey**
- **S-PLUS: Southern Photometric Local Universe Survey**

Javalambre Astrophysical Observatory



Operated by CEFCA

Centro de Estudios de Física del Cosmos de Aragón, Teruel, Spain



**Cerro Tololo
mushroom farm**



J-PAS J-PLUS S-PLUS

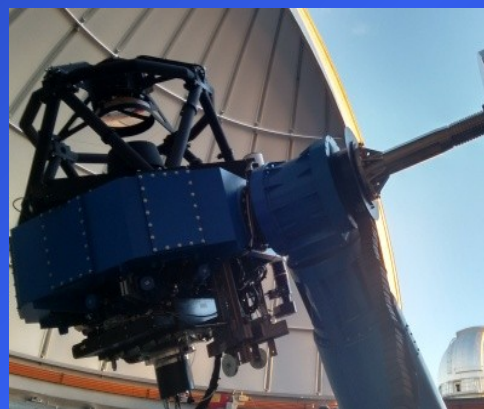


Javalambre Astrophysical Observatory

two survey telescopes @JAO:
2.5m (FOV 3 deg diam) & 80cm (FOV 2 deg diam)



JAO T250 telescope



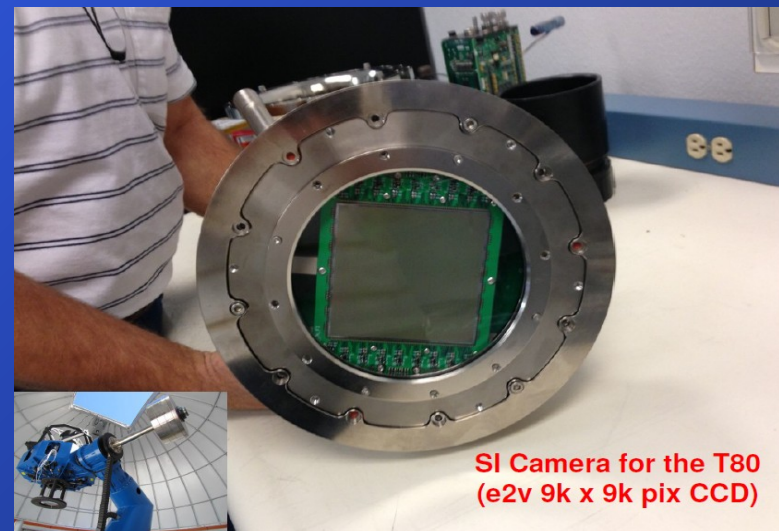
T80-N,S telescope



T80-S @ CTIO



JPCam
mosaic of 14 10kx10k CCDs
(2nd largest astronomical camera!)



SI Camera for the T80
(e2v 9k x 9k pix CCD)



J-PAS

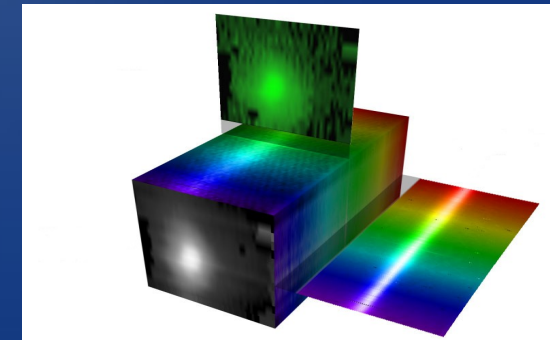
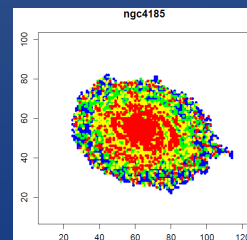
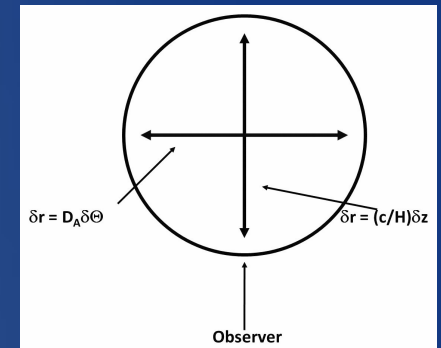
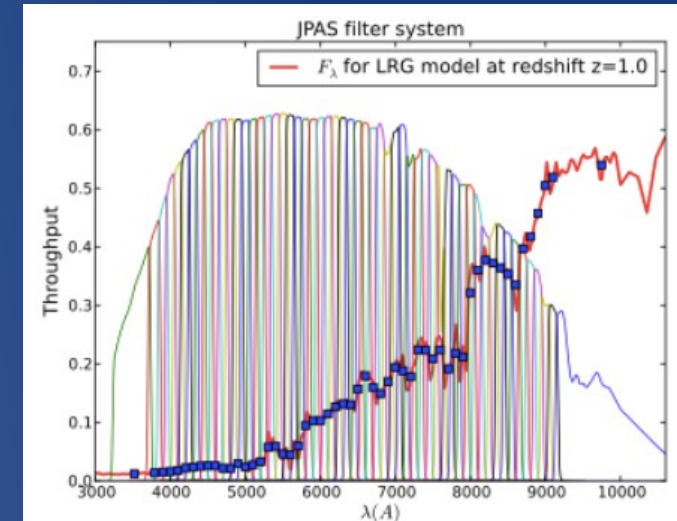
Javalambre Physics of the Accelerating Universe Astrophysical Survey



