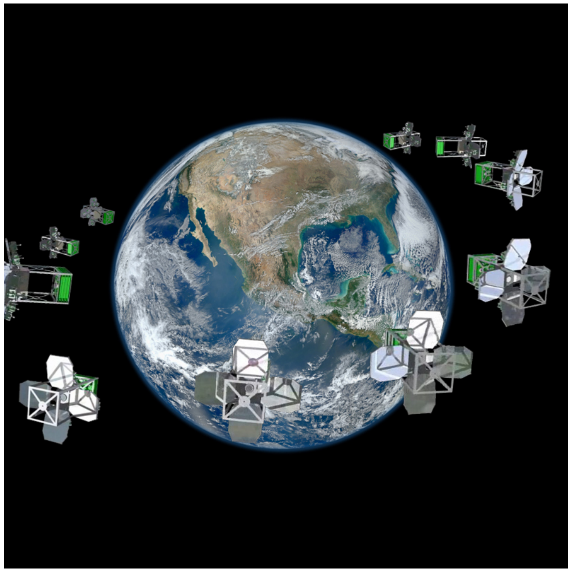
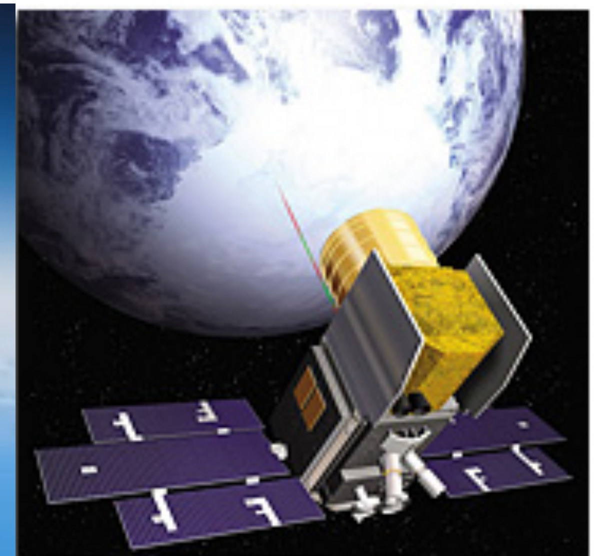




Origami NanoSat Telescopes

Franck Marchis (SETI Institute)

With Jon Jenkins (SETI Institute), Julie Castillo (JPL), R. Dissly (Ball Aerospace), Andrew Klesh (JPL)

Astrophysics Roadmap Town Hall Meeting – May 7

JPL

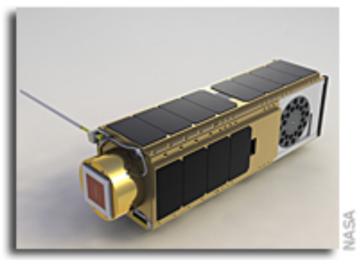
SETI INSTITUTE

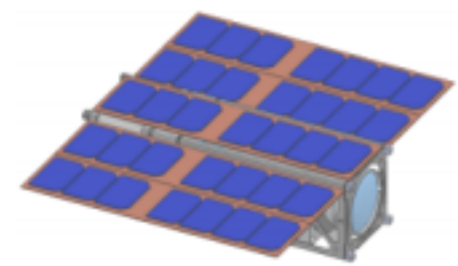
Ball

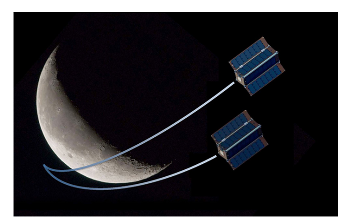
Today's NanoSats

- Nano-satellites ("NanoSats" 1-10 kg)
- Why now? Key developments in microelectronics, micro-propulsion, and miniaturization of detectors
- Success stories with NanoSats
  - Earth Environment (e.g RAX)
  - Biological experiment (e.g. O/OREOS)
  - New technology validation (e.g. NanoSail)
  - And more to come
    - First NanoSat for Planetary mission (INSPIRE)
    - First NanoSat for astronomy (ExoplanetSat)

(Smith et al. 2010)

