ASTRONOMY FROM THE MOON AND INTERNATIONAL LUNAR OBSERVATORY MISSIONS. S. Durst1 and Y. D. Takahashi1, 1International Lunar Observatory Association (Kamuela, Hawai’i; info@iloa.org).

Introduction: Astronomy from the Moon has been proposed since at least the 1960s, and two telescopes have already operated on the lunar surface, on Apollo 16 and Chang’e 3. With numerous lunar missions being planned in the coming years, many astronomy proposals are being considered around the world. The International Lunar Observatory Association (ILOA) is one organization advancing missions to the Moon for astronomy and communication.

History: The advantage of the Moon for astronomy was first brought up in 1964 by S. Gorgolewski, pointing out that the far side would be the best for radio observations avoiding terrestrial interference [1]. Since then, 100s of publications have discussed lunar astronomy. The pioneering astronomical telescope was on Apollo 16 in 1972, a far-ultraviolet camera/spectroscope operated by astronaut John Young [2]. In 1990, American Institute of Physics held a conference on “Astrophysics from the Moon”. In 1997, ESA conducted an in-depth study on “Very Low Frequency Array on the Lunar Far Side” [3]. Since a mission to the far side was not likely in a timely manner, a more realistic concept for a radio observatory at the lunar south pole was proposed in 2002 [4]. In 2003, NASA also sponsored an engineering study on “Astronaut-Aided Construction of Large Lunar Telescopes”, investigating infrared telescopes in permanently-shadowed craters.

Current Projects and Proposals: Currently one telescope is operating on the Moon and numerous projects are ongoing for realization in the next few years.

Chang’e-3 LUT. China’s first Moon lander Chang’e 3, which landed in 2013, has a 15-cm aperture Lunar-based Ultraviolet Telescope that continues to operate today [5]. ILOA has collaborated with National Astronomical Observatories of China (NAOC) to image the spiral galaxy M101 in 2014 (Fig. 1b).

Chang’e-4 LFS. Chang’e-4 lander and rover are expected to carry Low-Frequency radio Spectrometers to operate on the far side. LFS will consist of 3 orthogonal antenna elements operating below 10 MHz to survey the Galactic low-frequency radio waves for the first time [6].

NASA LUNAR. NASA currently funds Lunar University Network for Astrophysics Research (LUNAR), led by Jack Burns and Joseph Lazio. LUNAR has published over 100 peer-reviewed papers since 2008 [7].

LRX / Lunar LOFAR. A Europe-based team has been working on Lunar Radio Astronomy Explorer (LRX) to examine the suitability of a future 33-element interferometer, Low Frequency Array (LOFAR) on the Moon [8].

Figure 1: (a) M101 spiral galaxy image taken by LUT-ILOA, 2014 (Credit: NAOC/ILOA); (b) ILOA Moon South Pole astronomy vision by M. Carroll, 2015.

ILO Missions: ILOA is a non-profit enterprise based in Hawaii to expand human understanding of the cosmos through observation and communication from our Moon (Fig. 1b).

ILO-X. ILOA has developed the ILO-X telescope for Milky Way Galaxy first light imaging from the Moon, awaiting launch on a Moon Express spacecraft possibly on board the Rocket Lab Electron launcher.

ILO-1. The flagship ILO-1 mission is being developed through prime contractors Moon Express at Cape Canaveral and Canadensys Aerospace Corp in Toronto. Moon Express is working on landing and hazard avoidance technologies, with ILO-1 spacecraft development to begin NET 2018. Canadensys completed the Lunar Electronics Program in 2017 and is now working on Lunar Optics Program to deliver a flight-ready optical payload for ILO-1, ruggedized for the Moon. ILO-1 may be serviced by a future human mission.

Conclusion: Astronomy from the Moon provides a promising new frontier for 21st century astrophysics and related science activity.