j-pas.org

arXiv: 1403.5237

- ◆ Collaboration between Brazil and Spain
- ◆ Photometric survey of ~8500 sq. deg. to $i \sim 22$
- ◆ Photometric system with 59 filters
(54 narrow band, 5 broad band)
- ◆ Main driver: the nature of Dark Energy through measurement of the BAO scale up to $z \sim 1$
- ◆ *Large scope of science: from asteroids to cosmology...*
- J-PAS photometry ~ low resolution spectrum ($R \sim 40-60$) for each pixel in the sky up to 23 mag arcsec⁻²!
- distribution of stellar population properties within galaxies





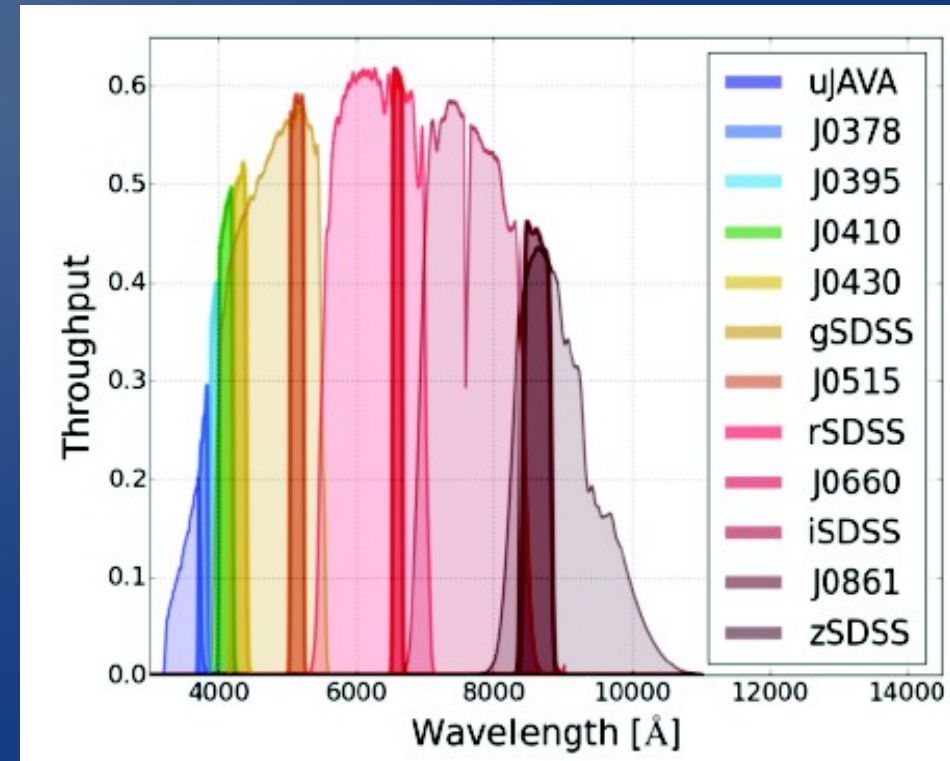
J-PLUS (T80-N)

J-PLUS: Survey with T80-N (@JAO)

PI: Javier Cenarro (CEFCA)

Motivation:

- Photometric calibration for J-PAS
- Test of J-PAS scientific and technical management systems
- 12 filters: SDSS griz + 8 narrow/intermediate band filters
- Survey area: 5000 sq. deg.
- ~3 years, started Nov 2015
- **Science:** from asteroids to distant quasars





S-PLUS (T80-S)



Principal Investigator: Claudia Mendes de Oliveira (IAG)
Project Scientist: R. Overzier (ON)

starts TODAY!



