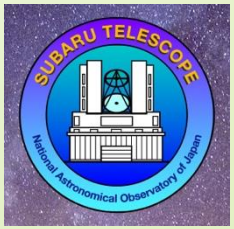


Scientific Interests of the Mexican Astrophysical Community with Subaru

Yair Krongold

Instituto de Astronomía, UNAM

Laurence Sabin, Joel Sánchez, Aida Kirichenko

Mexican Research Canters and Institutions in Astrophysics

1. Instituto de Astronomía, UNAM

2. Instituto Nacional de Astrofísica, Óptica y Electrónica

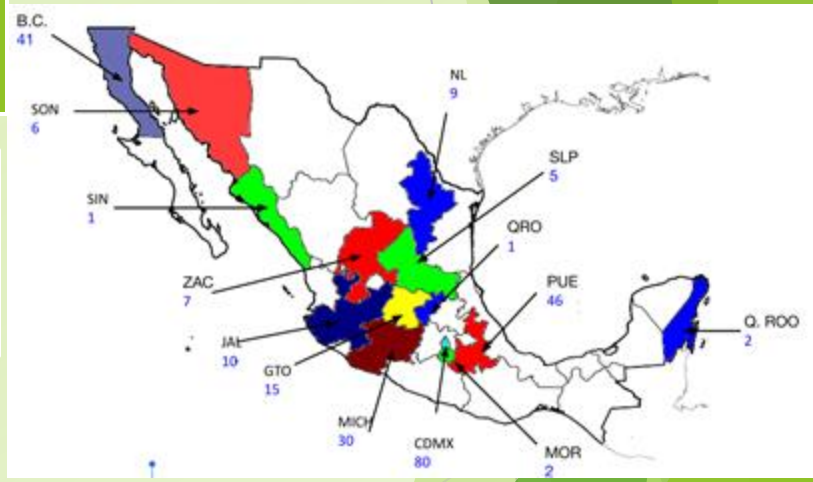
3. Instituto de Radioastronomía y Astrofísica, UNAM

4. Universidad de Guadalajara (UdeG) - CUCEI

5. Universidad de Sonora (UNISON)

6 Universidad de Guanajuato

7. Other institutions with astronomy programs



~255 researchers (incl. postdocs) in 19 institutes

Mexican Infraestructure and Collaborations

- Instituto de Astronomía runs the NATIONAL ASTRONOMICAL OBSERVATORY OF MEXICO.
  - 11 TELESCOPES between .8m and 2m. Many for dedicated scientific projects, many with remote of robotic operation. (collaboration with 10 different countries).

- LARGE MILIMETRIC TELESCOPE (Mexico-USA): 50m dish for millimetric observations with ample instrumentation (part of the EHT)
- High Altitude Water Cherenkov (HAWC) Observatory (Mexico-USA : for gamma ray astrohysics
- Partners of the GRAN TELESCOPIO DE CANARIAS with 5-7% of the time plus different instrumentation projects
  - Full memebers of the SDSS collaboration (Iincluding parts IV, V and VI)
  - Members of the LSST collaboratiom
  - Members of DESI and DESI-II collaboration

Community Consultation

A **survey** was conducted across the entire Mexican astronomical community

- to **assess interest** in using the **Subaru Telescope** and its **instrumentation.**

