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Missions and Instruments for the Moon

In preparation for future missions to the Moon, NASA has been busy selecting science instruments and technology-demonstration payloads to be delivered to the lunar surface. NASA and the companies partnering with NASA, through the agency's Commercial Lunar Payload Services, are heading toward the first missions in NASA's *Artemis* lunar exploration efforts.

On February 7, 2020 some of the key people involved in NASA's current, funded portfolio of lunar missions, instruments, and concept studies spoke at a virtual workshop held by the Lunar Exploration Analysis Group (*LEAG*). Their presentations covered projects being funded through these exciting NASA programs:

- DALI: Development and Advancement of Lunar Instrumentation, a payload development program that selected 10 projects in fiscal year 2018 and five more in fiscal year 2019.
- NPLP: NASA Provided Lunar Payloads, a call for proposals to NASA centers that selected 13 instruments in February 2019, which have been identified as ready or very nearly ready to fly, to accomplish a mixture of science, technology, and exploration objectives.
- LSITP: Lunar Surface Instrument and Technology Payloads, a call to the external community (e.g., universities and commercial sector) that selected 12 instruments in July 2019.
- SIMPLEX: Small Innovative Missions for Planetary Exploration, a program for small satellites that selected three finalists in June 2019.
- Artemis-1 Secondary Payloads, a selection of CubeSats chosen to fly on Artemis-1, part of NASA's Space Launch System rocket launch program sending an uncrewed Orion spacecraft to lunar orbit with return to Earth. Launch date is targeted for April 2021.
- PMCS: Planetary Mission Concept Studies, addressing NASA's planetary science objectives to ascertain the content, origin, and evolution of the Solar System and the potential for life elsewhere. Ten proposals were selected for funding in October 2019.

See the entire *archived playlist of presentations* or access each of the 28 presentations by clicking on the linked titles shown below.

Sam Lawrence, LEAG chair
Introduction to the meeting

Ben Bussey (NASA HQ)
NASA's Lunar Discovery and Exploration Program (LDEP) Update

Xu Wang (CU-Boulder)
EDA: Electrostatic Dust Analyzer, DALI-funded instrument for exploring the transport of dust on the lunar surface and evaluating potential dust hazards

Mehdi Benna (NASA GSFC/UMBC)
SEAL: Surface and Exosphere Alterations by Landers, instrument for Astrobotic 1 Mission lander

Mehdi Benna (GSFC/UMBC)
LEMS: Lunar Environment Monitoring Station, DALI-funded instrument package for long-term monitoring of the lunar exosphere and seismic activity

Stuart Bale (UC Berkeley)
LuSEE: Lunar Surface Electromagnetics Experiment, instrument to measure electromagnetic phenomena on the lunar surface and it will also carry the first U.S. radio telescope to the lunar surface

Seiichi Nagihara (Texas Tech)
LISTER: Lunar Instrumentation for Subsurface Thermal Exploration with Rapidity, instrument designed to measure heat flow from different depths in the lunar interior

Mike Seibert (Maxar)
SAMPLR: Sample Acquisition, Morphology Filtering, and Probing of Lunar Regolith, technology for acquiring samples with a robotic arm

Kris Zacny (Honeybee Robotics)
PlanetVac, technology for acquiring and transferring lunar regolith from the surface to instruments or containers

Tim Livengood (U. of Maryland/CRESST/NASA GSFC)
SSOLVE: Submillimeter Solar Observation Lunar Volatiles Experiment, DALI-funded instrument to determine the abundance or absence of lunar water vapor above the lunar surface

Lori Willhite (U. of Maryland)
CRATER: Characterization of Regolith and Trace Economic Resources, DALI-funded instrument for comprehensive chemical characterization of lunar surface samples

Craig Hardgrove (ASU)
LunaH-Map: Lunar Polar Hydrogen Mapper Mission, a CubeSat with neutron spectrometer, manifested on Artemis-1

Paul Hayne (CU Boulder)
L-CIRiS: Lunar Compact Infrared Imaging System, instrument for radiometric imaging in four infrared bands to create panoramic infrared images of surface composition and to map changes in temperature over time

Abigail Fraeman (JPL)
UCIS-Moon: An Ultra-Compact Imaging Spectrometer for the Lunar Surface, DALI-funded instrument for multispectral analysis of geologic materials and volatiles

Doug Currie (U. of Maryland)
NGLR: Lunar Laser Ranging and the Next Generation Lunar Retroreflector, will serve as a target for lasers on Earth to precisely measure the Earth-Moon distance.

R. Aileen Yingst (PSI)
Heimdall: Turning all Eyes on the Moon, LSITP-funded camera system with one digital video recorder and four cameras with capabilities for imaging at multiple scales

Bethany Ehlmann (Caltech)
Lunar Trailblazer: A Pioneering Small Satellite for Lunar Water and Lunar Geology, orbiting satellite with two instruments for simultaneous measurements of composition and temperature, a SIMPLEx program 2019 selection

S. H. (Hop) Bailey (U. of Arizona)
SLN: Seismometer for a Lunar Network, DALI-funded instrument for lander or rover

Bob Grimm (SwRI)
LMS: Lunar Magnetotelluric Sounder, LSITP-funded instrument to determine electrical conductivity structure of the lunar interior in order to infer internal temperature and composition

Bob MacDowall (NASA GSFC)
ROLSES: Radio Observations on the Lunar Surface of photoElectron Sheath, radio science instrument for Intuitive Machines Nova-C lander

Mike Purucker (NASA GSFC)
Fluxgate Magnetometer, NPLP-funded instrument for Astrobotic 1 Mission lander

Clive Neal (Notre Dame)
Lunar Geophysical Network Mission, PMCS-funded concept study to use distributed landers carrying geophysical instruments to understand the Moon's internal structure, seismic activity, global heat flow, bulk composition, and magnetic field

Tony Colaprete(NASA Ames)
NIRVSS: Near-Infrared Volatile Spectrometer System, resource-prospecting instruments for Astrobotic 1 Mission lander

Rick Elphic (NASA Ames)
NSS: Neutron Spectrometer System, resource-prospecting instrument for Astrobotic 1 Mission lander

Tony Colaprete (NASA Ames)
VIPER: Volatiles Investigating Polar Exploration Rover, part of the LDEP, a rover mission with four instruments and a drill to characterize the nature and distribution of volatiles at the lunar poles

Mark Robinson (ASU)
Intrepid: Long Range Lunar Roving Explorer, PMCS-funded concept study to investigate lunar magmatism, which incorporates the nature of the interior and diversity of volcanic activity over four billion years of lunar history

Warren McKenzie (U. of Hawaiʻi, Mānoa)
XTRA: An eXtraTerrestrial Regolith Analyzer, DALI-funded combined x-ray fluorescence and x-ray diffraction instrument

Ann Parsons (NASA GSFC)
BECA: Bulk Elemental Composition Analyzer, DALI-funded pulse neutron generator with a gamma-ray neutron spectrometer

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See also:
First Commercial Moon Delivery Assignments to Advance Artemis, January 22, 2020 NASA News Release.

NASA Selects 12 New Lunar Science, Technology Investigations, July 1, 2019 NASA News Release.

Written by Linda M. V. Martel, Hawai'i Institute of Geophysics and Planetology, for *PSRD*.

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