M83

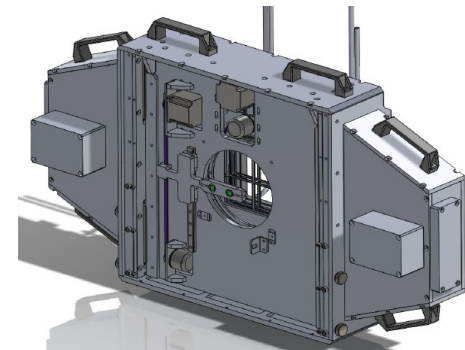
Full field



zoom



T80 South Polarimeter

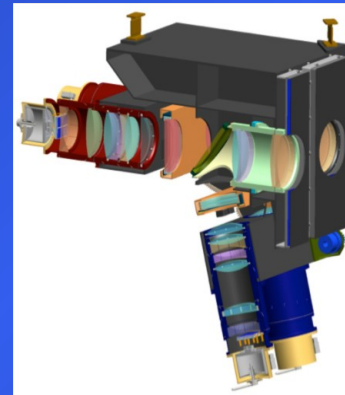


SOUTHPOL - polarimetric survey
with T80-South

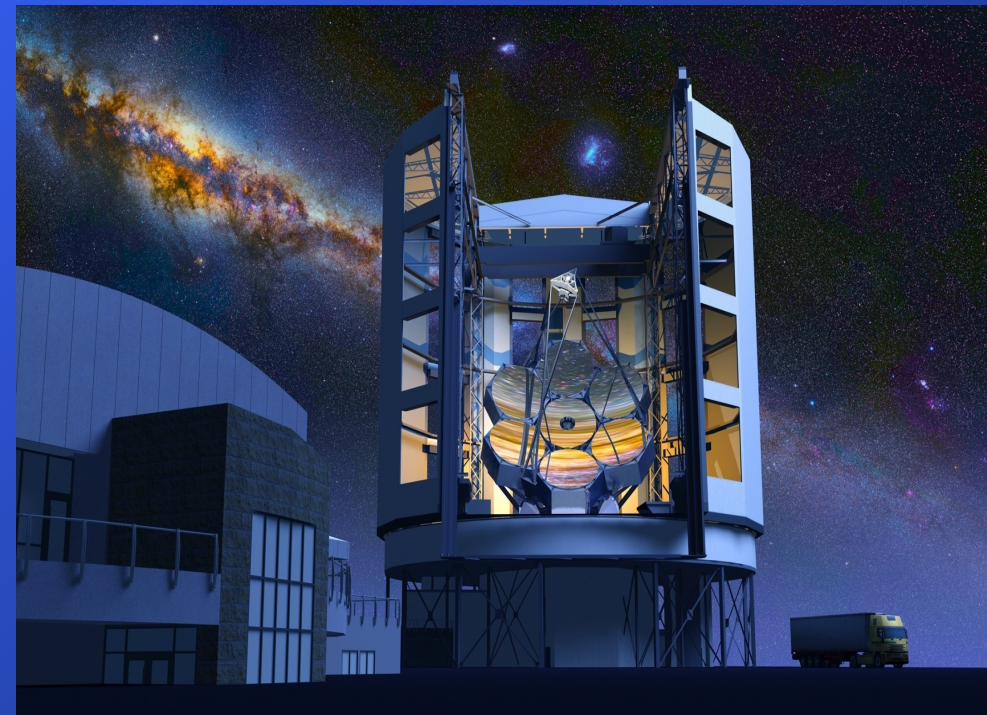
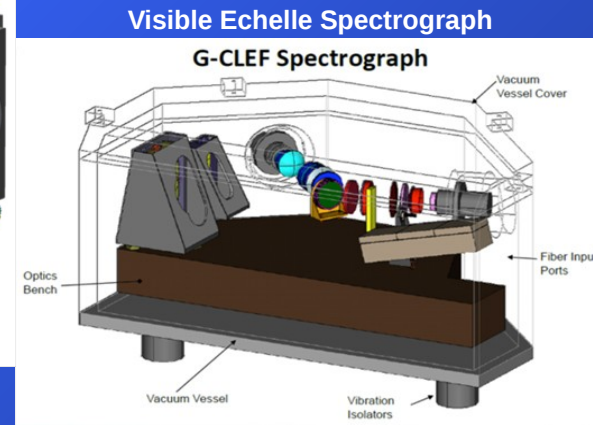
New Large Astronomical Projects @ IAG

GMT: Giant Magellan Telescope (4%, SP) - 2023

- @ Las Campanas Observatory (Chile)
- FOV of 20', resolution $\sim 0.020''$ at $2.2 \mu\text{m}$ (10x better than HST)
- seven 8.4m mirrors (equivalent to a single 24.5m mirror)
- PI: João Steiner



Visible Multi-Object Spectrograph - GMACS



New Large Astronomical Projects @ IAG

LLAMA: Large Latin American Millimeter Array- 2018

- @ NE Argentina (4820m)
- 12m diameter antenna (similar to those used by ALMA)
- Angular resolution of 8" at 900 GHz to 3' at 35 GHz
- PI: Jacques Lepine



- Antenna & detectors ~ ALMA
- Operation as a single dish or part of a VLBI network:
increase x10 the resolution of the ALMA interferometers



New Large Astronomical Projects @ IAG

ASTRI Mini Array (CTA precursor)

- Collaboration with INAF (Italy) and North-West University of South Africa
- @ Chile
- operational by 2019
- PI: Elisabete de Gouveia Dal Pino
- nine 4.3m Cherenkov telescopes for ultra-high energy γ -ray observations (up to ~ 100 TeV)
- FoV = 9.6 deg, resolution \sim arcmin, energy resolution 10-15%



INFIERI 2016

4th Summer School on INtelligent signal processing for FrontIer Research and Industry

January 23rd to February 3rd, 2017

University of São Paulo, Brazil

Enjoy the School!



PELO REPASSE DE 1% DA ARRECAÇÃO DE SÃO PAULO PARA A FAPESP



Conselho Nacional de Desenvolvimento Científico e Tecnológico