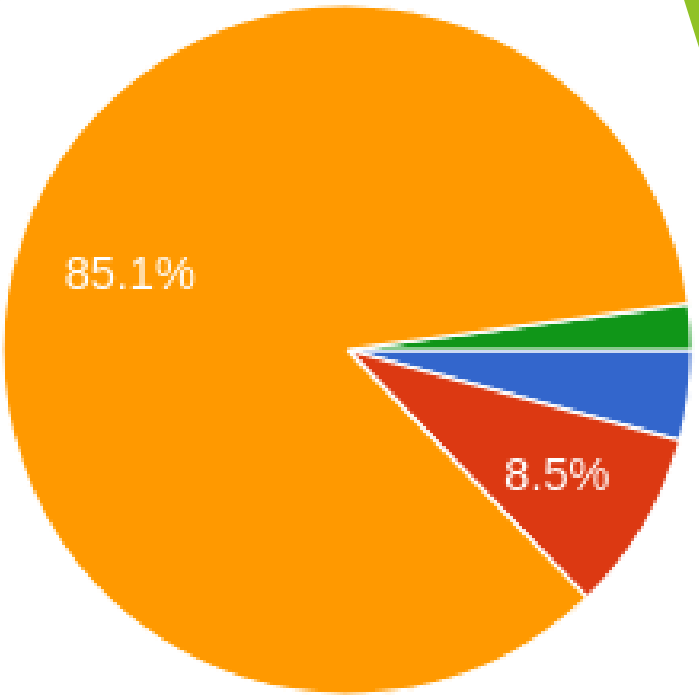
A **presentation** was held in early **October**

- An overview of Subaru's capabilities and instruments
- A space for questions and open discussion

