Linking a noble past to future challenges

Observational astronomy in Iran has witnessed a rise over the past two decades that has led to investment in its own astronomical identity, the Iranian National Observatory, and a flagship 3.4-m optical telescope.

Once host to the world's most advanced astronomical observatory, the Maragha observatory (established in 1259 CE), Iran is now developing a project to connect its noble past to the scientific and technical challenges of the future posed by the unknowns of the Universe. The Iranian National Observatory (INO), the first large project in fundamental sciences in Iran, is aimed at constructing an astronomical observatory with a state-of-the-art telescope to foster astronomical research, training and the development of related technology. The project is driven by a decade-long growth in higher education and has been demanded by academics and a large community of amateur astronomers. The INO is being developed nationally, from the site selection and monitoring to the design and construction of the main observing facility — the 3.4-m telescope (INO340). However, the presence and assistance of international experts is evident throughout the project's development.

The observatory site is under construction after a seven-year selection campaign, which led to the choice of the Mount Gargash peak, at an altitude of 3,600 m. Site selection was followed by equally exhaustive site characterization and monitoring activities. The civil construction — that is, the telescope pier, the enclosure building and the service building — began in 2017. The 11.5-km access road has been operational since 2016. The site is suitably located at 51° E, bridging the hour angle gap between the modern astronomical observatories of eastern Asia and the east Atlantic. With a median seeing of ~0.6 arcsec, the location is one of the most promising sites for astronomical observations in the Northern Hemisphere, and thus future instruments will be able to exploit the site quality offered by high altitude, good seeing, suitable winds and a relatively dry climate^{1,2}. Figure 1 shows the Gargash site plan and the operational and planned instruments.

The principal telescope, the INO340, will be a 3.4-m diameter Ritchey–Chrétien optical telescope offering a field of view of 20 arcmin at the main Cassegrain focus with an image resolution of better than 0.5 arcsec (FWHM) across the field. Three side ports

Fig. 1 | A view of the Iranian National Observatory site plan showing the existing, under construction and planned facilities. The observing facilities and buildings have been scaled up for clarity. Credit: Map imagery ©2018 CNES / AIRBUS; map data ©2018 Google; 3D models, INO/IPM

are available, each offering an 8-arcmin field of view, thus the telescope backend can be simultaneously equipped with up to four instruments, minimizing the overhead in responding to astronomical alerts and target-of-opportunity observations as well as adapting to weather conditions. The telescope's working wavelength range is 325–2,500 nm, though the initial focus will be on the optical range.

The primary mirror, with a diameter of 3,400 mm and a central hole of 700 mm, is polished to a surface micro-roughness of ~1 nm root mean squared³. It has a focal ratio of $f/1.5$ resulting in a compact tube, while the telescope focal ratio at the Cassegrain focus is $f/11.25$. The primary mirror is designed to be actively controlled by 60 actuators to compensate for the effects of weight and temperature variations. An integrated simulation of the telescope model taking into account the mechanical and optical characteristics and the control system^{4,5} in typical environmental conditions² shows that the design is able to deliver the desired image quality.

The telescope dome is 16 m in diameter and benefits from an active cooling system both inside the dome and in a lower floor to prevent thermal leak from human activities or equipment. The service building consists

of a mirror cleaning/coating hall and a central control room.

The INO will carry out large surveys, with visiting- and service-mode observations available to the international community. Spectroscopic surveys of galaxy groups and clusters, kinematics of galaxies, as well as follow-up observations of transient sources are among the key science drivers for the INO340. The INO340 is expected to be commissioned by 2021. However, the science operation of the site starts in 2018 with a telephoto array, which is currently undergoing commissioning. We invite other institutes to explore the site for their own observing facilities. □

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