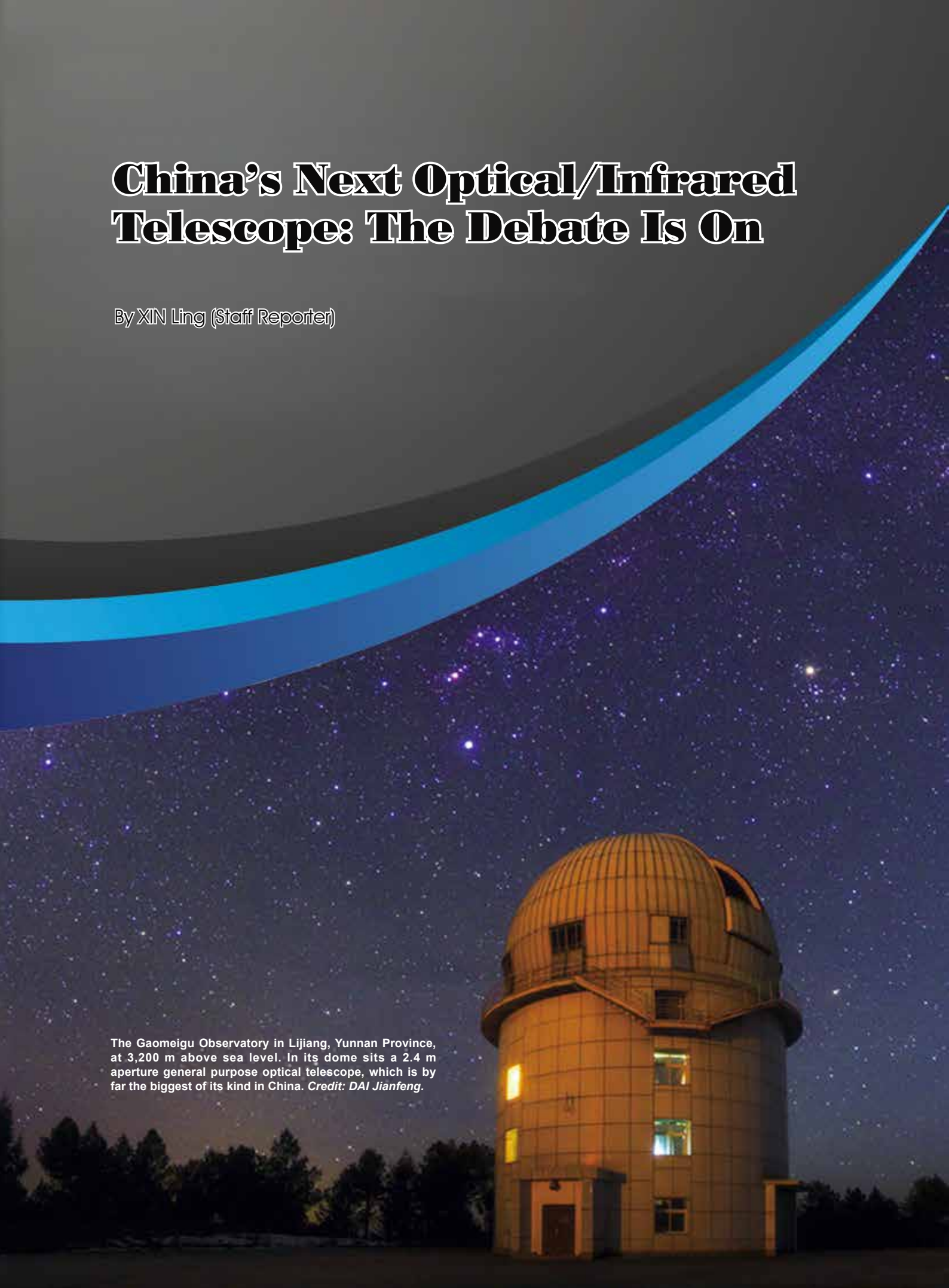
China's Next Optical/Infrared Telescope: The Debate Is On

By XIN Ling (Staff Reporter)



The Gaomeigu Observatory in Lijiang, Yunnan Province, at 3,200 m above sea level. In its dome sits a 2.4 m aperture general purpose optical telescope, which is by far the biggest of its kind in China. *Credit: DAI Jianfeng.*

China's ambition to build a 12 m aperture optical/infrared telescope in Tibet has been recently challenged by intense disputes over its design options. The Large Optical/Infrared Telescope, or LOT, which will become the world's biggest upon completion before the 30 m-level ones are in place, is expected to give Chinese astronomers a head start in exploring the early universe and exoplanets among other scientific goals. However, optical engineers and scientists are holding on to very different opinions as for what is the best technical route to get there.

Four vs. Three Mirrors

The largest general-purpose telescope China has now is a 2.4 m one in Lijiang, Yunnan province. The lack of a large-aperture optical telescope has seriously crippled the development of the Chinese astronomical community.

The proposal of LOT was a pretty smooth beginning. In December 2016, the National Development and Reform Commission released a list of ten research infrastructures to be considered for construction during the 13th national Five-Year Plan (2016-2020), and LOT came out as the second with an estimated budget of 2 billion yuan.

The original optical design for LOT features a four-mirror system: a primary mirror (M1), a secondary mirror (M2), a so-called SYZ relay mirror (M3), and a flat fold mirror (M4) which has a hole at its center to let light pass through. Somehow resembling the five-mirror European Extremely Large Telescope (E-ELT) under construction in Chile, the biggest advantage of such a scheme is the high image quality, according to its designers from the Nanjing Institute of Astronomical Optics & Technology (NIAOT) under the National Astronomical Observatories, Chinese Academy of Sciences (NAOC).