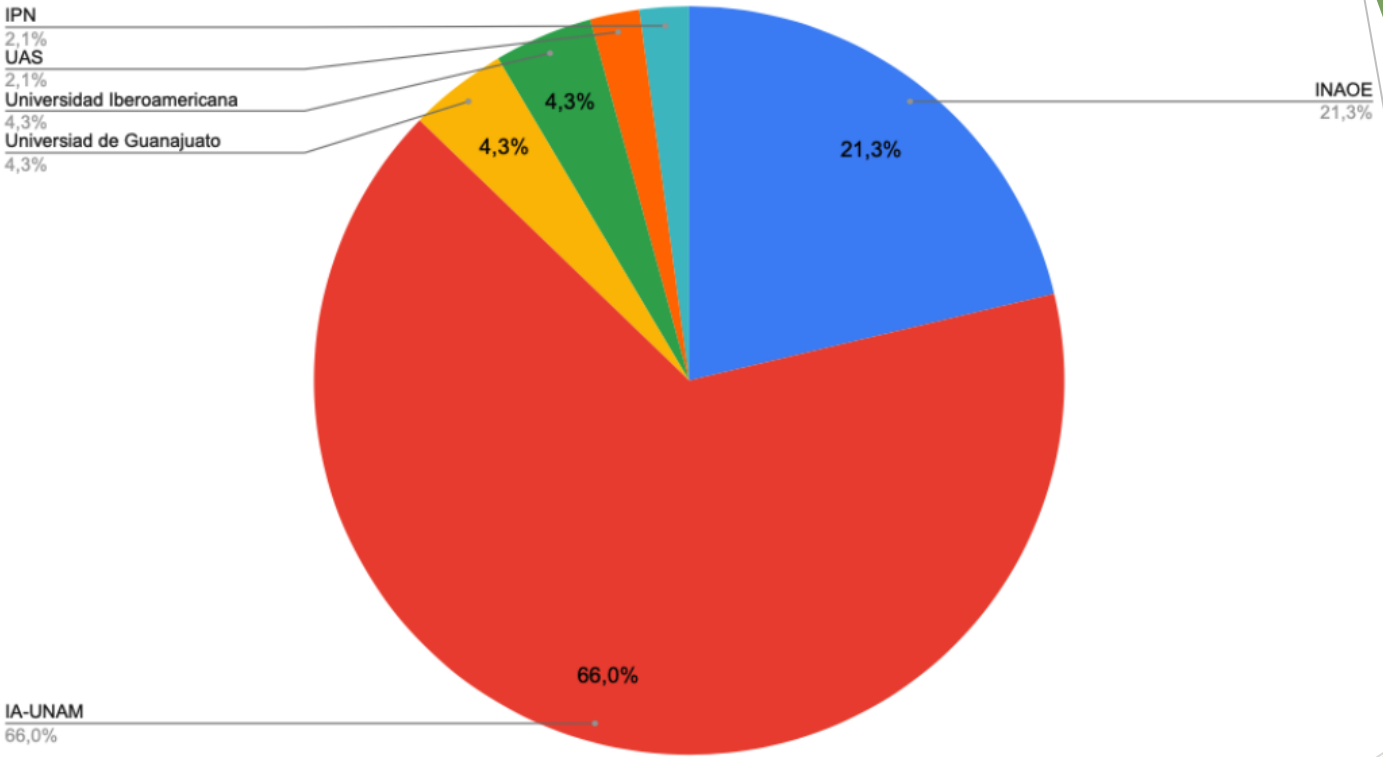
The meeting was **highly successful**

- **Strong participation** from multiple institutions
- **Clear enthusiasm** for Mexico's involvement in Subaru
- Recognition of the **new scientific opportunities** this collaboration will enable