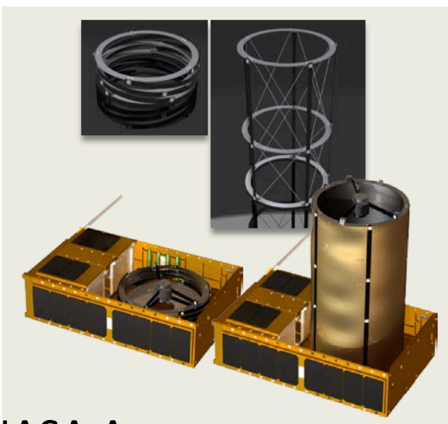






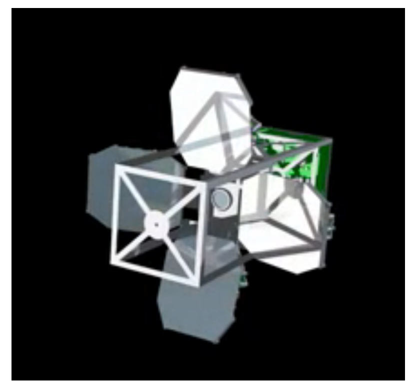
Origami NanoSats

- **In a few words:** Encapsulate a deployable 0.5-1m telescope and its instrument in a NanoSat Platform and deploy it in space after launch.
- Technological challenges:
  - Robust deployment of large apertures with low areal density
  - Wavefront sensing and control (see Cahoy et al. 2012)
  - Pointing accuracy and stability
  - System engineering (operation, communication, power, data volume)



NASA Ames
Collapsible Dobson Space Telescope
6U Nanosatellite

DARPA Concept
Earth Surface



Clyde Space
3U CubeSat

Relevance

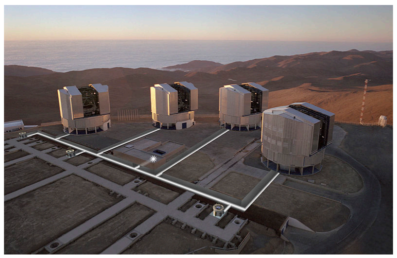
"Future leadership in space requires a foundation of sustained technology advances that can enable the development of more capable, reliable, and lower-cost spacecraft and launch vehicles." NRC in NASA Strategic Space Technology Investment Plan

- Smaller & cheaper (a few $M?)
- Rapid turn around time (take advantage of improving technology)
- Extended observation time
- Scalable technology to open the sky to more data with more partners (dedicated to well focused projects)
- Change of pace in discoveries (2-4 years development)

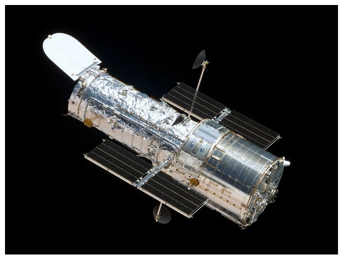
Challenges

- Paradigm shift in space telescope development

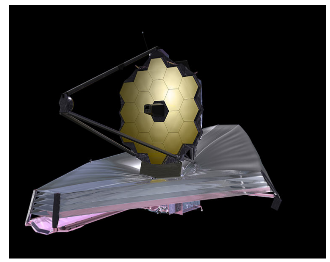
Can we break the **"bigger, higher, pricier"** motto?