In contrast to this relatively complicated and risky design – a lot of the techniques are still at experimental stage – there is a simpler, mature Ritchey-Chrétien (R-C) system which has been widely adopted by existing telescopes like the Keck Telescopes atop Mauna Kea, and can suffice the purpose of a 12 m telescope as LOT.

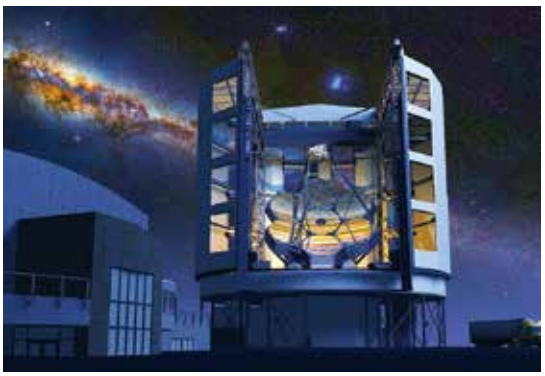
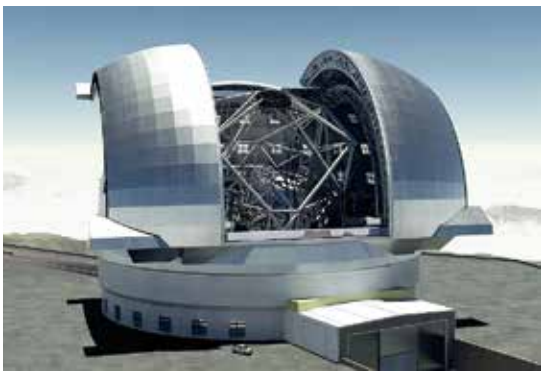
Some optics experts expressed their concern over the four-mirror system. "The extra reflections will cost extra light, and the hole in M4 will seriously limit the field of view which is going to be the most important use of the telescope," said Sandra Faber from the University of California at Santa Cruz.

The tentative structure for a four-mirror LOT, revealed at a workshop called "Future Large Optical and Infrared Facilities in China" which was held at the Kavli Institute for Astronomy and Astrophysics, Peking University in November 2016. *Credit: CUI Xiangqun, NIAOT.*

Scientists are also not hiding their preference for the three-mirror system. "We have little prior technical experience, so we need to minimize the risk, cost, and complexity by adopting as simple as a design as possible, and use available, proven technology to satisfy the scientific requirements," said Luis Ho, an astrophysicist and director of the Kavli Institute for Astronomy and Astrophysics (KIAA) at Peking University.

Two Contradictory Reviews

On April 19, 2017, a panel of nine experts from nearly all existing/planned 8-30 m class telescopes met in Beijing for an "international review" of the optical system designs of LOT. The rivals were the four-mirror design proposed by Nanjing and a three-mirror design presented by a group from Huazhong University of Science and Technology in Wuhan. The conclusion was overwhelmingly in favor of the three-mirror system. "The four-mirror 'SYZ' optical system cannot compete with the standard RC solution in meeting the government and scientific demands on limiting magnitude, field of view, operational flexibility, and total

Artistic rendering of the three next-generation giant telescopes. From left: the Thirty Meter Telescope (TMT), the Giant Magellan Telescope (GMT), and the European Extremely Large Telescope (E-ELT), with an aperture of 30 m, 25 m and 39 m, respectively. *Credit: TMT International Observatory; GMTO Corporation; European Southern Observatory.*

budget," the review read. "The 'SYZ' optical system is therefore eliminated from further consideration."

However, NIAOT people did not back down. They argued for the necessity of innovation in global competition, and against using technologies "from two decades ago". They also questioned the political correctness of the winning design, which was authored by a young, unknown professor with the assistance of American experts. "Why should foreigners be meddling with our own telescope?" They asked.

On July 10, a second "review" was organized at the CAS headquarters with the absence of three-mirror representatives. With a different panel made up of 21 domestic scientists, the new evaluation turned out to be in support of Nanjing and their four-mirror system.

These disputes, which were intended to stay within the academic circle only, went open and viral on a few Chinese social media platforms since early August. LIANG Ming, one of the designers of the four-mirror system, said public debate is good because it is a chance to familiarize people with their design. Pointing out that many calculations which have led to unfair accusations of their design are actually wrong, he reiterated the importance of self-confidence within the Chinese astronomical community. "I've never heard of such 'international reviews' for any big telescope in the world," he wrote on one of the social media platforms. "For a telescope funded by the Chinese government, the design should come from within the Chinese. We will take good suggestions from foreigners, but they don't get to decide how our telescope will be built."

What Next

"We are shocked and dejected by this chain of events," said Ho. "LOT is a hugely important opportunity, and we must rise to all the challenges, or we'll never catch up." This awkward state of affairs, however, needs to be ended as soon as possible to meet the project's timeline. As required by the government, the construction of LOT should begin before the end of 2018.

A consensus has to be reached, though no one knows how. Only one thing is for sure: all science facilities are science driven; so are their designs. "China does not need to prove any more that it can polish mirrors and design steel structures to hold them in place," said Faber. "What China needs to do is produce world-class science from this huge telescope. The whole astronomical world will be watching the science output of LOT. They will not care whether there are three mirrors, or five mirrors, or 10 mirrors – they will only care about the brilliance of the science results. If China wants to become a leader on the world astronomical stage, it needs to focus on good science, not on telescope design," she commented.