Poll Results

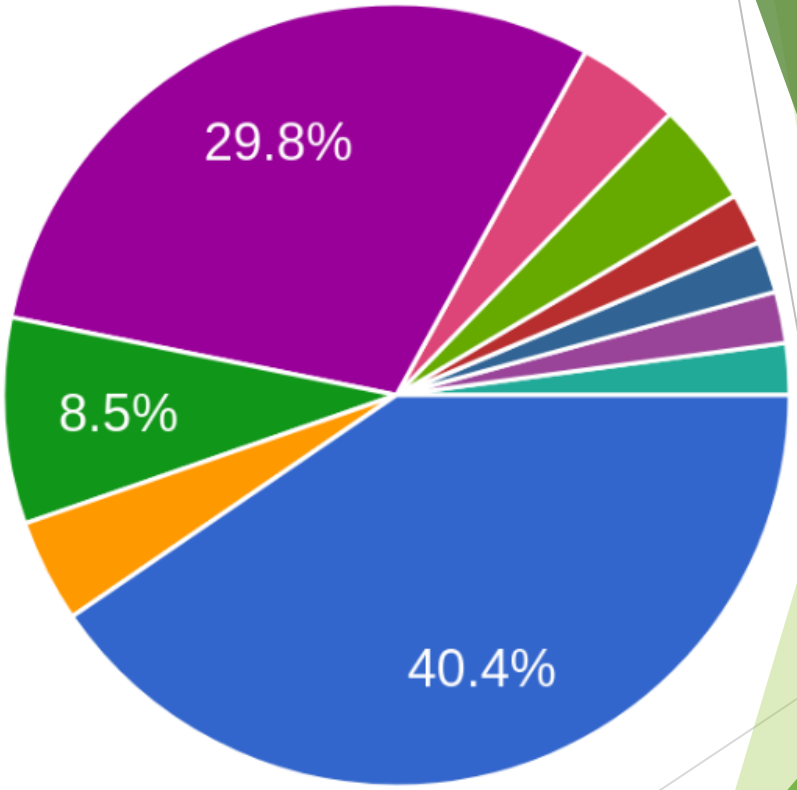


- 47 participants

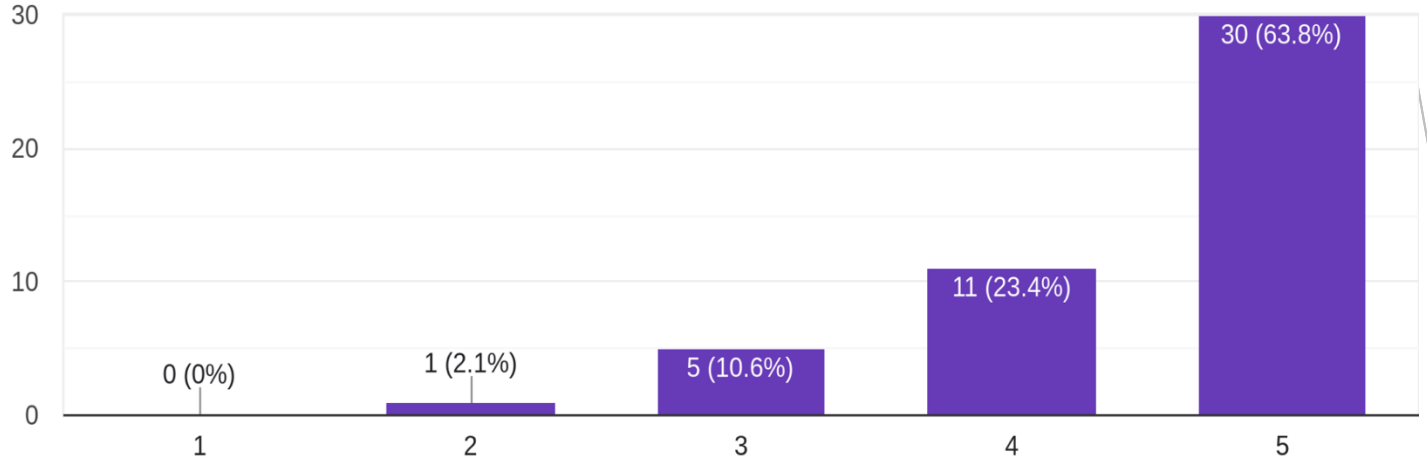


Distribution of participants per institution

- Galaxies / Cosmology
- Milky Way (dynamics)
- Exoplanets
- Stellar Astrophysics
- Interstellar Medium / SF
- Transients / Time domain
- High Energies
- Instrumentation
- Minor bodies of the Solar System
- Stellar populations / Interstellar medium / Close Galaxies
- Stellar clusters
- High energies / AGNs