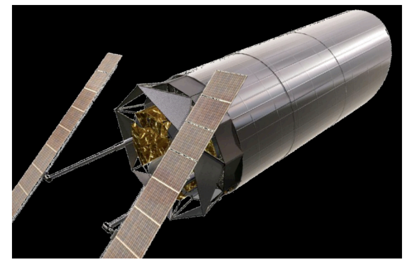
VLT – 8m
~$450 M
Since 2001



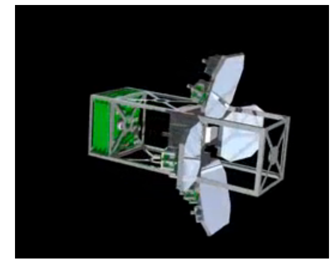
HST – 2.4m
>$6 B
Since 1990



JWST – 6.5m
~$8 B
In 2018



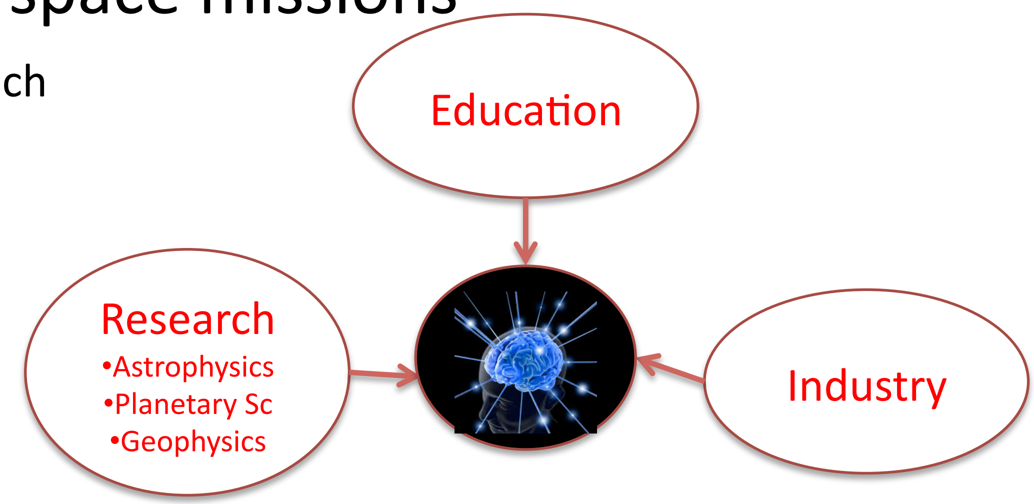
ATLAST – 8m
Cost unknown
NASA concept



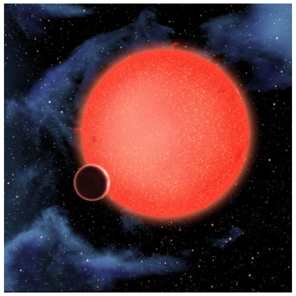
NanoTel- 0.5-1m
<$10M
this concept

- A different way to develop space missions

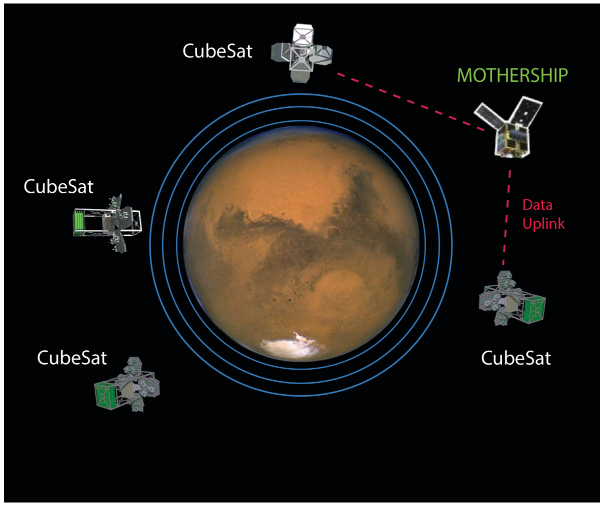
○ "Try, maybe fail and succeed later" approach
○ Funding - which programs?
○ Work with new partners
➔"Brain Storming" between engineers, scientists from different fields



Origami NanoTel Science Drivers

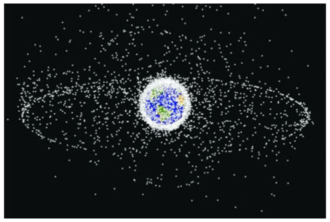


- **In Astrophysics**
  - Search of Earth-size exoplanets around M/K stars
  - Time-domain astronomy (asteroseismology)
  - UV telescope (a cheap replacement to HST after 2018+)
  - Technology demonstration (long based space interferometry, coronagraphy)



- **In Planetary Sciences**
  - Detection and Tracking of Comets and Asteroids
  - Swarm of NanoTelescopes - the mother ship concept

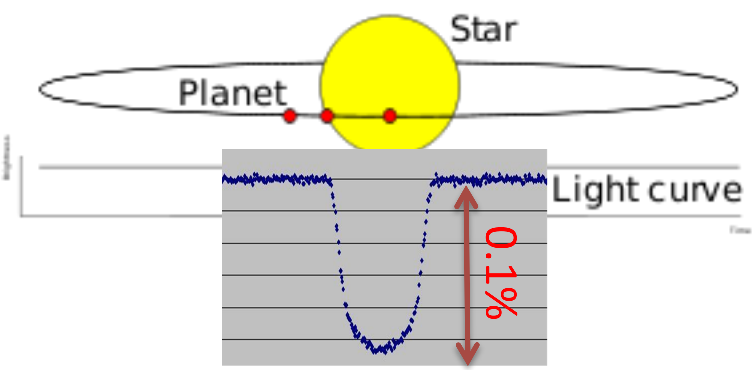
- **In Earth Sciences**
  - Volcanic activity monitoring
  - Disaster Alert system

