The Future of Robotic Space Exploration (Dr. Leon Alkalai)

* JPL – a laboratory of Caltech -> NASA-centered
  + Created in 1936 -> 1940s: army – missile launches -> space exploration
  + Working under Caltech – university -> able to do side projects (startups)
* Mass change -> changes in the gravity field
  + Moon: mass ~ overall distribution (little change in mass)
  + Determined volcanic craters or asteroids
* AstrLabs: space innovation & start-up incubation -> private investment
* InSight Mars Lander
* Budget: 80% from NASA (50% in competition -> funding)
* Change of Career
  + JPL Strategic Implementation Plan
    - Quest, Thrusts, Future capabilities
      * Quest: tackling scientific questions (history of Earth and the solar system, history of life, etc. of fundamental questions)
        + Motivated by Science
        + Layering of Canvas – Earth science -> exoplanets

Cross understanding – compare to solar sys

Ex. uniqueness of Earth

* + - * Categories
        + Earth science – observation from space

Overlapping with commercial

* + - * + History, evolution, future of the solar system
        + Cause of life (creation - > formation)
        + Life beyond Earth (availability of water)
        + Diversity of planetary systems (detection with origami technology.

Imaging planets

* + - * + Future destinations (similar structure with the
    - Missions
      * MARS Rover 2020
        + SUV sized -> nuclear power (10+ years of life)
        + Sign of life, water, drill
      * Testing: near vacuum + lesser gravity
      * Projects:
        + Lemur Climbing Robot

Exploration: underground (other planets)

* + - * + Telescope assembly – autonomous
        + CASSINI – Saturn: magnetic field

Probes to Titan -> lakes, geysers in Enceladus

* Miniaturization of Technology -> space
  + Examples
    - CubeSat (Micro-satellites)
    - MiniSat
  + MarCO – interplanetary CubeSats
  + ELFIN: energetic electrons – escaping the Van Allen Belts -> to Earth
    - Earth’s magnetic fields
* Advanced operation
  + AR: remote control -> visualization of the environment
* JPL Missions
  + OCO-3, COSMIC-2A, Mars 2020, Helicopter, NISAR
  + InSight 2018
* JPL Quests, Thrusts, Future Tech
  + Earth -> Moon -> Mars -> Solar system -> Galaxy
    - Earth: geolocation
    - Solar system – evolutions -> visit via satellites
  + Beyond: Pillar of Creation
  + Life beyond Earth
  + Diversity of planetary systems
  + Beginning of the Universe ~ +30 thousands
  + Future: Europa, Titan, Enceladus, Venus, Moon – darkvside
    - Mars exploration
      * Sample retrieval – 2020 mission
      * Mars helicopter
* Surface mobility
  + Lemur climbing robot
  + Telescope assembly
* CASSINI: exploration of Saturn
  + Huygens – pictures, radiation analysis + Enceladus geysers + Titan ice
* Sectrum of Satellite
  + CubeSat -> MiniSat -> Medium-Class, Large-Class, Flagship-Class
  + MarCo: first interplanetary Cubesats – data relay for InSight (entry, descent, landing) – communication
  + ELFIN: studying how energetic electrons escape the Van Allen belts
  + AR/VR on Earth -> discover Mars remotely