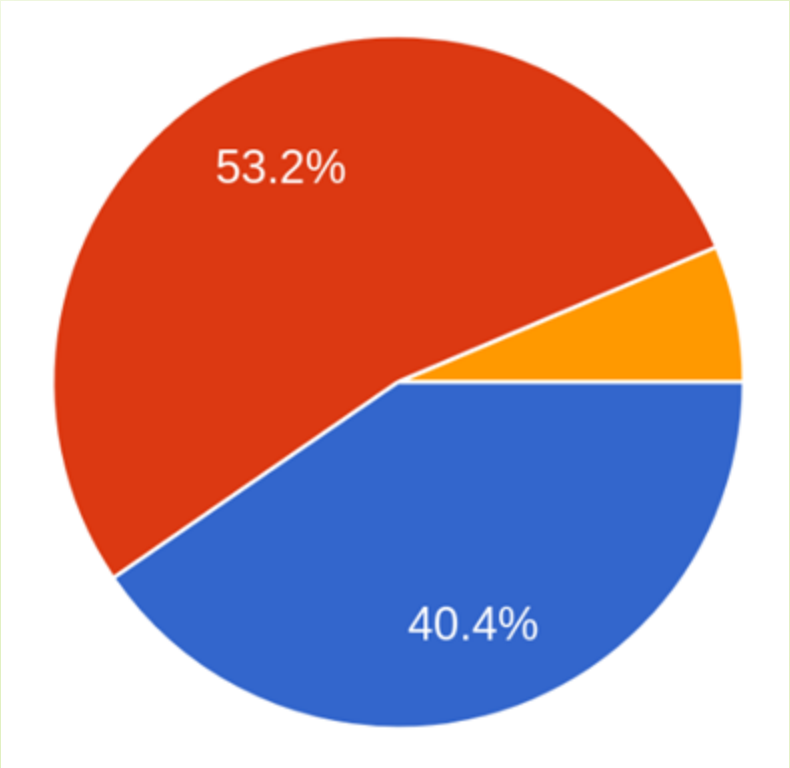


Research areas of the participants

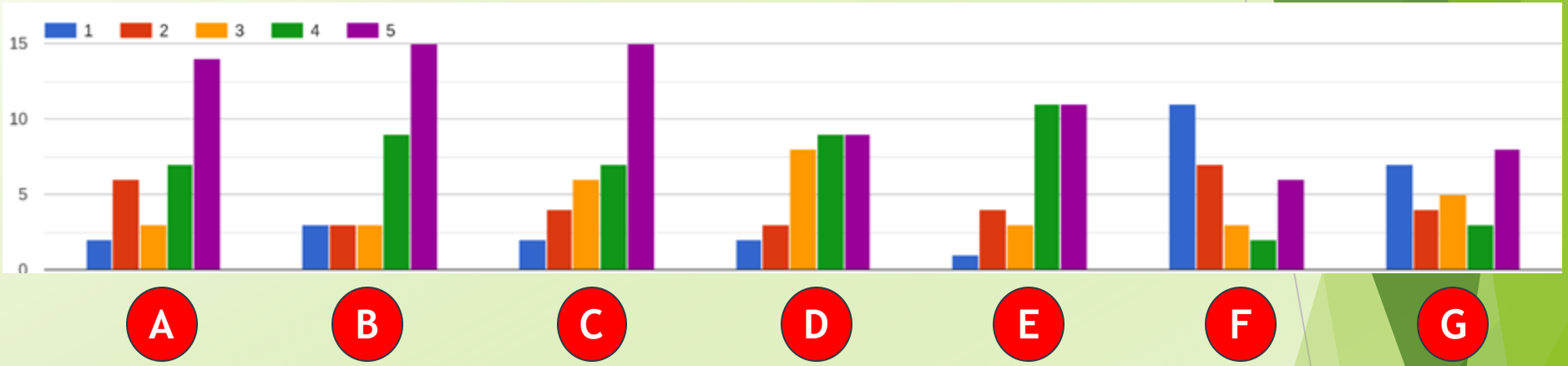


How interested are you in using Subaru in the next 3 years? (1=low, 5=high)

Do you know the instrumental offer from Subaru?

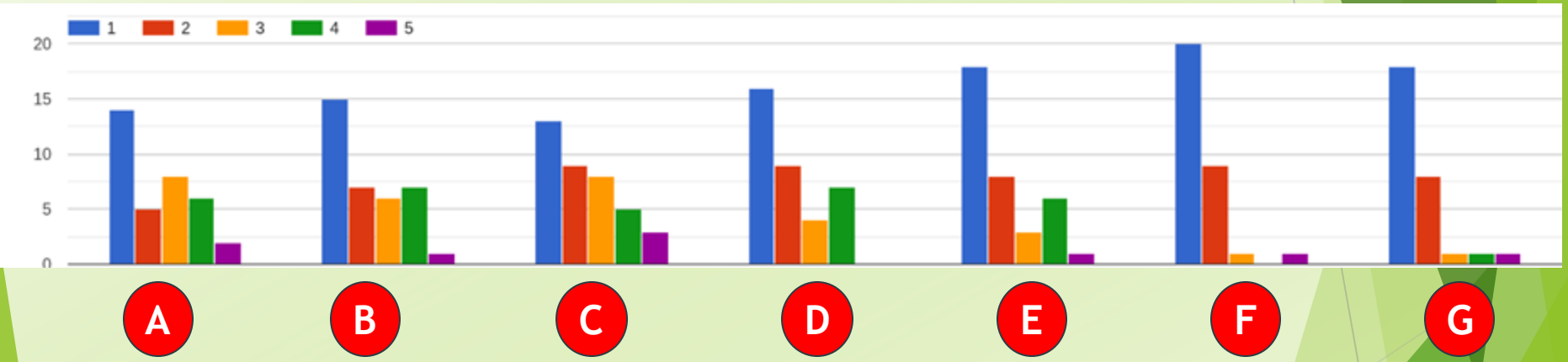


Interest per instrument (1=low, 5=high)



A- HSC (Imaging, large FOV, optical)
B- PFS (multi-object spectroscopy)
C- HDS (high-resolution, optical)
D- MOIRCS (imaging and MOS NIR)
E- IRCS (+AO) (Imaging, spectrum)
F- SCExAO+CHARIS (high contrast, exo-planet)
G- IRD (radial velocities, NIR)

Technical knowledge per instrument (1=low, 5=high)