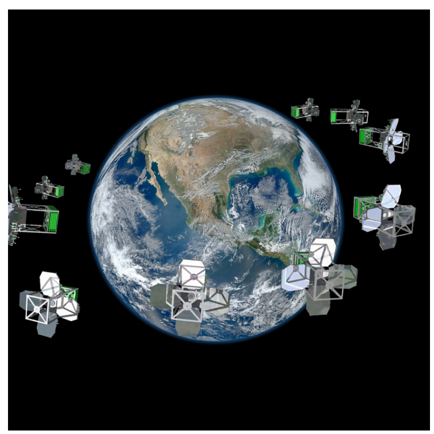


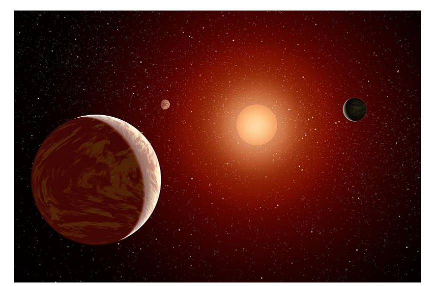
- **And more…**
  - Surveillance of spacecraft, tracking debris

Earth 2.0 around an M star?

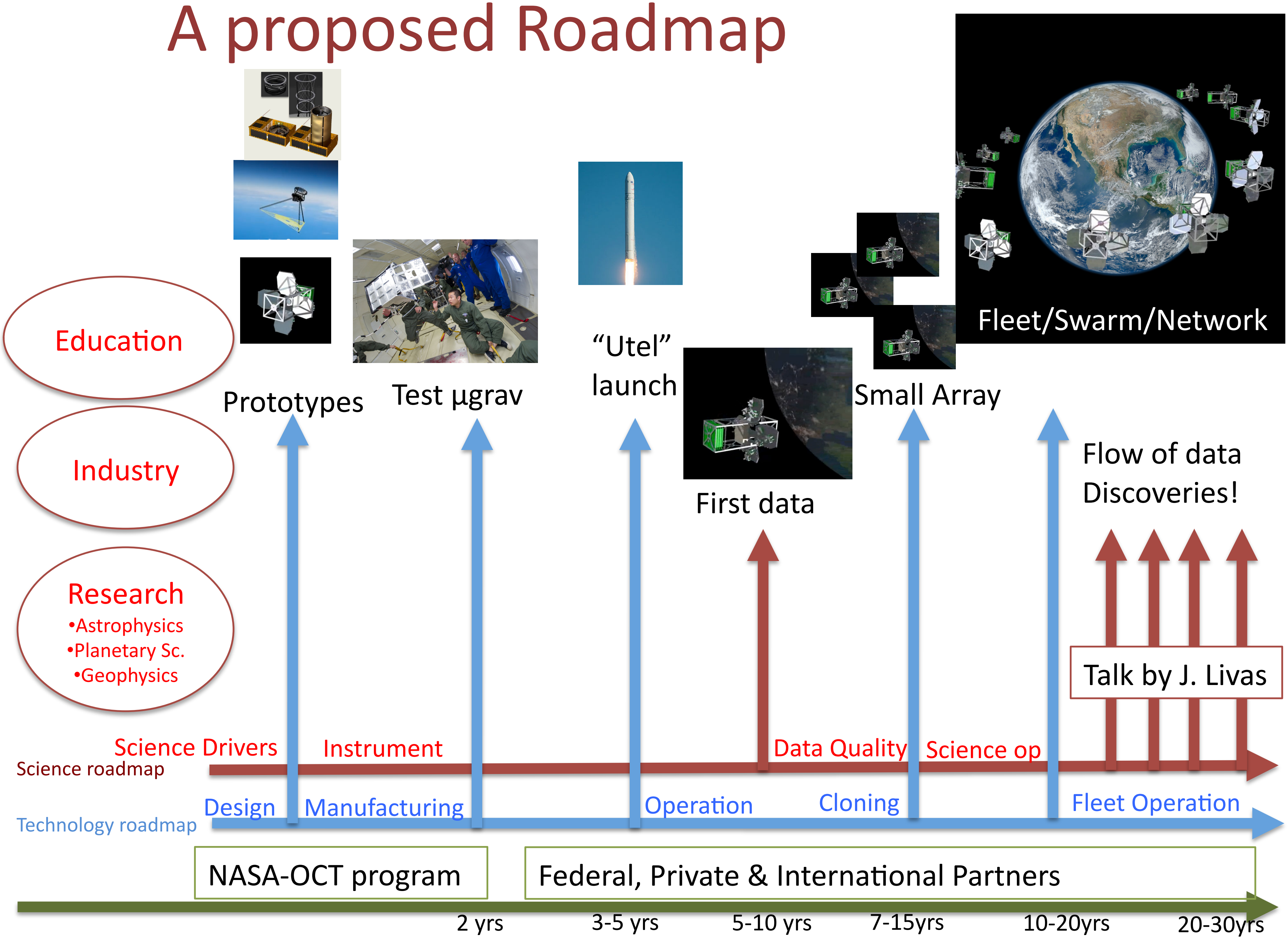
- **They must exist.** 1.0 ± 0.1 exoplanet around late type M-stars Swift et al. (2012); η_{Earth} ~ 0.15
- 75% of the stars in our neighborhood, 50 targets at less than 15 lyrs
- Faint in visible (V~11 at 15 lyrs for M4), brighter in NIR (K~6) -> **Transit Search by NIR photometry**
- 10h-Transit with 0.1% depth and SNR~3 **detectable** with D=50cm, Q=70%, Filter: λ=2.2 µm, Δλ=0.5 µm
- Multiple small assets ("a network") to monitor many candidates

