Technology for Discovery

Goddard Memorial Symposium

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Technology Drives Exploration*

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The Search for Life is on...

Exoplanets Discovered

1st Exoplanet Discovered in 1989

Kepler Mission

Fraction of stars with planets (P < 50 days)

Planet size (relative to Earth)

Howard, 2013

Most Earthlike Planets Found Yet: A "Breakthrough"

New exoplanets are at right distance from sun to support life, scientists say.

Newfound exoplanet Kepler-62f is imagined in an illustration. The shining star to the right is Kepler-62e.

How to Feed Our Growing Planet

The Future of...

So Many Earth-Like Planets, So Few Telescopes

It's a big universe, but it's full of small planets.

Astronomers announced on Tuesday that they had found eight new planets orbiting their stars at distances compatible with liquid water, bringing the total number of potentially habitable planets in the just-right "Goldilocks" zone to a dozen or two, depending on how the habitable zone of a star is defined.

NASA's Kepler spacecraft, now in its fifth year of seeking out the shadows of planets circling other stars, has spotted hundreds, and more and more of these other worlds look a lot like Earth — rocky balls only slightly larger than our own home, that with the right doses of starlight and water could turn out to be veritable gardens of microbial Eden.

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Howard, 2013
Planetary Exploration

MARS Rovers

1997: Mars Pathfinder
2004: MER (Mars Exploration Rover - Spirit)
2012: MSL (Mars Science Laboratory - Curiosity Rover)

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NASA Earth Science Missions
Current and Planned

Trends: Terabytes of data per day. Opportunities and need for data fusion, decision support systems.
Next Steps in Astrophysics Require Larger Apertures …

- **Needs:**
  - Robotic Assembly with Progressive diameter growth / proximity operation flying / additive docking
  - Adaptive optics
Search for Life: Science Signatures

Suppressing star light with a Starshade with properly shaped petals reveals orbiting planets.

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Planetary Exploration

LEAF
Lifting Entry / Atmospheric Flight vehicle

TITAN

VENUS
Earth Science Instruments

GSFC/NGES ACE Cloud Radar using Reflector/Reflectarray Technology for wide swath Ka-band profiling

Antenna Technology For A 3-D Wide Swath Imaging Radar Supporting the ACE Mission

Subscale Antenna for a/c flight demo using CRS

Thunderstorm anvil cloud imaged at W-band during IPHEX/RaDEX
Issues, Challenges and Opportunities

- Speed
- Cost
- Information
- Partnerships
- Convergence
Every revolutionary idea seems to evoke three stages of reaction:

- It’s completely impossible.
- It’s possible, but not worth doing.
- I said it was a good idea all along.

- Arthur C. Clarke
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