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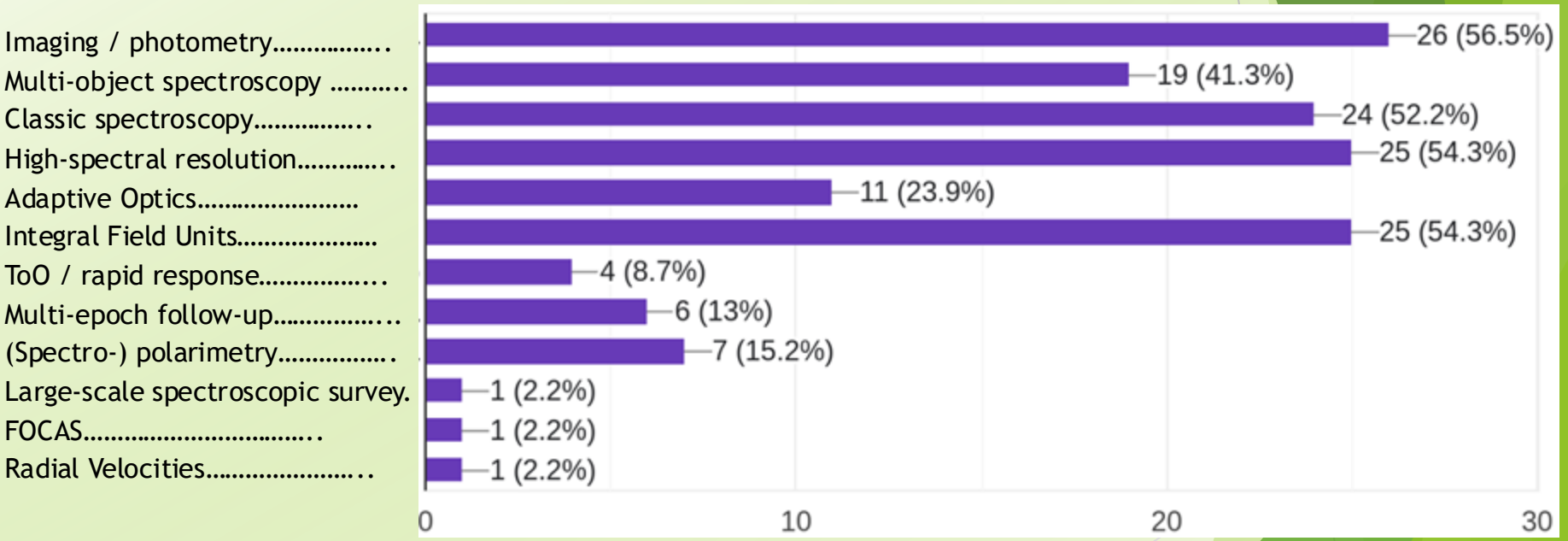
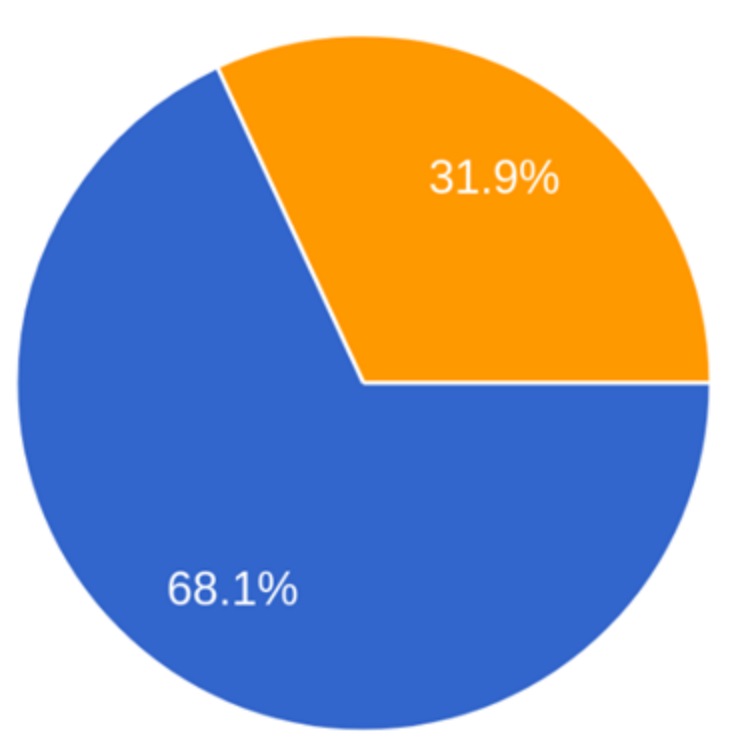
Type of observations for expected scientific projects



Would you be willing to be PI or co-I of scientific proposals for Subaru?