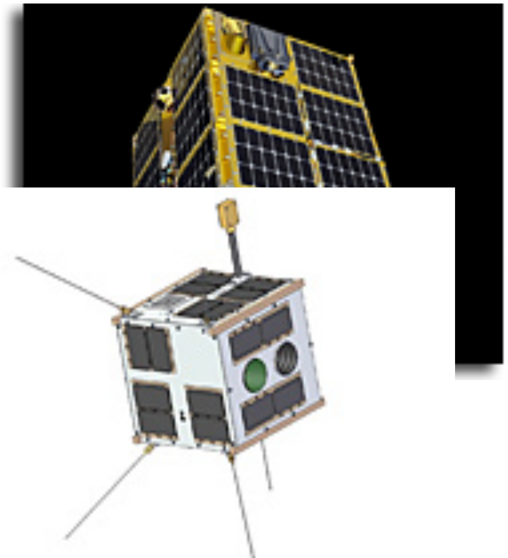






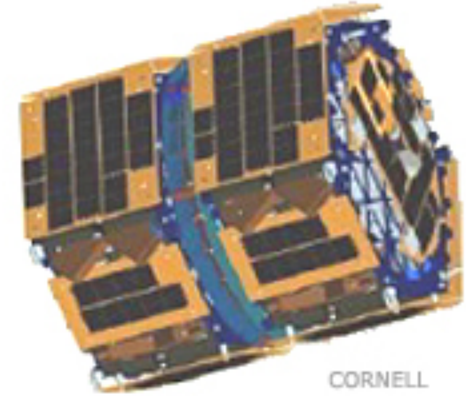
A proposed Roadmap





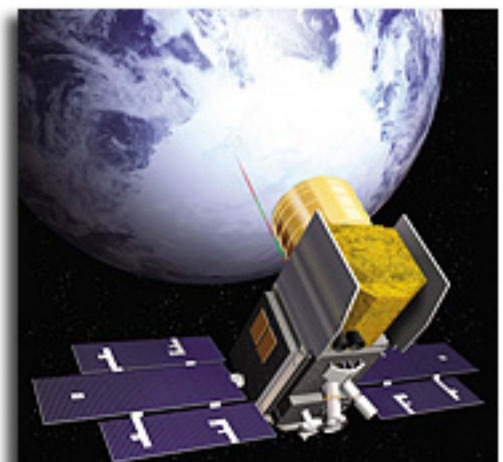
DYNETICS

MONTANA STATE UNIVERSITY



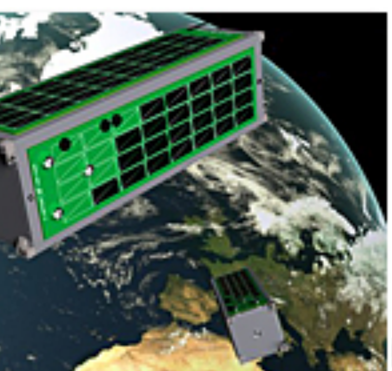
CORNELL

MIT



NASA

JAXA



SSTL