Scientific areas

The combined set of proposals demonstrates **broad scientific engagement** of the Mexican astronomical community with the Subaru Telescope, spanning:

- **Star and planet formation**
- **Stellar evolution and feedback**
- **Galaxy evolution across cosmic time**
- **AGN physics and large-scale structure**
- **Solar System and exoplanet studies**

1- Star Formation and Early Stellar Evolution

A major research line focuses on the study of young stellar objects (YSOs), substellar objects, and protoplanetary disks, particularly in nearby regions such as Orion, Taurus, and Sco-Cen. Using the High Dispersion Spectrograph (HDS) and the Prime Focus Spectrograph (PFS), the goal is to:

- Investigate accretion processes, chromospheric activity, and disk photoevaporation through key diagnostic lines such as Hα, [O I] λ6300, He I, and Ca II.
- Detect binarity and variability through multi-epoch radial velocity measurements.
- Extend large-scale spectroscopic characterization to faint and substellar sources ($V \approx 21$), complementing Gaia and VLA data.
- Study the magnetic fields and chemical abundances of young and cool stars using IRCS in the near-infrared, applying data-driven and machine-learning methods for atmospheric parameter estimation.

Parallel efforts propose wide-field surveys with PFS to complement the VLA Orion A Large Survey (VOLS) and other multi-frequency studies, extending coverage to other star-forming complexes such as Carina and Orion B.

2- Massive Stars and Protostellar Cluster Formation

Several projects aim to probe the **early phases of massive star formation**, focusing on **proto-clusters** like **GM24**. Using **IRCS** (with Adaptive Optics) and **MOIRCS**, these studies will:

- Perform high-resolution imaging and spectroscopy (1–5 μm) of **deeply embedded clusters**.
- Investigate the structure, multiplicity, and dynamics of massive protostellar systems beyond 1.5 kpc.
- Explore the **infrared variability** associated with **methanol maser flares**, linking maser excitation to episodic accretion events.

3- Evolved and Intermediate-Mass Stars

Another core theme addresses **late stellar evolution**, including **Planetary Nebulae (PNe)**, **post-AGB stars**, **symbiotic stars**, and **novae**. Subaru's large aperture and high sensitivity enable:

- High-resolution spectroscopy with **HDS** and **FOCAS-IFU** to study **chemical abundances**, **gas kinematics**, and **binarity** in faint evolved objects (surface brightness 10^{-16}–10^{-18} erg cm^{-2} s^{-1} Å^{-1}).
- Spectropolarimetric studies of **magnetic fields** in post-AGB stars.
- Near-IR characterization of **dusty circumstellar environments** with **IRCS**.

4- Ionized Gas, H II Regions, and Feedback

A coordinated proposal using **FOCAS in IFU mode** aims to map **Galactic H II regions** (e.g., NGC 7000, IC 5070, NGC 7635, W5) through narrow-band spectroscopy in lines such as Hα, [N II], [S II], and [O III]. These observations will:

- Produce spatially resolved maps of ionized gas and young stellar clusters.
- Derive physical parameters (electron density, ionization state) and **BPT diagnostics**.
- Study feedback processes in compact versus extended star-forming complexes.

5- Galaxies Evolution and Extragalactic Studies

Multiple proposals target **galaxy formation and evolution** across cosmic time, using **PFS**, **FOCAS-IFU**, **HSC**, and **MOIRCS**:

- **Intermediate-redshift IFU survey (z ~ 0.15):** A 500-galaxy legacy program with FOCAS-IFU, replicating CALIFA/MaNGA at earlier epochs (~2 Gyr lookback time) to study resolved stellar population gradients.
- **Cosmic noon (z = 1–3) galaxies:** Mapping star formation rate, metallicity, and age gradients to constrain **inside-out vs. outside-in** growth and AGN feedback.
- **High-redshift AGN pairs (z = 2–3):** Using IFU spectroscopy to study **merger kinematics**, outflows, and feedback mechanisms.
- **Galaxy clusters and large-scale structure:** PFS surveys of **group kinematics**, **ram-pressure stripping**, and **intra-cluster light**.
- **Low-surface-brightness and dwarf galaxies:** Deep **HSC imaging** of **nearby dwarfs**, **void galaxies**, and **tidal halos**, including synergy with **LSST** and **DESI-II**.
- **H II galaxies and cosmology:** Continuing high-resolution spectroscopy of extragalactic H II regions to refine cosmological applications.
- **Extragalactic massive star clusters and individual stars:** Spectroscopic classification of massive stars and compact clusters (V > 20) in nearby galaxies with HDS and FOCAS.

6 - Stellar Populations, Chemical Abundances, and Exoplanets

- Proposals also include:
  - **High-resolution spectroscopy of solar twins and binaries** with **HDS** to study **planet ingestion**, **chemical anomalies**, and **r- and s-process elements**.
  - **Spectroscopic studies of multiple stellar populations** in **globular clusters**, focusing on main-sequence chemistry before dredge-up.
  - **Radial velocity monitoring of giant stars** for exoplanet confirmation.

7 - Planetary Systems, Solar System Objects, and Exoplanets

Subaru's optical and infrared instruments will be used for:

- **Taxonomic classification of asteroids and near-Earth objects** through VIS+NIR spectroscopy.
- **Infrared spectroscopy of comets** and **polarimetric studies of young stellar objects.**
- **High-resolution IFU spectroscopy of exoplanet atmospheres** to characterize their dynamics and composition.

8- Active Galactic Nuclei (AGN) and Feedback

- Several projects focus on AGN physics using **FOCAS-IFU** and **HDS**:
  - Mapping the **ionized gas outflows** in AGN and their **feedback effects** on host galaxies.
  - High-resolution spectroscopy to probe **AGN kinematics**, **metallicities**, and **variability**.
  - Wide-field PFS surveys of AGN populations in well-studied extragalactic fields (e.g., Lockman Hole, AKARI-NEP).

Instruments of Interest and Their Roles

Instrument	Key Science Areas
HDS	High-resolution spectroscopy of stars, PNe, post-AGB stars, binaries, AGN, and exoplanet hosts.
PFS	Large-scale multi-object spectroscopy of YSOs, clusters, galaxies, and AGN; ideal for surveys tied to LSST, SDSS, and DESI-II.
FOCAS (IFU)	Spatially resolved spectroscopy of H II regions, AGN, and galaxies ($0 < z < 3$); optical diagnostic mapping.
IRCS / MOIRCS	Near-IR imaging and spectroscopy of young stars, protoclusters, and massive star-forming regions; AO-enabled studies.
HSC	Deep wide-field imaging of galaxies, halos, and low-surface-brightness structures; synergy with LSST and DESI-II.

Concluding remarks

- The proposals reflect the **strong enthusiasm** and **broad scientific engagement** of the **Mexican astronomical community** with the **Subaru Telescope**.
- Scientific interests cove a wide range of areas : **Star and planet formation, Stellar evolution and feedback, Galaxy evolution across cosmic time, AGN physics & large-scale structure, Solar System & exoplanet studies.**
- **Subaru's unique combination** of large aperture, wide field, and diverse instrumentation (optical → near-IR, imaging → IFU spectroscopy) makes it a **fantastic tool** for cutting-edge research for our community.
- The community is **eager and ready** to **actively participate** and **collaborate** in the scientific use of Subaru.
- **Looking ahead:** We are excited to **take the next steps** in establishing Mexico's active involvement with Subaru and its instruments. We are also eager to foster new collaborations with the Subaru Community.